INTERNATIONAL SYMPOSIUM ON 5G & BEYOND FOR RURAL UPLIFTMENT

In twinning activity between BIT Sindri & IIT(ISM) Dhanbad Jointly with the IEEE 5G summit and 35th GISFI Standardization Series Meeting (GSSM)

International Symposium on 5G & Beyond for Rural Upliftment

IN TWINNING ACTIVITY BETWEEN BIT SINDRI & IIT(ISM) DHANBAD JOINTLY WITH THE IEEE 5G SUMMIT AND 35TH GISFI STANDARDIZATION SERIES MEETING (GSSM)

Theme: 5G and Beyond for Rural Upliftment

February 8-9, 2020

—

Day 1: Indian Institute of Technology (ISM), Dhanbad, Jharkhand (INDIA)

—

Day 2: BIT, Sindri, Jharkhand (INDIA)

International Symposium on 5G & Beyond for Rural Upliftment

Jointly with BIT Sindri, IIT(ISM) Dhanbad, the IEEE 5G summit and 35th GISFI Standardization Series Meeting (GSSM)

February 8-9, 2020

The International Symposium on 5G and Beyond for Rural Upliftment with 35th GSSM meeting will provide the platform for exploring and exchanging the ideas among the networked people. It imposes how the combination of 5G, artificial intelligence, smart platforms and the Internet of Things can allow for embedding artificial intelligence into 5G communication systems for the smarter use of network-generated data, the automated enabling of network operators and service providers to adapt to changes in traffic patterns, security risks and user behavior and thus paving the way towards safe and reliable next-generation wireless ecosystems that go beyond the urban area to open the doors to equality in access to knowledge and information technology into the rural regions.

Venue
BIT, Sindri, and Indian Institute of Technology (ISM), Dhanbad, Jharkhand (INDIA)
Organizing chair:
Dharmendra K. Singh, Director, BIT, Sindri
Co-Organizing chair:
Kishore Kumar Thakur, Chairman IETE (Ranchi) & CGM, BSNL, Jharkhand
Chief Patron:
Ramjee Prasad, Chair GISFI & President CTIF Global Capsule, Aarhus University, Denmark.
Patron:
Rajiv Shekhar, Director, IIT(ISM), Dhanbad
Organizing Secretaries
Jitendra Kumar, HOD ECE, IIT(ISM) Dhanabd
Imteyaz Ahmad, HOD, ECE, BIT Sindri
Coordinators
Jaisingh Thangaraj, IIT(ISM) Dhanabd
Raghvendra K. Chaudhary, IIT(ISM) Dhanabd
Arvind Kumar, BIT Sindri
Co-coordinator
Santosh Kumar Verma, BIT Sindri

Contact Person:
BIT Sindri: **Arvind Kumar**; E-mail:aksingh738@gmail.com; Contact:-+91-9110986849;
GISFI: **Dnyaneshwar S. Mantri:** E-mail: dsmantri@gmail.com; Contact: +91-9922431612

Welcome Message

On behalf of the Organizing Committee, we warmly welcome you to the First International Symposium on 5G & Beyond for Rural-Upliftment in the beautiful cities of Dhanbad and Sindri. The Symposium is jointly organized with BIT SINDRI, IIT(ISM) DHANBAD, IEEE 5G SUMMIT & 35th GISFI STANDARDIZATION SERIES MEETING (GSSM).

We aim to make this Symposium a perfect platform for global networking as it brings together renowned speakers and scientists across the globe. Thus it is timely that this meeting will enable you to meet and discuss critical issues in the advancing technological era for India. We have an exciting program at this conference that will allow members to reflect upon and celebrate our past accomplishments, renew friendships and extend our networks, and jointly explore current and future research directions.

Lastly, we would like to thank all of the conference participants for their contributions, which are the foundation of this Event. To put a conference of this magnitude together is not a small task.

We do hope that you will gain something productive from this fruitful event!

Prof Ramjee Prasad

Chair GISFI & President CTIF Global Capsule,

Aarhus University, Denmark

Message from Director

It gives me immense pleasure that Department of Electronics & Communication Engineering, BIT Sindri and Department of Electronics Engineering, IIT(ISM) Dhanbad are organizing the “International Symposium on 5G & Beyond for Rural Upliftment” to be held on 8th and 9th February, 2020 at BIT Sindri and IIT(ISM) Dhanbad.

The fundamental theme of the symposium is to explore the ideas of 5G communication system for smarter and safe use of network-generated data, security risks and to provide reliable next-generation wireless ecosystems. Moreover the event will also provide the platform for exploring and exchanging the ideas among the networked people.

5G has the potential to be transformative for citizens, businesses, governments and economies. Investment is key but there are many factors to take into account before investments can be committed. This report helps navigate through the issues related to 5G and provides a measured, practical approach to policy-makers looking to make important investment decisions in the months and years ahead. The symposium is going to explore several important topics and opportunities for researchers in the field of 5G Communication for Rural Upliftment.

I hope that this Symposium would provide valuable, useful and informative ideas about 5G and beyond to the participant students, researchers and other experts. I convey my best wishes for the success of the event.

Prof. Dharmendra K. Singh

Director, BIT, Sindri

Message from Director

It gives me immense pleasure to learn that UT (ISM), Dhanbad and BIT Sindri are organizing the International Symposium on 5G and Beyond for Rural Upliftment during 8th and 9th February, 2020.

The Symposium provides a common platform to bring together the researchers, pract1cmg engineers and industry leaders for exchanging and updating their knowledge in the field of 5G technologies and their applications in varied areas like agriculture, health and education. Digital transformation has played a major role in improving economic outcomes, and SG is the next development in enhancing the capacity of communications services which can significantly contribute to the rural economy. The event will provide a platform for exchange of new research and technical developments in the intriguing field of 5G Communication and beyond.

I wish the conference organizers, participants from Academics and Industry, Exhibitors and student community a highly stimulating and fruitful event. I believe that the conference will offer an outstanding platform to address innovative trends and challenges.

I wish the conference a great success.

Prof. Rajiv Shekhar,

Director, IIT(ISM), Dhanbad

1. CARE YOURSELF: A Self Health Care Assistant for Elderly using Visible Light Communication

A.Kavitha, Department of ECE, Vel Tech Multi Tech Dr.Rangarajan, Dr.Sakunthala Engineering College, Chennai, Tamilnadu kavivenkat99@gmail.com

J.N.Swaminathan, Department of ECE, QIS College Engineering and Technology, Ongole, Andhra Pradesh sammbuddy@gmail.com

V.J.Karthik, Senior Technical Lead- Mercedes Benz Research & Development India, Banglore, Karnataka, karthik.vj2121@yahoo.com

O.Vignesh, Department of ECE, QIS College Engineering and Technology , Ongole, Andhra Pradesh vicky6058@gmail.com

ABSTRACT

In the recent decades there is an increase in the rate of elderly population, also increased life expectancy which has brought numerous challenges to the healthcare industry. New models of self care assist devices for elderly are developed to support the demand for healthcare. The elderly care should be enhanced through various parameter monitoring system, efficient sensor system and latest communication technologies. This proposal is concerned with the assistance to the elderly. The objective of this proposal is to assist elderly to live independently and to render immediate assistance to the elderly during any illness or accidental incidents. This system aims to reduce the burden and difficulties experienced by the caregivers, decreases the healthcare costs in managing the elderly without compromising the quality of care. The proposed system employs a sensor tag to measure the physiological parameters. Visible light communication (VLC) is used in the proposed system to transmit the monitored physiological parameters from the sensor tag for further processing. The proposed device is mainly focused to detect a fall event of the elderly. If it happens, this proposed system provides an air bag inflation to prevent the person from major injury during the fall event detection. The proposed system is designed as a self-powered device.

Keywords—*Visible Light Communication (VLC), Sensor Tag, Airbag Inflation, GAIT sensor, Gyro sensor.*

INTRODUCTION

According to Word Health Organization (WHO) report, the elderly population (people aged above 60) in the world will increase drastically to 2 billion by 2050. In the year 1951 the population of elderly persons in India was 1.98 crore, in 2001 it was 7.6 crore, 10.38 crore in 2011. It is foreseen that the number of elderly (age above 60) in India will be 14.3 crore in 2021 and will increase to 17.3 crore in 2026. Modern health care technologies and government schemes on elderly has increased their survival rate.

Activities of daily living are classified into three categories such as Stationary activities, Dynamic activities and Transitional activities. Standing, sitting and lying down are called stationary activities. Transition of stationary activities to dynamic activities like sit-to-stand, stand-to-walk and sit- to-lie are called transitional activities. Running, walking, jogging and cycling are called dynamic activities. Life is made meaningful, purposeful, independent and healthier for the elderly. In today’s scenario, there are so much of controversies between the older and current generation, eventually result in the isolation of elderly. Recently due to social media and internet, there is a drastic change in the lifestyle, behavior and attitude of our younger generation. There exists an opinion between the rational thinking of both the generation, so leads to the social isolation of the older people. Some people travel abroad for building their career and leaving their parents alone in their parent country. Larger community of younger generation needs privacy in their living, so they isolate their parents. Isolation of the older community may be due to so many reasons.

Being the engineer, we have to develop a device using technology which has major contribution towards the isolation of older people from the living community. The elderly might experience a feel of loneliness, insecurity, depression stress, negative impact on life which leads to various health issues like blood pressure, cardiovascular health problems, arthritis, mobility impairment, diabetes, dementia, etc irrespective of whether they live independently or living together with their kith and kin.

The majorly developed countries have led their research in ambient assisted living. Ambient assisted living means live monitoring action and detection of human activity wellness of the elderly. A smart home with ambient monitoring allows the elderly to live independently using our latest digital devices. Significant proportion of age-related health issues for elderly are Parkinson's disease, Alzheimer's disease, cardiovascular disease and diabetes. Smart homes with ambient assisted living enhance the quality of life, provides a caretaker free environment in a secured manner. Efficient and automatic way of identifying the medical emergency situations, early disease diagnosis, routine monitoring of various disease related parameters leads to provide good care to the elderly.

Current era of medical technologies in combination with Internet of things (IoT) has emerged out with various solutions to assist the elderly community. IoT based vital monitoring systems registers and monitors the elder person's vital information and triggers an alarm during emergency conditions [1]. Smart homes based on ambient sensors [2] is designed to monitor the activities of daily living and motion of a person using passive infrared sensors, video sensors, pressure sensors in bed and chair to detect their presence, floor sensors and Radar sensors. The wearable sensors [3] designed based on the special requirements of elderly are safe adhesion of sensors without skin irritation. It is easy to apply and change. It has efficient battery capacity, good data quality, reliable data and adequate data collection platform. Advanced assistive technology [4] based elderly care has contributed community alarms, video monitoring, various types of fall detectors, health monitors, hip protectors, pressure mats, door alerts, movement detectors, dawn dusk lights, smoke alarms, fire alarms, cooker controls, electronic calendars and speaking clocks. In a smart home environment [5], vision-based fall detection is proposed by extracting the motion and shape features of body parts and the persons daily activity is differentiated from the fall using rule-based classification. An automated analysis algorithm [6] is presented to detect the high impact falls vertical velocity and acceleration features of the user from the camera, sound amplitude feature also increases the detector specificity. Rapid detection of fall events is performed using floor vibration [7], sound sensing, and signal processing and pattern recognition algorithm to discriminate the fall events from other normal activities. A smart remote monitoring of health care [8] is presented to track the user's physiological data to detect some disorders and to aid them at the earliest. An End User Development (EUD) tool [9] is developed to customize the content dependent use by non – technical users for remote monitoring and assisting elderly at home by sending the multimedia messages and reminders to change the status of various domestic appliances. Elderly or chronic illness people is supported by an Integral Assistive Home Care system [10] by installing a domotic system's core in the personal computer and an ichnographic software (SICAA) is used for patient interaction with the environment and peripheral devices. Health hazards caused by the radio frequency communication technologies have paved way for replacement of it by a VLC technology [11]. VLC employs a white light emitting diode acting as optical information emitters for efficient transmission of biomedical signals; a photodiode is used at the receiver section to receive the transmitted data. LED source offers a fast switching characteristic, longer life time and higher efficiency, so a smart phone flash light LED [12] is used as a source and an optical receiver to enable the operation of an electric lock. A microwave radiation free system [13] is designed for a longterm monitoring of a brain using a single channel wearable EEG device integrated along with VLC technology, this system is capable of transmitting upto 2.4 kbps of error-free EEG data to a distance of 4 meters.

Drawbacks of radio frequency communication include high latency, interference, requires transmission and reception setup. The above limitations [14] are overcome by VLC and provide high bandwidth and immunity to interference from electromagnetic waves. VLC is the best communication technology for the high-density wireless data coverage [15], also provides secured transmission, better bandwidth, efficient data transmission. In future laptops, smart phones and tablets will allow data transmission and reception through the lights in the room.

OPERATING PRINCIPLE

The proposed scheme makes the elderly feel safe, secured and happy, since the designed live monitoring systems keeps their relatives and their family physician updated with their physiological parameters monitored and lives independently without any assistance. The proposed device is to be fabricated in three domains such as biomedical domain for sensor tag, communication domain to establish VLC and mechanical domain for airbag inflation.

The proposed scheme as shown in figure 1-1 employs a sensor tag comprising of various sensor like pulse sensor, temperature sensor, ECG sensor, SPO2 sensor, gait sensor, triaxial accelerometer sensor, three gyro sensors and a

piezoelectric transducer. The significance of the sensor tag is to monitor the physiological parameters to assess the health condition of the user. A multiplexer is used to multiplex the input sensor signals to provide the required serial output. Light emitting diode (LED) source is used as transmitter for transmitting the monitored parameters. The reception of data is done using a photo-detector and de-multiplexer is employed for data distribution. The received data is sent to the arduino microcontroller. In case if a fall is detected, then airbag inflation occurs, the airbag is placed around the body of the user to prevent the fall. If there is an abnormality detected in the sensor output like any changes in the physiological parameters is observed, then the message is send to the concerned doctors, close relatives and a call is initiated automatically to the ambulance to indicate the emergency situation of the patient.

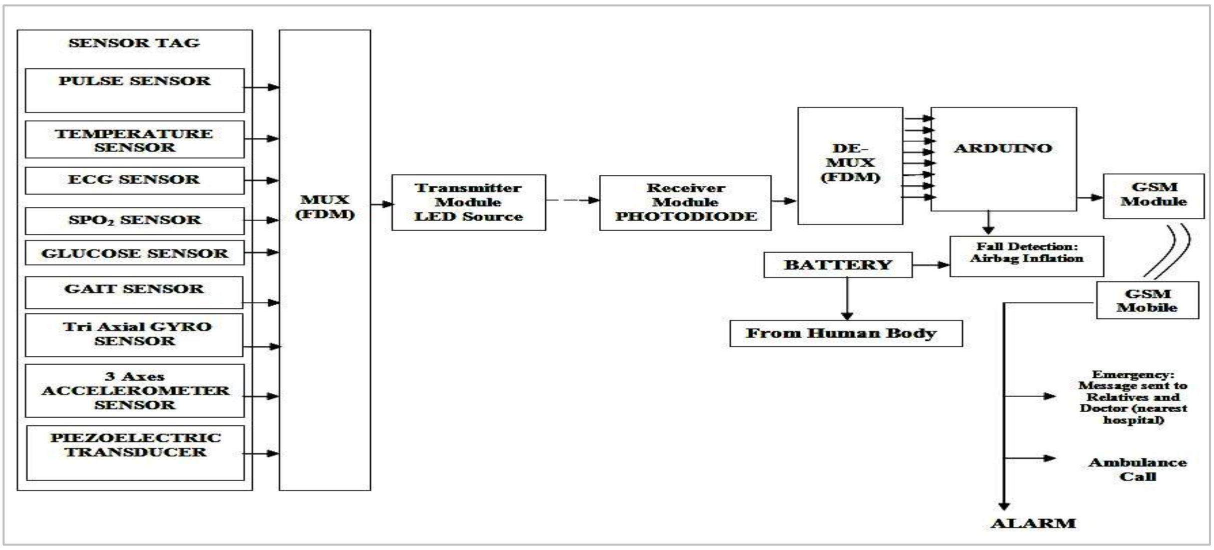


Figure 1-1 Block Diagram of proposed system

SENSOR PLACEMENT

The sensor tag is comprising of pulse sensor, temperature sensor, ECG sensor, SPO2 sensor, gait sensor, 3-axes accelerometer sensor, 3 gyro sensor and a piezoelectric transducer.

A. HEART RATE (HR) OR PULSE SENSOR:

Heart rate (HR) or pulse is the frequency of cardiac contractions, measured in terms of beats per minute. Photoplethysmography (PPG) is the conventional technique of heart rate measurement by detecting volumetric changes in the blood of peripheral circulation. A Photoplethysmography is the combination of optical and pressure sensors that obtain a plethysmogram by placing the sensors on the wrist. The working principle of PPG allows to pass a low intensity infrared (IR) light. The transmitted light is absorbed by the skin, bones, venous and arterial blood. The blood absorbs more light than the surrounding tissues. PPG detects the change in the intensity of light and produces a corresponding voltage proportional to the amount of blood flow in the blood vessel of peripheral circulation. Blood flow variations are mostly seen in arteries than in veins. A PPG signal has both AC and DC component. AC component represents the change in blood volume corresponding to each heartbeat. DC component represents the transmitted and reflected optical signals, determined by tissue structure and blood volume changes of artery and vein.

B. TEMPERATURE SENSOR

Body temperature is assessed using a thermistor configuration. The resistance of the thermistor varies based on the change in skin temperature. Skin temperature is also used to detect stress and emotions.

C. ELECTROCARDIOGRAM (ECG) SENSOR:

ECG is acquired using non-contact electrodes in a wireless system. Each heart produces an electrical pulse triggered by the cells of Sinu Atrial (SA) node, these acquired bioelectrical signals have lower amplitude. These acquired electrical signal are transformed into numerical values by ECG. The data acquisition is possible only at the chest and limbs of the user. The amplified electrical signals produce the diagnostic information of the condition of the heart.

D. PULSE OXIMETER SPO2 SENSOR:

Pulse oximeter sensor is used to measure the blood oxygenation by passing IR light and detects the reflected redlight intensities of oxygenated and deoxygenated hemoglobin. The sensor probe is placed in the patient's finger and sends to the data acquisition system and displays the calculated oxygen saturation level. LED is used as a light source, produces visible red and IR light. Deoxygenated hemoglobin allows maximum IR transmission, but red light is more absorbed. Highly oxygenated hemoglobin absorbs more IR light, but allows maximum transmission of red light to pass through it. The pulse oximeter senses the amount of light at those particular wavelengths, and produces a signal proportional to the oxygen saturation or desaturation of the hemoglobin. The pulse oximeter uses a light in the absorbency measurement, so a true light-to-voltage conversion is employed by using current as the input signal.

E. GLUCOSE SENSOR:

A wearable non- invasive epidermal glucose sensor is included to monitor the glucose level in sweat and interstitial fluid of the elderly. This sensor is a wrist watch comprising of photoplethysmographic (PPG) optical sensors. It is an indirect routine evaluation of blood components by sweat and interstitial fluids for monitoring the blood glucose levels. The measurements are done for both anteprandial and post prandial conditions. It is one of the efficient ways of measuring blood glucose concentration using optical sensor based wearable system.

F. GAIT SENSOR:

The wearable gait sensor is used to assess the gait patterns and motion of a person. The gait sensor estimates the temporal characteristics of the gait cycle i.e. stride time and the duration between the stance and swing phases. Gait cycle is defined as the time interval between the consecutive heel strikes, in other words gait cycle is the combination of stance and swing phases. Stride time is the duration of a gait cycle.

G. TRIAXIAL GYRO SENSOR AND 3-AXES ACCELEROMETER:

The combination of both accelerometer and gyro sensor provides robust fall detection. The accelerometer sensor detects the inertial changes of a body during any impact, whereas gyro sensor provides the information about the rotational velocity of the body during a fall event. During a fall event, higher acceleration and angular velocity is to be observed when compared to the normal daily activities. The wireless sensor system also employs a fall detection algorithm to recognize the abnormal fall event from the normal day-to-day activities.

H. PIEZOELECTRIC TRANSDUCER:

An inexpensive way of detecting the position of user on the floor, piezo electric transducers is used. The piezoelectric sensors are placed on the floor mat to measure the forces applied on the ground due to an abnormal fall. The force applied on the piezoelectric crystal deforms the shape of the crystal and also changes the atomic structure of the crystal. This mechanical deformation produces a charge transfer and a voltage proportional to the applied equivalent force in the crystal.

The proposed system monitors the physiological parameters like heart rate, body temperature, Electrocardiogram (ECG), blood oxygen saturation level to assess the health condition of the elderly. Gait sensor analyses the gait patterns of the person, gyro sensors, triaxial accelerometer sensor detects the angular velocity, inertial changes and physical balance of the people. Piezoelectric transducer detects the position of the user on the floor.

VISIBLE LIGHT COMMUNICATION

The limitations of radio frequency spectrum have paved way to the rising demand for the ubiquitous connectivity and high capacity. In the year 2018, CISCO has already predicted 11 times doubled the mobile data traffic due to the increase in the number of devices using the mobile networks, also due to the development of social media. Most of the wireless devices are electromagnetic, so interference is another problem in RF wireless communication. RF communication is suffering from the following problems:

Interference, as per the Federal Aviation Administration (FAA), the mobile phone usage is restricted on aircraft due to its interference with communication and navigational systems, also causes disruption of ground towers as per the Federal Communication Commission (FCC). In a wireless communication, interference is not the only problem but also communication system requires very low latency period, so RF communication is not better due to the bandwidth limitations. RF waves have security due to their capability of penetrating walls easily. Many human health hazards are recorded due to the increased RF wave transmission power beyond the specified limit. A separate communication setup is essential for wireless RF communication due to the power inefficiency, overcome these drawbacks in RF communication systems has paved way to the newer communication technologies called VLC.

Researchers are focusing towards non-invasive monitoring of human health as well as activity parameters through the wearable devices. RF communication is in need of its own setup devices for RF wave transmission and reception. Also, RF waves may be affected by interference and latency issues. In the present scenario, VLC is a suitable communication technique as well as a complement tool for RF communication. VLC is a type of data communication. It is also a type of optical wireless communication technology. Alexander Bell coined a term called “Virtual Light Communication” (VLC) and said in the late 18th century that the future of communication will be VLC and will have higher bandwidth, higher speed with minimum interference. Much attention was paid on the year 2003 to work on VLC and currently the technology is named as “Visible Light Communication”. The wavelength of visible light is around ranging from 380 and 780nm wavelength depending on the variation of visible light color. It is a form of optical wireless communication technology for efficient data transmission at higher data rates and provides a health hazardless environment, also provides secured transmission at a very minimum cost. This proposal presents sensor output for communicating the data through visible light. VLC environment of the room will be done through white LEDs that transmit sensor output to the receiver. This proposal describes the elder care and health monitoring system, where the healthcare information such as biomedical signals from the sensor output is to be transmitted via the LED lighting. VLC data transmitters turns a light source on and off at a higher speed, so fast that even our eye cannot sense the switching rate, nor it detects any change in color or intensity. The illumination difference between the ON and OFF states of the light source correspond between the two binary values: Zero and One. The transmission standard for VLC is IEEE 802.15.7.

AIR BAG INFLATION PRINCIPLE

The air bag is to be designed as light weight and easy to wear. The airbag comprises of battery, gas cartridge and an inflatable air bag. The air bag projects the user’s head and hip during a fall event. A triaxial acceleration sensor and a triaxial gyro sensor are used to measure the movement. If a

fall event is registered, the aurdino output triggers the cartridge to cause ignition. Then, the gunpowder explodes to release the gas, making a small hole in the gas cartridge and airbag is to be inflated. The inflator is to be made from an aluminum block big enough to avoid accidents when the gunpowder explodes. In case if a fall is detected, then airbag inflation occurs, the airbag is placed around the body of the user to prevent the fall. The entire system should be designed to have light weight, reusability, automatic and easy to use. The reusability of airbag is done using an electromagnetic valve. [16].

HUMAN POWER HARNESSING

Smart clothing is designed to have a piezoelectric crystal sandwiched between the two layers of fabric called as piezoelectric textiles. The piezoelectric textile is designed to convert the structural vibrations into an electrical energy. The user while breathing produces a strain on the piezoelectric crystal for every cycle of breathing phase. The deformation in the crystal produces a corresponding voltage, used to power the device. The gyro sensor signal output is also used to generate the power.

CHALLENGES AND FUTURE WORK

The challenge to be faced in our system implementation is ambient light interference. Many researchers have tried achieving a shortest distance between the transmitter and receiver as 120 cm in an artificially illuminated room, whereas 50 cm for naturally lit room. Indirect sunlight and fluorescent light lit room are considered as ambient light interference, the interference reduces the quality of signal reception. An amplifier is added in the transmitter circuitry and lens is added in receiver circuitry, highly efficient solar panel, noise cancellation circuit for an efficient data transmission up to few meters without any ambient light interference and also higher data transmission rates can be achieved. A part of enhancing the quality of elderly life a medicine reminder system can be incorporated to take their pills on time. In future an application may be developed for knowing the daily activities of elderly are performed on time, a self-enrollment application for the user. This application helps their relatives to assess them easily from farther place, also relatives can share their messages and photos of special moments to make the elderly stay well emotionally.

CONCLUSION

In the proposed work, a wireless wearable device is designed to enhance the quality of life of an elderly person by making them live independent. This proposed work monitors the various physiological parameters like heart rate, blood pressure, blood oxygen saturation, body temperature, ECG, body inertial changes, rotational velocity, gait patterns, fall forces in the ground during a fall event. A passive infrared sensor is to be placed in the room to detect the motion of the person. The monitored data is transmitted through VLC. Visible light communication is used in the proposed system to transmit the monitored physiological parameters from the sensor tag to the arduino board for further processing. In case of any abnormality assessed in the monitored physiological parameters as well detection of a fall event, then an emergency message send to the relatives and doctor to indicate the abnormal health condition of the person. The alarm is also set to indicate the emergency status of the person to neighbors and an automatic call is initiated to ambulance. The proposed system also has an air bag inflation to prevent the person from major injury during the fall event. The proposed work consumes the required power from the user itself. This novel work also employs a VLC based communication for data transmission and reception. The airbag inflation is another added advantage of the proposed work to prevent the fall of the elderly.

DISCLAIMER

The views expressed here are solely those of the author and do not in any way represent the views of Mercedes Benz Research & Development India or its affiliates/ group companies

REFERENCES

[1] Sandro Pinto., Jorge Cabral and T Gomes., “We-Care: An IoT-based Health Care system for Elderly People”, IEEE International Conference on Industrial Technology (ICIT), IEEE xplorer, pp.13781383, 2017.

[2] Uddin M.Z., Khaksar W and Torresen J., “Ambient Sensors for Elderly Care and Independent Living: A survey”, Sensors (Basel), vol 18, no 7, pp.1-31, 2018.

[3] Hugo Saner, “Wearable Sensors for Assisted Living in Elderly People”, Frontiers in ICT, vol.5, Feb 2018.

[4] Miskelly, F. G., “Assistive Technology In Elderly Care", Age and Ageing, vol 30, pp. 455-458, 2001.
[5] Chadia Khraief., Faouzi Benzarti and Hamid Amiri., “Vision-Based Fall Detection for Elderly People Using Body Parts Movement and Shape Analysis”, Indian journal of Science and Technology, vol 8, no S9, pp.167-175, 2018.
[6] Evelien E Geertsema, Gerhard H Visser, Max A Viergever and Stiliyan N Kalitzin, “Automated Remote Fall Detection Using Impact Features from Video and Audio”, Journal of Biomechanics, vol 88, pp.25-32, 2019.
[7] Zigel Y., Litvak D and Gannot I., “A Method for Automatic Fall Detection of Elderly People Using Floor Vibrations and Sound-Proof of Concept on Human Mimicking Doll Falls”, in IEEE Transactions on Biomedical Engineering, vol. 56, no. 12, pp. 2858-2867, Dec. 2009.
[8] Al-khafajiy, M., Baker, T., Chalmers, C., Asim, M., Kolivand, H., Fahim, M and Waraich, A., “Remote Health Monitoring of Elderly Through Wearable Sensors”, Multimedia Tools Applications,pp.1-26, 2019.
[9] Corcella, L., Manca, M., Nordvik, J.E., Paternò, F., AnneMarthe Sanders and Carmen Santoro., “Enabling Personalization of Remote Elderly Assistance”, Multimedia Tools Applications, vol 78, no 15, pp.21557-21583, 2019.
[10] Sergio Ponce., David Piccinini., Sofía Avetta., Alexis Sparapani., Martín Roberti., Nicolás Andino., Camilo Garcia and Natalia Lopez “ Wearable Sensors and Domotic Environment for Elderly People”, World Congress on Medical Physics and Biomedical Engineering Singapore. Springer IFMBE Proceedings, vol 68/3, 2018.
[11] Yew-Kiat Cheong., Xiao-Wei Ng and Wan-Young Chung., “Hazardless Biomedical Sensing Data Transmission Using VLC”, IEEE Sensors Journal, vol 13, no 9, pp. 3347-3348, Sep 2013.
[12] Linyong Fan., Qunxing Liu., Chunxu Jiang., Huawei Xu., Jianyao Hu., Dongxiang Luo., Zhiyuan He and Qingli Huang., “Visible light communication using the flash light LED of the smart phone as a light source and its application in the access control system”, Conf. proceedings on IEEE MTT-S International Wireless Symposium(IWS), Shanghai, 2016, published in IEEE xplorer.
[13] Vega Pradana Rachim., Yubing Jiang., Hyeon-Seok Lee and WanYoung Chung., “Demonstration of long-distance hazard-free wearable EEG monitoring system using mobile phone visible light communication”, Optics Express, vol 25, no 2, pp.713-719, 2017.
[14] Latif Ullah Khan, “Visible light communication: Applications, architecture, standardization and research challenges”, Digital Communications and Networks, vol 3, no 2, pp 78-88, 2017.
[15] Kushal Dhawad, Wankhade C.M and Shilpa Kapse., “Li-Fi Technology Transmission of data through light”, International Journal of Computing Technology and Applications, vol 3, no 5, pp 278-281, 2016.
[16] Toshiyo Tamura., Takumi Yoshimura., Masaki Sekine., Mitsuo Uchida and Osamu Tanaka., “A Wearable Airbag to Prevent Fall Injuries”, in IEEE Transactions on Information Technology in Biomedicine, Vol. 13, No. 6, November 2009

2. Sum Rate Performance for Full-Duplex User in Co-operative NOMA Systems over Weibull Fading Channel

Rampravesh Kumar, Department of ECE, Birla Institute of Technology, Ranchi-835215, India
rampraveshkumar6@gmail.com
Sanjay Kumar, Department of ECE, Birla Institute of Technology, Ranchi-835215, India
skumar@bitmesra.ac.in

ABSTRACT

This work evaluates the sum rate performance for dual user with full duplex co-operative nonorthogonal multiple access (FD-CNOMA) over Weibull fading channel environment. For this, we derived closed form expressions for sum-rate in various scenario. One user always acts as decode and forward full duplex relay to help far users in each scenario. In the first scenario, no direct link exist between base station (BS) and far user. In second scenario, direct link exist between BS and far user. The main investigation is to study the effect of fading parameters in different channel condition on sumrate performance. Since, Weibull Distribution (WD) has an advantage to model different fading condition using varying parameter it is more suitable to study impact of fading condition on different wireless techniques for next generation mobile cellular communication. Therefore, WD is used in this study for sum rate performance evaluation . Finally simulations were conducted on MATLAB to evaluate the system performance under different fading parameters of Weibull fading channels.

Index Term- *NOMA; FD-NOMA; Weibull Distribution; Sum Rate Performance; DL*

INTRODUCTION

A lot of attention has been paid to achieve higher spectral efficiency of the fifth generation (5G) mobile communication network, NOMA [1] is one of them. NOMA's key features are to allow multiple users to share the same resource elements (i.e., time / fequency / code) across different power lev-els. The successive nterference cancellation (SIC) is done on the receiver side. In [2], the effect of user pairing with the NOMA system's fixed power allocation was analyzed in depth.

However, in deep fade case, cooperative communication is a powerful technique to either expand network coverage or improve the reliability of communication [3]. Recent contributions to NOMA research in the field of cooperative communication discussed in [4–8] are as follows.

In [4], the authors explored the probability of decoding-and-forward (DF) relaying for NOMA. In [5] Nakagami-m fading channels addressed the outage performance of a variable gain amplify-andforward (AF) relaying with NOMA. In addition, a cooperative NOMA definition was first suggested in [6], where near-users with better channel conditions were considered to be DF relaying to support the far-off users. As a further advancement with consideration of energy-related issues, simultaneous wireless information and power transfer (SWIPT) was used by close NOMA users, which was considered to be DF relays in [7]. While cooperative NOMA can improve performance gains for weaker users (not necessarily far-off users), it does bring additional slot costs to the systems. To avoid this problem, the implementation of full-duplex (FD) relay technology is a promising solution. FD relaying receives and transmits simultaneously in the same frequency band and time slot stimulated researchers ' interest in exploring more effective spectral systems [8]. FD relay technology has recently been suggested as a promising technique for 5G networks in [9]. The authors tested the efficiency of the cooperative NOMA based on FD device-to-device in [10]. Nonetheless, only the weaker user's outage performance was analyzed.

In [11], cooperative NOMA with FD relay has been used for finding the outage performance in closed form expressions, assuming Rayleigh fading channels. Note that the Rayleigh distribution is widely used to model the fading due to multi-paths in an urban environment, where radio waves are received via large number of paths. Therefore, the central limit theorem (CLT) is used to derive the Rayleigh model theoretically. Nevertheless, if the number of incoming radio paths is small, the Rayleigh distribution may not be a suitable fading model as the CLT's validity conditions may not hold. Some evidence suggests that Weibull distribution may explain the signal amplitude in this situation. Experimental evidence is published in [12] supporting the appropriateness of the Weibull model and [13] considered its use as a basis for indoor fading channels. The distribution of Weibull is useful for modeling the amplitude of multipath fading signals. Based on fading channel data from [14], in some cases the Weibull distribution can be used to model well outdoor multi-paths.

The Weibull distribution's probability density function (PDF) [17] is given as in equation *1*, where, B is called the Weibull fading parameter and A is a positive scaling parameter. The Weibull fading parameter B can take values between 0 and ∞. In the special case when B = 1, the Weibull distribution becomes an exponential distribution; when B = 2, the Weibull distribution specializes to a Rayleigh distribution.

$$f_x(x) \;=\; \mathrm{B}x^{B-1}e^{(-x^B/_A)}/\,\mathrm{A} \qquad \ldots\ldots.(1)$$

These all, inspires us to work on for the evaluation of various performance parameters for the next generation mobile cellular system in wireless environment. Sum rate performance, one of those parameters under NOMA with FD Relay over Weibull fading channels has been analysed in this paper. Sum-rate is the sum of individual user rate.

This paper is organized as follows. Section II presents the proposed system model with related works done so far of our interest. This section highlights the processes involved at the transmitting and receiving ends in the FD-CNOMA System. Section III derives the generalized expressions for sum rate performance under the defined system model in various scenario where as section IV describes the simulation parameters taken according to formulated sum rate expressions on MATLAB over Weibull fading channel conditions. Section V interprets the obtained simulation results and finally, section VI concludes the sum rate performance of FD-CNOMA over conventional NOMA.in various scenario.

THE SYSTEM MODEL

Under this section, the system model in downlink (DL) channel with dual users in single cell along with relevant equations for different scenarios are discussed.

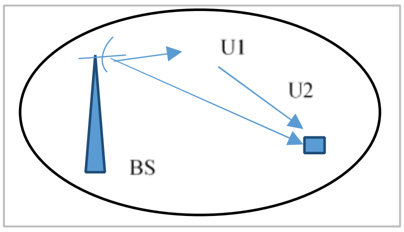


Figure 2-1 Single cell two users FD-CNOMA in DL channel

We consider a FD cooperative NOMA system composed of one source (i.e. the base station (BS)) that intends to communication with the far user U2 under the assistance of the near user U1. Both no direct link and direct link scenarios between the BS and U2 are considered. U1 is regarded as user relaying and DF protocol is employed to decode and forward the information to U2 .

To enable FD communication, U1 is equipped with one transmit antenna and one receive antenna, while the BS and U2 are single-antenna device. All wireless links in the network are assumed to be independent non-selective block Weibull fading and are disturbed by additive white Gaussian noise with mean power . h , h , and h are denoted as the complex channel coefficient of BS →U1, U1 → U2, and BS →U2 links, respectively. The channel power gains $|h_1|^2$, $|h_2|^2$ and $|h_0|^2$ are subjected to Weibull random variables (RVs) with the parameter B_i, A_i, $i \in \{1, 2, 3, 4\}$, respectively. The residual loop self-interference (LI) is modelled as a Weibull fading feedback channel with coefficient h , B and A is the corresponding fading parameters.

According to [15], U1 receives the superposed signal and loop interference signal simultaneously. The observation at U1 can be given by

$$y_{U1} = \mathrm{h}_1\left(\sqrt{a_1 P_s} x_1 + \sqrt{a_2 P_s} x_2\right) + \mathrm{h}_{LI}\left(\sqrt{\overline{w} P_r} x_{L1}\right) + N_0 \qquad \text{.......(2)}$$

where $\overline{w}$ is the switching operation factor between HD mode and FD mode. In this work, $\overline{w}$=1. P_s and P_r are the normalized transmission powers at the BS and U1 respectively; a_1 and a_2 are the power allocation coefficient and x_1 and x_2 are the signal of U1 and U2, respectively; denotes loop interference signal. Without loss of generality, we assume that $a_2 > a_1$ with $a_1 + a_2 = 1$.

Applying NOMA principle, successive interference cancellation (SIC) [16] is employed at U1. Therefore, the received signal to interference and noise ratio (SINR) at U1 to detect the U2's message x_2 is given by

$$\gamma_{U1+U2} = \frac{|h_1|^2 a_2 \rho_s}{|h_1|^2 a_1 \rho_s + \overline{w}|h_{LI}|^2 \rho_s + 1} \qquad \text{..(3)}$$

where $\rho_s = P_s / N_0$ is transmit signal to noise ratio (SNR). Note that x_1 and x_2 are supposed to be normalized unity power signals, i.e. $\mathrm{E}\{{x_1}^2\} = \mathrm{E}\{{x_2}^2\}$. Where E { ▪ } denotes expectation operation. After SIC, the received SNR at U1 to detect its own message x1 is given by

$$\gamma_{U2} = \frac{|h_1|^2 a_1 \rho_s}{\overline{w}|h_{LI}|^2 \rho_s + 1} \qquad \text{.....(4)}$$

In the FD mode, the received signal at U2 can be written as;

$$y_{U2} = \mathrm{h}_0\left(\sqrt{a_1 P_s} x_1 + \sqrt{a_2 P_s} x_2\right) + \mathrm{h}_{LI}\left(\sqrt{P_r} x_2\right) + N_0 \qquad \text{......(5)}$$

However, the observation at U2 for the direct link can be written as;

$$y_{U2Direct} = \mathrm{h}_0\left(\sqrt{a_1 P_s} x_1 + \sqrt{a_2 P_s} x_2\right) + N_0 \qquad \text{......(6)}$$

The received SINR at U2 to detect is given by

$$\gamma_{U2} = |h_2|^2 \rho_s \qquad \text{.....(7)}$$

As in [17, 18], the relaying link from U1 to U2 corresponding to the direct link from BS to U2 has small time delay for any transmitted signals. Therefore, we assume that the signals from the relaying link and direct link can be combined by maximal ratio combining (MRC) at U2. The received SINR after MRC at U2 can be given by

$$\gamma_{U2DR} = \frac{|h_0|^2 a_2 \rho_s}{|h_0|^2 a_1 \rho_s + 1} + |h_2|^2 \rho_s \qquad \text{.....(8)}$$

SUM RATE PERFORMANCE EXPRESSIONS

In this work, generalized sum-rate performance expressions for two users in NOMA and FD-NOMA have been derived using the above set of equations.

A. USER RELAYING IN NON-DIRECT LINK

$$sumrate = \log_2(1 + \gamma_{U1}) + \log_2(1 + \gamma_{U2}) = \log_2\left(1 + \frac{|h_1|^2 a_1 \rho_s}{\overline{w}|h_{LI}|^2 \rho_s + 1}\right) + \log_2(1 + |h_2|^2 \rho_s) \quad (9)$$

B. USER RELAYING IN DIRECT LINK

$$sumrate = \log_2(1+\gamma_{U1}) + \log_2(1+\gamma_{U2DR}) = \log_2\left(1+\frac{|h_1|^2 a_1 \rho_s}{\overline{w}|h_{LI}|^2\rho_s+1}\right) + \log_2(1+\frac{|h_0|^2 a_2 \rho_s}{|h_0|^2\rho_s+1} + |h_2|^2\rho_s) \quad (10)$$

C. USER WITHOUT RELAYING (NOMA)

SINR at U1, U2 can be written as

$$\gamma_{U1N} = |h_1|^2 a_1 \rho_s \qquad .....(11)$$

$$\gamma_{U2N} = \frac{|h_0|^2 a_2 \rho_s}{|h_0|^2 a_1 \rho_s + 1} \qquad .....(12)$$

$$sumrate = \log_2(1+\gamma_{U1N}) + \log_2(1+\gamma_{U2N}) \quad (13)$$

SIMULATION SETUP

This study compares the sum-rate performance of NOMA and co-operative NOMA for direct and nondirect relay scenario for different channel fading condition derived from Weibull distribution. Initially, experiments were carried on to study Weibull distribution curve for different scaling and shape parameter A and B respectively.

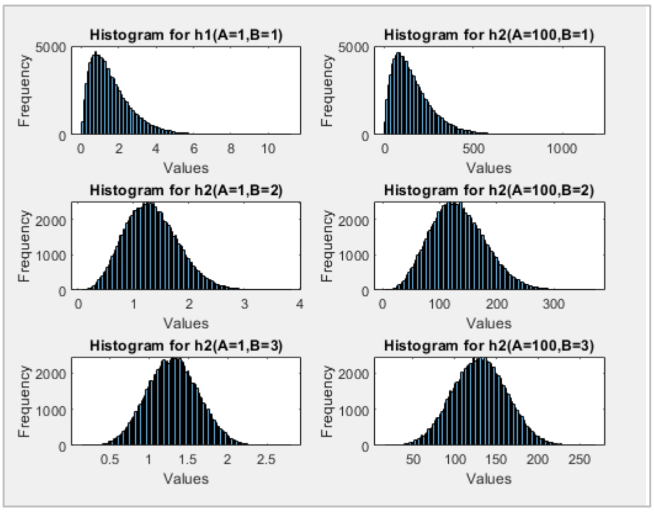


Figure 2-2 Histogram plot (Weibull distribution) for different A and B

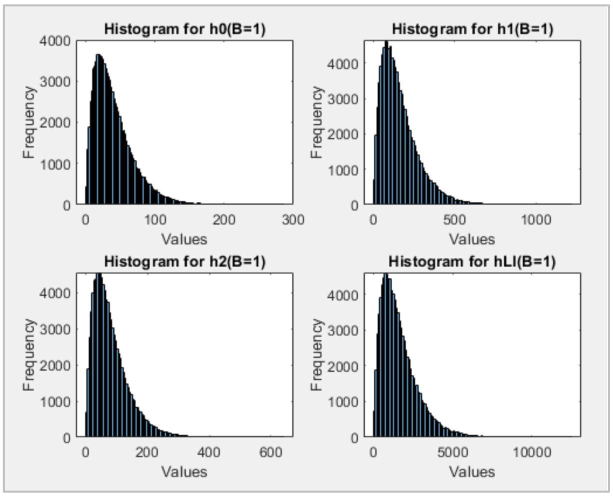


Figure 2-3 Histogram plot for different channel condition

Fig. 2-2 plots histogram for random variable x generated for different values of A and B. As clearly evident from the Fig.2-2, as value of A is increased from 1 to 100 keeping B constant, the magnitude of the data points increases by 100 times. Simultaneously, when value of B is changed from 1 to 3, shape changes from Exponential to Gaussian.

To simulate the experiment, four channels with different strength in every fading scenario have been simulated The order of strength for the four channel conditions are: $|h \,| < |h \,| < |h \,| <|h \,|$. Fig.2-3 plots the histogram for random vector generated for different channel condition satisfying the above stated strength condition. Power allocation factor a_1 and a_2 is selected to be of values 0.1 and 0.9 respectively. SNR is varied from -20db to 20db.

SIMULATION RESULTS & INTERPRETATION

Under this section sum rate performance for various conditions are discussed. Initially, sum rate performance for different values of B are observed individually for both NOMA and Full Duplex relay Co-operative NOMA (FD-CNOMA). Further sumrate comparative performance is observed.

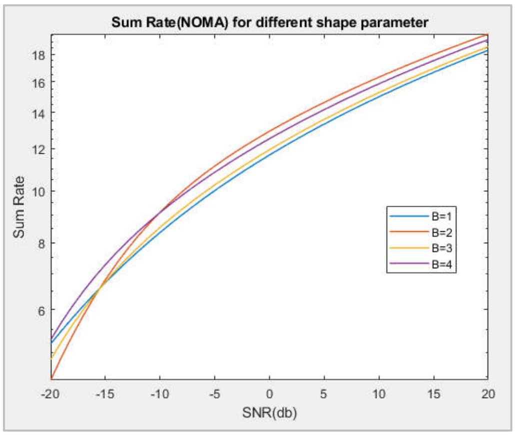


Figure 2-4 Sum Rate for NOMA

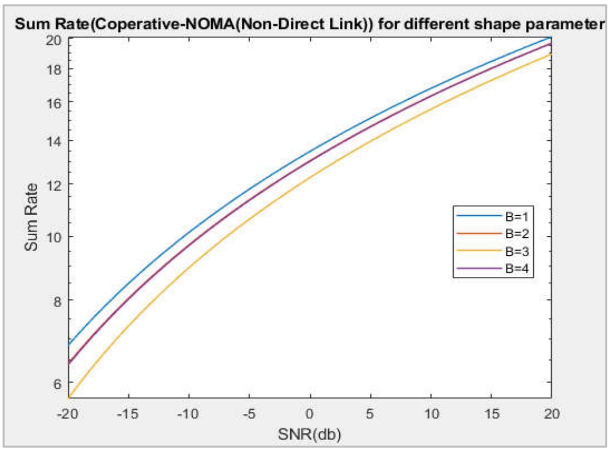


Figure 2-5 Sum Rate for Co-operative-NOMA (Non-Direct)

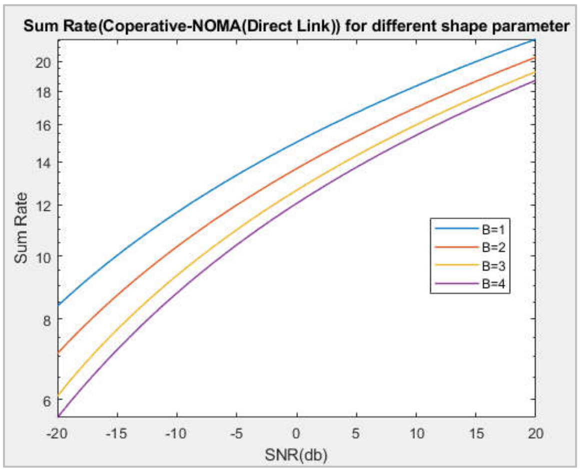


Figure 2-6 Sum Rate for Co-operative-NOMA (Direct)

Fig. 2-4, 2-5 and 2-6 plots the experimental results of sumrate obtained on varying SNR from -20db to +20db for different shape parameter for NOMA, C- NOMA (Non-Direct Link) and FD-CNOMA (Direct Link). In Fig. 2-4, the sum-rate performance for B=2 is comparatively superior to others. However, for noisy data (i.e. SNR < -10 dB), sum rate performance of B=4 is found to be best. However, for FD-CNOMA, the sum-rate performance for B=1 is comparatively superior to others for all SNR condition for both direct and non-direct relay.

The next study is to observe the comparative variation in sum-rate performance for NOMA and FD-CNOMA with changing SNR for different values of B.

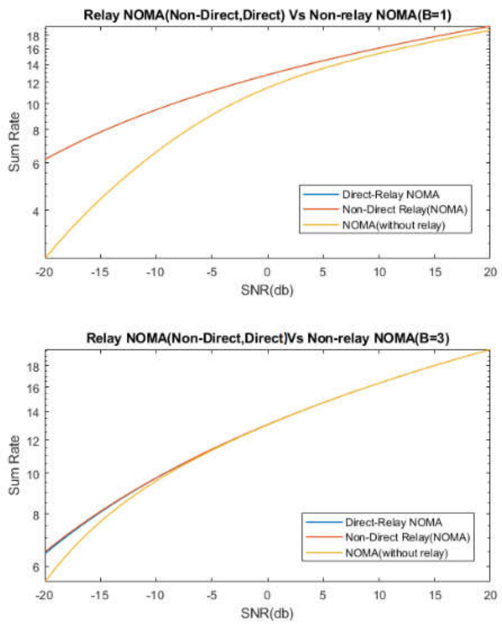


Figure 2-7 Sum Rate for B=1, B=3

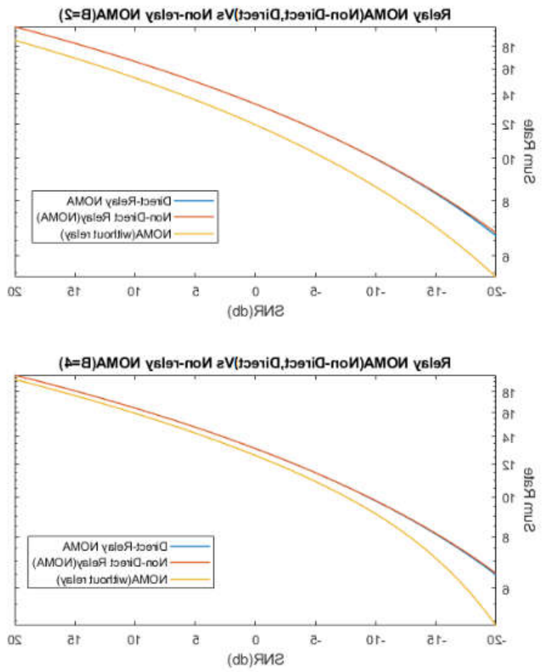


Figure 2-8 Sum Rate for B=2, B=4

Fig. 2-7 and 2-8 plots the results for the same for nondirect and direct FD-CNOMA. From both Fig. 2-7 and 2-8, it is observed that the sum-rate performance of both direct and non-direct relay FD-CNOMA is identical for different values of B for higher SNR. As SNR is decreased to -20db, performance of nondirect relay FD-CNOMA is slightly better than direct relay FD-CNOMA. Moreover, sum-rate performance of both direct and non-direct relay NOMA is superior to conventional NOMA for all values of B. However, for higher SNR, the sum-rate performance values for both NOMAs converges for all values of B.

CONCLUSION

This paper has investigated Weibull fading channel condition for varying scaling and shaping parameter for NOMA and FD-CNOMA. It is observed that the sum-rate performance of FD-CNOMA is superior to NOMA for all fading conditions obtained by varying B. For NOMA, best sum-rate performance is observed for B=2 for higher SNR. However, the performance for same degrades for lower SNR. In comparison of direct and non-direct relaying, best sum-rate performance is observed for B=1. In terms of magnitude of sum-rate performance at -20db, best performance of 8.25 bps/Hz is observed for direct relaying, followed by 6.5 bps/Hz for non-direct relaying for FD-CNOMA and 5.75 bps/Hz for conventional NOMA.

ACKNOWLEDGEMENT

We thank Dr.S.S.Sahu, Prof. Sanjeet kumar & Prof. Janardan Sahay, from ECE Department, BIT Mesra, for providing valuable suggestions and resources as well as UGC-NET JRF for providing the fellowship.

REFERENCES

[1] Z. Ding, Y. Liu, J. Choi, Q. Sun, M. Elkashlan, C. L. I, and H. V. Poor,“ Application of non-Orthogonal multiple access in LTE and 5G networks,” IEEE Commun. Mag., vol. 55, no. 2, pp. 185– 191, Feb. 2017.

[2] Z. Ding, P. Fan, and H. V. Poor, “Impact of user pairing on 5G non-orthogonal multiple access downlink transmissions,” IEEE Trans. Veh Technol., vol. 65, no. 8, pp. 6010–6023, Aug. 2016.

[3] F. Gao, T. Cui, and A. Nallanathan, “On channel estimation and optimal training design for amplify and forward relay networks,” IEEE Trans. Wireless Commun., vol. 7, no. 5, pp. 1907–1916, May 2008.

[4] J. B. Kim and I. H. Lee, “Non-orthogonal multiple access in coordinated direct and relay transmission,” IEEE Commun. Lett., vol. 19, no. 11, pp. 2037–2040, 2015.

[5] J. Men, J. Ge, and C. Zhang, “Performance analysis of nonorthogonal multiple access for relaying networks over nakagami-m fading channels,” IEEE Trans. Veh. Technol., vol. PP, no. 99, pp. 1–1, 2016.

[6] Z. Ding, M. Peng, and V. Poor, H, “Cooperative nonorthogonal multiple access in 5G systems,” IEEE Commun. Lett., vol. 19, no. 8, pp. 1462–1465, 2014.

[7] Y. Liu, Z. Ding, M. Elkashlan, and H. V. Poor, “Cooperative nonorthogonal multiple access with simultaneous wireless information and power transfer,” IEEE J. Sel. Areas Commun., vol. 34, no. 4, pp. 938–953, April 2016.

[8] H. Ju, E. Oh, and D. Hong, “Improving efficiency of resource usage in two-hop full duplex relay systems based on resource sharing and interference cancellation,” IEEE Trans. Wireless Commun., vol. 8, no. 8,pp. 3933–3938, August 2009.

[9] J. Men and J. Ge, “Full deplex techniques for 5G networks: self-interference cancellation, protocol design, and relay selection,” IEEE Commun. Mag., vol. 53, no. 5, pp. 128–137, 2015.

[10] Z. Zhang, Z. Ma, M. Xiao, Z. Ding, and P. Fan, “Full-duplex device-to-device aided cooperative non-orthogonal multiple access,” IEEE Trans. Veh. Technol., vol. PP, no. 99, pp. 1–1, 2016.

[11] Yue, Xinwei, Yuanwei Liu, Shaoli Kang, Arumugam Nallanathan, and Zhiguo Ding. "Outage performance of full/halfduplex user relaying in NOMA systems." In 2017 IEEE International Conference on Communications (ICC), pp. 1-6. IEEE, 2017.

[12] N. H. Shepherd, “Radio wave loss deviation and shadow loss at 900 MHz,” IEEE Trans. Veh. Technol., vol. 26, pp. 309–313, Nov.1977.

[13] H. Hashemi, “The indoor radio propagation channel,” Proceedings of the IEEE, vol. 81, pp. 943–968, July 1993.

[14] G. Tzeremes and C. G. Christodoulou, “Use of Weibull distribution for describing outdoor multipath fading,” Antennas and Propagation Society International Symposium, vol. 1, pp. 232–235, 2002.

[15] T. M. Cover and J. A. Thomas, Elements of information theory, 6th ed., Wiley and Sons, New York, 1991.

[16] T. Riihonen, S. Werner, and R. Wichman, “Hybrid fullduplex/half-duplex relaying with transmit power adaptation,” IEEE Trans. Wireless Commun., vol. 10, no. 9, pp. 3074–3085, September 2011.

[17] D. P. M. Osorio, E. E. B. Olivo, H. Alves, J. C. S. S. Filho, and M. Latva-aho, “Exploiting the direct link in full-duplex amplify-and forward relaying networks,” IEEE Signal Process. Lett., vol. 22, no. 10, pp. 1766–1770, Oct 2015.

[18] I. S. Gradshteyn and I. M. Ryzhik, Table of Integrals, Series and Products, 6th ed. New York, NY, USA: Academic Press, 2000.

3. Posterirori Minimization for Pre-Error Inclusion Linearizer of 5G-HPA

J.N.Swaminathan, Department of ECE, QIS College of Engineering and Technology Ongole, Andhra Pradesh
sammbuddy@gmail.com
O.Vignesh, Department of ECE, QIS College of Engineering and Technology Ongole, Andhra Pradesh
vicky6058@gmail.com

ABSTRACT

The Number of Android Mobile (Voice, Mobile Data, Internet) users getting increased year by year, But there is a major scarcity of operating frequency for the users. Even though many spectral efficient techniques like OFDMA and NOMA are introduced to manage the spectral scarcity. The real time interference problems due to harmonics still exist. With the introduction of 5G Mobile Communication there is an exponential increase of radiations from communication equipment (BTS, Mobiles) due to massive MIMO antennas, mixers, H-PA (High-Power-Amplifier). To reduce the above effects, a modified V-LMS linearizer has been introduced instead of the conventional nonlinear filter methods (N-LMS, RLS). V-LMS not only estimates the gain error (priori) of the HPA, but also introduces very low additive error (posteriori). The proposed has been executed through the 64-QAM nonlinear modulated signal with amplifier operating at 1.89 GHz to 2.32 GHz.

Keywords— *H-PA-High Power Amplifier, V-LMS-Variable Least Mean Square, N-LMS-Normalized Least Mean Square, RLS-Regressive Least Square*

INTRODUCTION

The H-PA has been used in almost all the transmitter equipments for improving the power of the nonlinear modulated signals. Since the amplifier behaves as nonlinear device, the output signal is introduced with the harmonics (Even Order) and Intermodulates (Odd Order). The newly introduced intermodulates in adjacent band of the desired signal is hard to eliminate where as the harmonics can be eliminated using a simple 1st order Low Pass Filter (LPF) or Band Pass Filter (BPF).

The intermodulates which represent the odd order of the amplifier output is very adjacent to the message signal. This unwanted output is introduced due to the varying gain value of the amplifier. Since it is adjacent to the message signal the odd intermodulates create interference sideband distortion and self-heating effect of the device. The sideband distortion cannot be negated but it can be minimized. To minimize the distortion, pre-error inclusion method is well renowned and wide implemented.

In Pre-error inclusion method the various adaptive filters have been used to estimate the gain error of the poweramplifiers. In this work, the performance of various adaptive filters (N-LMS, RLS, V-LMS) has been analyzed which is a part of pre error inclusion linearizer module of PA. The proposed method (V-LMS) has been only examined for the High-PA type i.e for the saleh model.

The same analysis will be implemented for other PA nonlinear models like hyperbolic tangent, cubic polynomial, Ghorbhani and Rapp model. The work has been executed by considering the amplitude distortion value as α=4 and phase distortion value as β=2. A generic model has been given below,

$$H(z) = \frac{\alpha z^{\gamma}}{(1+\beta z^2)^n} \qquad (1)$$

where γ =1,2,3 and n=1,2. Here the error has been estimated as generalized Cartesian form instead of polar format (AM-AM and AM-PM). In Previous models, the signal has been converted into Cartesian to polar form and each error(Phase and amplitude) has been estimated, but in our proposed method the signal has been estimated as generic Cartesian form.

ADAPTIVE ERROR ESTIMATION MODEL

A. N-LMS MODEL

The N-LMS nonlinear filter model estimates the error from top to bottom structure using the Widrow-Hoff function. In this non-linear adaptive method of error estimation(Mean-Square-Error-MSE), it estimates the huge error using the filter tapes. After a number iteration the error has been fully minimized. The N-LMS estimation error time totally depends upon the step size of the filter function μ which varies between 0 and 1. If the μ value is close to 1, the error estimation speed is fast, but the priori error can not be quantified correctly. Similarly, when the μ value is close to 0, the error estimation speed will be very slow, but the priori error has been quantified.

This conventional filter model has more number of filter tapes which increases the computational complexity and introduces the posteriori error for initial set of iteration upto 20k to 50k samples. So this method further introduces a new additive distortion to the signal. Even though there is a tradeoff done between estimation speed and μ value, the posteriori error inclusion has been considered as a major disadvantage for utilizing N-LMS during error estimation process.

B. RLS MODEL

The RLS Adaptive filter method totally depends upon the forgetting factor. Unlike the N-LMS, RLS method will use the forgetting factor with reduced number of filter tapes. The model estimates only 3rd order and 5th order intermodulate distortion which is very adjacent to the signal. The estimated speed of the filter is normal as well as it quantifies the first 2 orders of the odd intermodulates.

The forgetting factor fails to keep the error in a constant suppressive mode. The filter introduces occasional high posteriori error variations which lead to the non stability of gain error which may spoil the power amplifier. To overcome this issue a new modified method using improved RLS algorithm increases the computational complexity of the gain error estimation.

PROPOSED V-LMS METHOD

The proposed V-LMS algorithm is working on the concept of variable step size to reduce the computation complexity. For each iteration the step size will be varied, so new step size will be found as,

$$\mu(n+1) = \alpha\mu(n) + \gamma\rho_2(n) \qquad (2)$$

where $\mu_{min} < \mu(n+1) < \mu_{max}$ & $0 < \alpha < 1$ and $\gamma > 0$ which are represented as varying parameters utilized from Aboulnasr's algorithm. As the variable step-size, modeled with time changing correlated signals and successive errors. The impulse samples are noted as p(n) and its future response will be derived as follows,

$$p(n+1) = \big(1 - \beta(n)\big)p(n) + \beta(n)e(n)e(n-1) \qquad (3)$$

The future response with time varying and averaged data has been found with β(n) as error signal. So from the error response, the future value will be derived as follows,

$$\beta(n+1) = \eta\beta(n) + \lambda_{e2}(n) \qquad (4)$$

where $\beta_{min} < \beta(n+1) < \beta_{max}$ and $0 < \eta < 1$ and $\lambda > 0$ are the parameters influencing the error power signal. It has been found that β(n) is variable between 0 and 1. So the maximum value of the error will be less than 1. The modification of the step size of the conventional model will give good error tracking capability with convergence. The equation 2.8 gives the solution for the additive error, misadjustment which has been called as posteriori error. Around 6 to 8 parameters has been utilized for the error estimation process. The upper bound of the step size will be represented as μmax in N-LMS. The value of the maximum step-size has to be chosen carefully such that it should not increase the complexity in step-size and the actual correct convergence. The upper value totally depends on the experimental values and it is not like the minimum step size which will be chosen as a rough approximate value.

$\mu_{max} = s2\mu T(n)u(n)$ where $0 < s < 1$ is the measuring factor for scaling.

The V-LMS algorithm does not have constant μ, so it adjusts the error estimation speed as needed. It has introduced a minimal posteriori error range with constant suppression of gain error for all the orders of the intermodulates. The performance of the V-LMS has been compared with conventional N-LMS and RLS method using gain error vector magnitude analysis.

COMPARATIVE ANALYSIS AND RESULTS

The Linearizer has been designed for the purpose of reducing the harmonic distortion of Saleh-TWT based 5G-HPA. In the previous model, N-LMS and RLS used to estimate the priori error by comparing with the input signal and feedback down converted signal. The same will be now carried out by V-LMS algorithm which also reduces the posteriori noise effect of conventional model and quantization memory effects of 2D-ML-LUT. Similarly the V–LMS error estimator reduces the computational complexity with minimum priori error estimation time. To validate 5G-HPA performance, Peak, RMS and 95th percentile EVM has been estimated according to the standards

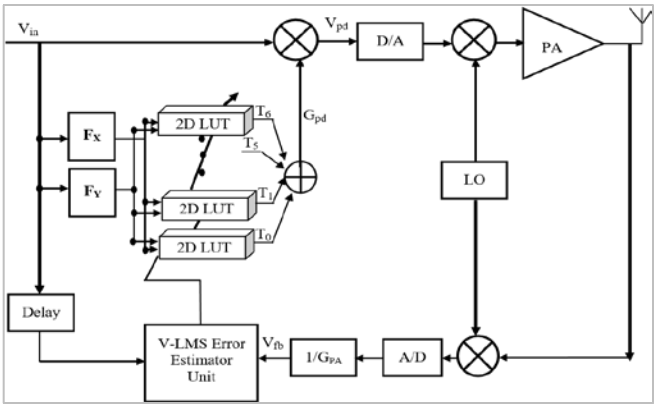


Figure 3-1 roposed Pre-Error Inclusion V-LMS Linearizer

A. RMS-EVM ANALYSIS

The model has been implemented mathematically in Matlab environment with α = 4 and β = 2 of the saleh 5G-HPA. The constant step size μ=0.23 (NLMS), forgetting factor =0.18. The prori estimation is done in Cartesian mode.

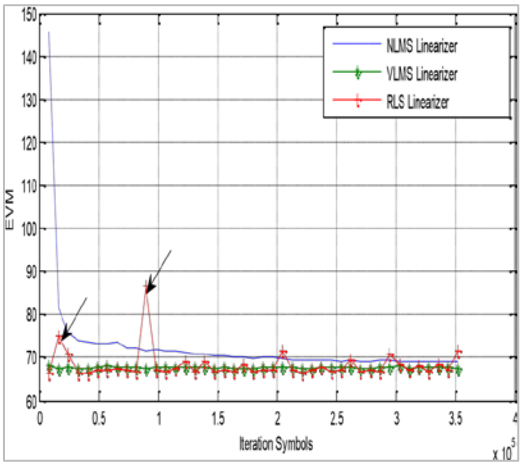


Figure 3-2 RMS-EVM analysis (V-LMS vs N-LMS & RLS)

Around 0.35 million of iteration sampled symbols has been taken to estimate the RMS-EVM. In figure 3-1 shows that initially the conventional N-LMS has a huge unnatural error of around 140-150 which means the N-LMS priori estimator added the posteriori error which was later reduced to the normal level after 0.15 million of iterations. Both RLS and V-LMS has a same priori error level of (65-70). However, it is evident from figure 3-2 that RLS failed to keep the constant gain error with the inconsistent estimation process.

B. PEAK EVM ANALYSIS

In figure 3-3 the 0.35 million of iteration symbols, random EVM peak values have been estimated for saleh-5G-H-PA, and all nonlinear error estimators. The peak EVM measurement also confirms the inconsistency of RLS method which has many high inconsistent tall peaks. There is a chance to the H-PA failure due to these inconsistent tall peaks introduced by the RLS error estimator. V-LMS once again perform consistently educes both the priori and further not introduce any posteriori distortion.

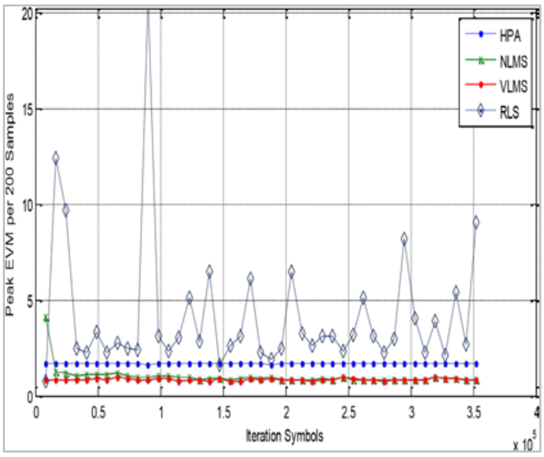


Figure 3-3 Peak EVM analysis (V-LMS vs N-LMS & RLS)

C. 95TH PERCENTILE EVM ANALYSIS

Once again like the RMS-EVM, in 95th percentile EVM also the N-LMS error estimator has an unnatural error initially, but later it has a consistent error compression. Unlike in earlier two EVM analysis, RLS has a consistent gain error suppression and inline with V-LMS.

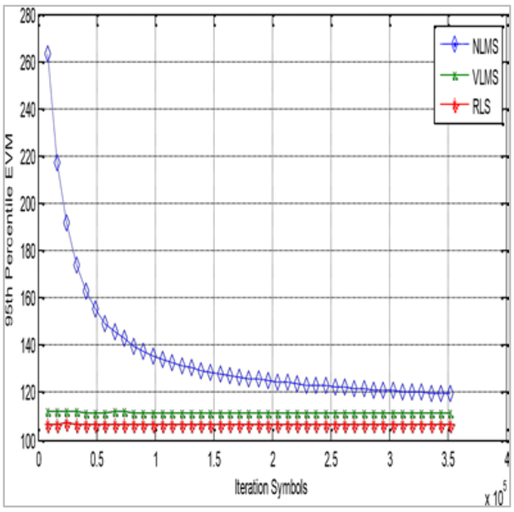


Figure 3-4 95th percentile EVM analysis (V-LMS vs N-LMS & RLS)

CONCLUSION

As per the 5G Communication 3GPP standards the RMS, Peak and 95th percentile EVM should not exceed 10%, 30% and 15% of the mobile station in worst case. N-LMS exceed all these limits for the initial 0.15 million of iteration later it comes under this level. RLS cannot able to maintain the error consistently and introduces tall gain posteriori peaks. In all these three analysis only V–LMS linearizer has a consistent error suppression performance and in line with the worst case EVM values. The worst case EVM values are listed at various intervals has been tabulated below in Table 3-1.

Table 3-1 EVM ANALYSIS FOR 5G-3GPP STANDARDS

Error Estimator	**EVM Analysis**		
	RMS-EVM	***Peak EVM***	***95th Percentile EVM***
N-LMS	8.33% (Initial 0.15 million Symbols 48%)	26.43% (Initial 0.15 million Symbols 52%)	13.5% (Initial 0.15 million Symbols 45%)
RLS	7.52% (Inconsistent short, tall posteriori peaks 33%)	32.12% (Inconsistent short, tall posteriori peaks 67%)	8.21% (Consistent)
V-LMS	7.56% (Consistent)	23.33% (Consistent)	9% (Consistent)

ACKNOWLEDGMENT

The Authors want to acknowledge Dr. N. S. Kalyan Chakravarthy, Chairman & Correspondent, QIS Group of Institutions, Ongole, Andhra Pradesh.

FUNDING DETAILS

The Research work is carried out in Product-Research and Development Lab, QIS College of Engineering and Technology, Ongole, Andhra Pradesh, funded by Sri Nidamanuri Educational Society. (File No: QISCET/ S&C/02/04/1255)

REFERENCES

[1] Dickshaw D., Shanthi P. (2020) Performance Analysis of Digital Predistortion on Orthogonal Frequency Division Multiplexing Systems. In: ICSCN 2019. Lecture Notes on Data Engineering and Communications Technologies, vol 39. pp.183-190.

[2] Romio Rosan Sahani, Utpal Mandal, Anupam Shrivastava, Hare Krishna Ratha, "High power UHF transmitters using SSPA for flight termination system in test range: A detailed study", Circuits and Systems (ICCS) 2017 IEEE International Conference on, pp. 340-345, 2017

[3] R. Gomes, C. Duarte and J. C. Pedro, "Analysis and Design of a Polar

[4] Digitally Modulated CMOS PA Based on Switched ConstantCurrent," in IEEE Transactions on Microwave Theory and Techniques pp.1-11 2019

[5] Y. Chen, T. Wang, S. Lin, J. Chen and Y. E. Chen, "A PulseModulated Polar Transmitter Using Direct Digital Synthesis for 5G NR Mobile Applications," in IEEE Transactions on Circuits and Systems II: Express Briefs.pp.1-1, 2019

[6] A.Kavitha and J.N.Swaminathan, “Design of flexible textile antenna using FR4, jeans cotton and teflon substrates”, Microsystem Technologies (25) 4, Pp 1311–1320, 2019

[7] Swaminathan, J. N., Kumar, P., & Vinoth, M. (2013). Performance analysis of LMS filter in linearization of different memoryless non linear power amplifier models. In Proceedings of International conference on Advances in Computing, Communication and Control (ICAC3) (pp. 459–464)

[8] Swaminathan, J. N., Kumar, P., & Vinoth, M. (2012). Performance Analysis of LMS filter in SSPA linearization in different modulation conditions. In Elsevier conference proceedings ICECIT.

[9] S. Habu, Y. Yamao and H. Suzuki, "Unified Feedback Beamforming Digital Predistorter," 2019 14th European Microwave Integrated Circuits Conference (EuMIC), Paris, France, 2019, pp. 350-353

[10] S. Habu, Y. Yamao and H. Suzuki, "Unified Feedback Beamforming Digital Predistorter," 2019 49th European Microwave Conference (EuMC), Paris, France, 2019, pp. 904-907

[11] A. Hu, D. G. Byrne, R. Farrell and J. Dooley, "A Complexity Reduced Non-Uniform Generalized Memory Polynomial Model for Nonlinear Power Amplifier Behavioural Modeling," 2019 30th Irish Signals and Systems Conference (ISSC), Maynooth, Ireland, 2019, pp. 1-5

[12] J. Lu et al., "Machine Learning based Adaptive Predistorter for High

[13] Power Amplifier Linearization," 2019 IEEE Cognitive

[14] Communications for Aerospace Applications Workshop (CCAAW),

[15] Cleveland, OH, USA, 2019, pp. 1- 6

[16] X. Chen, W. Chen, F. M. Ghannouchi and Z. Feng, "The NestedMode Power Amplifiers for Highly Efficient Multi-Octave Applications," in IEEE Transactions on Microwave Theory and Techniques pp-1-13, 2019.

[17] O. Vignesh and H. Mangalam, (2019), " Low power binomial coefficient architecture for unused spectrum detector", Analog Integrated Circuits and Signal Processing, Vol. 99. No.3, pp. 599-606.

4. Analysis of NOMA: In Capacity Domain

Saurabh Srivastava, Dept. of EC, BIT, Mesra, Ranchi, India saurabhnitkian@gmail.com
Prajna Parimita Dash, Dept. of EC, BIT, Mesra, Ranchi, India ppdash@bitmesra.ac.in
Sanjay Kumar, Dept. of EC, BIT, Mesra, Ranchi, India skumar@bitmesra.ac.in

ABSTRACT

Non-orthogonal multiple access (NOMA) is supposed to be used for forthcoming 5G cellular networks. In this paper, the expressions for the channel capacities for symmetric and asymmetric NOMA networks have been analyzed. The performance measure of user spectral efficiency and the sum-rate bounds, for the NOMA and the existing OMA networks have been compared. Furthermore, analysis of user rate and capacity of NOMA network has been carried out and observed that the NOMA capacity region varies as a function of the power allocation factor. The corresponding models have been developed for both uplink and downlink, and simulated with MATLAB. The experimental results show that even in the symmetric channel conditions, NOMA is able to perform and provides the same spectral efficiency as OMA.

Keywords—*OMA, NOMA, rate-region, spectral efficiency, power allocation factor*

INTRODUCTION

The mobile communication has come through various generations over a little span of time. The motivating factor for every next generation is marked with higher user data rate and enhanced user service. Though the current 4G cellular standard provides a high data rate, the requirement of highdata rate is massively increasing. Moreover, the variety of user services such as massive machine type communication (mMTC), ultra-reliable low latency communication (URLLC) and enhanced Mobile Broadband (eMBB) demand new architectures and configurations for the upcoming 5G cellular services.

It is also expected that the number of connected devices to reach 29 billion by 2022 [1], out of which 1.5 billion would be Internet of Things (IoT) devices. These massive connections characterize high connection volumes as well as small data traffic volumes and on the other contrary, they require ultra-reliability, availability, low latency high throughput etc. The current 4G cellular is not able to fulfil these diverse requirements, as the 4G vision is centred on cellular mobile and not focused on these diversified cases. Thus, 5G has to come up with the solutions to the above cases. The next generation mobile networks (NGMN) alliance provides the vision for 5G, while discussing these cases [2]. Specifically, it mentions the improvements required in spectral efficiency of the cell (bps/Hz/cell) and user spectral efficiency (bps/Hz/user) for supporting the massive connectivity between users as well as devices.

The major objective in the cellular generations has been to achieve a larger user capacity, and inturn a larger sum-capacity. A large sum-rate signifies an efficient network by maximizing each user’s throughput to its capacity. So, the objective across the generations has been to maximize the sum-rate. Moreover, the 5G network is also supposed to cater a number of other key performance indicators such as a reduced latency (user-plane) of about 1 ms for eMBB and URLLC applications; and energy efficiency in eMBB use case [3]. The above performance indicators suggest a new waveform design or specifically a multiple access scheme that provides a higher spectral efficiency, high energy efficiency, lower latency, more user-fairness and massive connectivity for device to device communication and IoT.

Since the waveform design has been the most fundamental aspect of the physical layer, the signalling and multiple access formats have significantly changed over the cellular generations. The analog Frequency Modulation (FM) and Frequency Division Multiple Access (FDMA) based 1G systems got transformed into a digital Time Division Multiple Access (TDMA)/FDMA based 2G systems. The focus of all the global 3G systems was on Code Division Multiple Access (CDMA).Further, due to increasing bandwidth requirements Orthogonal Frequency Division Multiple Access (OFDM) that was adopted in 4G, as (Orthogonal Frequency Division Multiple Access (OFDMA). OFDM offered several advantages compared to its predecessors, like computationally efficient implementation and simple equalization [4]. The foremost flaws of OFDM include its high peak-to-average-power ratio (PAPR), and the requirement of strict orthogonality among its subcarriers.

All the existing multiple access techniques have been utilizing the orthogonality between their shares in the resource block. For TDMA, the resource block is time, and different users are allowed to ccommunicate only in their respective time slot. In FDMA and OFDMA, the users are differentiated in frequency domain and permitted communication only during their frequency slots. In CDMA, although the users can use entire time/frequency resource block, but are differentiated with orthogonal spreading codes.

Hence, these can be classified as orthogonal multiple access (OMA) schemes. The major concern of the provision of massive connection density and high capacity for eMBB and low latency for URLLC communication the 5G networks specify the current spectrum utilization to be made more efficient. One of the mechanism is simply allocating more users within a resource block, avoiding the orthogonality restriction between the users. In this regard, Non–Orthogonal Multiple Access (NOMA) is treated as the best candidate for 5G cellular networks [5]. NOMA simply allocates more than one user to a resource block. Currently, with 4G OFDMA, each resource block is allocated to a single user. Hence, a significant increase in capacity can be observed theoretically, if each resource block is shared among several users, and each user completely utilizes the whole resource block. Thus, NOMA provides system overloading [6], which is highly desirable for massive connection density. In NOMA, the user's utilize the complete resource block and transmit simultaneously without being differentiated in time/ frequency/code domain. The receiver differentiates the users either based on the different user power levels or by different sparse (spreading) codes that are non-orthogonal.

In this paper, we evaluate the effect of power allocation factor on the capacity region of NOMA in the downlink as well as in the uplink scenarios. For the downlink case, we assume a single transmitting antenna at the BS and two different user devices as receivers. The uplink scenario consists of the user devices transmitting to the BS antenna. In the downlink, the superposition coding (SC) is performed by the BS, and successive interference cancellation (SIC) is done by the user equipment (UE). On the contrary, SIC is done at the BS in the uplink.

The rest part of the paper is organized as follows. Section II presents the related work with NOMA classification. This section highlights the characteristics of Power Domain (PD) NOMA, and the processes involved at the transmitting and receiving ends of the system. Section III identifies the performance metrics of the proposed system, specifically defining the capacity, spectral efficiency, user-rates and the sum-rate.

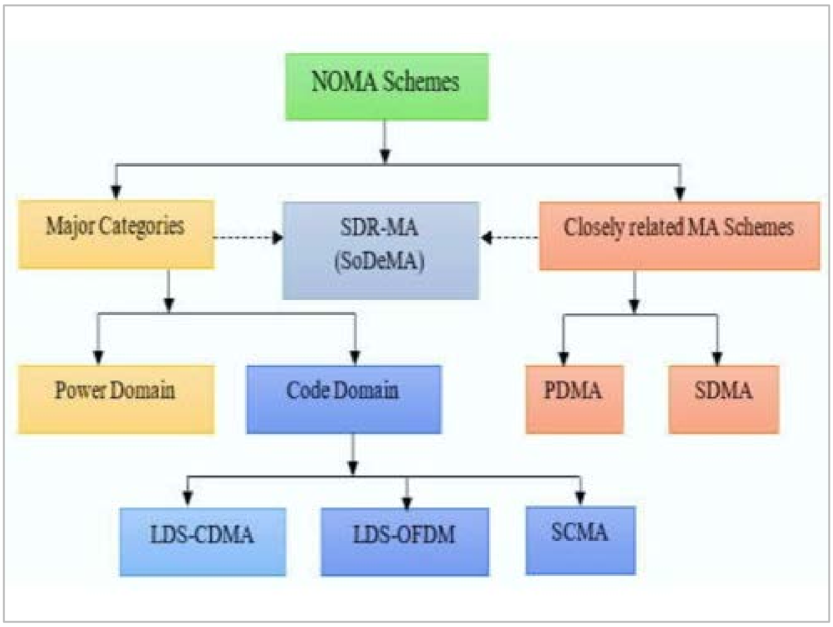


Figure 4-1 Classification of NOMA and similar schemes

In section IV, we describe the proposed system model for carrying out the analysis of the capacity region in PD-NOMA network. In this section, we evaluate the rate-region depending upon the received signal-to-noise+interference ratio (SINR). We also deal with the mathematical analysis of the symmetric and asymmetric cases and thus obtain the rate-region variation based upon the SINR. As far as our knowledge is concerned, no such in-depth analysis has been presented in the available literatures that takes both of the cases into account. Section V describes the simulation parameters and interprets the results obtained with MATLAB. Finally, section VI concludes the paper justifying the candidature of NOMA as a future multiple access scheme.

RELATED WORK

NOMA refers to a new signal design where the users share time and frequency simultaneously. Some studies [5], [7], [8] show that higher spectral efficiency can be achieved with NOMA techniques. The NOMA schemes are categorized as power domain multiplexing and code domain multiplexing including multiple access with low-density spreading (LDS), sparse code multiple access (SCMA), multiuser shared access (MUSA) and so on [9]. Some other proposed NOMA schemes are pattern division multiple access (PDMA), bit division multiplexing (BDM) and interleave division multiple access (IDMA). Software Defined Multiple Access (SoDeMA) has been proposed to address the issue of coexistence between different NOMA schemes. A simple classification of NOMA schemes is given as shown in Fig. 4-1 [10]. For NOMA, the users may be multiplexed and differentiated in the power domain, hence the name,

PD-NOMA. NOMA offers some significant capabilities that may assist in achieving the key performance metrics of diverse 5G use cases. Owing to the less complexity among all the schemes, the PD-NOMA has become the most studied scheme among all the NOMA schemes [5-7].

First, it utilizes the power domain multiplexing hence there is no need for orthogonality between user's shares either in time/frequency/code domain. Secondly, it can easily be implemented along with narrower beams for spatial multiplexing, providing a combination of power domain multiplexing and spatial multiplexing. This would be increasing the overall system capacity. Thirdly, SC and SIC are simple processes and have been well studied by the academia. Fourthly, as each of the user utilizes the complete resource block, it may transmit instantly as it requires, thereby reducing the overheads and increasing the latency. Last but not the least, other emerging techniques such as Multiple Input Multiple Output (MIMO) and millimeter waves (mmWaves) can also be combined with NOMA.

The foremost processes required in PD-NOMA are twofold. Superposition Coding of the user's signal at the transmitter, and subsequently Successive Interference Cancellation at the receiver side [10]. Both of the processes assist in achieving higher capacity of the system and are used jointly. The SC performs the vector superposition of the user's signal constellation, and SIC helps to increase the received SNR by the successive cancellation of the other user's signal (acting as interference).

PRE-REQUISITES

Channel Capacity: The channel capacity for an Additive White Gaussian Noise (AWGN) channel for a point to point link, is represented in [11] as

$$C_{awgn} = W log_2(1 + \frac{\overline{P}}{N_0 W}) \qquad (1)$$

where, W is the channel bandwidth, $\frac{\overline{P}}{N_0 W}$ is the signal-to-noise-ratio (SNR), $\overline{P}$ is the power constraint in watts and $N_0/2$ is the power spectral density (PSD) of Gaussian noise. *Spectral efficiency:* The spectral efficiency is a measure of the supported user data rate for a given bandwidth. Thus, the maximum bound for the spectral efficiency is determined by the channel capacity, which implies the maximum rate of information transfer per unit channel bandwidth

$$SE_{awgn} = W log_2(1 + SNR) \qquad (2)$$

Equations (1) and (2) assume a discrete time baseband channel model described as y[m] = x[m] + w[m], with x[m] as the input to the channel, y[m] being the channel output and w[m] is $CN(0, N_0)$. For a point-to-point link, the maximum user rate for a user i, can be represented as:

$$R_i = log_2(1 + SNR_i) \qquad (3)$$

where is the SNR received at the i^{th} user, and has an upper-bound suggested by (1) and (2). *Sum-rate:* The sum-rate, i.e. the sum of the rates of all the users in the network, is defined as

$$R_{sum} = \sum R_i \qquad (4)$$

where, R_i is the i^{th} user throughput or data-rate [12].

Another performance indicator for 5G network, derived from the sum-rate is the energy efficiency (EE). EE is defined as the ratio of sum-rate with the total power consumed by the base station (BS) [13]. The sum-rate is also used to define the fairness index F for a network of K users as $F = \frac{(\sum R_k)^2}{K\sum(R_k)^2}$ [13]. This fairness index represents a fair sharing of the system capacity between the users. The fairness index F=1 implies all the users achieving the same capacity.

THE SYSTEM MODEL

In pursuance of achieving the demands of 5G, the development of new architectures and configurations is the most essential task. Conductive to this, a profound analysis of the system model is required.

In this paper, we have analysed the system model of a simple NOMA network by considering a a single antenna at the BS and two user-equipment (UE). In the downlink scenario, the BS is transmitting the superposed signal for both the users and the users have to decode their message from the superposed signal (Single Input Multiple Output, SIMO).For the uplink scenario, the BS receives the superposed signal of both the users, and the BS has to decode the user messages from the superposed signal (Multiple Input Single Output, MISO). In both the downlink and uplink, the users signal are weighted with different powers.

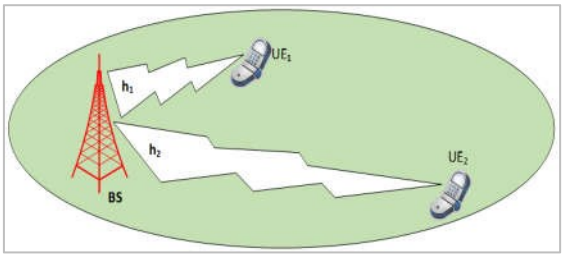


Figure 4-2 Single cell two-user NOMA downlink channel model

A. DOWNLINK NOMA ANALYSIS

A single cell two user NOMA downlink channel model is shown in figure 4-2. For the downlink, the BS, depending upon the individual channel gains, performs this power allocation for the users. More power is allocated for the user with less channel gain (weaker user), and less power is allocated to the user with higher channel gain (stronger user). Further, we assume the channel gain to be constant over every transmission time Interval (TTI), i.e. the channel gain is quasi-static. In this case, first the weaker user decodes its signal from the superposed signal. The stronger user has to decode its own signal after cancelling the weaker user signal with the SIC process. As shown in the Fig.4-2, the NOMA cell consists of two users, at the cell-edge and around the centre of the cell. The BS forms the superposed signal to be transmitted to both of the users. This superposed signal is represented as:

$$x_s = P_1x_1 + P_2x_2 \qquad (5)$$

where P_i is the allocated power for the symbol x_i of the i^{th} user. This superposed signal is to be received by the UE_1 which has the point-to-point channel gain h between itself and the BS. The same superposed signal is also received by the UE_2 which has the point-to-point channel gain h between itself and the BS. Without loss of generality, it is assumed that $h_1 > h_2$ to designate the users as weaker user and stronger user. Now, the corresponding received signal y_1 for UE_1, and y_2 for UE_2, respectively are described as:

$$y_1 = h_1\sqrt{P_1}x_1 + h_1\sqrt{P_2}x_2 + n_1 \qquad (6)$$

$$y_2 = h_2\sqrt{P_1}x_1 + h_2\sqrt{P_2}x_2 + n_2 \qquad (7)$$

According to the NOMA principle, UE_2 has to decode its message x_2 considering x_1 as an interference. The SNR for UE_2 is then given as:

$${\gamma_2}^{x_2} = \frac{|h_2|^2P_2}{|h_2|^2P_1+1} \qquad (8)$$

where, the noise variance is assumed to be unity.

The UE_1 performs SIC by cancelling the component with x_2 from its received signal y_1. Hence, the SNR for UE_1 becomes:

$${\gamma_1}^{x_1} = |h_1|^2P_1 \qquad (9)$$

Based on (3) and using (8), (9), the rate R_i for UE_i, $i = 1,2$ can be computed as follows.

$$R_1 = log_2(1 + |h_1|^2P_1) \qquad (10a)$$

$$R_2 = log_2(1 + \frac{|h_2|^2P_2}{|h_2|^2P_1+1}) \qquad (10b)$$

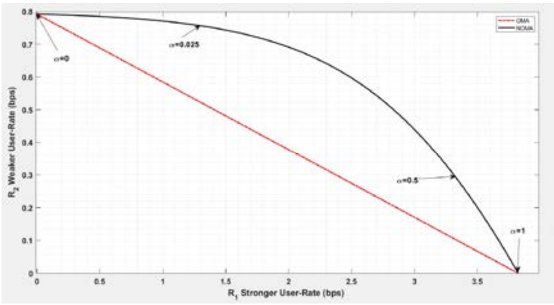


Figure 4-3 Capacity region plot for Downlink NOMA asymmetric channel

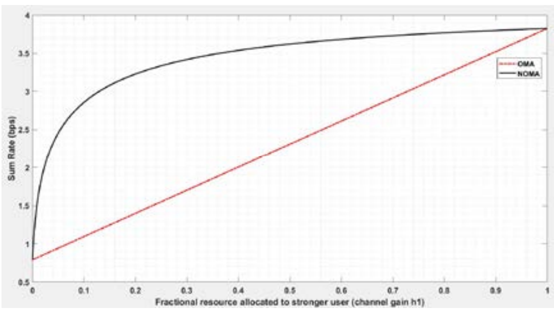


Figure 4-4 Sum-rate plot of Downlink NOMA asymmetric channel.

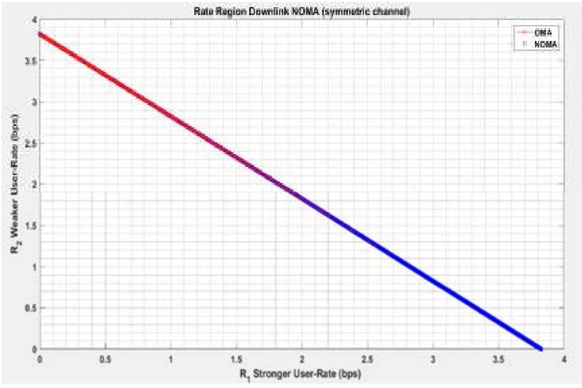


Figure 4-5 Rate region of Downlink NOMA symmetric channel.

From (8) and (9), it is clear that the user SNR increases as the allocated power to that user increases. For the downlink transmission, the BS allocates a limited power resource to the users, thereby, placing the power constraints as $P_1, P_2 \geq 0$ and $P_1 + P_2 = P$, where P is the total power constraint of the BS. Considering the extreme cases, i.e. when the total power P is allocated to one of the users (say UE_1) and no power is allocated to the other user, gives the maximum achievable rate or the capacity for that user (i.e UE_1). Now considering the power allocation factor, as the allocated power to the user performing SIC. Hence, the power of UE_1 is given as $P_1 = \alpha P$ and of UE_2 is given as $P_2 = (1-\alpha)P = \overline{\alpha}P$. We chose the power allocation factor to be the fractional power allocated to the stronger user and varied from 0 and 1, for the two extreme cases discussed above. Hence, by varying the parameter from 0 to 1, the set of rate points ($R_1{}^{*}, R_2{}^{*}$) are easily obtained as:

$$R_1{}^{*} = log_2(1 + |h_1|^2 \alpha P) \qquad (11a)$$

$$R_2{}^{*} = log_2\left(1 + \frac{|h_2|^2 \overline{\alpha} P}{|h_2|^2 \alpha P + 1}\right) \qquad (11b)$$

Varying α from 0 and 1, we can obtain the two extreme cases discussed above.

For the improvement over 4G OFDMA (OMA) system, we consider the same scenario of two users, having weaker and stronger channels with the bandwidth allocation factor τ that represents the fractional bandwidth allocated to the stronger user. Unlike the power allocation factorα, τ is selected as 0.5, which implies equal bandwidth sharing between OMA users, to maintain user fairness. The capacity regions for Downlink NOMA as well as for Uplink NOMA were obtained for the downlink parameters given in [14] . The corresponding plot for the same parameters for downlink NOMA asymmetric channel is also obtained and is shown as Fig. 4-3. Moving further, the same capacity regions and sum-rate performance of Downlink NOMA for a symmetric channel are simulated and the plots are shown in fig. 4-4 for the sum-rate of asymmetric channel.

B. UPLINK NOMA ANALYSIS

For the uplink, it is assumed that the *UE's* transmit their signals with different power levels depending upon their distance from the BS and the channel conditions. More power is transmitted by the weaker user, and less power is transmitted by the stronger user. Just like the downlink case, we assume the channel is quasi-static. The simple uplink channel model for a single cell two user NOMA is shown in fig. 4-6.The uplink model is slightly different from the downlink NOMA model (5). In the uplink model, the BS receives the superposed signal of the users as:

$$x_{BS} = P_1 x_1 + P_2 x_2 + n_{BS} \qquad (12)$$

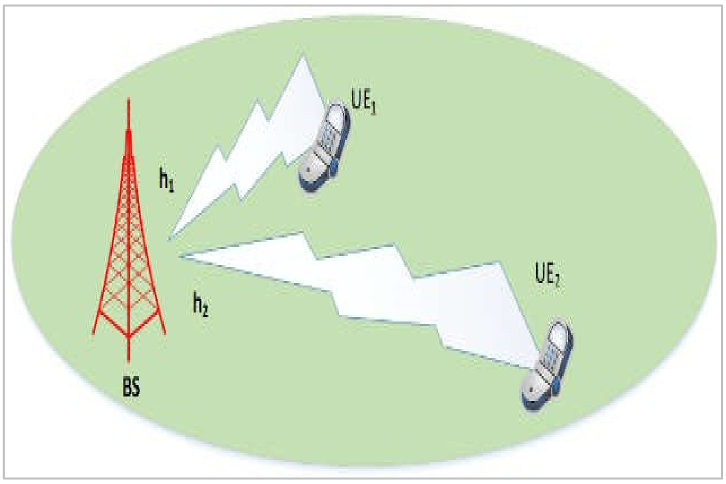


Figure 4-6 Single cell two-user NOMA uplink channel model

This superposed signal consists of UE_1 signal x_1 and UE_2 signal x_2, and the AWGN noise is specified as n_{BS}.

Without the loss of generality, again we assume that $h_1 > h_2$, where h_i, $i = 1,2$ is the channel gain for UE_i , and n_{BS} is Gaussian noise with unity variance.

According to the NOMA principle, the BS has to decode one of the user signal first, treating the other user's signal as interference. Then the BS cancels the earlier decoded signal from the superposed signal (using SIC) to decode the other user's signal. Hence there are two possibilities, first is that the BS decodes UE_2, cancels UE_2 signal from the superposed signal and then decodes UE_1 signal. The second possibility is interchanging the user order, i.e. start with the decoding of UE_1 , followed by cancellation of UE_1 signal from the superposed signal and finally decoding UE_2 signal.

According to the first possibility, the SNR for UE_2 may be given as:

$$\gamma_2{}^{x_2} = \frac{|h_2|^2 P_2}{|h_1|^2 P_1 + 1} \qquad (13)$$

where the noise variance is assumed unity. Following the SIC of UE_2, the SNR for UE_2 then becomes:

$$\gamma_1{}^{x_1} = |h_1|^2 P_1 \qquad (14)$$

Based on (3) and using (13), (14), the rate R_i for UE_i , $i = 1,2$ can be computed as following.

$$R_1 = log_2(1 + |h_1|^2 P_1) \qquad (15a)$$

$$R_2 = log_2(1 + \frac{|h_2|^2 P_2}{|h_1|^2 P_1 + 1}) \qquad (15b)$$

In the OMA case as seen earlier, the rate region is a straight-line segment joining the extreme points. We designate the point $A(0, log_2(1 + |h_2|^2 P_2))$ on the UE_2 rate-axis and the point $B(log_2(1 + |h_1|^2 P_1), 0)$ on the UE_1 rate-axis for this purpose.

Moreover, this straight line segment on the $R_1 - R_2$ plane has a slope of $(-\frac{log_2(1+|h_2|^2 P_2)}{log_2(1+|h_1|^2 P_1)})$.

It is interesting to observe from (15a) and (15b), if $= 0$, the point B becomes (0,0) and point A attains a maximum $A(0, log_2(1 + |h_2|^2 P_2))$. Also notice that if $R_1 = 0$, then the same points A and B are achieved and $R_2 = log_2(1 + |h_2|^2 P_2)$. Similarly, $P_2 = 0$ implies the point A becomes (0,0) and point B attains a maximum (0, $log_2(1 + |h_1|^2 P_1)$). Notice again, if $R_2 = 0$, then the same points A and B are achieved as $R_1 = log_2(1 + |h_1|^2 P_1)$.

Hence, we conclude the order of SIC is important for the capacity analysis. Therefore, for the determination of capacity-region of NOMA, we consider both the decoding and SIC ordering possibilities.

First, we consider the case when the sequence of detection is- decoding of UE_2 signal, followed by cancellation of UE_2 signal from the superposed signal to decode UE_1 signal. We consider a point as C on the $R_1 - R_2$ capacity plane, having the coordinates of achievable rate-pair $(R_1{}^*, R_2{}^*)$. For the decoding and cancellation sequence considered above, the rate- pair is given as:

$$R_1{}^* = log_2(1 + |h_1|^2 P_1) \qquad (16)$$

$$R_2{}^* = log_2(1 + \frac{|h_2|^2 P_2}{|h_1|^2 P_1 + 1}) \qquad (17)$$

For the other decoding-cancellation sequence, we define another point D on the capacity plane, having the coordinates:

$$R_1{}^{**} = log_2(1 + \frac{|h_1|^2 P_1}{|h_2|^2 P_2 + 1}) \qquad (18)$$

$$R_2{}^{**} = log_2(1 + |h_2|^2 P_2) \qquad (19)$$

Finally, we have four set of points on the capacity plane, given as:

$$A(0, log_2(1 + P_2|h_2|^2)) \qquad (20)$$

$$B(log_2(1 + P_1|h_1|^2), 0) \qquad (21)$$

$$C(log_2(1 + P_1|h_1|^2), log_2\left(1 + \frac{P_2|h_2|^2}{P_1|h_1|^2 + 1}\right)) \qquad (22)$$

$$D(log_2\left(1 + \frac{P_1|h_1|^2}{P_2|h_2|^2 + 1}\right), log_2(1 + P_2|h_2|^2)) \qquad (23)$$

To determine the effect of power allocation on the capacity region that is defined by (20)-(23), we again employ a power allocation factor α', such that $\alpha' = \frac{P_2}{P}$.

The above capacity region points $ABCD$ can then be expressed as:

$$A(0, log_2(1 + \alpha' P|h_2|^2)) \qquad (24)$$

$$B(log_2(1 + (1 - \alpha')|h_1|^2), 0) \qquad (25)$$

$$C(log_2(1 + (1 - \alpha')|h_1|^2), log_2\left(1 + \frac{\alpha' P|h_2|^2}{(1-\alpha')|h_1|^2 + 1}\right)) \qquad (26)$$

$$D(log_2\left(1 + \frac{(1-\alpha')|h_1|^2}{\alpha' P|h_2|^2 + 1}\right), log_2(1 + \alpha' P|h_2|^2)) \qquad (27)$$

Finally, plugging the values of various parameters from [14], and varying α' from 0 to 1, the characteristics of the capacity region may be deduced. Fig. 4-7 shows the obtained capacity region for a symmetric channel. As seen from fig. 4-7, we observe that the maximum permissible userthroughput achieved in NOMA uplink in a symmetric channel is less than the maximum permissible user-throughput achieved in OMA.

Figure 4-8 shows the variation of the points $ABCD$, and from here the symmetric capacity can be derived. This symmetric capacity is the common maximum rate at which the user's can transmit. In fig. 4-8, this symmetric capacity is given by the intersection of the locus of points C and D.

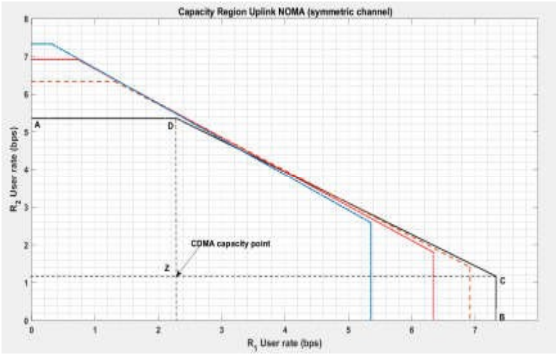


Figure 4-7 Capacity region for Uplink NOMA for symmetric channel (|h | = |h |)

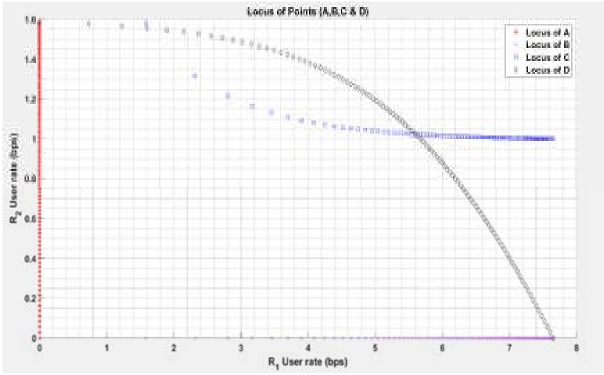


Figure 4-8 Variation of capacity-region points with power allocation factor

SIMULATION AND INTERPRETATION

The simulation for the analysis was carried out in MATLAB 9.6.0.1214997 (R2019a) Update 6 on a windows operating system with Intel i-5 dual core processor@ 2.9 GHz and 8GB installed RAM. For the simulation of the two user NOMA cell (downlink) , the channel gain for user (h_1) and for user (h_2) were selected to be $h_1 = \sqrt{5}$ and $h_2 = \sqrt{5}/10$, for asymmetric channel, and the power constraint $= 40$. These values were taken from [14]. The obtained results can be grouped into two categories- asymmetric channel, and symmetric channel.

A. ASYMMETRIC CHANNEL

For the asymmetric channel, we assumed unequal channel gains h_1 and h_2. The user-rate obtained for the downlink case are shown in fig. 4-3, with the solid-red line representing the achievable user-rate for the two user OMA network, and the solid-black line representing the NOMA network. Both the curves meet at the power allocation factor values of 0 and 1 that shows the single-user maximum rate is the same for both OMA and NOMA network. However, between these two extreme values (0 and 1), the NOMA network shows significant rate-increase. As user UE_1 is stronger user, therefore the SIC has to be done by UE_1 , and UE_2 simply decodes its own data without SIC. As we can see from fig. 4-3, allocation of more power to the stronger user reduces the user-rate of weaker user. This happens when the power allocation factor is increased towards one. Further, fig. 4-3 also shows the achievable rate when OMA is used. We considered equal bandwidth and equal power allocated to both the users in OMA so as to maintain the fairness in the system. The comparion of the curves indicate the superiority of NOMA over OMA in downlink scenario with different channel gains. Now, if large power is allocated to the stronger user, then the weaker user rate approaches zero. Hence, in this scenario, the weaker user should be allocated higher power.

Fig. 4-4 shows the variation of sum-rate with the power allocation factor, which again confirms that both the networks have the same sum-rate at the extreme values of power allocation factor.

However, allocating a large power to the stronger user does not vary the sum-rate significantly, whereas allocating less power to the stronger user varies the sum-rate significantly , that can be observed by the larger slope of the NOMA curve in fig. 4-4.

B. SYMMETRIC CHANNEL

For the symmtric channel, we assume equal channel gains h_1 and h_2 . The user-rates obtained for the downlink case are shown in fig. 4-5, with the solid-red line representing the achievable user-rate for the two user OMA network, and the solid-blue line representing the NOMA network. This suggests that under the same channel conditions, both the networks have same rate-regions, thus have a similar performance. Hence, the performance is NOMA is not inferior to OMA even under symmetric channel case. For the uplink scenario the same channel gains were assumed as for the downlink, and the results are plotted in Fig. 4-7 and Fig. 4-8.

For the symmetric channel, it was observed that the optimum rate region points i.e. points *C* and *D* require a specific range of power allocation factor to maintain the given quality of service to the users.

Hence based on these curves, an optimum range of power allocation factor could be decided for required guaranteed quality of service to the users. Further, even for the symmetric channel conditions, the rates offered are much higher than the CDMA scheme. Finally, fig. 4-8 shows the variation of the points ABCD of the capacity region with the power allocation factor. The loci of these points would help in the visualization of the capacity region for the symmetric case.

CONCLUSION

The basic models for uplink and downlink NOMA systems are analyzed in depth, and the simulated results are in agreement with the theoretical NOMA models presented in earlier literatures. A number of observations can be made related to our work. First, it justifies the superiority of NOMA over the existing multiple access techniques. Properly chosen power allocation ratio, both in the uplink and in the downlink could significantly increase the user-throughput than compared to the OMA schemes. Another result obtained is that even under the same channel conditions the performance of NOMA is not inferior to OMA. The results may help to suggest the optimum achievable rate region for a given power allocation coefficient. Thus, determining this optimum region will be an imperative aspect for the researchers. We analyed the system for two users, but we expect that to utilize NOMA, more users can be accomodated to the network. This would be our future work.

ACKNOWLEDGEMENT

We thank Dr. S.S. Sahu, Prof. S. Pal and Prof. Nisha Gupta, from ECE Department, BIT Mesra, for providing valuable suggestions and resources to carry out this work.

REFERENCES

[1] "Internet of Things forecast," Ericsson, 2019. [Online]. Available: https://www.ericsson.com/en/mobilityreport/internet-of-things-forecast

[2] Rachid El Hattachi; Javan Erfanian, "NGMN 5G White Paper," NGMN, 2015.

[3] D. Tse and P. Viswanath, Fundamentals of Wireless Communications, Cambridge University Press, 2005.

[4] S. Kumar, Wireless Communication: The Fundamental & Advanced Concepts, River Publishers, Denmark , 2015.

[5] R. C. Kizilirmak, "Non-Orthogonal Multiple Access (NOMA) for 5G Networks," in Towards 5G Wireless Networks : A physical layer perspective, Intech Open, 2016, pp. 83-98.

[6] E. Mohyeldin, "Minimum Technical Performance Requirements for IMT-2020 Radio Interface(s)," NOKIA, 2017.

[7] C. Xiong, G. Li, S. Zhang, Y. Chen and S. Xu, "Energy and Spectral Efficiency Tradeoff in Downlink OFDMA networks," IEEE Transactions on Wireless Communications, vol. 10, no. 11, pp. 38743886, 2011.

[8] M. Aldababsa, M. Toka, S. Gokceli, G. K. Kurt and O. Kucur, "A tutorial on Nonorthogonal Multiple Access for 5G and Beyond," Wireless Communications and Mobile Computing , vol. 2018, pp. 1-24, 2018.

[9] M. Vaezi, Z. Ding and H. V. Poor, Eds., Multiple Access Techniques for 5G Wireless Networks and Beyond, Springer, 2019.

[10] K. HUGUCHI and Anas BENJEBBOUR, "Nonorthogonal Multiple Access (NOMA) with Successive Interference Cancellation for Future Radio Access," IEICE Transactions on Communication, Vols. E-98, no. 3, 2015.

[11] Q. C. Li, H. Niu, A. Papathanassiou and G. Wu, "5G network capacity: Key elements and technologies," IEEE Vehicular Technology, vol. 9, no. 1, pp. 71-78, 2014.

[12] L. Dai, B. Wang, Y. Yuan, S. Han, C.-L. I and Z. Wang, "Non-orthogonal multiple access for 5G: solutions, hallenges, opportunities, and future research trends," IEEE Communications, vol. 53, no. 9, pp. 74-81, 2015.

[13] S. M. R. Islam, N. Avazov, O. A. Dobre and K.-S. Kwak, "Power-Domain Non-Orthogonal Multiple Access (NOMA) in 5G Systems: Potentials and Challenges," IEEE Communication Surveys and Tutorials, vol. 19, no. 2, pp. 721-741, 2017.

[14] M. Vaezi, R. Schober, Z. Ding and H. Poor, "Nonorthogonal Multiple Access: Common Myths and Critical Questions," IEEE Wireless Communications , vol. 26, no. 5, pp. 174-180, 2019.

[15] A. Benjebbour, Y. Saito, Y. Kishiyama, A. Li, A. Harada and T. Nakamura, "Concept and Practical considerations of Non-orthogonal Multiple Access (NOMA) for Future Radio Access," in 2013 International Symposium on Intelligent Signal Processing and Communication Systems, Naha,Japan, 2013.

[16] L. Dai, B. Wang, Z. Ding, Z. Wang, S.Chen and L. Hanzo, "A survey of Non-orthogonal Multiple Access for 5G," IEEE Communications Surveys and Tutorials, vol. 20, no. 3, pp. 2294-2323, 2018.

[17] K. Yang, N. Yang, N. Ye, M. Jia, Z. Gao and R. Fan, "Non-orthogonal Multiple Access: Achieving Sustainable Future Radio Access," IEEE Communications Magazine, vol. 57, no. 2, pp. 116-121, 2019.

[18] Q. C. Li, H. Niu, A. Papathanassiou and G. Wu, "5G network capacity: Key elements and technologies," IEEE Vehicular Technology, vol. 9, no. 1, pp. 71-78, 2014.

[19] L. Dai, B. Wang, Y. Yuan, S. Han, C.-L. I and Z. Wang, "Non-orthogonal multiple access for 5G: solutions, challenges, opportunities, and future research trends," IEEE Communications,

5. Data Privacy Technology for Society

Aaloka Anant, CTIF Global Capsule, Aarhus University, Herning, Denmark aaa.sap@gmail.com
Ramjee Prasad, CTIF Global Capsule, Aarhus University, Herning, Denmark ramjee@btech.au.dk

ABSTRACT

Data Privacy is more prominent than ever in this connected and technology driven world. All information available is derived in one way or the other from data generated by individuals directly or indirectly. This paper presents the argument that we must have a way of using information out of the vast data-sets without impacting individuals. As long as we do not have such a way, there would always be issues, giving rise to misuse of information for someone's benefit and manipulative outcomes. This paper analyzes not only technical but other safeguards, in place which enable an overall benefit of society and individuals with data privacy at its core.

Keywords — *Data security, data privacy, anonymization, privacy protection, social benefit*

INTRODUCTION

Data security has a different meaning in different context and also an evolving meaning with time. In the early days before the development of information systems, limited resources were available and most of the data would reside on paper. Data security would mean protecting access of individuals to these papers and storage mechanisms. Coding patterns and secure methods of transferring the data sets were invented. With the advancement of technology and advent of analogue tapes, data storage and reproduction were easier and lead to evolution of methods of protection. Floppy disks came with protection passwords. Furthermore, the evolution continued, with the advancement of digital storage mechanisms on drives to store data in binary format, came many methods including encrypting the whole drives with password. With the advancement of internet and the ability to transmit data across the globe with ease, evolved many methods including encryption (different methods), hashing (different methods) and many more techniques.

Despite the advancement in technology, there always has been the need to do more. Data has always been vulnerable. Data has always been key to make intelligent decisions and the lack of it. Not only businesses and Governments has been the consumer and creator of data but every individual. Data has been a vital asset even for the individuals, with the advancement of technology and communication devices like mobile phones. With the increasing generation of data and increasing digitalization, data utility cannot be ruled out only due to concerns on security and privacy. Though at the same time, its important to use data wisely, in order to avoid situations like the case at US elections and the firm Cambridge Analytica.

PERSONAL TOUCH

No individual wants to reveal any personal information except if it is for their own use. Every individual shares his/ her personal information with government departments, companies where they buy things from, different events where they register, different social platforms where they interact with others, different service providers where they get services and the list goes on. Without providing the needed personal information, an individual cannot expect to get needed services. Every other organization, which holds individual data, is termed as 'other party' in further text. All this data individuals share is stored and can be used by these 'other parties' for providing goods or services to an individual. To serve the individual in a better way, these other parties can use the data in their operations, where the individual is impacted.

Every individual love to have a personalized service. Its delightful to have a special treatment. Individual is presented with a consent or contract clause, which he/ she rarely reads through before providing his personal information on a website or in a physical store, where it is converted into digital format. In most cases, it is the urgency of receiving a service, or the word of mouth, which prompts an individual to share his/ her personal information. Benefits may not be limited to any monetary benefit or a quantifiable incentive, but can be something emotional, which an Individual receives in return of sharing his/ her data to “other party”.

WHY WORRY ABOUT PRIVACY PRESERVATION

The topic of privacy preservation is getting more and more important because now we have advanced technologies to handle large data sets. These technologies increase the potential of what can be done with these data sets. The benefits can be sky rocketing as well as the dangers.

A. INTENT OF USE OF TECHNOLOGY

It is possible to use these technologies and make data useful for business operations, political campaigns or other purposes. If the new technologies are limited to research on nature and doing weather forecasts, or finding out stars and galaxies in universe, individuals may not have a problem, but the moment, the same technologies, which can analyze large amounts of data sets to predict what an individual would do in a given situation, it becomes scary. Scare is not for the reason that technology can assist individuals with the vast amount of knowledge on their fingertips, but scare is by the fact that this capability of technology can be misused to manipulate individual’s behavior.

B. DIGITIZATION

Once individual has given his personal information and it is converted into data sets, which can be subject to analysis by technology, “other parties” gain the power to manipulate individual’s behavior. In a democratic environment, where every individual is free to give his information or not, can we really stop by making regulations, which enable individuals, to have right to share their information? Practical answer to the above question is a prominent “no”. The individual is not as empowered as the group of individuals like companies, government, trusts and other parties. These “other parties” have much more resources and power than individuals. Individuals are not even trained or aware about the risks of sharing their personal information on different digital platforms, or even physical locations (stores etc.), where its converted to digital form.

C. AWARENESS IN MASSES

Moreover, individuals in several countries do not even have education on data privacy and privacy protection. They are more vulnerable as the technology has reached in the most nuke and corner of the earth via mobile phones, but the awareness on misuse of information, not so much. For a poor subject, who use a mobile device for a service like making payments, and their data is misused; we are looking into a global catastrophe. In addition, there is a high risk of manipulating human behavior with targeted attacks in a geographic region with misuse of personal information of individuals. Manipulating elections and mobilizing mobs for protests can be some of the already seen examples.

D. WHAT MONITORS SAY

As per one of the most popular web browser Firefox monitors [1], 2019 saw a lot of data breaches and personal information leaked. 2 billion passwords exposed in one single year across the globe. Is there any service with any authority, which informs the individuals, whose data has been breached? The simple answer is, “no mandatory service of that nature exists”. Even when such breaches are identified, they are published in general media and the individuals who data has been breached are not notified. With the most under – privileged internet user in mind, mostly likely his/ her data has already been breached and he is fully exposed for manipulation by other parties.

Table 5-1 STATISTICS OF DATA BREACH FROM NORTON

Fact	Figures
The number of publicly disclosed breaches.	3,800
The number of records exposed	4,100,000,000
Increase in number of reported breaches in first six months of 2019 vs. first six months of 2018	54%

As per the latest report from Norton presented in Table 1, a leading company in cyber security space, mega breaches grab headlines, but hundreds of less familiar data hacks also increase the risk of identity theft [2]. These breaches have been in the area of Financial data, Entertainment data, Healthcare data, Education data, Government data and other business data.

SOCIAL DRIVE CONVERTS INTO A LEGAL DRIVE

There has been severe outrage by technologists over the years and several cases of violation of integrity of individuals, still there are no safeguards in place on a global scale but only in some countries. Prior to 2018, if one would look into technology which can be used to alter voice of an individual, or identify an individual from his/ her data this could be not having any financially punishable offence. Even one could run targeted marketing campaigns, make phone calls to people, even send them targeted mails, emails, letters by easily finding loopholes in regulation on these. There has been companies, whose business was to collect and manage individual's information and sell them to other companies, who can run targeted marketing campaigns against those individuals.

Not only financial losses for an individual, but breach of privacy can be in other forms impacting individuals in several ways. There have been several legal cases, where individual was arrested based on tweet alone. In one such case, the tweet was found suspicious by police and the individual was arrested as a precaution for crime prevention, by using his address and location information from the device he used to tweet with and his face for identification and no other evidence [3].

A. LARGE GLOBAL IMPACT

The authorities across different countries came to senses, only when there are mass breaches, which are exposed. And more when the government sees a compromise in security, for example the US authorities cracking a whip on the company Huawei. The global impact of the data privacy breaches can be huge.

Organizations like WikiLeaks which published the information from several whistle blowers in public platform, exposed several wrong doings. These would have never been exposed otherwise to society. Such platforms have a huge global impact, and the need is already there for such measures on a global scale to facilitate protection to individual's privacy at the same time, usage of data in such a way that the vulnerable individuals are not impacted. Whistle blowers came to WikiLeaks and other such platforms as it provides protection to individuals submitting such information. Journalism is a major area, where individuals are impacted at large, and it is the responsibility of the journalists, to safeguard the informer who bring value to the whole society by sharing the story.

B. AN EXTREME EXAMPLE OF MONITORING

In China, the drive to safeguard individual's data, has been taken up in a different way by the Chinese government. Instead of giving the freedom to the individual, Chinese government is taking all the data of individual to do surveillance. In fact, a social credit system is being designed to benefit good citizens and discourage bad citizens based on criteria set by the government. Government is using all the data including voice calls, facial recognition via surveillance cameras, social interactions by individual and all possible digital presence. On one hand it claims to crack down on the ill effects of data breach and misuse of personal information, for example, this system would enable the government to more effectively crackdown rumormongers, data thieves, unauthorized VPN connections and ill usage of data. On the other hand, it would give immense power to Government of China to manipulate the behavior of individuals based on the objectives of the Government. In addition, more so the Government officials who are in charge of running and maintaining that system of monitoring and surveillance [4].

C. EUROPE LEADING THE CHANGE

Other extreme to China is Europe, which is giving full data privacy to individuals via its General Data Protection Regulation, GDPR [5], which became law across Europe since June 2018, with fines for breach, ranging up to 4% of the gross revenue of the firm responsible for the breach of the regulation exposing data of individuals. In fact, GDPR, even forbids any non-necessary data collection by any company, which is not mandatory to provide a given service to an individual. Individuals have a forum to complain against such request by any company, which would then be looked into and the company may be fined, or at least directed to correct its data collection practices to provide a particular service to individuals. California Consumer Privacy Act, CCPA is the law being formulated in California US and coming into effect since 1st January 2020 to provide protection to individuals data [6].

A brief analysis of the GDPR fines clearly suggests that the Enterprise are not really aware of the right measures to ensure information security. Security of data for individuals have never been so important than after the implementation of GDPR in EU effective June 2018. Any company having any business in EU, need to comply with these regulations. This includes any website, which is available for people to see in EU countries. If there is any data collected by those websites of the user viewing the website, they have to comply to EU regulations. Around 80% of the fines by value, amounting to over Eur 330 Million were imposed on 38 entities for “Insufficient technical and organizational measure to ensure information security”. Hence only 27% of fines by count, cumulated to 80% of fines by value [7].

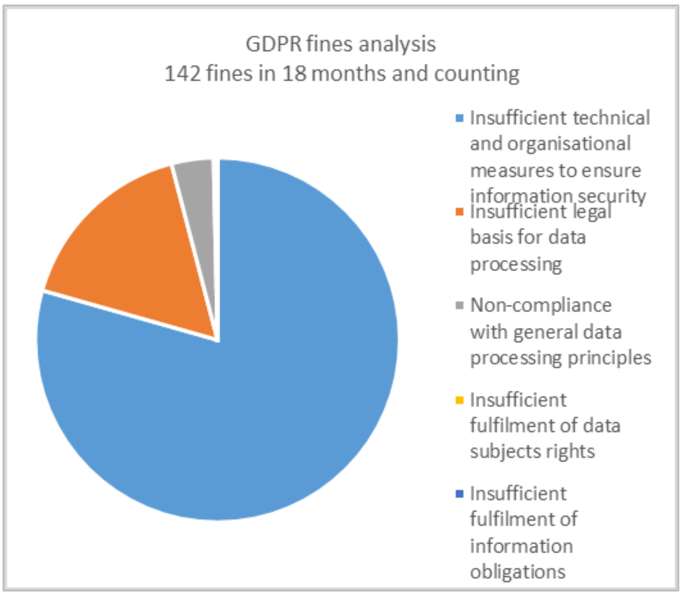


Figure 5-1 GDPR fines analysis (by fine type)

Also the distribution of fines across the countries in Europe is interesting as presented in table 2. This reflects clearly that the fines are more for companies, which have higher revenues, the underlying principle in GDPR to relate the fines to the earning of the company. There are 11 fines in Hungary, but the total value is not enough to compare to fines with countries in the top ten list in terms of value of the fines. This also reflects the value such a regulation is trying to bring into the lives of people. At the same time, promoting innovations and not taxing small companies, which deal with data by big fines, to shut them down, but for sure, giving enough blow to warn them and take care of individual's data security and privacy.

Table 5-2 GDPR FINES BY COUNTRY (TOP 10 IN VALUE)

Country	Total Fine value (EUR)	# Fines
UNITED KINGDOM	314,990,200.00	2
FRANCE	51,100,000.00	5
GERMANY	24,619,925.00	16
AUSTRIA	18,070,100.00	8
BULGARIA	3,173,370.00	9
THE NETHERLANDS	1,360,000.00	2
SPAIN	1,179,600.00	31
POLAND	933,868.00	5
GREECE	550,000.00	3
ROMANIA	445,000.00	12

COMPLEXITY BY DESIGN

Data collected for different usage, like social media have a completely different level of storage and security needs compared to data collected for something like a sales contract with an individual for a mobile phone. Similarly, the volumes of data are also different on a social media website which has over million messages per day compared to a retail store which processes thousands of invoices per day.

A. HOW MUCH DATA

According to an IDC whitepaper by David Reinsel "Mankind is on a quest to Digitize the world" [8, p. 3]. Enterprises are increasingly storing this data. Individuals benefit from the services provided by these enterprises, for example photos stored in free on a google drive with 15GB capacity. Enterprise in turn benefit from this data under contractual agreements with the individuals. Overall data generation is on the endpoints with the mobile devices and PCs used by individuals and the new IOT devices as machines, and accounts for the huge growth in data to over 175 Zettabytes by 2025. A Zettabyte for clarity is 1000 Exabytes, which is 1000 Petabytes, which is 1000 Terabytes, which is 1000 Gigabytes, which you may know how much it is. IDC is talking about 33 ZB already in 2018, which means something like 33 trillion 1 TB computers, something like 5000 1TB computer worth of data for every living being in 2018. Even though individuals may not have a single computer in their hand, but the data generated in relation to different interactions within society and stored with repeated copies make this huge data set.

B. WHERE IS THE DATA STORED

Where is this data stored, is another very significant fact to establish the need of data privacy. As per the same IDC [8, p. 10] report the data is increasingly being stored in the public cloud setup. This is a major factor as earlier trend was the storage of data increasingly at the edge, the device where it is generated, for example a mobile phone. With increasing size of data and improved reliability of public cloud environment and increased upload and download speeds with 4G and 5G networks, data storage in public cloud is becoming more commonplace. Fig 5-2 below from the IDC DATA Age 2025 represents the shifting trend of data storage.

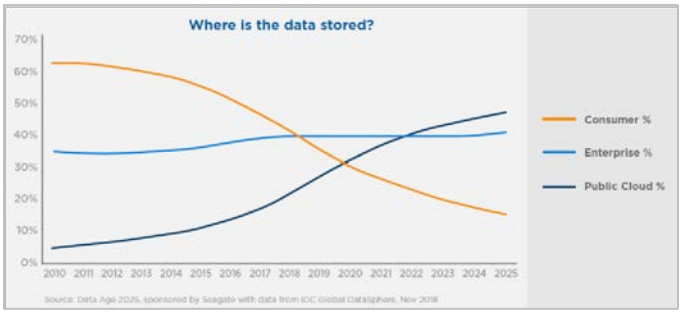


Figure 5-2 Where the data is stored (trend and forecast)

With the storage in public cloud, limited in features for individuals, and access available to the cloud storage offering company, creates a unique challenge to data privacy. For example, a company offering free storage for cloud photos, can use the photos of an individual to improve its face recognizing algorithms. The individual is not even aware of the same and is bound by a contract for it, but at the same time, he gives up his data to the company offering free storage. The company can make good use of data in improving its algorithms, which they can later use for other purposes and make money. This is good or bad, ethical or not ethical is a related question, but not currently addressed under any framework.

C. DIFFERENCE IN DATA

Data is stored in different forms for different usage. In terms of its storage location, structure and source, data can behave differently, when it comes to revealing or hiding personal information. For example, a comment in a social media network like Facebook may not be revealing anything about the person posting the comment, though it may be specifying the name of the one who posts the message. Though a feedback given for a hotel stay, maybe stored in a database, in a table, along with full information about the person and details of his/her stay in the hotel. Similarly, for a sales contract, the company making the sales of suppose a mobile phone, may be storing the contact details of the person purchasing the phone, his/her address, and many other information in one place related to that particular transaction.

D. ENTERPRISE DATA

In terms of Enterprise data, companies, categorize less frequently changing data, which has information on people, products etc. as “master data” and more frequently changing data or data with a timestamp as transaction data. Transaction data may not be revealing a lot of personal information except if combined with master data. Though it may contain attributes like name, card details etc, which may accurately reveal a person’s identity. Data engineering or feature engineering may be used /misused, to derive personal or sensitive information from a large data set with high accuracy, even though any personal information may not be present in the data set.

E. STORAGE TECHNOLOGY

In terms of structure of the storage of the dataset, different technologies, enable different types of storage. The Enterprise dataset is primarily in structured form as relational tables. Such a storage facilitates easy storage, easy retrieval and high concurrency in order to enable real-time operations. ACID (atomicity, consistency, isolation and durability) compliance is one of the standards, which certifies technology being used to manage Enterprise Data. Other technology also termed with BASE (Basically Available, Soft state, Eventual consistency) [9] compliance is perfectly valid and used for many other uses and storage of data like social media. Due to variation in basic methods on storing data, these technologies have different methods of querying data. And also, the data types, in use are also different. Images and videos are not so commonly stored in Enterprise data, though they are the most common elements to store in data in social media. This is also a reason why social data grows very high in volume and footprint across the globe.

F. STRUCTURE OF DATA

The data structure is a good topic when it comes to anonymization and different methods to find the most effective method.

- Structured data is primarily data with a defined structure, primarily tabular form. This dataset is stored in data bases mostly relational and has well defined authorization and access management. This is in fact the most widely used type in Enterprise world.
- Unstructured data is data stored in a running format. For example, free text. This can be used to represent many forms of data like media, images and any other form, which is not structured.
- Semi-structured – this term is also used in some places, where a structure can be easily derived/ seen in the stored data, though data is not stored in a tabular format. For example, an email. Some argue that email is an unstructured data, but some argue it is structured as it has a header, body and defined format. This category does not have a clear demarcation and is not widely used.
- Graph data – this data type is unique and evolving in how it is stored and used in database. Even though it has a structure, it is meaningful only in a certain context of usage. There are specific technologies, which guide the use of this data type, and provide a lot of convenience to dealing with locations specially, when using this data type. This data type is pretty clear in what it represents and even though it has no personal information on its own, but very significant in the world of mobile technology.

G. SPECIAL CHALLENGE WITH GRAPH DATASETS

With the GPS enabled on the mobile phones, or otherwise as well, due to nature of the technology of mobile communication, the accurate location of the mobile phone is always available with the telecom network. It can be a dataset, which is very much revealing personal information about an individual. Its usage to find out personal information about an individual is not unseen, with so many movies being based on the same. Though in the context of usage for privacy preservation, dealing with this data, presents a very unique challenge, when storing or analysing the same, in order to protect privacy. There has been a clear evidence, that even though the data is not associated to any individual, if available data points are presented for an unknown person, it is very easy to associate the same and find out who is the individual, revealing an individual's movement across different locations, by identifying a pattern[10].

H. WHAT IS CURRENTLY IN DEMAND

There is a lot of work and patents on how to interpret information from the images and videos, to make them searchable using voice or text search. Hence this area has more attention than the Enterprise data area from the technologists and researchers. As the boundaries between Enterprise data and nonenterprise data vanish, with more and more companies using social media to connect to their customers, the importance of data security and privacy becomes more pronounced.

These new innovations of identifying the name of the person from a photo, or identifying the address where the photo was taken, has a huge potential in how the social media data can be utilized. Just for a hypothetical example, if the individual is uploading every image taken on phone to a cloud storage, the company managing the cloud storage, has a potential to identify the location of the individual and also identify his needs feeding these data sets to machine learning algorithms. This would mean, the company holding this information on images would be in a position to offer a product promotion to the individual which he/she needs, or the company may predict his/ her need as well. This and many other such use cases, make the logical choice between data privacy and the lack of it a very thin line to cross for several organizations.

HOW WE PROTECT DATA PRIVACY – WHAT IS ANONYMIZATION

Anonymization is primarily defined as a process for information sanitization whose intent is privacy protection. Different industries see it differently. For example, medical information about a patient is recorded in public health records[11]. These are not public, but accessible to doctors in the system and many other authorized staff. In some cases, this data has to be published to provide information to public in general. And also, for researchers, who are doing research on a given topic, where a given patient's data may add value. Such specific and general cases, where this patient's information may need to be published are cases, where it is very necessary to understand the privacy concern for the individual. On one hand, the patient may benefit by sharing his data for a research or may be not. It may so happen that the patient attracts some unnecessary attention, which he/she is not seeking and may be uncomfortable with sharing such information.

A. WHAT NEEDS TO BE ANONYMIZED

Any data set, which can be used to reveal personal information should be anonymized. It may include the data set, where the information is not personal to an individual but can be used to identify the individual. For example color of hair of a person if combined with his address, may be used to identify who the person is. So the color of hair of a person, may not be a personally identifiable information, but in a context, it can be used to identify the person. Hence there is no general rule on what should be anonymized. Rather important is to check post anonymization, that the individuals cannot be identified in a

process, for which the data has been anonymized, and to ensure that the anonymized data is not used for any other purposed but deleted after its use for an intended purpose, leaving no trace to identify the individual.

B. HOW IT WORKS

Anonymization intends to alter data in such a way that the personal/ private information is removed from the dataset. Anonymization may be used for any data and not only private data, but sensitive data, which is not so private, but not something which the owner of the data is comfortable in sharing with others. One example of a dataset with no personal information but information, which one would not like to share is a mobile manufacturing company's information on defective mobile phones and returns by its customers in a given year.

C. METHODS FOR ANONYMIZATION

Anonymization can be achieved using different technologies as claimed by the developer and researchers on those technologies. Some of those technologies include below methods.

1) Differential Privacy - This method is attributed to be primarily developed by cryptographers. In 2006, published work "Calibrating Noise to Sensitivity in Private Data Analysis", may be considered as the foundation of Differential privacy. Differential privacy ensures that once the data has been differentially private, the user of the data would not be able to identify if a given individual's data is in the dataset being analysed or not. The user even if he/she has information about a given individual, whose data is in the dataset, there is no possibility to identify any other individual from the data set. This is one of the most renowned methods for sharing information publicly as per researchers. The implementation of this concept has been done by several researchers in different geographies, different industries on different data sets.

2) k-anonymity – This method is also very much used in relation to datasets, where the data can be grouped into levels of hierarchy. For example, villages being part of a district, districts being part of a state, and states being part of a country. Based on the defined rules, a particular subjects' data can be replaced with a value, which is higher up in hierarchy in order to protect an individual being identified. As long as there are more than enough individuals for a given value of a record identifier, the algorithm can keep doing aggregations. There have been improvements in this algorithm, with l-diversity and t-closeness, being safer from an implementation perspective for this logic to avoid any personal data identification.

3) Other methods – pseudonymization, scrambling, masking and cryptography based many other methods are in use today for data anonymization. Basic purpose of all these approaches is to alter the data in such a way, that the individual's data in a dataset, may not be revealing any information to trace back the individual and find out specifically, whose data is being presented.

D. DIFFERENTIAL PRIVACY WITH SYNTHETIC DATA GENERATION

This presents a unique approach in which the data from the original dataset is not taken after anonymization, but a deep learning [12] or another form or machine learning approach or a mathematical approach is taken to identify patterns in the data. Based on the identified patterns in the data, data elements are regenerated to retain those relationships. But the original data is not reproduced in the output. Such a method ensures that there is no way to recreate the original dataset with any accuracy, but at the same time, it is an attempt to keep the data relevant for use by machine learning algorithms, which need the relationship between the different attribute values as an input to infer meaningful output as a part of analysis.

E. WHAT'S ACHIEVED

Anonymization of data leads to alteration of data attribute values in order to protect the privacy of individuals and to avoid tracing back the individual, whose data is being observed. Such an operation also results in loss of utility of data. This loss of utility is a primary element in determining which method of anonymization should be selected. Even more evolved methods of data encryption like cryptography, appear to be appropriate in some of the cases. It is simply the post anonymization usage of data, which primarily drives the choice of method of anonymization, in combination with other elements like the source and type of data.

TECHNOLOGY – IS IT ENOUGH

In a paper submitted in Open Identity Summit in Bonn, 2019, authors argue that "Anonymization is dead, Long live Privacy". They advocate a paradigm shift, away from anonymization towards transparency, accountability and intervenability [13]. There have been several papers published on the topic of anonymization, over 500 papers in 2017 alone. Despite a lot of work in this area, for over 10 years, researchers have found that the top of class methods are still not able to make data fully anonymized, so that the individuals are not traceable back. There is a constant research also for algorithms to brake anonymity and de-anonymize information, proving that the methods are not sufficient in general and even methods considered sufficient, applied to some data, have been proved to be insufficient.

A. CONTEXT TO DATA

Overall, more than technology it is important to understand, what is being dealt with here. Data which is generated by individuals have their own writing styles, their own use of words, frequency of words and variety of words from a vocabulary. To represent the same emotion, different people may use a completely different term. Also, the same words used in a given context and environment/ group, may have a very direct meaning compared to usage of such words outside of that environment.

For example, use of the "man with a white hat" can be very specific to a person who always wears a white hat in a given office. Though white hat represents "information" in case of a "six thinking hats" method of discussion. Hence if a text is written as "man with a white hat was responsible for breaking a glass bottle on the way" – may reveal the identify of the person, if the statement is given by the employees of that office in our example. Though if the same statement is made by someone from outside that office, maybe on a road, it may not reveal any person's identity as white hat can be worn by anyone, walking on the road. Based on this example, it is easy to understand that whatever method of making the data not identifiable to personal level, it is very difficult to classify itself, which data can be personally identifiable, and context to data is very important, which is most of the time, not stored with data itself.

B. ENTERPRISE DATA CONTEXT

Other type of data, which is enterprise data, may not suffer from the same constraints as unstructured data, which is more in the form of text or comments. Enterprise data is more of structured data, which is generated by applications. These applications process personal information, for example an application to generate an invoice at a point of sales terminal in a shop, can process card information and attach it to the transaction, thus storing the card information and other details of purchase. This application would write the data to a database, where it can be stored and later retrieved for reporting purposes by the company, for example to report the total volume of products sold from the store or the total revenue generated by the store or any other information. Later on, in time, if the customer is returning one of the items purchased, the application would fetch the information on the transaction from the database and provide that service of return of product, to the customer. When these data are used by a company to analyse who are the customers of the company, the company can use this information. This data stored with the company can be used by the company for any purpose technically.

C. VALUE DRIVING MISUSE

Though this data about the customer can be misused too. For example, if a person is buying medicines for treatment of a disease, and this data is provided by the selling shop to external parties, then this can be used by other companies to market products to this person or the doctor, manipulating their buying decision. Also, if this data is sold to a political campaign manager, they can prepare customized incentives for this person, this can manipulate their voting patterns in an election. Technology can be used to anonymize this data. Then the owner of the data, which is the business selling medicine, may provide this data to an external company, which can analyse how many patients are in a given area, and may increase stock of medicines. But in no way, this external company would have any way to reaching the individual and manipulating his buying pattern. Also, if anonymized appropriately, the data can be provided to a political party for example, which can design a campaign to improve the condition of patients in a region in general but would have no way to manipulate the votes of an individual by reaching out to him for bargaining on incentives.

WHO BEAKS THE TECHNOLOGY – PROFIT SEEKERS OR MANIACS

Every method comes with its limitations and with the advancement of technology, different methods get outdated and need to be re-defined or modified. In case of anonymization as well, there has been several instances, where a completely unexpected anonymized data set has been used to reveal personal information.

A. METHODS OF ATTACK

Some of the identified methods of attack which are invented and documented work on the basic objective to make it possible to identify an individual from a dataset, where the specific individual is not mentioned. Linkage attack, Inference Attack, Homogeneity attack, background knowledge attack, social engineering attacks are a few of those. Some of them are described below with examples.

1) Linkage attack – in this type of attack, the data in an anonymized dataset, is linked with other dataset, where there is more personal information about the individual<ref8>. If the linkage is successful, the personal information of the individual, which is available in limited form in one place, can be linked to get much more information on the person. For example, date of birth of a person, if combined with the pin code of address of the person, this can form a very unique combination to identify an individual. Hence if data is published by a hospital with only the pin code and address of a person with details on what all diseases are being treated in a hospital for what age groups of people, then if combined with their published voter records, names can be obtained. And once names are obtained, health information including the types of disease for which the person has been treated can be inferred from the other dataset from hospital, making the anonymized data from hospital, deanonymized. This can adversely affect the individual.

2) Inference attack - [14] In this type of attack the information is inferred from another available information, with a high certainty. This type of attack is done with various data mining methods and data engineering techniques. For example, if the location of a person can be verified with certainty and it is a location of a home, it can be inferred who is the person. Hence other movements based on this location information, can be used to make an inference about the movement of a given person. There is certainly a need of distorting this information with noise in order to avoid inference attacks.

3) Homogeneity attack and background knowledge attack – these are more of data engineering attacks. When there is a lot of homogeneous information, meaning same value for a sensitive attribute in a dataset, with high certainty, this can be assumed to be true for any subject of the dataset. Hence, there is a possibility of deanonymization, even though the methods like k-anonymity would have been applied. Background knowledge attack is simple as it states. Having a knowledge of some of the data elements/ individuals, if it is possible to derive information about other individuals in the dataset, by using various data engineering techniques.

4) Social engineering attack – these attacks can be intrusive attacks, where a subject is prompted to provide personal information based on fake/ simulated tricks. Using this information, other information about the person can be revealed using their social media accounts, or corporate account or other digital accounts. For example, by calling an employee of an organization as the Information technology staff of the same company, attackers, can get access within an organization via his/her user id for that organization. Then the attackers can find out more information about the employee from this access of organization records about the employee. Also, they may gain access to the same information that the employee has in the that organization [15].

B. MOTIVE OF ATTACK

Motive of attack is am important consideration in preventing attacks as in case of any crime. The motive of attack, clearly hints the incentives to prevent attack. If the attack is done for profits, its for benefit of an individual not a society, but if the attack is done for no profits, who is behind the attack and what is the real motive, needs to be identified as it may be for a good reason.

1) PROFITS

With many of these attacks described above and other attacks, the objective of the attacker is to get information about an individual, which is not published. Using this information, the attacker, may gain a financial advantage, like withdrawing money from individuals accounts, blackmailing individual, to return some favors or bullying in general in the cyber space. There have been instances, where the whole institution has been put on hold by the attackers, who could muddle with data in such a way that the organization or the individual affected had to pay ransom to the attackers in order to get their data back. This was called ransomware attack and affected hundreds and thousands of users and organizations [16] as reported in 2017.

2) NOT FOR PROFITS

Apart from these direct attacks, which are for immediate benefit by the attacker, there are attacks, which were done for no profit seeking but only to prove that the method used for anonymization are insufficient. These kinds of attacks are done by intellectuals and researchers, in order to expose vulnerability in the system. At the same time, a lot of data is exposed but it gives an alarm to authorities to deploy other methods of anonymization to save individuals data [17]. This type of attack saves other attacks and misuse of data and help the practice of data security advance further.

WAKE UP TECHNOLOGY – CAN TECHNOLOGY BEAT TECHNOLOGY ALWAYS

Technology is created based on certain theories and research. Hence the attacks to break technology as well. There are several methods, created with accuracy, which cannot be broken down by attackers[18]. Things like hash algorithm, which were supposed to be unbreakable, could be broken with advanced power of computing, but new hash algorithms were created with more sophisticated technology and are not broken yet, like the HSA256. Similarly, the field of cryptography has seen a very successful history, with evolving practices and technology to safeguard data and its subjects. The researchers are ahead or the hackers, is always a question of subjective bias, as who is a researcher and who is a hacker. Though considering the geopolitical situation across the globe, it has been quite established fact that hackers are not different than the creators of technology. Something which is loss for one is seen as an opportunity by the other.

A. CASE WITH NO PERSONAL DATA

Netflix, a popular movie streaming service, published the comments on movies removing the individuals who have made those comments. Netflix assumed that by removing the individuals, there is no conflict with privacy. But in due course of time, researchers proved that with only little knowledge of the users from some other movie service, it was easy to identify the people who gave those comments on Netflix by Cross reference attack[19]. Do we call such an attack as an attack by Maniacs or by profit seekers?

Actually, this attack was done in 2006 and the attackers were not profit seekers but researchers. This attack prevented Netflix from starting their second similar challenge. In one way, it was an eye opener at its time and gave one of the first alarms on how sensitive data is and what seemed to be impossible can be easily possible.

B. CASE WITH UNIQUE ATTRIBUTES – SPARSE DATA

In a famous case in US, data of the Governor of Massachusetts [20], could be identified, with matching the Date of Birth and zip code of address for the person, against other identifiers for Mr. Governor like his filing for election etc. Just with this little information, it could be said with certainty that the person was Mr. Governor. As zip code and date of birth are not common. In a given area, with several people living, rarely two people are born on the same date. So just getting the zip code of the area and the date of birth of the person in one place can be misused to identify the person.

With different patterns for zipcode across the globe, some places, zip code is called, pin code, some places EIR code and some places with other name, and also the way zip codes are organized is quite different. For example, in Ireland, every individual house has its own EIR code. In UK, a small location has a given EIR Code, and in a location like India, a pretty large population has one PIN code. Hence this rule to match a date of birth with an address based code, may not be leading to a unique person in a data set. And there may be exceptions, but important point to note is that this can be as option to expose personal information. This is good enough to create safeguards, to avoid such an exposure. Can we say in this case, it’s the fault of technology, or maybe on a lighter note, the fault is for the state which allocates same address codes to more than one people born on the same date?

C. TECHNOLOGY – IS IT SUFFICIENT TO ENSURE DATA PRIVACY

What we advocate is that technology alone may not be enough, to provide a completely safe data security framework [21]. There is a human element, which drives the need of technology. There is a human element, which also drives the need of hacking this technology (so that hackers/ sole profit seekers cannot harm individuals). So, what is the resort to provide data security to individuals. Based on the discussion for a social drive turning into legal drive, it can be easily seen that society is definitely looking to provide more security to individuals, so that innovation can flourish. Vulnerable individuals are provided protection from the resource rich parties, in order to avoid any temptation of being tricked into giving up whatever they have in hope of leading a better life. Even then the cost they pay to better their lives is at times compromising their integrity.

D. TECHNOLOGY FOR TECHNOLOGY OR HUMANITY

Anonymization technology is designed in order to prevent and data privacy loss. But at the same time, its technology and has, as in most other cases, more than one purpose. Not only it has to protect data privacy, but also it has to retain usage of data after anonymization. For example, if all names and all personally identifiable information is removed from a dataset, like Date of birth, address, card number, any unique transaction value, transaction timestamp, and so on, the dataset, may be of no use as these would be needed to make any meaningful analysis of the interaction with this individual by the institution, which is storing this data and intends to analyse it. This make the anonymization technologies, vulnerable in one way or the other, as they have to ensure that the post anonymization utility of data is retained. This may clearly mean some sort of compromise for the method to be chosen. This itself may lead to attacks and may need additional steps to improve the effectiveness of method of anonymization [22] in order to protect data privacy in view of this vulnerability.

E. THE TIME FACTOR

If technology can always beat technology be true, it’s the time lag, which it takes between the creation and the breaking of a technology, which is the lifecycle of that technology. There has to be identified frameworks, which advocate the use and also evolution of technology in order to protect the privacy of individuals. Of course, putting legal directives can be one of the methods to keep check on what can be done by the resource rich parties, but at the same time, these guards have to be flexible enough, that the individuals can enjoy the benefits of technology.

What comes out to be important is not possibly a static framework but an evolving framework, which enables to keep in line with the latest technology and also enables the new innovations using these technologies.

WHY NOT PROFITS – WHO HATES MONEY

Entities storing information on individuals, often have great utility of this data, in order to drive efficient handing of these individuals as their customers. Also this vast amount of data they store can be used by these parties, in doing machine learning and other innovative solutions, which can drive efficiency and cost saving for these companies. The analytics on the dataset apart from the analytics needed for driving operations, may also be a source of income for these companies. Companies can provide many value added services by analysing the data of a group of individuals and using the conclusion from the wide data analysis to provide one individual with a value added service.

A. INTERNET FACILITATES AND CREATES VALUE

An example from data on internet can be that small information like what an individual is searching on a search engine, itself is good enough for a website to publish a relevant advertisement and make money from the advertisement. If a company can identify what triggers a user to buy a product by analysing their social media feed and their behaviour on internet, it can be a great deal for the company to increase their revenues from their customers. If an electricity supply company can predict the consumption of electricity of its customers, it would be in a very good position to save on its electricity purchase from the grid, saving it a lot of money. If a company can predict with a good accuracy the price of a product and the optimal volume which users would be happy to buy, the company can magically improve its margins.

B. WHAT IS THE URGENCY

Not that these things have never been done, these are done by companies all through these years. What is added with the new technologies – to handle big data, communicate in real-time with 5G, store massive amounts of data and retrieve with unlimited calculation potential with cloud computing, and compute month long calculations within seconds using quantum computing (the list goes on) – is a great potential to do more. Provide more value added services to individuals and at the same time reward the innovators, to promote innovation based societies.

C. WHAT TO DO BY PRIVATE PARTIES

'Other Parties' have to carefully select the methods to anonymize in order to ensure that the objective they intend to use data for, do not in any way affect any specific individual whose data is concerned. Also, in no way, there should be a possibility of identifying the individual at the end of analysis or via other methods of attack on anonymized data, to protect the individual. Once this has been achieved, the individual is no more vulnerable.

D. CONTRACTS INSTEAD OF CONSENT

This may or may not be possible for data in a public domain, though for data in a private domain, where the access to data is restricted, this can be definitely possible. Those who have access to such data, are bound by confidentiality agreements on data protection and use for only a specific purpose to perform their duties. In case of Enterprise data, it is common to have the data access pretty bound by the contractual agreements between the people who have access to data and the organization which holds ownership to that data. If an organization intends to use the information it has collected from individuals, for a purpose, for which the information has not been collected, the organization is restricted by laws in doing so. Moreover, if the purpose for which the organization wants to use this data is covered in the contractual agreements between the organization and the individual/ party, whose data is in question, then still, the access of this data has to be ascertained in such a way that there can be no harm/ disadvantage for the individual. Anonymization can easily provide the needed alteration in data in order to protect the individual in such cases.

E. WHAT REMAINS AFTER ANONYMIZATION

After this anonymization, if the data is suitable for any use, is definitely not the case. As the anonymization would alter the utility of data for post anonymization usage. For example, if the data is stripped of personal information like contact number, there is no way after anonymization to contact the individual, hence in this case, the data cannot be used as a basis of running a marketing campaign via phone. Though this data can still be used to find out other important facts about the marketing campaign. Segmenting the users, with random ids, can help the company find out what attributes are there for running a successful marketing campaign, based on the purchase history of these users, whose identity has been replaced with these random ids. Many other usage of this data are possible like in case of fraud detection, demand forecasting and likes.

F. WHO GETS THE REWARD

Innovation always comes with new usage and expectations never seen before. And the innovator in most cases expects a

reward for his/her innovation. The rewards can be in any form and may not be monetary. Innovations in general do not consider rules and regulations like the ones for data privacy. Innovations lead to new rules being formed in order to make the innovation benefit individuals in particular and society in general.

G. IS DECISION SCIENCE WORTH A SPECIAL MENTION FOR DATA SECURITY

With new set of tools in the recently prominent field of decision science also known as data science, there has been several new methods invented with the aim of discovering new information from data. Though business users and Enterprise has traditionally relied on data and experience to take informed decisions, decision science tools, have been quite instrumental in making this practice more and more scientific and transparent giving it a structure and repeatability, also substituting "experience" in some sense. The practice of creating machine learning models for a machine to learn from past data, is practically an attempt to replace experience in the traditional decision-making process.

Though this is still an emerging field of study and yet to find an acceptable place in day to day business of the Enterprise, this practice has created a high demand for data to be available for machines to learn. Such data has never been exposed to any individual who would design and review and prepare such machine learning algorithms. This has created a void, where technology is ready with a lot more to offer. But businesses cannot spare so much of data to this technology, due to restriction on data exchange and high risk in this valuable (including personal data) being misused. Anonymization can be a solution to fill this void and open new possibilities.

H. WHO MAKES MONEY

Companies which are leading in the field of machine learning are definitely leaving no stone un-turned to make it reach the masses. For example, the use of location data from individuals to provide accurate travel statistics to other in general using differential privacy to protect data privacy while still using this data generated by individuals [23]. Another example of Apple using differential privacy in ios10 to improve quick type and emoji suggestions and others [24] [25]. These companies have proved that the usage of anonymization techniques can definitely open new use cases and can benefit the individuals with innovations, at the same time ensuring data privacy.

I. CHANGING PARADIGM IN SOFTWARE WITH CLOUD ENVIRONMENTS

With the data increasingly residing in cloud environments, the importance of data security is further amplified. Most of the users of social media technology are not even aware of the fact that their data is available in public cloud environment. Though this does not pose any risk, but the recent breaches due to failed security standards maintained by companies on MongoDB [26] leading to compromise of several accounts clearly indicates a need of awareness.

Not only social media, but all the Enterprise companies, colleges and eventually everyone including governments as well, may move to cloud environments to store their data. All this not alone for technology adoption, but definitely for saving money too. Technology and innovation has always helped companies to save money. Money has always been a driver for innovation. Hence we cannot ignore the fact that data privacy can be taken as an excuse to restrict "other parties" from using the vast store of data they have for deriving more workable information, in order to benefit the individuals at the same time, making these other parties increase their profits and reward the innovators.

CONCLUSIONS

In this paper, we have analyzed the different aspects related to Data privacy in addition to the technology aspects. As data is never alone, but always has a meaning with a context, so is the technology for data security. The technology used to provide protection to the privacy of individuals, needs to be safeguarded with appropriate framework, in order to evolve itself. GDPR and other such framework being established form a good basis on data management. These frameworks do not have any dependence on technology. Also, they do not recommend or restrict any technology as long as the objectives set under the framework are met. Though the impact of such a framework is yet to be seen as individuals do not need the companies to pay fines, but more that the safeguards are adopted to protect individuals, without them even worrying about the same.

For public data availability, which is a primary responsibility of Govt. and other public entities, it is vital that not only the personal information, but also personally identifiable information is appropriately redacted or anonymized appropriately from the primary collected information. There is a constant need to keep a watch on the technology getting outdated. It is of paramount importance to keep updated with the latest technology in case of data anonymization. Would this also advocate removing some publicly available datasets, from time to time – maybe not, but for sure, keeping a close watch on the publicly available datasets and remove them, as soon as any vulnerability is reported by the researchers or the hackers. A proactive approach would always be the best under a defined framework.

When these OTHER parties, want to utilize the individual's data to improve their services in general and not specific to that particular individual, they need to anonymize the data. The 'other parties' cannot use the data from individuals for any purpose other than what the data was collected for, as per the data protection regulations like GDPR, CCPA and others across the globe. This clearly indicates that the companies and other entities storing information on individuals, must have proper safeguards in place to protect the privacy of individuals. The analysis of fines in the last 18 months under GDPR clearly indicates that the fines are not for the breach of technology, but for the non-compliance in general. The technology has proven to be enough only if all other safeguards are maintained by the organizations.

REFERENCES

[1] N. Nguyen, "Introducing Firefox Monitor, Helping People Take Control After a Data Breach," The Mozilla Blog.

[2] "2019 Data Breaches: 4 Billion Records Breached So Far." Norton, Security centre, emerging threats.

[3] J. Wright, "Teen blasted out of Rod Laver after 'Timebomb' tweet," The Sydney Morning Herald, 08-Jul-2013.

[4] X. Qiang, "The Road to Digital Unfreedom: President Xi's Surveillance State," J. Democr., vol. 30, no. 1, pp. 53–67, Jan. 2019.

[5] P. Voigt and A. von dem Bussche, The EU General Data Protection Regulation (GDPR). Cham: Springer International Publishing, 2017. [6] E. Goldman, "An Introduction to the California Consumer Privacy Act (CCPA)," Social Science Research Network, Rochester, NY, SSRN Scholarly Paper ID 3211013, Jun. 2019.

[6] G. Graham and A. Hurst, "GDPR enforcement: How are EU regulators flexing their muscles?," IQ RIM Q., vol. 35, no. 3, p. 20, Aug. 2019.

[7] D. Reinsel, J. Gantz, and J. Rydning, "The Digitization of the World from Edge to Core," p. 28, 2018.

[8] W. Vogels, "Eventually Consistent," Commun ACM, vol. 52, no. 1, pp. 40–44, Jan. 2009.

[9] S. Gambs, M.-O. Killijian, and M. Núñez del Prado Cortez, "Deanonymization attack on geolocated data," J. Comput. Syst. Sci., vol. 80, no. 8, pp. 1597–1614, Dec. 2014.

[10] L. Sweeney, Datafly: a system for providing anonymity in medical data. Database Security, XI: Status and Prospects, T. Lin and S. Qian (eds), Elsevier Science, Amsterdam, 1998.
[11] N. C. Abay, Y. Zhou, M. Kantarcioglu, B. Thuraisingham, and L.
[12] Sweeney, "Privacy Preserving Synthetic Data Release Using Deep Learning," in Machine Learning and Knowledge Discovery in Databases, Cham, 2019, pp. 510–526.
[13] J. Zibuschka, S. Kurowski, H. Roßnagel, C. H. Schmuck, and C. Zimmermann, Anonymization Is Dead – Long Live Privacy. Gesellschaft für Informatik, Bonn, 2019.
[14] J. Krumm, "Inference Attacks on Location Tracks," in Pervasive Computing, Berlin, Heidelberg, 2007, pp. 127–143.
[15] Department of Telematics Engineering, ETSI Telecommunication Technical University of Madrid, Madrid, Spain, W. Fan, K. Lwakatare, and R. Rong, "Social Engineering: I-E based Model of Human Weakness for Attack and Defense Investigations," Int. J. Comput. Netw. Inf. Secur., vol. 9, no. 1, pp. 1–11, Jan. 2017.
[16] Mohurle, Savita; Patil, Manisha, "A brief study of Wannacry Threat: Ransomware Attack 2017 - ProQuest." International Journal of Advanced Research in Computer Science; Udaipur Vol. 8, Iss. 5, May 2017.
[17] J. S. Yoo, A. Thaler, L. Sweeney, and J. Zang, "Risks to Patient Privacy: A Re- identification of Patients in Maine and Vermont Statewide Hospital Data," . October, p. 62.
[18] F. Liu and T. Xie, "How to Break EAP-MD5," in Information Security Theory and Practice. Security, Privacy and Trust in Computing Systems and Ambient Intelligent Ecosystems, Berlin, Heidelberg, 2012, pp. 49– 57.
[19] A. Narayanan and V. Shmatikov, "How To Break Anonymity of the Netflix Prize Dataset," arXiv:cs/0610105, Nov. 2007.
[20] D. Barth-Jones, "The 'Re-Identification' of Governor William Weld's Medical Information: A Critical Re-Examination of Health Data Identification Risks and Privacy Protections, Then and Now," Social Science Research Network, Rochester, NY, SSRN Scholarly Paper ID 2076397, Jul. 2012.
[21] L. Sweeney, "Weaving Technology and Policy Together to Maintain Confidentiality," J. Law. Med. Ethics, vol. 25, no. 2–3, pp. 98–110, Jun. 1997.
[22] R. C.-W. Wong, A. W.-C. Fu, K. Wang, and J. Pei, "Anonymizationbased attacks in privacy-preserving data publishing," ACM Trans. Database Syst., vol. 34, no. 2, pp. 1–46, Jun. 2009.
[23] "Tackling Urban Mobility with Technology," Google Europe Blog.
[24] "Apple Previews iOS 10, the Biggest iOS Release Ever," Apple Newsroom.
[25] H. B. Kartal, X. Liu, and X.-B. Li, "Differential Privacy for the Vast Majority," ACM Trans Manage Inf Syst, vol. 10, no. 2, pp. 8:1–8:15, Jul. 2019.
[26] DK Kola, S Barre, S Medipally, A Gaikwad, "Information governance failure in MongoDB," From the selective works of Dinesh Kumar Kola, University of Cumerlands, September, 2019.

6. EEHRP: Energy Efficient Hybrid Routing Protocol for Wireless Sensor Network

Nandkumar Kulkarni[1] Dnyaneshwar S Mantri[1], Ramjee Prasad[2]
Sinhgad Institutes Pune[1]
CTIF Global Capsule , Aarhus University, Herning Denmark[2]
{npkulkarni.pune[1],dsmantri[1]}@gmail.com, ramjee@btech.au.dk[2]

ABSTRACT

A key challenge in the Wireless Sensor Networks (WSNs) is to route the aggregated data from different applications to sink in an efficient and reliable way under mobility consideration for improving throughput, energy consumption and delay. In this context, the paper proposes efficient; delay tolerant Energy Efficient Hybrid Routing Protocol (EEHRP). The core of EEHRP is optimization of multiple metrics for selection of the best route. Multi-Objective optimization is a NP-hard problem from optimization theory. EEHRP tries to obtain a Pareto optimal solution for selecting the best route based on multi-objective optimization. Simulation results demonstrate that, EEHRP is energy efficient, has less delay as compared with state-of-the-art solutions.

Keywords- *Delay; Energy Consumption; Multi-objective; Routing; Wireless Sensor Network (WSN).*

INTRODUCTION

With increased application areas of WSN, the data handling requirements are demanding careful attention to reduce the energy consumption and minimize the latency in communication. Since nodes used for data collection and communication with proper route to the sink are scarce with energy, availability of communication bandwidth, computational speed and storage memory. Also the lifetime of the WSN depends on the energy usage during communication of aggregated packets to destination as sensor nodes consumes more energy in communication than computation and sensing. Also unlike with traditional networks like WI-FI it is difficult to change the energy source of sensor node in the WSN and is the most distinguishing attribute since depletion of node energy results to network failure. For applications in IOT where huge data is collected from different sources (non-smart and smart objects) need reliable transport to destination with efficient route. Hence, a proper balance needs to be achieved between the reliability and energy conservation for an efficient routing in WSN. The effort to choose the efficient route need to consider the single or multi-hop communication, time required to reach destination (transmission delay), energy consumption in deciding the path, the number of packets transmitted and the number of nodes involved in transmission [1].

WSNs are used to collect useful information from the applications. It is different from the other traditional network like ad-hoc and cellular due to First, WSN has large number of sensors deployed and difficult to get the global addressing hence it is important to deal with data rather than its identification. Second, mass data communication happens in one and multi-hop from source node to Cluster head and finally to sink. Third, the nodes used for sensing and communication are scares with resources like energy, memory and communication bandwidth. Fourth, Mobility of nodes in the network increases the overheads with energy depletion and reduces the life-time. Fifth, WSN are application specific and data collected will be based on common phenomenon with increased redundancy [2-3].

The potential sources of energy consumption and delay is the collisions due to multipath data propagation, when a receiver node receives more than one packet at the same time. All packets that cause the collision have to be discarded, and the re-transmissions of these packets increase the energy consumption. Also, the delay introduced in retransmission of packets needs to be calculated for performance evaluation. As the packets generated by the nodes are of different in numbers and, they are routed to BS in the different time slot [2 - 4].

The different methods used to reduce energy consumption during finding the shortest route may include duty-cycled scheduling and synchronization of routes which does not guarantee the efficient and reliable delivery in time. In this connection, with increased data handling capacity and finding the efficient route in terms of reduced latency, energy consumption, and routing overheads, demands for the development of lightweight multi-objective protocol. With increasing demand of applications with energy saving and reduced latency in communication, Multi–objective routing is a promising technique to achieve the better QoS parameters in WSN. Furthermore, this novel routing can also guarantee the minimum delivery latency from each source to the sink. The policies of routing in WSNs are impacted by countless thought-provoking issues. These issues must be overthrown prior to effective communication in WSNs. Node placement, Energy concerns, Data transfer model , Node/link heterogeneity, Fault acceptance, Scalability, Network activity, Transmission means, Association, Exposure, Data accumulation[5].

The focus of paper is elaborated with different sections as; section II presents an overview of related works focusing on the requirements of Multi-objective in WSN-IOT. Section III gives information about proposed EEHRP. Section IV describes assumptions and system model. Section V and Section VI describes the energy and mobility models of EEHRP. Section VII discusses simulation setup and results, and finally paper is summarized with fruitful conclusion in section VIII with future work.

RELATED WORK

Many researchers based on various, criteria, design issues and applications in order to increase energy efficiency have proposed several multi-objective routing protocols [4]. Nevertheless, no routing protocol is ideal, which can be used the different routing schemes are proposed in [6] with different addressing scheme on the basis of location, structure and working methods. In [7], the lightweight routing protocol (LNDIR) is proposed which works on the state of nodes radio. It adjusts the duty cycle while scheduling the activities of nodes in the network to achieve minimum latency with increased energy efficiency. In [8], author proposes the method to reduce the communication delay and overheads between source node and destination with congested network. It also takes into account the routing paths while transmitting the data. Multi-Objective Evolutionary Algorithm based on Decomposition (MOEA/D) [9] is intended to resolve the energy preservation, MOP problem simultaneously by means of precise awareness about problem specific knowledge and Euclidean distances amongst the weight vectors. AACOCM [10] proposes a multi-objective model based on energy consumption, network delay, and packet loss rate for route optimization AACOCM attempts to lessen energy, delay, and PLR. Functioning of AACOCM is dependent on ordinary-, greedy-, unusual- ant nodes. Here routing tree is built, data is transmitted and feedback is taken from destination. As convergence ratio is more, AACOCM is appropriate for the large-scale network. [11] Proposes scalable, multi-objective framework based on native awareness of every node where routing is determined by Source_id, Unicast/Multicast, LRC and Purpose. LRC and RO is eliminated by avoiding low-energy, hazardous areas. Simple Hybrid Routing Protocol (SHRP) [12] chooses the finest route built on the metrics such as hop-count, LQI, and Residual-energy. In SHRP, the route is updated if there is a variation in the value of the metrics or periodically Typically, SHRP prefers a route that has smaller hop-count and larger Residual-energy. SHRP tackles the fragile connection and dead neighbor problem using LQI. DyMORA [13] is an extension of SHRP which is banking on multi-objective hybrid strategy and Hierarchical Routing Algorithm (HRA). DyMORA makes fewer comparisons for selecting Pareto optimal route. Due to MO mechanism it needs more processing time.

EEHRP: ENERGY EFFICIENT HYBRID ROUTING PROTOCOL

Most of the conventional routing protocols direct the data based on single metric. They adopt a policy where a threshold is set for a metric as a reference. A fraction of total number of nodes is responsible for sending the data from source to the base station and other nodes are in the sleep mode. This strategy causes quick exhaustion of the energy amongst the energetic nodes. In due course, these energetic nodes will exhaust their energy and will become inactive. This phenomenon will end up with a partitioned network. To alleviate this problem EEHRP takes on route selection based on multiple metrics. Optimization of multiple metrics simultaneously helps to balance the energy amongst various nodes in the network with different paths available from source to base station. The proposed EEHRP tries to find out the optimal route based on a fitness function derived from multiple metrics such as energy, overhead, response time LQI, hop count. The fitness function is given by the following equation [5].

$$f(nij)=\alpha.m_{energy}(n_{ij})+(1-\alpha).[\ \beta.m_{overhead}(n_{ij})+(1-\beta)$$

$$[\gamma.m_{rtime}(n_{ij})+(1-\gamma)[\delta.m_{lqi}(n_{ij})+(1-\delta)[\eta.m_{hops}(n_{ij})]]]] \text{ ------------- } (1)$$

Where α, β, γ, δ, ε are weighing factors.

ASSUMPTIONS, SYSTEM MODEL OF EEHRP

A. ASSUMPTIONS TO IMPLEMENT EEHRP:

Node Assumptions

- All nodes are homogeneous.
- Nodes don’t have GPS capabilities.
- Every single node has a UID.
- The Base Station (BS), CHs are static and few nodes (20% of the total no of nodes) are mobile.

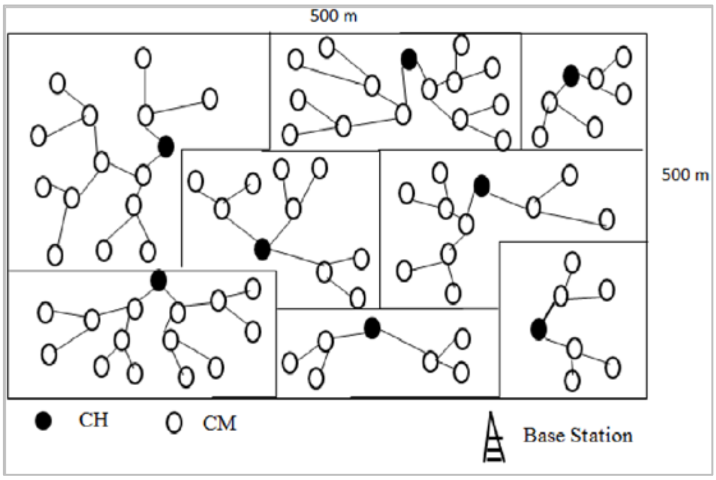
Network Assumptions

- There is a single BS in the network.
- The network is divided into clusters; every cluster has a CH and CM.
- CH election is based on the outcome of multi-objective function.
- Within the clusters a BHT is formed by all the CMs the root of the BHT is a CH.
- Intra cluster communication is single hop.
- The links are bidirectional.

B. SYSTEM MODEL OF EEHRP:

The whole target territory is split into tiny clusters. Every cluster has CH and CM. The sensor nodes are indiscriminately placed within the objective territory and that they are immobile. All the sensor nodes are similar regarding initial energy. The CMs are accountable for sensing the events within the close region. Every one of the CMs goes with themselves for choosing the CH. The CMs communicate solely with the CH of that cluster or the CMs of the similar cluster. They’re not allowed to speak to CMs or perhaps CH of the opposite cluster directly. The CHs have a second level of hierarchy. The CHs can connect with the CHs of another cluster. The Base Station (BS) could be a high-energy node arranged far from the topographic point. The CM, CHs and the sink node are immobile. At the outset, the density of sensor nodes within the topographic point is very high because it helps for the cluster based routing.

As appeared in Fig. 6-1, WSN is exhibited as a graph (G). Here, the vertices of the graph are nothing but sensor nodes. The graph G= (V, E) where V= {V1…..Vn} is set of vertices, and E {(ni, nj) Vi X Vj | i ≠ j} is a set of edges between vi and vj. The intra-cluster and the inter-cluster communication is categorized into different levels of hierarchy. At the first level in the hierarchy, CMs within the cluster elect a CH based on a fitness function mentioned in section III. The CMs will logically organize themselves like a BHT. As we move, up in the BHT the value of the fitness function increases. The root node of BHT is CH. The procedure is repeated for every cluster. After consecutive rounds of communication, the role of CH is switched among the various CMs to balances the energy within the entire network. At the second layer of the hierarchy, all the CHs will organize themselves into BHT and the process is same as that of intra-cluster communication. The designated CH will forward the accumulated data to the BS.



Figur 6-1 A Clustered Wireless Sensor Network

EQUATIONS OF ENERGY-EFFICIENCY OF EEHRP

Each node is non-rechargeable and has the opening energy of E0. Energy depletion while transferring a packet beginning with ith node to jth node uses a free-space as well as multi-path fading model banking on the distance amongst source and target. The source and target node has radio electronics for energy depletion. Depending upon distance and whether a node is a child or parent node in BHT the energy depletion varies for all packet of size Ps.

When the child node transfers Ps bytes of data, then the energy depletion is specified as: (Ref. eq. 1 to 5) [14]

$$E_{DISSI}(N_i)= E_{elec}*P_s+ E_{amp}*P_s*\|d_{ij}\|^4 \ if \ \|d_{ij}\| \geq d_0 \text{ ----------- } (1)$$

$$E_{DISSI}(N_i)= E_{elec}*P_s+ E_{amp}*P_s*\|d_{ij}\|^2 \ if \ \|d_{ij}\| < d_0 \text{ -------------- } (2)$$

Where, E_{elec} is electronic-energy centered on coding, distribution, modulating, filtering and amplification. d_{ij} is the distance amongst i^{th} and j^{th} node. When the j^{th} node accepts the packet of size P_s the energy dissipation is specified as:

$$E_{DISSI}(N_j)= E_{elec}*P_s \text{ --------------- } (3)$$

The energy cost of all nodes is amended after transferring or reception of packet of size P_s.

$$E_{remain+1}(N_i)= E_{remain}(N_i)- E_{DISSI}(N_i) \text{ --------------- } (4)$$

$$E_{remain+1}(N_j)= E_{remain}(N_j)- E_{DISSI}(N_j) \text{ --------------- } (5)$$

The procedure of data transferal and energy cost amendment is recurrent until every node is dead.

EQUATIONS OF MOBILITY-AWARENESS OF EEHRP

In EEHRP, movable nodes are well thought-out to be traveling alongside a one-dimensional territory also the pause-time of the nodes are exponentially disseminated. EEHRP utilizes Random-Way-Point (RWP) model for mobility. In this model interval for the travel phase is governed by endpoint and speed. The end-users don't have control on this. The following section illustrates thru mathematical equations how the mobile state dissemination go forward over time.

Notations

[a1, au] – Area where the sensor node can travel

λ - Exponential distributed pause time

d – Destination Point

r(d) – Random Distribution

V_{max} – Upper bounded Speed

K(t) – Instantaneous State of the node

$\emptyset$(t) – Instantaneous Phase of the node either {Move or Pause}

A(t) – Instantaneous Position belongs to [a_1, a_u]

V(t) – Current Speed belongs to [$-V_{max}$,V_{max}] in case $\emptyset$=move

D(t) – Current destination belongs to [a_1, a_u].

P(a, v, d, t) – Cumulative probability at time t in case $\emptyset$=move

Q(a, t) – Cumulative probability at time t in case $\emptyset$=pause at position A(t)∈[a_1, a]

When the mobile node move in the region a first they select d according to r(d). Then they select the speed permitting to the distribution $f_V(v|d,a)=0$ for v>0. $f_V(v|d,a)=0$ belongs to the interval [$-V_{max}$, V_{max}],∀ d,a. the dynamism of the mobile node can be described in terms of Markov-Process in which K(t) is characterized by$\emptyset$(t)∈ $\emptyset$={move,pause}. The probability at time (t) of a mobile node is (Ref. Eq. 6 – 13) [15]

$$P(a,v,d,t) \triangleq \emptyset r\{\emptyset(t)=move, A(t)\in[a_1,a], D(t)\in[a_1,d], V(t)\in - V_{max}, v)\} \text{ ------------ (6)}$$

$$Q(a,t) \triangleq \emptyset r\{\emptyset(t)=pause, A(t)\in[a_1,a] \text{ ----------- (7)}$$

Introducing the densities

$$p(a,v,d,t)= \frac{\partial 3P(a,v,d,t)}{\partial a\ \partial v\ \partial d} \text{ ------------ (8)}$$

$$q(a,t)= \frac{\partial Q(a,t)}{\partial a} \text{ ------------ (9)}$$

Subsequent pair of equations can be obtained

$$\partial p(a,v,d,t)\partial t = -v\ \partial p(a,v,d,t)\partial a+ \lambda\ fV(v|d)r(d)q(a,t) \text{---------- (10)}$$

$$\partial q(a,t)\partial t = \lambda q(a,t)+ \int v\ p(a,v,d,t)\ dv \text{ ----------- (11)}$$

Boundary Situation

It depicts the chance of a mobile node hitting the boundary is null

$$p(a_l,v,d,t)=0\ ;\ p(a_u,v,d,t)=0\ \forall\ v,d,t \text{ ------------ (12)}$$

$$s(a_l,t)=0\ ;\ s(a_u,t)=0\ \forall\ t \text{ ------------ (13)}$$

The initial situation

$$p(a,v,d,0)=p0(a,v,d)\ ;q(a,0)=s0(a) \text{ ------------- (14)}$$

Which is an appropriate pdf for mobile node's original position, speed, and endpoint. The procedure for building neighborhood relationship is given in Fig. 6-2.

A. EEHRP FLOWCHART

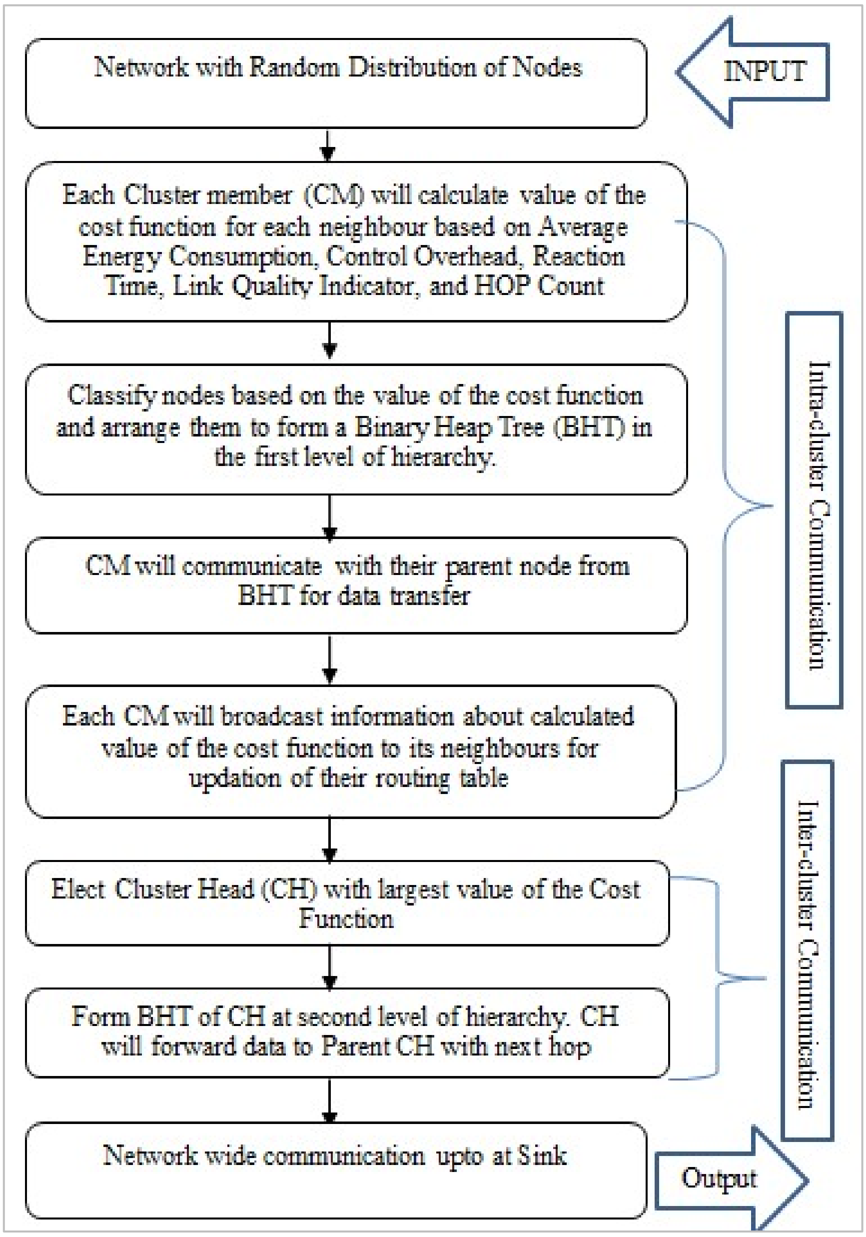


Figure 6-2 Flowchart of EEHRP

SIMULATION AND RESULT ANALYSIS

The simulation is carried out using Network Simulator (ns2.34). The aim of the simulation is to comment on the QoS parameters and compare the Throughput, Average Residual Energy (ARE), and End-to-End delay, Control Overhead in EEHRP, SHRP, and DyMORA[13]. SHRP is not multi-objective but uses single value metric and used to validate the performance of EEHRP, following simulation parameters stated in Table 6-1 are used.

Table 6-1 SIMULATION PARAMETERS

Wireless Physical	
Network interface type	Wireless Physical
Radio propagation model	Two-Ray Ground
Antenna type	Omni-directional Antenna
Channel type	Wireless Channel
Link Layer	
Interface queue	Priority Queue
Buffer size (ifqLen)	50
MAC	802.11
Routing protocol	EEHRP, DyMORA, SHRP
Energy Model	
Initial energy (Joule)	20
Radio Model	TR3000
Idle power (mW)	13.5
Receiving power (mW)	13.5
Transmission power (mW)	24.75
Sleep Power (µW)	15
Node Placement	
Number of nodes	50, 60, 70, 80, 90 and 100
Number of sink	1
Placement of the Sink	Bottom right corner of the simulation area
Placement of nodes	Nodes are placed randomly in the given area
Node placement	Random
Number of simulation runs	10
Miscellaneous Parameters	
Area(m)	500 * 500
Simulation time (s)	2000
Packet size (bytes)	64
Hello Interval (s)	5
CH Election Interval (s)	20
Packet Interval (s)	0.2
Mobility	20% nodes are mobile

A. THROUGHPUT

Throughput is a degree of how quick data can be send through a network. Fig. 6-3 demonstrates the throughput of EEHRP, SHRP, and DyMORA. The reason why throughput of EEHRP is higher than DyMORA and SHRP is the hybrid nature of the protocol. For development of EEHRP multiple metrics are optimized simultaneously from different layers of WSN. EEHRP has throughput higher by a factor of 39.19 % and by a factor of 22.71% with reference to SHRP and DyMORA respectively. The throughput endorses the efficiency of EEHRP for data forwarding.

B. AVERAGE RESIDUAL ENERGY(ARE)

ARE is a ratio of sum of the residual energy of different nodes to the sum of total number of nodes. Fig. 6-4 shows the average residual energy. ARE of EEHRP is higher than DyMORA and smaller than SHRP in quite a few conditions due to tiered grouping. EEHRP beats DyMORA by a factor of 7.7 % and SHRP by 9.2 % in terms of ARE. This conservation of energy prolongs the life expectancy of the system and proves the usefulness of EEHRP.

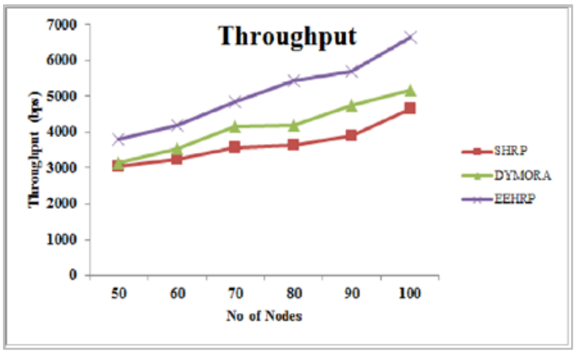


Figure 6-3 Throughput

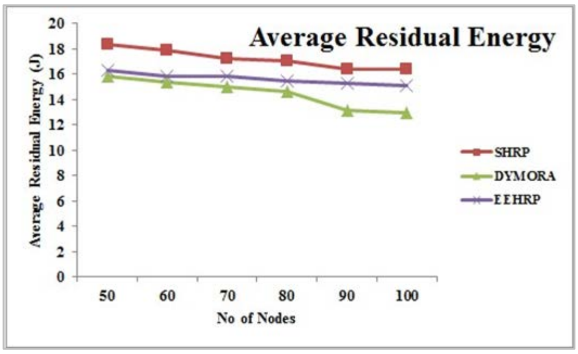


Figure 6-4 Average Residual Energy.

C. END-TO-END DELAY

The end-to-end delay (delay) is the time variance between the first data packet a source node produces after identifying an event and the time the data packet is received at the sink.. Since EEHRP uses reaction time as one of the optimization metric for finding the best route, the delay is less by a factor of 24% contrasted with DyMORA. SHRP is better protocol compared with EEHRP in terms of delay by 16.22% as seen in Fig 6-5.

D. CONTROL OVERHEAD (COH)

COH is the number of control packets essential for network communication. Fig. 6-6 illustrates the comparison of COH. EEHRP has lesser COH than DyMORA and greater COH than SHRP. SHRP picks the finest route centered on a single metric and is not a true MOHR protocol. Additionally, EEHRP is efficient in terms of COH equated with DyMORA. EEHRP improves COH by a factor of 10.85% as equated with DyMORA.

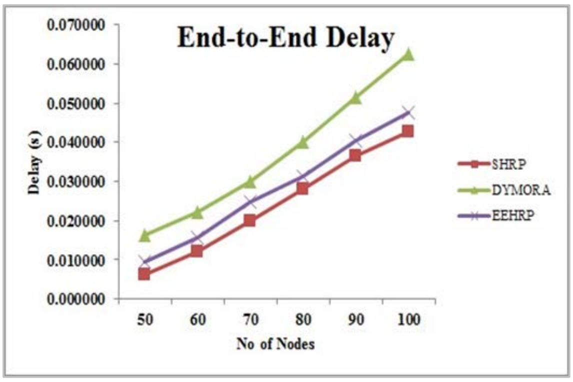


Figure 6-5 End-to-End Delay

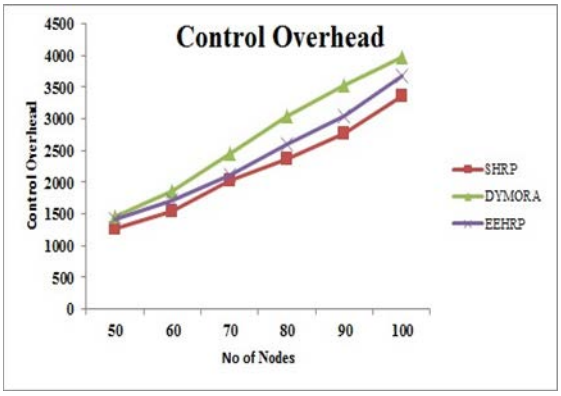


Figure 6-6 Control Overhead

CONCLUSIONS AND FUTURE WORK

This paper put forwards a novel QoS guaranteed energy competent Multi-Objective Routing Protocol called EEHRP for WSNs. The foremost aim of EEHRP is to pick best path up to base station reliant on multi-objective principles. EEHRP is verified and compared with SHRP, and DyMORA. EEHRP is better protocol in terms of energy efficiency, throughput, control overhead, and delay with reference to SHRP and DyMORA. The routing protocol can be further tested by replacing homogeneous sensor nodes with heterogeneous and by assigning mobility to them.

REFERENCES

[1] J. Al-Karaki and A. Kamal, “Routing techniques in wireless sensor networks: a survey”, IEEE Journal, Wireless Communications, Vol. 11 , Issue 6, pp . 6-28, DOI - 10.1109/MWC.2004.1368893, 2004.

[2] N. Pantazis, S. Nikolidakis and D. Vergados, “Energy-Efficient Routing Protocols in Wireless Sensor Networks: A Survey”, IEEE Journal, Communications Survey and Tutorials, Vol.15, Issue 2, pp. 551-591, DOI- 10.1109/SURV.2012.062612.00084, 2013.

[3] N. Magaiaa, N. Hortab, R. Nevesb, P. Pereiraa and M. Correia, “A multi-objective routing algorithm for Wireless MultimediaSensor Networks”, ELSEVIER Journal, Applied Soft Computing, vol - 30 pp. 104–112, DOI- 10.1016/j.asoc.2015.01.052, 2015.

[4] M. Bala Krishna and M. Doja, “Multi-Objective Meta-Heuristic Approach for Energy-Efficient Secure Data Aggregation in Wireless Sensor Networks”, Springer Journal , Wireless Personal Communication, Vol. 81, pp, 1:16, DOI 10.1007/s11277-014-2114-3, 2015.

[5] N. Kulkarni, N. R. Prasad and R. Prasad, “G-MOHRA: Green Multi-Objective Hybrid Routing Algorithm for Wireless Sensor Networks”, International Conference on Advances in Computing, Communications and Informatics (ICACCI), New Delhi, India, pp. 2185 – 2190, DOI- 10.1109/ICACCI.2014.6968329, 2014

[6] Shabbir, N., & Hassan, S. R. (2017). Routing Protocols for Wireless Sensor Networks (WSNs). Wireless Sensor Networks - Insights and Innovations. doi:10.5772/intechopen.70208

[7] Shahzad, M. K., Nguyen, D. T., Zalyubovskiy, V., & Choo, H. (2018). LNDIR: A lightweight non-increasing delivery-latency interval-based routing for duty-cycled sensor networks. International Journal of Distributed Sensor Networks, 14(4), 155014771876760. doi:10.1177/1550147718767605

[8] Kuntz, R., Montavont, J., & Noël, T. (2011). Improving the medium access in highly mobile wireless sensor networks. Telecommunication Systems. doi:10.1007/s11235-011-9565-6.

[9] S. Özdemir, B. Attea and Ö. Khalil, “Multi-Objective Evolutionary Algorithm Based on Decomposition for Energy Efficient Coverage in Wireless Sensor Networks”, Springer Journal , Wireless Personal Communication, Vol. 71, pp, 195–215, DOI 10.1007/s11277-012-0811-3, 2013.

[10] X. Wei and L. Zhi, “The multi-objective routing optimization of WSNs based on an improved ant colony algorithm”, 6th International Conference on Wireless Communications Networking and Mobile Computing (WiCOM), pp. 1-4, DOI-10.1109/WICOM.2010.5601072, 2010

[11] S. Bhunia, S. Roy and N. Mukherjee, “Adaptive Learning assisted Routing in Wireless Sensor Network using Multi Criteria Decision Model”, International Conference on Advances in Computing, Communications and Informatics (ICACCI), New Delhi, India, pp. 2149 – 2154, DOI- 10.1109/ICACCI.2014.6968354, 2014

[12] D.Mahjoub and H.El-Rewini, “Adaptive Constraint-Based Multi-Objective Routing for Wireless Sensor Networks”, In Proceedings of IEEE International Conference on Pervasive Services, Istanbul, pp. 72–75, 2007.

[13] G. Valentini, C. Abbas, L. Villalba, and L. Astorga, “DyMORA :A Multi-Objective Routing Solution Applied on Wireless Sensor Networks”, IET Communications, Volume. 4, Issue. 14, pp. 1732–1741, 2010.

[14] R. Kumar, D. Kumar, “Multi-objective fractional artificial bee colony algorithm to energy aware routing protocol in wireless sensor network”, Springer, Wireless Networks, Vol. 22(5), PP. 1461–1474, 2015

[15] M. Garetto, E. Leonardi, "Analysis of Random Mobility Models with Partial Differential Equations", IEEE Trans. Mobile Computing, vol. 6, no. 11, pp. 1204-1217, Nov. 2007.

7. CoAP based Energy-aware Cluster-based Mobility Management Protocol in WBAN Health Care Environment

Mrinai M. Dhanvijay, Research Scholar, Department of Technology, Savitribai Phule Pune University, Pune, India
mrinai@yahoo.co.in
Shailaja C. Patil, Professor, Department of Electronics and Telecommunication Engineering, Jayawant Shikshan Prasarak Mandal's, Rajarshi Shahu College of Engineering Pune, India
shailaja.rscoe@gmail.com

ABSTRACT

The Wireless Body Area Network (WBAN) is the interconnection of tiny sensor nodes which is fixed or incorporated within the human body. Sensors are used to sense the biological factor of the human body like pulse rate, temperature, blood pressure, etc. These sensor nodes are integrated with a limited source of energy. The power consumption of these sensor nodes has to be reduced in order to enhance the lifetime of the network. The proposed CoAP (Constrained Application Protocol) based Energy-aware Cluster-based Mobility management Protocol (CoECMP) is designed to reduce energy consumption by creating a cluster head (CH) for a group of a cluster. The modified firefly algorithm is proposed to optimize the effective cluster head (CH) using the parameters like residual energy, distance, path loss and node density. These optimized cluster heads collects the information from the member nodes and forward the information to the client (caretaker or doctor) via WMMS (Web-of-things Mobility Management System). The proposed protocol is very much effective in reducing the energy consumption and increasing the lifetime of the network. The mobility management using handover operation is also employed when the patients move from one Base station to another base station. The numerical analysis and the result impose performance and the proposed scheme has been simulated in terms of network stability, network lifetime, and residual energy. The experimental result shows that by using the proposed protocol the energy consumption by the nodes has been reduced when compared with the previous existing protocols.

Keywords—*Cluster Head selection, cluster formation, energy consumption, Firefly Algorithm, WMMS (Web-of-things Mobility Management System), Hand over*

INTRODUCTION

Nowadays there is tremendous growth in healthcare monitoring of mobile patients using compact wireless sensor nodes [1]. Wireless sensor nodes play a vital role in health care environment. It is a platform that provides status, location, and tracking of patients. WSN provides a guaranteed infrastructure for tracking both the users and assets [2]. In WBAN, nodes are capable of expensing vital body signs such as, temperature, blood pressure, sugar level, location, heartbeat, oxygen level etc. WBAN can easily monitor aged, handicapped and people in coma stage [3].

This network interacts with IoT (Internet of Things) which means that these sensor nodes make links with internet; WBAN starts to transmit and receive signals, which reduce human interventions, which makes it very helpful to save the life of a patient in emergency conditions [4]. These sensor nodes are wearable in fashion and it transmits both the health condition and general information about the patient. The information exchanged between WBN is very sensitive and security is a main constraint [5].

In real-time, WBAN sensors sense the signs of the patient along with the biological factor and it processes and transmits it to the sink node. Doctors will access the condition of the patient through the sink node [6]. In this WBAN, the patients may change their position and location hence WBAN is not a fixed network. WBAN is separated into inter, intra and beyond WBAN communication based on their location in the human body. [7].

In these nodes, power consumption is a challenging factor and a wide range of health monitoring is assisted and the devices are equipped with limited capacity. Energy limitation is the main factor that makes the usage of WBAN [8] less. According to the application, these tiny sensor nodes are implanted inside or outside the body.

The energy consumption of the nodes fixed on the body is more compared to that of nodes fixed inside the body. MAC protocols are implied to increase the lifetime of the network. Delays and packet loss also leads to decrease in the network lifetime [9].

These sensor nodes are powered by batteries and the lifetime of these batteries is an important factor; for exampleimplanted nodes like pacemakers require at least five years of a battery lifetime. In this application, the power consumption is important to increase the lifetime of the WBAN. Several MAC protocols designed for the energyefficient reliable data transmission has poor efficiency [10] These MAC protocol based on Quasi sleep prompt algorithm used the sleep mode of the nodes in WBAN which reduces the energy consumption. This algorithm can be adopted only for fewer applications [11].

Previously Low energy clustering adaptive hierarchy (LEACH) was implied for energy consumption. The wireless sensor nodes fixed on the patient were grouped to form a cluster and one node acted as a cluster head and the other nodes were member nodes. These member nodes send the vital signs to the cluster head (CH) and the CH transmitted the vital signs of the patient to the Base station which lead to less energy consumption [12]. In this paper, the proposed system CoAP based Energy-aware Cluster-based mobility management (CoECMP) protocol is cluster-based and it will first identify the effective clustering heads using the modified firefly algorithm and then member nodes join the CH according to their threshold. Then the cluster head node of each cluster transmits the information to the base station and in this method the power consumption is less.

The contribution of this paper includes,

- The elaborate design of CoECMP and a detailed process of information transferring process from the sensor nodes to the client.
- The newly adopted modified firefly algorithm is used for the cluster head selection and the energy consumed is reduced.
- Mobility management is implemented using hand over operation.

The systematic work is arranged as shown here: the section 2 describes about the related works in clustering of sensor nodes in WBAN. The section 3 illustrates about the, proposed cluster based CoAP-ECMP model. The section 4 deals with the results and discussion about the proposed work and section 5 describes about the conclusion.

RELATED WORKS

In WSN, the energy consumption is a great issue, because of low power batteries that are installed in the sensor nodes. The related works are summarized below, based on the clustering techniques without power consumption.

Anguraj DK et al. [13] introduced a Multi-Objective Firefly Algorithm (MOFA) in which the parameters, delay and throughput were used to select the CH. If the distance was increased the attractiveness got reduced. The attractive nodes moved towards a cluster Head to form a cluster. Member nodes send the information to cluster heads and the cluster heads forward it to the sink node and then to the hospital database. This scheme identified malevolent nodes and data transmission occurred. Even though, the energy of the malevolent nodes soon got reduced, there was a network failure associated with it.

Choudhary et al. [14] proposed an Energy budget based multiple attribute decision-making algorithm (EB-MADM). In this cluster head selection was based on, the node residual energy, the node connectivity, and the node proximity. A sensor node sensed the data and transmitted it according to two conditions; they are-data should be different from the previous one and out of threshold limits. Thus the redundant bits were removed from the transmission. These methods reduced the data traffic and increased the throughput, even though; the delay is higher during the emergency data transmission.

Saha S et al. [15] presented a clustering scheme in which nodes listened to the medium if there was any ongoing transmission. When the nodes detected the cluster head within its range, the regular operation got started. When more than one beacon was heard the node which is very close to high receiving power is assigned as cluster head. When no beacon is heard least noisy frame will be selected to transmit its beacon signal till the timer is expired.

During this period, if a beacon was heard timer stops and automatically starts the normal operation. Once the timer expired, the node assigns the position of cluster head and sends the beacon signal. This reduced some defects of clustering and it utilized the bandwidth. Still, this scheme failed to consume the energy of the sensor nodes.

Jamshidi M et al. [16] proposed an algorithm with two phases; they were scan phase and an examination phase. In the scan phase, the CH calculated the average distance. Then CH scanned the member table of member nodes with greater than average distance and saved it in a list called suspicious list. In the second phase, CH selected an experimental sample (ES) whose distance was more from CH; then each cluster heads sends the ES to other cluster heads. Every CH stored the ES of its own and other CH in a list called ES list. The cluster head with maximum distance was selected as a malicious node. All the cluster heads transmitted the information to this malicious node and this node sends the information to the base station. Malicious node would transfer the information of all other nodes continuously which lead to drop down of energy very soon.

Sundararaj V et al. [17] presented a variable step size firefly algorithm (VSSFFA) using the parameters such as headcount, node degree, energy and distance. The fireflies are unisex and it attracts using the brightness. When the distance reduces the brightness increases and it decreases with the increase in distance. The low brightness nodes move towards the brighter nodes to form a cluster. The fitness function of CH was evaluated based on distance, residual energy, node degree, and headcount. The best location was chosen using these attributes and the sensor which was near to the best location was assigned as the cluster head. These cluster heads sends messages to the other nodes in the specified area and form a cluster using the request and accept messages. Now the cluster head transmits the information to the base station. The cost of placing the header node was reduced in this method, even though there was some unnecessary energy drainage.

Ullah Z et al. [18] proposed a Dual Sinked Software defined Networking approach using clustering in a BAN. In this, two sink nodes were used in a human body and all other sensors fixed on the body formed two clusters under these sink nodes S1 and S2. These sink nodes had good battery power, memory, and transmission power compared to other sensors fixed in the body. If any of the critical data was sensed by any of the sensors in the body then it transmitted the critical data to the sink node, which means; to the cluster head. These sink nodes would send the information to the base station. This concept improved throughput and delay but there were little gaps regarding energy consumption.

Isabel RA et al. [19] presented an Improved Evolutionary Particle swarm optimization (IEPSO). The aim of this algorithm was to make the fittest node as a CH. PSO is that concept in which head searches for the food spot and the birds altogether move towards that spot. In this, the fittest node is obtained by the entire location they move. The main goal of this algorithm was to position the CH nodes in the best possible position. This CH node collected data from the cluster and transmited it to the base station. The energy dissipation was quite high due to alive of nodes in the entire transmission.

Ullah Z et al. [20] proposed an E-HARP (Energy efficient Harvested-Aware clustering and co-operative Routing Protocol) focused on energy efficiency and on the path loss of the sensor nodes which was fixed on the patients. In this, the sensor nodes fixed on the human was grouped into two clusters using two fixed sink nodes. These sink nodes collected the information from the cluster heads and forwarded it to the client via the base station. The sensor node in this WBAN harvested energy from the solar and on behalf of this energy the network lifetime increased. Moreover, there is a little gap in fulfilling the reduction of energy consumption.

In the previous papers regarding the energy consumption in WBAN the authors considered only the network lifetime using the sleep and alive nodes. The sensor nodes in WBAN were designed with limited power and the energy was maintained for the entire communication to save the life of the patient. For this purpose, the proposed CoAP based Energy-aware Cluster-based mobility management (CoECMP) protocol was implemented in which the sensor nodes of the patients were grouped under a cluster head (CH). These CH nodes collected the information from the member nodes and forwarded it to the client-side via WMMS. Using this, the energy consumption of the nodes got reduced by grouping the nodes under CH. The energy efficient nodes were selected as CH. The cluster head was changed for every iteration. Handover operation was also performed to maintain the communication to retrieve the information while the nodes were moving. The existing methods had gaps in satisfying the above needs.

DESIGN OF HEALTH CARE ENVIRONMENT USING CLUSTER-BASED COAP

This section describes the architecture of the CoAP based Energy-aware Cluster-based Mobility management Protocol (CoECMP) and it gives a clear note about its implementation. This protocol is designed to reduce the power consumption of each node in the network and manage the data communication throughout the network. Fig. 7-1 shows the architecture of the proposed system.

A. ARCHITECTURE OF THE CLUSTER-BASED CoECMP

In this proposed system model, the sensor nodes are placed on a human. The energy efficient node is selected as cluster head and other nodes are member nodes. The data transmission in this BAN network is processed through the cluster Head and this cluster head maintains overall information of the sensors in a human body. The components of this proposed system are COAP sensors, Web-of-things Mobility Management system (WMMS) and COAP clients.

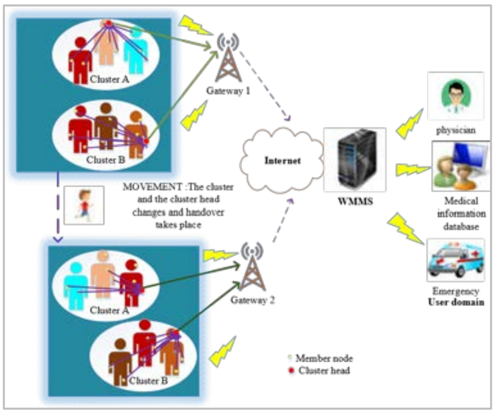


Figure 7-1 Architecture of the CoAP based Energy-aware Cluster-based Mobility management Protocol (CoECMP).

This framework consists of hundred sensor nodes, which are fixed on the human body (patients). These sensor nodes are grouped to form a cluster by selecting some nodes as cluster heads and others as member nodes. These cluster heads gather the information from the member nodes and forward it to the gateway 1. Due to the mobility of patient if any sensor nodes moves away from a particular network. Handover operation takes place and it transmits the information through gateway 2. Then the information retrieve from the gateway is forwarded to the WMMS via internet. This WMMS forward the information to user domain (doctor, medical information database, emergency).

The cluster head selection process takes place according to the attributes given by the proposed algorithm. Then the cluster head ID is distributed to all the sensor nodes. All the sensor nodes receive the ID of the cluster heads. Then the nodes send the reply POST message to the cluster head to form a cluster. Hence at the end of the configuration phase, the details of the total sensor get updated on the cluster head.

The cluster head transmits the data to the WMMS through the gateway and then to the client (Caretaker). In WMMS, the permanent IP address is denoted as P_Addr of the CoAP device node that's listed at the healthcare database. Then, the temporary IP address is denoted as T_Addr of the gateway and H_flag denotes the handover standing of the set of sensors. Then the data initialization takes place using WMMS system and the client-server sensor node is selected as the group head. This is executed by sending a POST topic of all the sensor nodes through the cluster head to the WMMS. Then the WMMS sends a response message that is created to all sensor nodes through the cluster heads. The information from the sensors is sent to the WMMS through the gateway. The cluster head sends a post request. This request is forwarded by the WMMS through the gateway to the client. The clients will respond to cluster head with an acknowledgment. Then the client sends the control messages to the WMMS and WMMS forwards it to the cluster heads. During data transmission, the sensor sends multicast information to collect the data of the sensors in the network.

Next, the handover operation is performed while the user is moved from one base station (BS) to another BS without terminating the session. During this process, when the signal strength falls below a particular range the handover is carried out by sending the request for holding messages. Hence in the final stage, the group head changes its communication from the first gateway and gets attached to the second gateway for further communication in the body network. Because of this handover operation the WBAN transforms the information without any loss of data which can save the precious life of the patient who is critical. The proposed model of cluster-based COAP consists of energy consumption at the sensor nodes and mobility management throughout the communication network. Fig. 7-2 shows the signal flow diagram which explains the flow in the basis of three phases, they are; configuration phase, initialization phase and hand over operation.

1) Procedure for clustering using CoECMP: WBAN system consists of a set of sensors fixed on the human body. These sensor nodes include Blood pressure sensor, motion sensor, ECG sensor, pulse rate sensor, EMG sensor etc. These sensor nodes are fixed on different parts of the body. The sensor nodes sense the vital signs of the human body and send it to the cluster head. For enormous number of nodes there is a WBAN installed on the human body and these nodes are grouped to form clusters each having its own cluster heads. After receiving data every CH forwards it to WMMS. In this, configuration phase is partitioned into two:

- Cluster head selection process
- Cluster formation

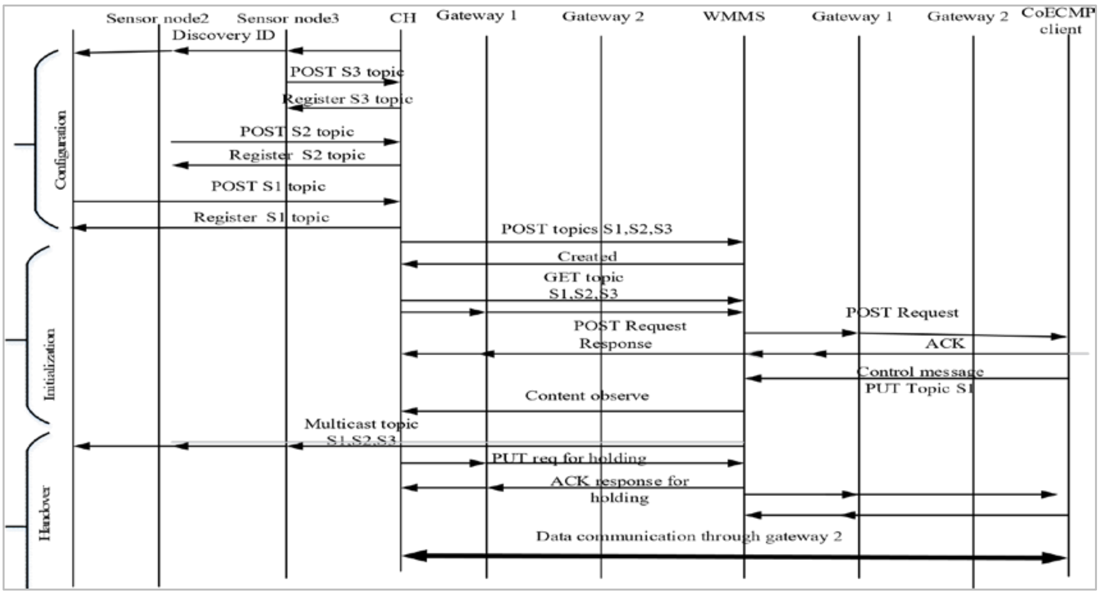


Figure 7-2 Process flow of the CoAP based Energy-aware Cluster-based Mobility management protocol.

a) Cluster head selection process: In the configuration phase, the clustering of the nodes takes place; there are a number of nodes fixed in a WBAN. These nodes are grouped under a cluster head to form a cluster. Here the modified Firefly Algorithm is used for the cluster head selection process. In this, the cluster head selection is assigned using a fitness function. The attributes to find the fitness function is the distance, residual energy, node density, and path loss.

To improve the execution and the lifetime of the network the fitness function has to be improved. Firefly is the little insect which emits light. These insects are unisexual and its attractiveness is based on the brightness of the light. According to the light intensity, it will attract other fireflies having low light intensity. When the distance increases the light intensity gets decreases. The firefly algorithm is used to find the perfect cluster heads in a WBAN. Here the fitness function is based on the parameters given. A Modified firefly algorithm is proposed in which the residual energy, distance, path loss, and node degree are the primary attributes. These parameters are used to find the best cluster head. Based on the values obtained from the above fitness function the final cluster head is predicted.

The mathematical investigation of the cluster head selection process is shown below. The fitness function is calculated to improve the network lifetime and also to make the network energy efficient.

The residual energy of a node is the overall energy saved by the node and is calculated as,

$$E_{Res}^{(i)} = \left[E_t^{(i)}(k, dist_{BS}) + N_D^{(i)} \times E_r^{(i)}(k)\right] \quad (1)$$

Where $N_D^{(i)}$ denotes the number of sensor node. $N_D^{(i)} * E_r^{(i)}(k)$ is the total energy received from the sensor nodes. Once receiving the information from all the nodes, the sensor node which is elected as a cluster head will transmit the information to the base station.

The transmitted energy based on the data transmitted is given by,

$$E_t(k, dist) = \begin{cases} k * E_{ele} + k * E_{fs} * d^2 \text{ if } d < 0 \\ k * E_{ele} + k * E_{mp} * d^4 \text{ if } d \geq 0 \end{cases} \quad (1)$$

For receiving the information that is send from the base station to the sensor nodes in WBAN, energy is required and the receiver energy is computed as,

$$E_r(k, d) = k * E_{ele} \quad (2)$$

Where E_{ele} denotes the electronic energy consumed by the node. $K * E_{fs} * d^2$ and $k * E_{mp} * d^4$ denote the amplifier energy with respect to the distance.

Path loss in WBAN is based upon two factors they are frequency and distance. Distance is an important factor because the range of the WBAN is limited,

$$PL^{(i)} = \alpha \times \log_{10}(d) + \beta \times \log_{10}(f) + Ndf \quad (3)$$

Where α and β are the linear fitting co-efficient (-27.6, 46.5). N_{df} is the normally distributed variable (157 dB). *f* and d are the frequency and distance.

The distance between the nodes is taken into consideration because it is also an important factor to reduce energy consumption. In this, the distance dist (i, j) is the Euclidian distance between the node i and node j. Here the distance of i and j is calculated using equation (5),

$$dist(i,j) = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (4)$$

Node density is the node which is placed in the dense area of the network and is selected as a cluster head. The node degree of the node i is calculated by the equation (6) which is given below,

$$N_D^{(i)} = \left|Nb_r^{(i)}\right| \quad (5)$$

In the above equation, $Nb_r^{(i)}$ represents the set of nodes at the one-hop distance from node i.

From the above function the residual energy, path loss, distance and node degree are used to make a fitness function to make an efficient node as a cluster head,

$$F^{(i)} = w_1 \times E_{res}^{(i)} + w_2 \times PL^{(i)} + w_3 \times dist(i,j) + w_4 \times N_D^{(i)} \quad (6)$$

Where w^1, w^2, w^3, w^4 are the weights for the parameters, $0 \leq w^1, w^2, w^3, w^4 \leq 1$. The values are adjusted as per the application of the WBAN.

According to the firefly algorithm, the intensity of the fireflies is calculated. In this proposed algorithm firefly is the set of sensor nodes. The intensity $I_f^{(i)}$ of the firefly is calculated as per the equation given below,

$$I_f^{(i)} = \frac{1}{r}\sum_{j=1}^{r} F^{(j)} \qquad (7)$$

In every iteration, numbers of fireflies are populated and each firefly evaluates the intensity value that is $firefly_{best}$. Remaining fireflies updated their node by randomly selecting the nodes of $firefly_{best}$. Then the calculation of the intensity of the fireflies is done again and each firefly compares the intensity of the fireflies with the $firefly_{best}$. If any of the updated fireflies gets better intensity than the previously selected $firefly_{best}$ then it will be considered as the $firefly_{best}$. The process continues till the iteration ends. These finally selected cluster heads perform the process of the transmission, reception, and aggregation of information with minimal loss of energy from the residual energy.

The Algorithm of the cluster head selection based on the firefly is shown below,

1	Initialization
2	Set of sensor nodes $\{n_1, n_2, n_3 \ldots\ldots\ldots\ldots\ldots\}$is the input
3	Each node calculate $E_{Res}^{(i)}, PL^{(i)}, dist(i, j), N_D^{(i)}$.
4	All the nodes calculate the fitness function using the equation (7)
5	Fireflies are generated and each firefly is the cluster head.
6	calculate the intensity based on the equation (8)
7	The node, which is having maximum intensity, is the firefly best.
8	Update the nodes randomly as per the firefly best.
9	Calculate the intensity values.
10	if(a new set of fireflies is more than the firefly best) then
11	current firefly is considered as the cluster head
12	else
13	firefly best is considered as cluster head.
14	Repeat steps 8 to 14 until it met the termination criteria.

b) *Cluster formation process.* Following the selection of the cluster head, this cluster head broadcasts the Discovery ID message to the sensor nodes in its sensing region. The nodes which are in the transmission range of the cluster head node replies to the cluster head within a time slot with a requisition message POST ID topic. Then the cluster head counts the total number of the POST ID topic and confirms the nodes by sending Register ID topic message. The sensors which receive the register ID are the members of a particular cluster. The member nodes send the information to the cluster heads. It helps in low energy transmission while sending the information to the cluster head.

In the initialization phase, the selected cluster heads transmit the vital signs of the human body to the base station. The initialization phase is done with the help of the WMMS system using the sensor node that is the cluster head which was selected in the previous phase. The nodes in the WBAN which are related to the WMMS exchange the control messages. Then the verification process is carried out between the client and the server. The data exchange takes place between the client-server using Encryption Standard Cipher Feedback Message Authentication Code (AES-CFMAC) algorithm. This is done by sending the POST messages with the registered topics to the mobility management system and the client. Based on these messages, the WMMS maintains the information of each body sensors. During data transmission, the sensor sends multicast information so as to collect the data of the sensors in the network.

Handover is a necessary process because in WBAN the sensors are fixed in the human body and the person will be moving from one place to another. The network area of the nodes gets changed according to the mobility of the patients.

The mobility management is done through the handover process. In the hand over process the cluster head will detect the RSS from the gateway 1. The node finds the Radio Signal Strength (RSS) and accomplishes to connect gateway 1 from the sink. The RSS from the gateway 1 drops below the threshold value and the nodes prepare for handover operation. The message using the PUT request/response message along with H_Flag is forwarded to WMMS. If the set of body sensors assessed along with H-flag set to 1, then it is in the handover status. If the H_Flag set to 0, then the sensors are not in handover status. A lifetime binds the P_Addr of a set of body sensors and T Addr of gateways is effective. At the time of handover operation, the H_Flag can stop packet loss of the nodes. A pair of network domains coated by gateway1 and gateway 2 will acquire a new temporary IP address from gateway 1. In order to update the gateway, the node sends a PUT request message to WMMS. As the WMMS receives the PUT request message for binding the update, the T_Addr and H_Flag are updated in WMMS. During this process, the cluster head node and web client can exchange their data during handover operation without packet loss.

NUMERICAL RESULTS

The analysis of CoECMP is based on network stability, network lifetime and residual energy. In the proposed scheme, energy consumption is very much reduced. This can be mathematically analyzed and compared with the existing schemes like Co-Laeeba and E-HARP regarding energy efficiency.

A. NETWORK LIFETIME

Network lifetime denotes the total lifetime of the network. The lifetime of the WBAN is based on the lifetime of the sensor nodes. The sensor nodes are mostly battery operated and it has limited energy and this energy would have to be saved to improve the lifetime of the network. Here the analysis is done by comparing with previous protocols: Co-Laeeba and E-HARP. The simulated result of the lifetime of the network is analyzed using the number of rounds the sensor nodes survive. Fig.7-3 clearly shows that in the previously generated algorithms the nodes start to die from 6500th round itself. In our proposal, the last node is surviving above the maximum of more than 16000th round. The network lifetime of the CoECMP is higher as compared to that of the previous algorithms. The effective selection of the CH makes the network lifetime enhanced.

B. NETWORK STABILITY

The network stability is computed based on the time before the death of the first sensor node in the body area network. It is one of the primary criteria to estimate any of the strategies in the sensor network. It can also be defined as the total period of the sensor node alive. The analysis of the network stability of the proposed system is compared with the previous systems and the result is shown below. This shows that the network stability is increased in the CoAP based Energy-aware Cluster-based mobility management (CoECMP) than the previous schemes. This improved performance of the proposed protocol regarding network stability is due to the efficient cluster head selection and cluster formation.

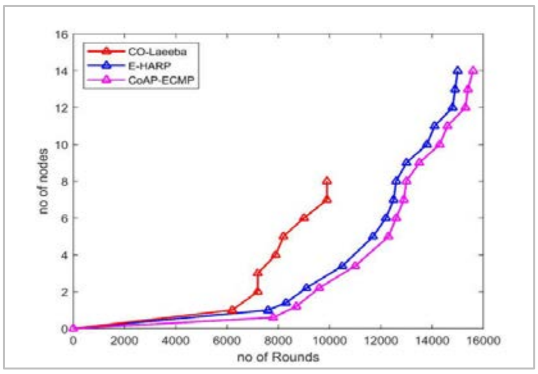


Figure 7-3 Analysis of network lifetime

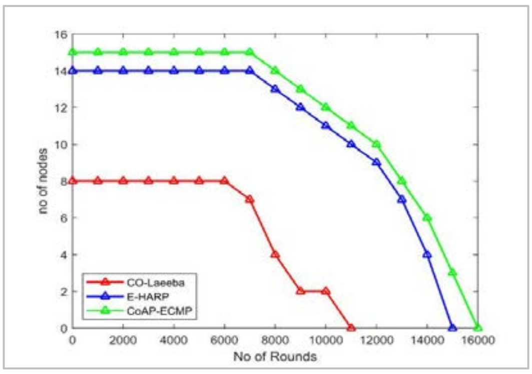


Figure 7-4 Analysis of network Stability

C. RESIDUAL ENERGY

The residual energy refers to the remaining energy of a sensor node in a BAN. In WBAN the energy is absorbed by processes like sensing, processing, transmitting and receiving of the information. To enhance the network lifetime and the network stability the energy consumed by the sensor nodes must be reduced. Few of the previous techniques took effort to minimize energy consumption. Figure 5 shows the comparison of the proposed protocol with the previous schemes like Co-Laeeba and E-Harp in terms of the residual energy. It clearly indicates that the energy of the nodes stays long for the proposed system. It concludes that the proposed protocol works efficiently in reducing the energy of consumption.

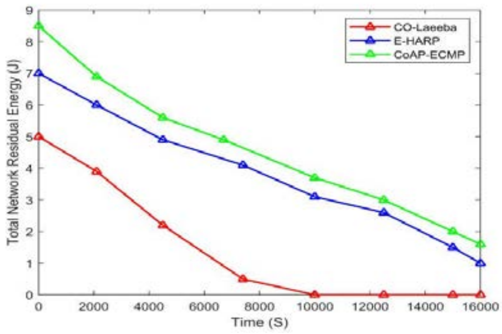


Figure 7-5 Analysis of Residual energy

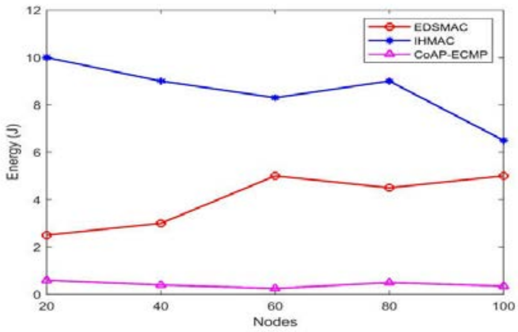


Figure 7-6 Analysis of Energy Consumption

D. ENERGY CONSUMPTION

Energy consumption is always a great issue in the WBAN network. Our proposed CoECMP achieved good energy consumption when compared to previous IHMAC and EDSMAC protocols. The average energy consumption using the proposed protocol is less than 6.5 micro Joule in each nodes. Because of the better enhancement in the energy consumption of the sensor nodes in WBAN the lifetime of the network increases.

CONCLUSION

In this paper, the CoAP based Energy-aware Clusterbased Mobility management Protocol (CoECMP) is presented in which the energy consumption is reduced by cluster Head selection process using the modified firefly algorithm and the optimization is done using the parameters residual energy, distance, path loss, and node density. In particular, in this paper the cluster formation takes place and it reduces the energy consumption by distributing the load evenly to all sensor nodes. The average energy consumption in each node is less than 6.5 micro Joules. The handover operation is also integrated into the network to get the information without loss when the sensor moves from one base station to another base station. The comparative performance is evaluated between E-HARP, CO-Laeeba, and CoECMP in terms of residual energy. Our performance analysis results confirm that the total energy consumption of using the proposed CoECMP is reduced when compared with that of using existing schemes.

REFERENCES

[1] Verma M, Rai R., “Energy-efficient cluster-based mechanism for WBAN communications for healthcare applications,” International Journal of Computer Applications 120(19), 2015.

[2] Al-Janabi S, Al-Shourbaji I, Shojafar M, Shamshirband S., “Survey of main challenges (security and privacy) in wireless body area networks for healthcare applications,” Egyptian Informatics Journal 18(2), pp.113-22, 2017.

[3] Imtiaz S, Khan MM, Mamun-or-Rashid M, Rahman MM. “Improved Adaptive Routing for Multihop IEEE 802.15. 6 Wireless Body Area Networks,” International Journal of Intelligent Systems and Applications 5(12), 64 ,2013.

[4] Rahmani AM, Gia TN, Negash B, Anzanpour A, Azimi I, Jiang M, Liljeberg P., “Exploiting smart e-Health gateways at the edge of healthcare Internet-of-Things: A fog computing approach,” Future Generation Computer Systems 78, pp. 641-58, 2018.

[5] Li X, Ibrahim MH, Kumari S, Sangaiah AK, Gupta V, Choo KK., “Anonymous mutual authentication and key agreement scheme for wearable sensors in wireless body area networks,” Computer Networks 129, pp. 429-43, 2017.

[6] Al-Janabi S, Al-Shourbaji I, Shojafar M, Shamshirband S., "Survey of main challenges (security and privacy) in wireless body area networks for healthcare applications," Egyptian Informatics Journal 18(2), pp. 113-22, 2017.

[7] Abidi B, Jilbab A, Haziti ME., "Wireless sensor networks in biomedical: Wireless body area networks," Europe and MENA Cooperation Advances in Information and Communication Technologies, pp. 321-329, Springer, Cham, 2017.

[8] Akhtar F, Rehmani MH., "Energy harvesting for self-sustainable wireless body area networks," IT Professional 19(2), pp. 32-40, 2017.

[9] Rasheed MB, Javaid N, Imran M, Khan ZA, Qasim U, Vasilakos A., "Delay and energy consumption analysis of priority guaranteed MAC protocol for wireless body area networks," Wireless networks. 23(4), pp. 1249-66, 2017.

[10] Roy M, Chowdhury C, Aslam N., "Designing an energy-efficient WBAN routing protocol," 2017 9th International Conference on Communication Systems and Networks (COMSNETS), pp. 298-305, IEEE, 2017.

[11] Kalaiselvi K, Suresh GR, Ravi V., "Genetic algorithm based sensor node classifications in wireless body area networks (WBAN)," Cluster Computing, pp. 1-7 , 2018.

[12] Darabkh KA, Zomot JN., "An improved cluster head selection algorithm for wireless sensor networks," 2018 14th International Wireless Communications & Mobile Computing Conference (IWCMC), pp. 65-70, IEEE, 2018.

[13] Anguraj DK, Smys S., "Trust-based intrusion detection and clustering approach for wireless body area networks," Wireless Personal Communications 104(1), pp. 1-20, 2019.

[14] Choudhary A, Nizamuddin M, Singh MK, Sachan VK., "Energy Budget Based Multiple Attribute Decision Making (EB-MADM) Algorithm for Cooperative Clustering in Wireless Body Area Networks," Journal of Electrical Engineering & Technology 14(1), pp. 421-33, 2019.

[15] Saha S, Anvekar DK., "An Energy Efficient Cluster-Head Formation And Medium Access Technique In Multi-Hop WBAN," ICTACT Journal on Communication Technology, 9(3), 2018.

[16] Jamshidi M, Zangeneh E, Esnaashari M, Darwesh AM, Meybodi MR., "A Novel Model of Sybil Attack in Cluster-Based Wireless Sensor Networks and Propose a Distributed Algorithm to Defend It," Wireless Personal Communications 105(1), pp. 145-73, 2019.

[17] Sundararaj V, Muthukumar S, Kumar RS., "An optimal cluster formation based energy efficient dynamic scheduling hybrid MAC protocol for heavy traffic load in wireless sensor networks," Computers & Security 77, pp. 277-88, 2018.

[18] Ullah Z, Ahmed I, Razzaq K, Naseer MK, Ahmed N., "DSCB: Dual sink approach using clustering in body area network'" Peer-to-Peer Networking and Applications 12(2),pp. 357-70, 2019.

[19] Isabel RA, Baburaj E., "An Optimal Trust Aware Cluster Based Routing Protocol Using Fuzzy Based Trust Inference Model and Improved Evolutionary Particle Swarm Optimization in WBANs," Wireless Personal Communications 101(1), pp. 201-22, 2018.

[20] Ullah Z, Ahmed I, Khan FA, Asif M, Nawaz M, Ali T, Khalid M, Niaz F., "Energy-efficient Harvested-Aware clustering and cooperative Routing Protocol for WBAN (E-HARP)," IEEE Access 7, 100036-50, 2019.

8. Mobile Charging for Off-grid Areas

Risha Mal, Souvik Dey, Saharab Mohsin, Gyandeep Daimari
Electrical Engineering Department, National Institute of Technology Silchar, Assam, India.

ABSTRACT

This paper signifies that communication and access to internet is also for the population residing in remote locations and off-grid areas. The vital necessity is to charge the gadget to access the network. Most predominantly mobiles phones are used for communication. Therefore, it is essential to charge the mobile phones even in off-grid areas. Sustainable solutions like solar and thermoelectric mobile charger will be helpful to uplift access to communication for such regions. The thermoelectric generator is integrated into a cookstove for power generation. The two technologies are broadly discussed with its design and development in this paper mainly to uplift rural areas for access to 5G communication.

Keywords–*thermoelectric generator (TEG); biomass; combustion; Solar; mobile charger.*

INTRODUCTION

The mobile phone has to keep charged to provide instantaneous communication under off-grid conditions. The challenge is to charge the mobiles even where there is no electricity and still people has access to internet communication. The electrification rates in Indian rural areas are daunting. One third of the rural population of India (approximately 8.2 million household) still remains un-electrified [4]. The majority states are, Meghalaya, Arunachal Pradesh, Assam, Nagaland and Uttar Pradesh. Together these states held nearly 80% of the total remaining un-electrified household base. There are other conditions like camping, hiking, some military operations in remote areas where un-interrupted communication is required. Hence, charging of mobile phones become extremely necessary in these conditions. Therefore, two technologies are demonstrated in this paper to provide charging of phones in off-grid areas.

The first technology is a thermoelectric generator integrated biomass cook stove. In rural areas people use to cook food in traditional biomass cook stove. The heat of the burning biomass can be harnessed and a thermoelectric module can be introduced to convert the heat energy into electricity. The electricity generated can be used for charging the battery of a mobile.

The second technology is a solar PV mobile battery charger. The conversion of sunlight into electricity through semiconductor materials exhibit PV effect. This electrical energy can be utilized to store in a battery and later used for charging mobile phones. The major drawbacks of solar PV battery charger is that it require high initial cost, low efficiency and they are weather dependent. Therefore, to maintain maximum power from the PV panel, a maximum power point tracker (MPPT) is developed. The developed PV mobile charger is portable and almost maintenance free. The novelty is the design of a compact battery charger by solar PV whose power can be used for charging mobile phone and lighting LED so that the mobile has not to be kept along the solar panel for charging. Otherwise the intense heat may damage the device.

TECHNOLOGY DEVELOPMENT

A. STOVE TECHNOLOGY

A biomass cookstove is a heating device that helps user to cook food in traditional way mostly in developing countries. The fuel required for cooking in cookstoves are usually organic waste like fire wood, cow dung cakes, crop residues, corn cobs etc. The burning of organic waste results in high harmful emissions in the form of smoke and soot. The emissions are the resultant of incomplete combustion of fuel due to insufficient air-to-fuel ratio. Approximately half of the world's population cooks food on biomass cookstoves. The harmful effects of indoor air pollution are affected to women and children. The gathering of fuel for cooking sometime leads to women drudgery due to travelling longer miles to fetch fuel [1]. The traditional biomass cookstove is generally manufactured by the cook itself with the use of clay, biomass and bricks. The making of these biomass cookstove is the most convenient procedure for rural people due to its simplicity, effectiveness, low or almost no cost of manufacturing and ease of re-building once damaged. The concern of harmful emissions from the biomass cookstove has led to researchers to put efforts on building improved cookstove with less emissions and low fuel consumption. The forced draft biomass cookstove provides better mixing of air with fuel which results in better combustion and low emissions compared to all other types of designs. There are numerous designs of forced draft biomass cookstoves in the market. These forced draft cookstoves run their fan with the help of power supply or rechargeable batteries.

To make an off-grid forced draft cookstove a TEG is used to run the fan. The excess power generated by the TEG is used for charging a battery whose power is later used to charge mobile phones.

B. SOLAR PV TECHNOLOGY

An uninterrupted power supply is required for the charging of mobile phones. Technology and communication are intertwined with each other closely. Communication has become wireless and done with the help of mobile phones. These mobiles are operated with the help of rechargeable batteries. Therefore, it becomes necessary to charge these phones for the access of network. Statistics indicate that about 24 percent population have smart mobile phones in India. According to TRAI (Telecom Regulatory Authority of India) data, tele-density in rural India is growing at a much faster rate than in urban India [3]. The penetration of smart phones will be even more if the charging will be hassle free, portable and uninterrupted. Many rural household do not have smart phones because they are not connected to grid supply to charge their mobiles. To make communication accessible to off-grid population a solar PV mobile charger could be used.

PERFORMANCE CHARACTERISTICS OF TEG

When a semiconductor is heated the charge carrier tend to flow from hot junction to cold junction. The non-uniform distribution of charge carriers help to build charge that results in back e.m.f. and restricts further flow of charge. This phenomenon of conversion of heat energy to develop electrical power is known as Seebeck effect. This effect was first observed by Thomas J. Seebeck in 1821. The junctions of the TEG are made up of dissimilar p-type and n-type materials as shown in figure 8-1. They are connected electrically in series and thermally in parallel [6]. The p-type junctions have more number of holes and n-type junctions have more number of electrons.

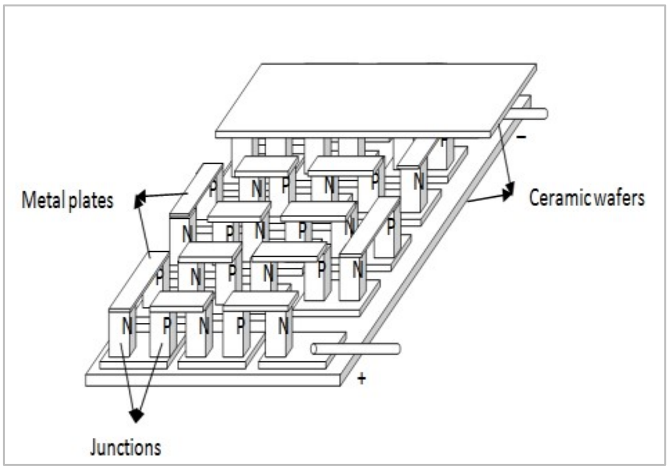


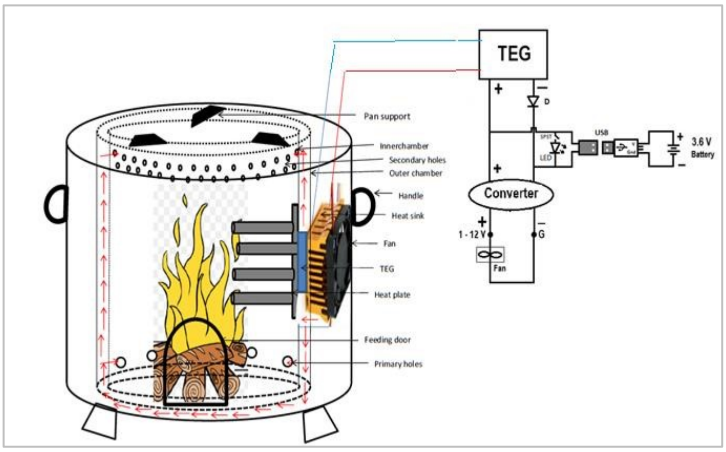
Figure 8-1 Arrangement of junctions in a TEG module

If we consider hot side of the module at temperature T_H and cold side of the module at temperature TC, the charge carriers will flow from T_H to T_C. The arrangement is such that alternate p and n junctions are connected with each other with the help of metal plates to allow flow of current. The resulting voltage that is developed by connecting two dissimilar materials of p-type and n-type whose junctions are a two different temperatures is given by equation 1.

$$V = (\alpha_p - \alpha_n)(T_H - T_C). \quad (1)$$

Where α is the Seebeck coefficient V/°C, T_H is the hot side temperature °C, and T_C is the cold side temperature °C.

The schematic of TEG integrated cookstove is shown in figure 8-2.



Figur 8-2 Schematic of TEG cookstove [8]

The figure 8-2 shows that a stainless plate with probes is inserted inside the combustion chamber. The TEG is sandwiched between the heat plate and the heat sink. The heat plate serves as the hot side of the TEG and the heat sink serves as the cold side of the TEG. The temperature difference between the hot side and the cold side of the TEG is proportional to the output voltage. The rise of voltage is from 0V to a maximum of 5V with a 1.4W load of a DC fan. The DC fan runs at a voltage of 12V. Therefore, it becomes necessary to steup the output voltage of the TEG. A DC-DC boost converter with the capacity to stepup minimum input voltage of 1V to output voltage of 12V is used for the fan. The TEG is capable to generate a power output of 8W. The fan and other electronics take around maximum of 2W. The remaining power is utilized to charge the mobile phone battery. The cookstove has multiple advantages. It provides clean combustion with less harmful emissions and also has the facility to charge the mobile for communication and internet access. The actual power output of the TEG is given by equation 2,

$$P_{actual} = V_{load} \times I_{load} \quad (2)$$

Where, load is the DC-DC step up converter, fan and LED light.

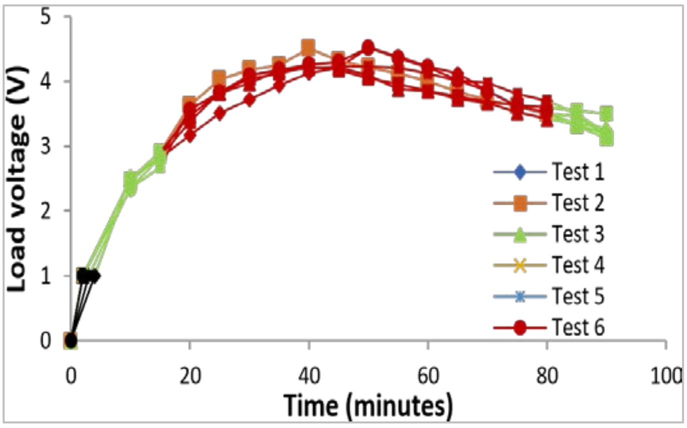


Figure 8-3 omparison of load voltage with respect to time where black marker shows that the voltage is not significant for any application with respect to time, green marker shows the range of running fan only, and red marker shows the running of fan and lighting

The figure 8-3 shows that the fan takes around 2-4 minutes to start after ignition of the biomass inside the cookstove chamber. The fan runs for around 20-25 minutes and thereafter the power output is sufficient to light a 2W LED light. The cookstove is feed with 1kg of biomass for one hour. This enable TEG to power LED light for one hour. In place of LED light a mobile phone battery can also be connected for charging.

From the figure 8-4 it may be observed that the maximum power output of the TEG is nearly 6W. The electronics and the dc-fan consume nearly 3W and thus nearly extra 2-3W power is available for other applications. A LED light of 2W is tried simultaneously with dc-fan for lighting purpose without compromising the speed of the dc-fan.

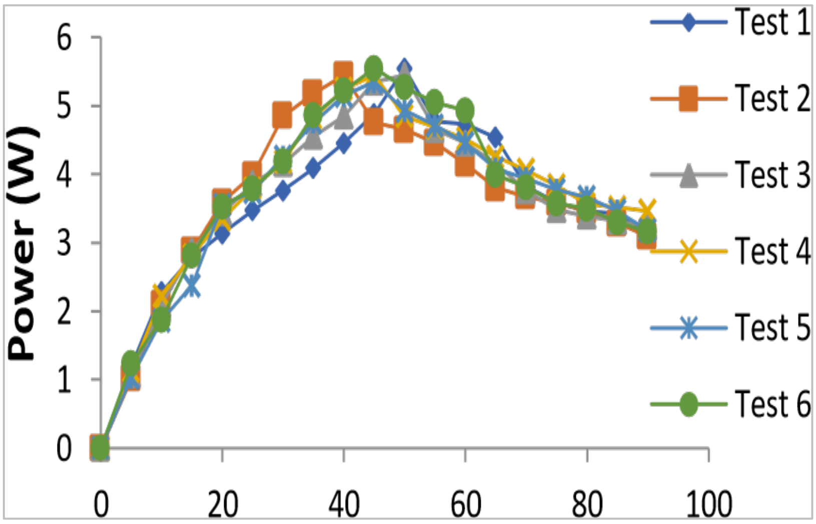


Figure 8-4 Comparison of power output with respect to time.

SIMULATION CHARACTERISTICS OF SOLAR PV

A low power solar battery charger can solve the above problem off-grid mobile charging. But though solar energy is available throughout the day its insolation varies from morning to evening and with changing climatic conditions. As the efficiency of solar PV panel is quiet low it becomes necessary to extract maximum power from the PV panel at any given period of time. Therefore, Perturb and Observe algorithm is used to track the maximum power point. It deals with the designing and implementation of low power PV integrated solar battery charger which can store charge energy and can be used whenever needed. As it is portable it can be carried anywhere easily. High frequency DC-DC Buck converter is used to interface the PV panel with load. A rechargeable lithium ion battery is connected across the terminals of the buck converter for storing the charge. A low power PV panel can also be used for tracing the maximum power and voltage by using maximum power point tracking methods. There are many MPPT methods such as Perturb and Observe, incremental conductance, Fractional short circuit current, Fractional open circuit voltage etc. Out of which Perturb and Observe method is used as it is easier to implement and also the time complexity of the algorithm is very less. Lithium ion batteries are rechargeable and use renewable sources for recharging like solar power. They also tolerate movement and temperature changes, as well as maintain their power delivery during use. A combination of both low voltage PV panel and lithium ion battery can be used for solving various power shortage problems.

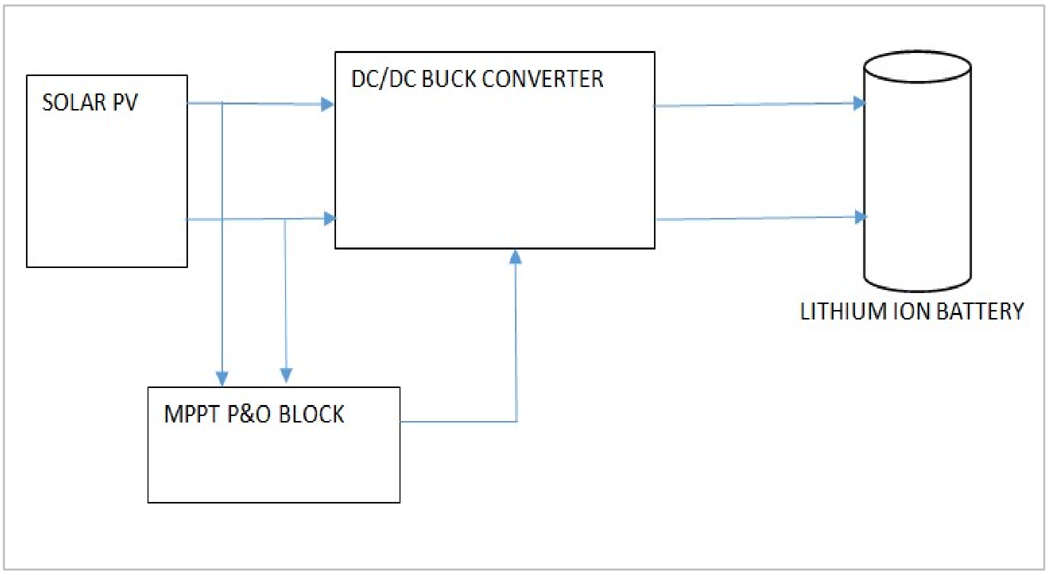


Figure 8-5 Block diagram of solar PV mobile charger

As the working model to be developed has to be of cost efficient as well as less bulky, the ratings and specifications of the PV panel and battery chosen are as shown table 8-1.

Table 8-1 Ratings and specifications of the PV panel and battery

SNo.	Components	Ratings and Specifications
1	PV panel	V_{oc}=15V , I_{sc}=1.3A, P_{max}=16.2W V_{max}=13.5V, Imax=1.2A
2	Lithium Battery	Nominal Voltage=4.2V, Rated Capacity= 5Ah

A buck converter is used to step down the voltage obtained from the PV to a voltage suitable for charging the battery. Since the load used here is lithium battery which is a nonlinear load, so for the designing of buck converter hit and trial approach is used. Considering maximum value of duty cycle as

$$D_{max} = V_{out}/V_{in} = 6/13.5 = 0.45 \qquad (3)$$

As MPPT algorithm P&O is used to track the maximum power point, the duty cycle will vary accordingly [9]. Below are the results shown with various values of inductor L and capacitor C.

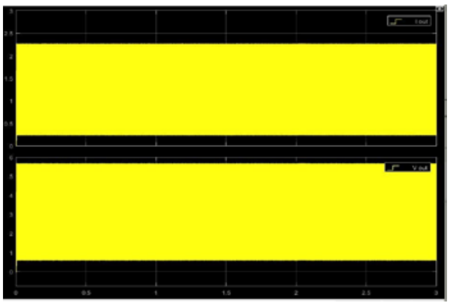


Figure 8-6 Output voltage and current characteristics for L=0.10 mH , C=0.1µF

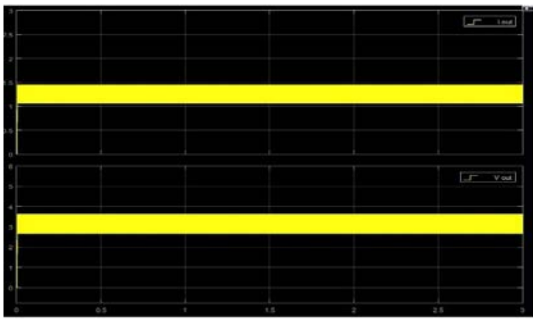


Figure 8-7 Output voltage and current characteristics L=1mH, C= 0.1uF

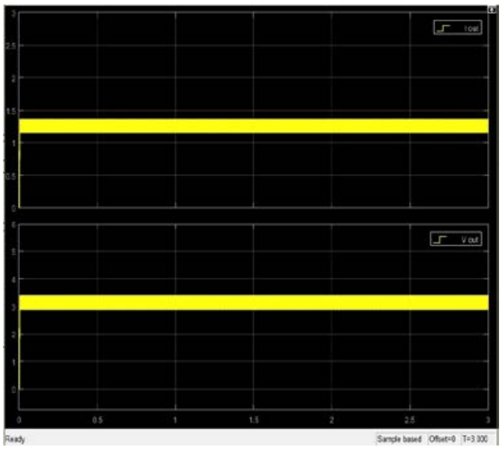


Figure 8-8 Output voltage and current characteristics L=1Mh, C= 1uF

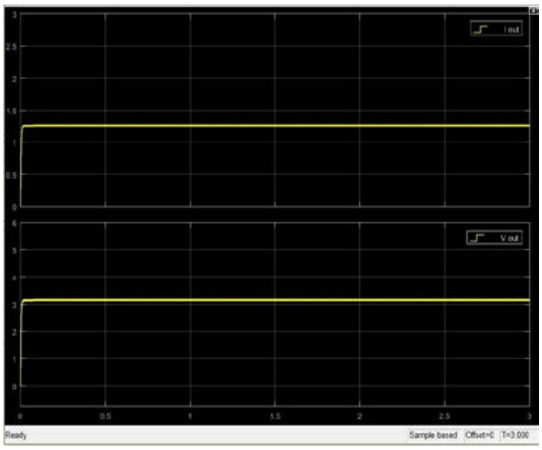


Figure 8-9 Output voltage and current characteristics L=15mH, C= 10uF

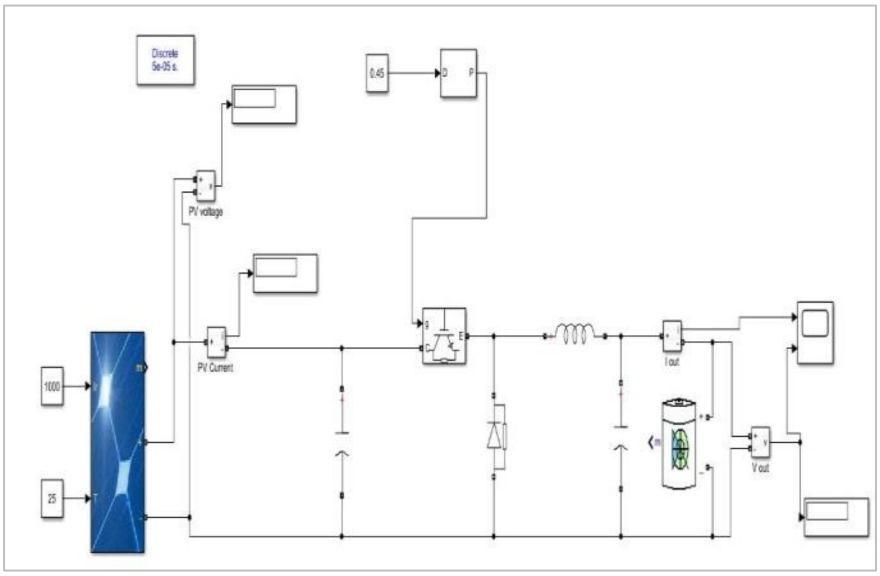


Figure 8-10 Buck converter design

As here it is observed that there is huge amount of ripples, so to reduce it the values of L and C has to be increased. First keeping the value of C same, L is increased. Similarly, with this approach L and C values are further increased for getting minimal ripples possible.

The design of converter is shown in figure 8-10

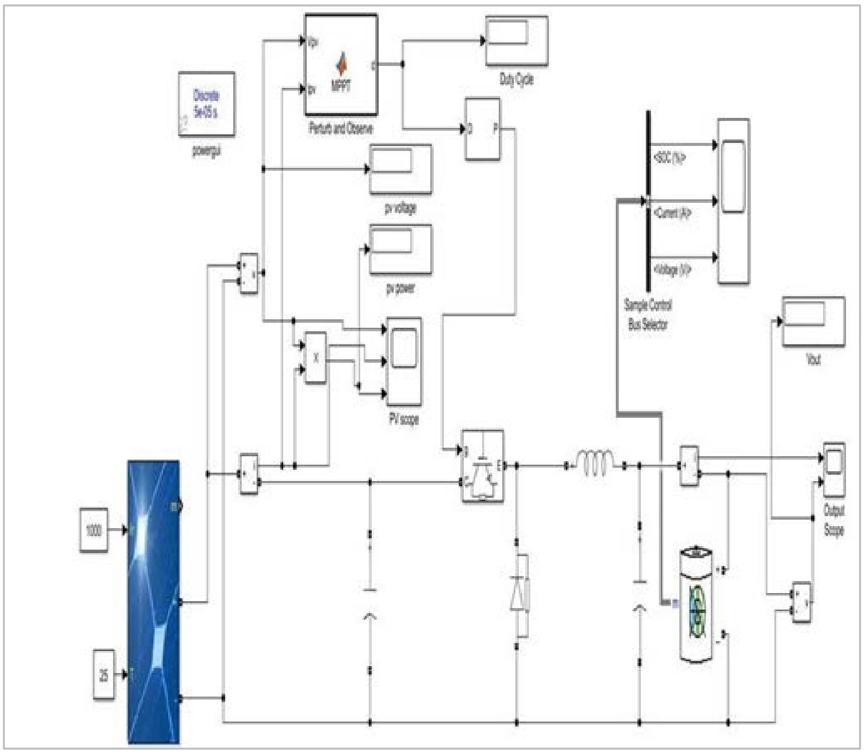


Figure 8-11 Design prototype of solar PV mobile charger

The testing the MPPT code simulation is done and the results are matched with the reference values.

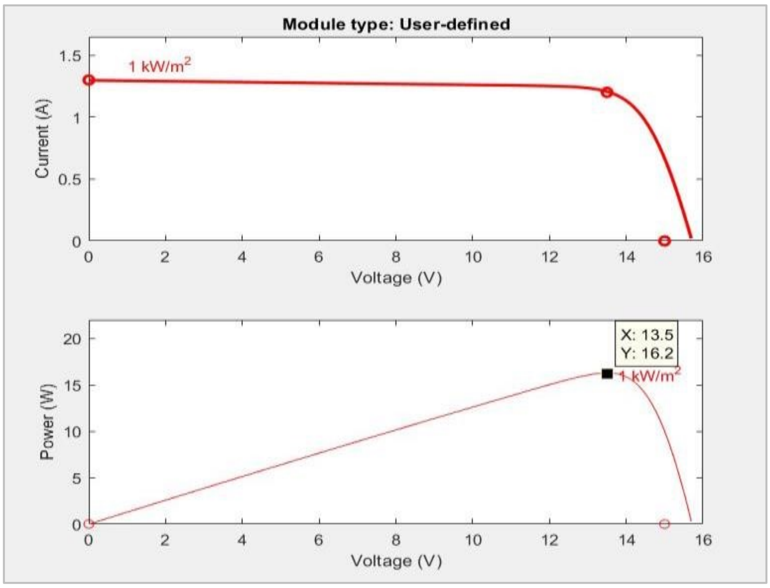


Figure 8-12 Value of power after simulation

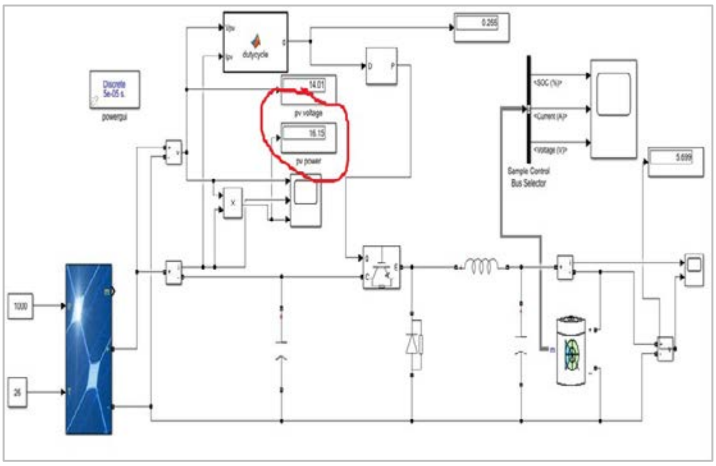


Figure 8-13 Reference values of maximum voltage and power as generated

From figure 8-13, it is observed that the value of maximum power after simulation is nearly equal to the reference as generated from the PV panel. So it successfully tracks the maximum power from the PV panel using MATLAB.

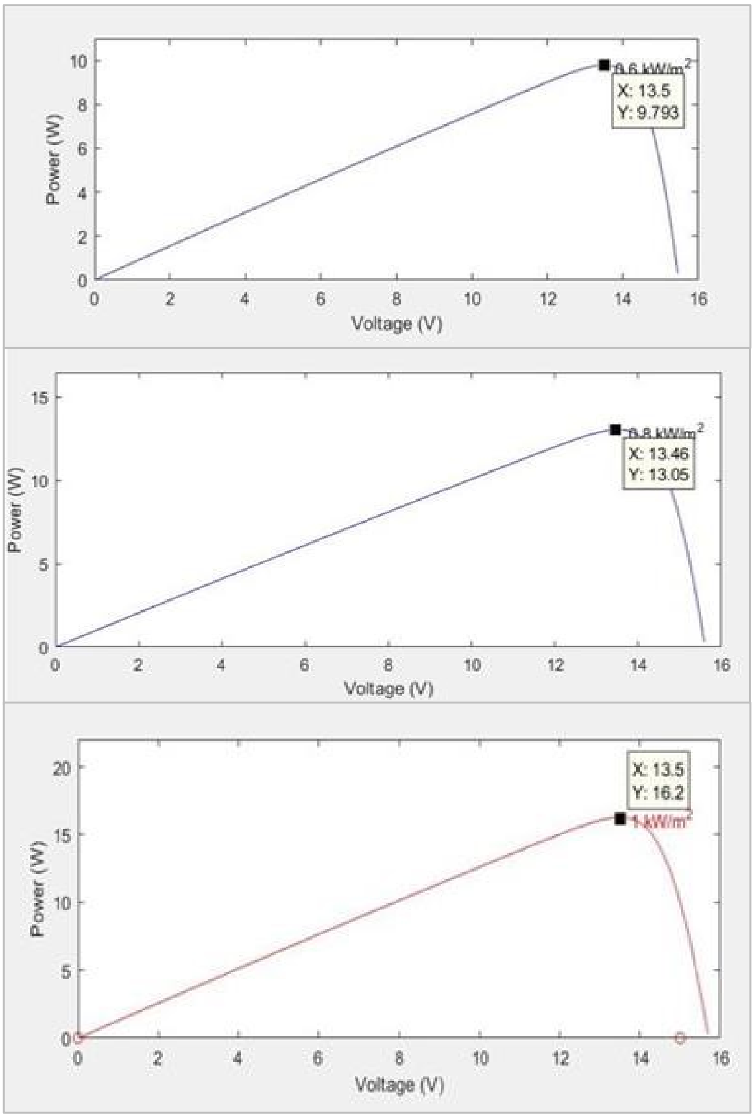


Figure 8-14 Reference power versus voltage generated from PV for different

As the maximum value of voltage is maintained constant for different values of irradiations, it can be concluded that the MPPT code is successful in tracing the maximum power point. Final values of parameters for designing the buck converter is shown in table 8-2.

Table 8-2 Parameters for designing the buck converter

Sl. No.	Components	Rating
1	PV panel	Voc=15V, I_{SC}=1.3A,P=16.2W
2	Inductor for buck converter	15mH
3	Capacitor for buck converter	10µF
4	DC link for buck converter	300µF
5	Switching frequency of PWM	5000 Hz

Now for testing whether the battery is charging, the initial State of Charge (SOC) is kept at 2% and simulation is performed. The observed charging characteristics of the battery are as shown below:

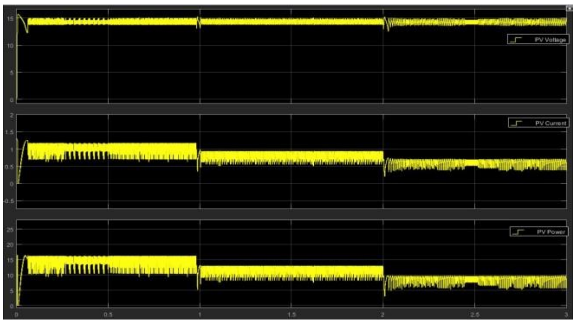


Figure 8-15 Simulation results for different irradiations (1, 0.8, 0.6 KW/M^2)

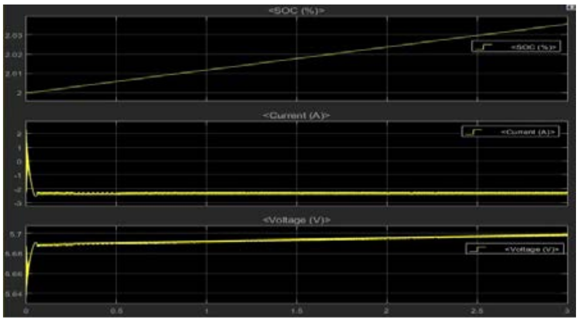


Figure 8-16 . Output waveforms showing SOC (state of charge), battery current and voltage respectively (for 1000 kw/m^2S)

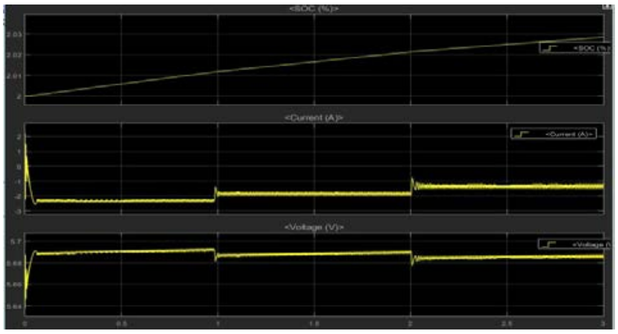


Figure 8-17 Output waveforms showing soc(state of charge),battery current and voltage respectively for changing irradiation

The charge is increasing as can be seen from the waveforms and it can be concluded that the battery is charging. Hence the proposed model is working successfully.

The method presented here use Perturb and Observe method for tracing the maximum power point according to solar irradiance and match load impedance with source impedance to provide maximum power. The MPPT model is more suitable because of less cost, easier circuit design and also better efficiency. Here a rechargeable Lithium ion Battery is used to store the charge and its charging characteristics is shown. As the simulation is successful, its hardware implementation can be done.

COST ANALYSIS

The effective cost of the two technologies has to be estimated as it will be disseminated in rural off-grid areas. Thermoelectric generators available in Indian market do not provide sufficient output. The TEG is imported from Marlow industries, USA. Hence, the cost of the TEG is a bottleneck to make the technology affordable. But, when TEG integrated cookstove is manufactured in bulk the cost reduces effectively.

Table 8-3 Effective cost of TEG integrated cokstove

Parts	TG1208-1LS(INR)
TEG+ ceramic wafer + grease	2665
Hot plate	520
Heat Sink	520
Electronics	200
Batteries	150
Stove	1000
Miscellaneous	200
Total	**5255**

Table 8-4 Effective cost of solar based mobile charger

S.No.	Component	Rating	Price (Rs)
1	PV panel	16W	700
2	arduino	--	350
3	Lithium ion battery	3.6V	100
4	capacitor	10uF	35
		300uF	100
5	inductor	15mH	40
6	IGBT	313W	120
	Total		**1445**

The scaling up of both the technologies will help to reduce the cost of the products. Therefore, on successful implementation of the two technologies, bulk manufacturing is appreciated to make the products affordable and accessible to rural households.

CONCLUSION

Internet has become affordable to most of the population in India. But, a great deal of people residing in rural areas is derived from internet because of being off-grid. Mobile charging in off-grid areas is a challenge. Therefore, the TEG integrated cookstove will have positive impact on health as well as charge mobile phone and the solar PV mobile charger is cheaper, portable and will help charging mobile in off-grid areas. Hence, not having a power supply will not pose as a barrier to access internet even in remote rural areas. The TEG integrated cookstove has been developed and running successfully in some parts of India. The cookstove efficiently cuts down harmful emissions resulting from biomass burning and improves thermal efficiency of the cookstove. It is also capable of mobile charging and lighting a LED lamp. The low watt Solar PV mobile charger has been simulated in MATLAB and successfully executed. In future the PV integrated solar mobile charger has to be developed as a product with efficient design and test the results for validation in field.

ACKNOWLEDGEMENT

The author would like to thank Indian Institute of Technology, Delhi for development of TEG cookstove and National Institute of technology Silchar for supporting solar PV mobile charger.

REFERENCES

[1] WHO. Fact sheet no. 292, Indoor air pollution and health. Available from: www.who.int/mediacentre/factsheets/fs292/en/ [cited 01.09.2013].

[2] World energy outlook. Paris, France: IEA; 2010. Available from: www.worldenergyoutlook.org/media/weo2010.pdf [cited 12.12.2013].

[3] Measures to Improve Telecom Penetration in Rural India – The next 100 million subscribers, Telecom Regulatory Authority of India, Paper No 1/2008. Government of India.

[4] Rajpal, P.S., et al. (1994). Energy-efficiency design of a cook stove. Energy Sources, Vol. 16, pp. 387-399.

[5] Gill, B; Gupta,A ; Palit, D; Rural electrification: impact on distribution companies in India. https://www.teriin.org/sites/default/files/2019-02/DUF%20Report.pdf

[6] H.J. Goldsmid, 'Applications of Thermoelectricity', Methuen Monograph, London, 1960

[7] Cedar, Jonathan M. (Scarsdale, NY, US), Drummond, Alexander H. (Austin, TX, US), 'Portable combustion device utilizing thermoelectrical generation', 8297271, 2012, http://www.freepatentsonline.com/8297271.html

[8] Mal R., Prasad R., Vijay V. K., 'Multi-functionality clean biomass cookstove for off-grid areas', Process Safety and Environmental Protection, Volume 104, Part A, November 2016, Pages 85–94.

[9] Sukumar,G. Durga. Research Survey on Various MPPT Performance Issues to Improve the Solar PV System Efficiency. 31 July 2016, https://www.hindawi.com/journals/jse/2016/8012432/.

[10] Salman, S., AI, X., & WU, Z. (2018). Design of a P-&-O algorithm based MPPT charge controller for a stand-alone 200W PV system. Protection and Control of Modern Power Systems, 3(1). doi:10.1186/s41601-018-0099-8

[11] Hart, D. W. (2011). Power Electronics. New York, NY: Tata McGrawHill Education.

9. User Privacy in Big Data Analytics for eHealth: Data Privacy Model

Nidhi, Department of Business Science and Technology, Aarhus University, Denmark
nidhi@btech.au.dk
Albena Mihovska, Department of Business Science and Technology, Aarhus University, Denmark
amihovska@btech.au.dk
Ramjee Prasad, Department of Business Science and Technology, Aarhus University, Denmark
ramjee@btech.au.dk

ABSTRACT

Big data analytics can benefit the healthcare sector by incorporating improved situational analysis, database management, real-time decision making and new ways of diagnosis and treatment. However, its use opens critical security and privacy concerns. This paper surveys the open challenges of collecting and accessing health data, and the different types of possible breaches of privacy and security that are the key to the successful deployment of eHealth systems. To mitigate the privacy hindrance issue with the medical data, we propose an eHealth data privacy model, which will add transparency in to the personal data collection, aggregation, handling and storage. Transparency in healthcare sector have different interpretation at different level. We'll look at some different segments in the healthcare industry working to adapt to the call for transparency. The model builds upon the Information Accountability protocol for the transparency. The user will be the player and take decision on their data, how is to be used and shared.

Keywords—*Big Data; e-Health; e-Health Data; Data Security and Privacy*

INTRODUCTION

A typical eHealth system should be highly secured, responsive, and controlled and one, where the users' privacy and the protection of their personal data, remains intact. eHealth systems demand integrity, accessibility and availability along with interoperability, which is even more important with the colossal pool of data defining the infrastructure of today. Many everyday applications and services rely on the collection, storage, processing and analysis of data, often user-related, and often made available to different sectors irrespective of boundaries ranging from machine learning and engineering, to economics and medicine [1].

The amount of data generated in healthcare sector is increasing and will continue to increase with the technological enactments, creating room for new data handling and analysing techniques. Big data analytics provide tools to benefit healthcare for example; it provides customized medications, anticipated analytics, risk-intervention etc. [2]. It has marked a presence in handling and analysing data generated via the social media but it offers promising solutions for handling efficiently eHealth data (also, commonly referred to as "health big data"). Big data analytics includes data aggregation, processing, storage of eHealth data to make decisions and evolve new ways of treatment, keep the population healthy etc. [1].

The health-related data are usually stored and processed at distributed repositories at different levels [3]. There are numerous security and privacy concerns in moving the health data under the big data approach. The privacy of the patients and the safeguarding of their personal data are major issues in applying big data analytics to eHealth.

A recent survey published in [4], suggested that the lack of adequate security measures had resulted in numerous data breaches in the healthcare sector, exposing certain patients to economic threats, mental stress, and even social embarrassments. Sharing the patients' personal information without the user's official consent is one critical privacy breach for the healthcare sector. The authors in [5] have summarized the issue of connected healthcare and requirement of appropriate protections to safeguard the privacy of the patients and for minimizing the medical error. Therefore, an appropriate equity is needed to maintain privacy and security of data and the patient's personal space in healthcare.

In this paper, we survey and analyse the privacy and security issues in healthcare when using big data analytics. Based on the investigation, we propose an eHealth Data Privacy Model for enabling transparency in the flow of data over the network and that only the data relevant to a particular health service provider would be delivered. The model is based on the concept of Information Accountability [6] which enable patients to decide the usage of their data on a shared platform. It advocates transparency in the data usage and enable one with the ability to track the appropriate use of data under the predefined rules.

The paper is organized as follows. Section II describes the current state of the art in the area. We elaborate the concept of eHealth data, and survey the associated threats and vulnerabilities, the potential attack zones and how data are transmitted and received in the network. Section III analyses the key factors and issues related to the flow of information in an eHealth scenario. We explore the different aspects of information security related to healthcare and the user. We highlight the issues in eHealth for data privacy and formulate the need for a data privacy model. In Section IV, we propose the health data privacy model and the related functionalities, modules, protocols and required networking. Section V highlights the issues and challenges involved in implementing the proposed model. Section VI concludes the paper.

STATE OF THE ART

The healthcare sector spans over a vast landscape demanding cooperation and the active participation of public and private bodies, the individual user along with innovations and initiatives from various fields including marketing, finance, education and many more. The eHealth's objective is to avail medical services and amenities accessible and available at a reasonable cost and available resources while maintaining the quality of care and productivity. In an eHealth scenario, both, the patient and the medical service provider will be connected for the health monitoring, routine check-ups and even emergency services, facilitated by real-time secure data exchange. The healthcare industry dominates the data volume per person per day ratio generated. To handle data, Big Data can make significant revolution without resulting into additional infrastructure. It is an emerging technology for the future generations, which can analyse wide variety of voluminous data. It enables the processing of high-volume, high-velocity, and/or high variety of data aiding optimized results, better and efficient analysis, improved decisionmaking etc.

A. EHEALTH DATA AND DATA FLOW STRUCTURE

In an eHealth scenario, human and associated data are the most valuable and vulnerable assets. The medical reports generated electronically, called Electronic Health Records (EHR) are documents containing the patient's personal details (i.e., that have been used for registration over the network, the personal social security numbers used for the medical insurance, the medical reports, the diagnosis reports, the discharge summaries etc.) The medical data represents the patient–doctor relationship (e.g., the information including the patient-identification, the medical history, the digital renderings of the medical images, the treatment received, dietary habits, sexual preference, genetic information, psychological profiles, employment history, income, and physicians 'subjective assessments of personality etc. [3], [7].) Figure 9-1 shows the flow of medical data within the healthcare system. The patient shares their medical history, symptoms and personal identification details to the primary health services' unit. The primary health service unit then registers the patient using a unique identifier and creates the patients' file, which is shared with restrictions with the billing unit (relevant treatment charges and genuine user detail) and organization's IT unit (billing details and treatments' summary). The primary health services are responsible for the various test reports, clinical data, laboratory activities etc. and accordingly communicate with the secondary health services, pharmacy and regional health centers using patients' identifier and hiding other background details. The primary health services also share the details with its employees, which are strictly service-based i.e. ground staff are only exposed to the details like medication timings, test routines while doctors get detailed medical history irrespective of personal details. Third party IT services are used to store the health record files. They have an access to patients' personal data (identifiers) and medical data (contributed by health organizations) and make the same available on demand.

The information transfer and storage in organization's and third party's IT servers are critical [4] as even a single careless activity can expose a patient's details. The data of the patients can be used to improve the efficiency within the healthcare system, to drive the public policy development and the administration at a state and federal level, and in the conduct of the research to advance the medical science apart from the personal care [8][9].

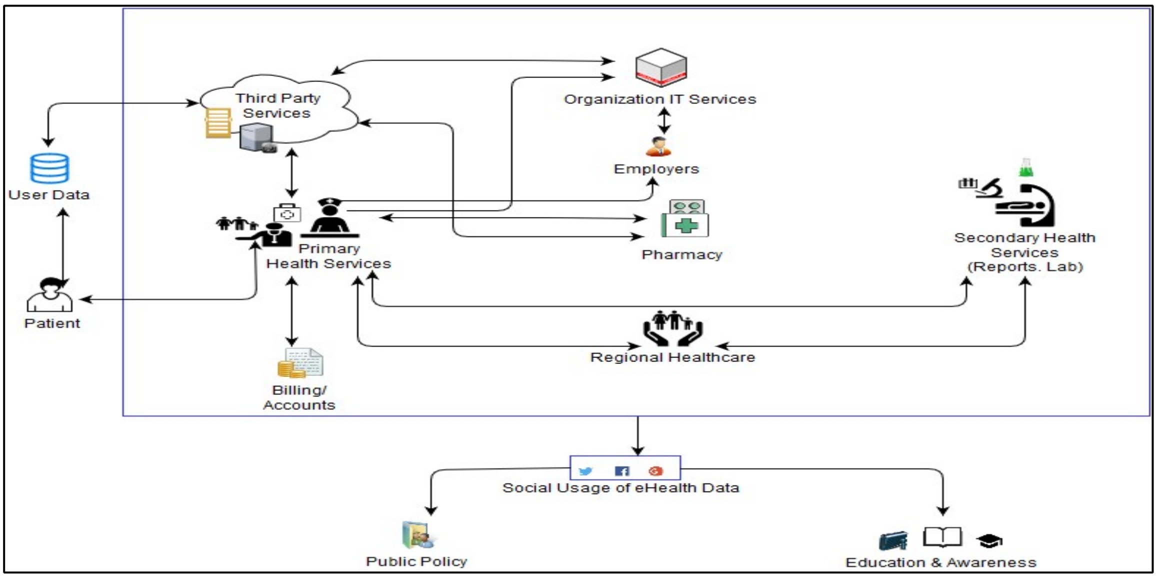


Figure 9-1 Data Flow in eHealth Scenario

B. DATA BREACHES

A medical data breach can lead to everything from an identity theft to billing fraud to blackmail, some breaches ultimately have little consequence on the patients affected. Whenever a medical data breach occurs, it signifies that there is a lack in security, while handling the information of the patient. In recent years, the survey [4], [10] recorded that 43 per cent of the total data breaches involved healthcare data. The healthcare breaches originated

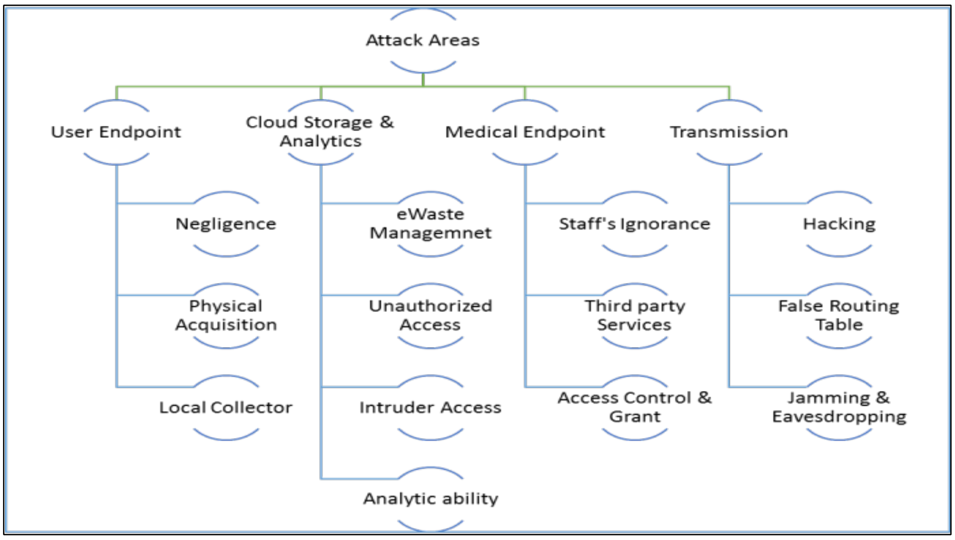


Figure 9-2 Attack Areas in Healthcare system

mostly from the service provider organization and/or a third party associate. It has been reported in [10], that about 90 percent of healthcare organizations had suffered data breaches, such as cyber attacks, employee mistakes, theft etc. Most common breaches are data and identity theft, unauthorized access, hacking the transmission, the loss of data in transmission, improper disposal, denial of service etc.

Figure 9-2 summarizes the vulnerable areas in each segment of the eHealth scenario cycle. The healthcare sector can be defined broadly into four sub-sectors, namely, theuserendpoint, the cloud storage and analytics, the medical endpoint and the tranmission. At the user end, the breaches mainly would be the result of ignorance or access to wearables, documents etc., unethically. At the storage and the analytics end, the unauthorized access, a compromised node/ employee, the lack of security measures and the improper disposal of data may cause medical breaches. The staff's negligence, unauthorised access, third-party service dependency are some of the root causes to breaches. Hacking or jamming the transmission of information also contribute to compromised and lost data.

C. THREATS TO PATIENTS' PRIVACY AND DATA SECURITY

A threat scenario is defined by the motives, resources, accessibility and technical capability. The threats to the privacy of the patient are a major outcome of the illegitimate usage of data either by internal/ external agents or by a third party agent in the data flow chain. The authors in [7], [8] summarized various threats to the user integrity and life. The threats impose different level of risk depending on the motive, the attack zone, the sensitivity and the mitigation and prevention strategies. The threats were categorized as the threats arising from accessing the patients' data inappropriately either by internal or external sources, and as the threats arising from data exposure over the network.

INFORMATION IN HEALTHCARE

The increased use of Web-based services has significantly raised the bars for the privacy concerns of the users. Published research has summarized the user content among a wide range of users, which include students, employed, senior citizens etc. The disclosure of data is user-dependent, i.e. a user agreement is needed in eHealth to verify the consolidation of the user to disclose personal data for research and development and/or other healthcare related needs. The current security and privacy in health data was summarized into the following subcategories [11-17].

A. DATA ACCESS AND SECURITY IN EHEALTH:

The healthcare institutions appeal to have security measures to govern the data access. Some of the common steps taken in that direction include access control systems, intrusion detection systems, policies etc. In [11], the authors have used a game theoretic approach to model the optimal levels of access. Remodeling the existing access control policies in the healthcare scenario is challenging apart from being highly expensive. In healthcare, we have individuals having different sets of roles, dependent data streams, independent data systems, dynamic configurations etc.

Data security requires concrete frameworks and defined protocols to identify, solve and mitigate the related security issues as stressed in [3], [5]. The emergence of ubiquitous access to patient data via mobile devices has exposed the vulnerabilities of the patients even further.

B. AUTHORIZED DATA DISCLOSURE AND INTEGRITY:

Attributing public health, the privacy policies should be made strongest when it comes to individual and communal interests. For each solution proposed, it should be carefully outweighed how much data gets disclosed and at what span [12]. Health services should be available on demand, which requires a full-time data protection.

Healthcare systems are getting more and more vulnerable to cyber security incidents nowadays. Factors like voluminous data generation; extensive usage of IT technologies to connect patients and healthcare utilities; data exposure over the network; diversified nature of healthcare systems; outdated applications and systems; poor security algorithms; expansion in devices with enhanced capabilities and many more have contributed to the exponential increase in the number of incidents in the healthcare [16], [17].

C. EHEALTH AS A CRITICAL DATA PLATFORM

The above mentioned factors along with the data breaches makes the healthcare sector critical. A healthcare platform deals with asset classification and requirement to form a base layer of the healthcare system and the components may include index services of the user and/or service provider, registration proofs, identifiers etc. The data privacy, security and integrity involves network elements and storage (internal/external clouds). Access is determined using identifiers. Availability is the crucial among all as it can cost even life of the patient in case of emergencies.

D. CHALLENGES IN THE HEALTHCARE DATA

The authors of [14], [16] and [19] suggested that to maintain the users' privacy and in order to establish a balance in the economic constraints, quality of service and care and availability are the main challenges in healthcare. They advocated on the efficient and effective solutions for privacy maintenance at affordable and operative costs.

E. TRANSPARENCY IN HEALTHCARE

In healthcare sector, transparency is needed at every sector and individual end-point. Transparency has its individual definition from patient, doctor, healthcare organization, payers and providers [20]. From patients' perspective, transparency is needed in data acquisition and its usage and the cost for quality and services. The data collected from patients are in silos hence it becomes more important to check how data moves into the network both online and offline. With each bit of data comes an individual role and responsibility of data managers in healthcare sector. Data are subjected to limited access grants to protect patients' confidentiality.

F. DATA ANALYTICS

"Big Data" in health is defined as a voluminous complex and distributed data set, which imposes difficulty for conventional technologies in analysing and maintaining the information [19].

In order to safeguard the user privacy and tackle issues with interoperability and data repositories, we need a data model, which will be transparent, secure and able to analyse to produce the desired results. The data model should be able to manage widely distributed and scattered data. The data scheme should address user privacy and data sharing within agreement.

PROPOSED MODEL FOR DATA TRANSPARENCY

Health data are sensitive and demand appropriate and authenticated usage. While implementing digital data records, the required security measures for data storage, access and monitoring should also be put in place [14], [15]. Our proposed data privacy scheme allows for transparency in data-handling. It reinforces mechanisms to mitigate the illegitimate (unauthorised access, modification, disclosure to unintended user etc.) use of data [13], [21] and to best exploit the benefits gained from sharing the health data.

In our proposed data privacy model, the patients set the usage authority for their information and decide the extent, to which data can be aggregated with others. The data is shared under well formulated set of rules, guidelines and policies.

A. COMPONENTS AND PARTICIPANTS

The proposed model is shown in Figure 9-3. The following agents are the entities in the eHealth scenario;

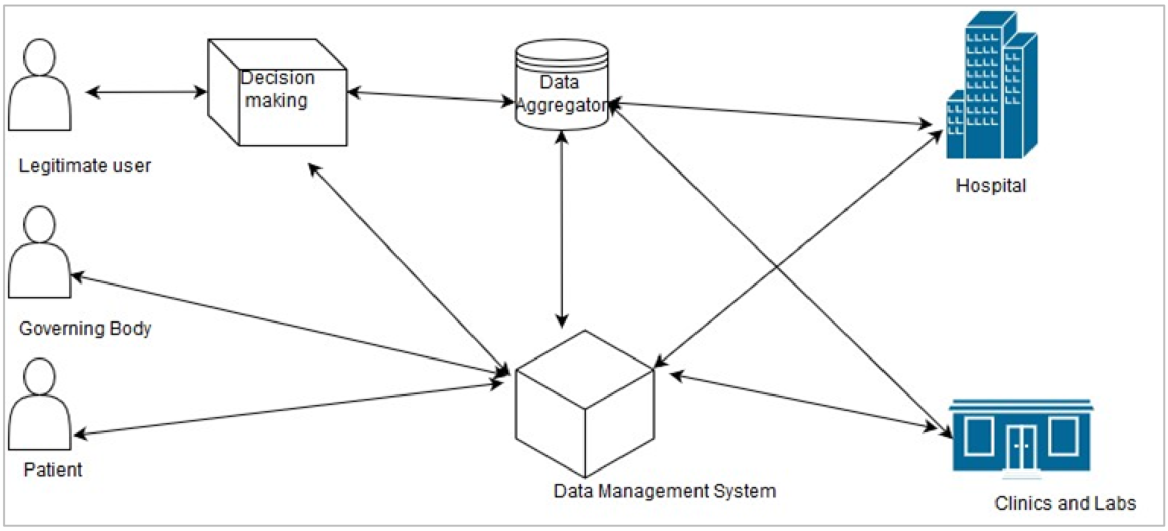


Figure 9-3 Proposed Data Privacy Model

Patient: Patients are the data owners. They can view the records of accesses made at any time and can submit their queries on unauthorized accesses.

Healthcare Utility: These are the healthcare authorities, responsible to aggregate the patients' personal data and medical history, test reports, medication briefs etc. These are often referred to as Data Providers. They are responsible to provide data to the data aggregator, which maintains, stores and analyzes using big data analytics and policies imposed by a system manager. They also maintain data logs to manage risks.

Governing Body: These system managers make and set policies to regulate the shared eHealth system and avoid misuse. These are responsible for the data integrity and log authenticity.

Data Users: Data users would make use of the aggregated data. Healthcare professionals, approved researchers, and government studies are examples of data users. Data users will be able to access specific log entries regarding their own access to patient information. They will be able to review the entries when they receive an inquiry requesting that they justify why they needed to access the relevant information in the given situation.

Data Aggregator: It collects information from the data providers. It works based on a policy set that considers the data provider and owner and allows aggregation of unobjectionable data.

Data Management System: It acts as the main governing body that maintains interoperability among various participants as well as the services in the eHealth scenario.

The Data Management System regulates and governs each of the related entities, to ensure that there is no hindrance to the patient's privacy. It sets usage policies that allow for inflow and out-flow of data for research-based applications, for maintaining logs, and for making the logs available for the patients to review anytime.

The data management system is responsible for establishing default policies and maintaining logs and other information for the governing body. The data aggregator and data management system coordinates while maintaining the retrieval policies and recording the logs events. The data management system also sets policies for the smooth functioning among the clinics, hospitals, laboratories and other medical end utilities. The data aggregator sends and receives data requests and responses from the laboratories and other users responsible for generating viable health information. The legitimate user sends requests to the decision making body to execute the request. The decision making body on receiving the request from a legitimate user, generates a query data and sends it to the data aggregator for approval.

B. DESCRIPTION AND WORKING PRINCIPLE

The proposed data protection model, shown in Figure 3, allows for transparency on how the patient's data are used within the healthcare system. The model guarantees no data usage without the users' consent or agreement. The model uses the secure key management scheme as proposed by the project MAGNET and MAGNET Beyond [23]. It explains a new key agreement protocol based on elliptical curve cryptography and personal public key infrastructure. The patients have control over the data access by intended or third-party users. The Governing Body, responsible for regulatory policies have power to grant/deny any request to access the user-data without hampering their privacy.

The model creates log for all the successful and unsuccessful accesses, which can serve as a database to validate future requests. The patients can refer to the log to check their access details periodically. The data management system monitors and controls all accesses together with the system manager, a patient and data aggregator. In the case of an unauthorized request, patient can go for inquiry and ask justification. The data management system is responsible to answer the user's inquiry.

The basic working principle is explained through the flowchart in Figure 9-4. The model works based on the policies that take into consideration the interests and concerns for the patient as well as the healthcare utilities. The following section describes briefly the Model's working;

GOVERNING POLICIES

Healthcare Utility: Data providers share their data under predefined set of usage and collection policies. These policies are user-friendly and do not interfere in the services provided. Policies would only govern the data usage and access for the healthcare development and facilitate research.

Patient: The user controls the personal data shared on the network for maintaining health and disease control by setting up policies, which let them, decide when, how and by whom the data is to be accessed. The policies also govern the amount of visibility depending upon the usage, purpose and motive. The users can invoke filters at their choice.

Governing Body: the system managers are the government bodies, which set up certain rules and regulations to maintain a social balance and to restrict privacy hindrance to the individual.

DATA COLLECTION AND AGGREGATION

In the model, a data aggregator collects information from the data providers and the data owners. Only the permissible data would be stored and analysed further for other purposes intending to develop an overall eHealth scenario.

REQUEST TO ACCESS DATA

When a data user executes a query in the system, the query service retrieves a policy for the data user. This can include rules regarding, which data they can access, how they can use data, and required de-identification of the results. If they are permitted to perform the query, the retrieved rules are then applied to filter the result set, removing restricted information. The information access request is logged, and the policy versions used to determine the access request is stored with the context-aware log entry.

MAINTAINING ACCESS RECORDS

The logs produced in an accountable system can contain sensitive information themselves and must be appropriately protected, including restricting who can view these logs and for what purpose.

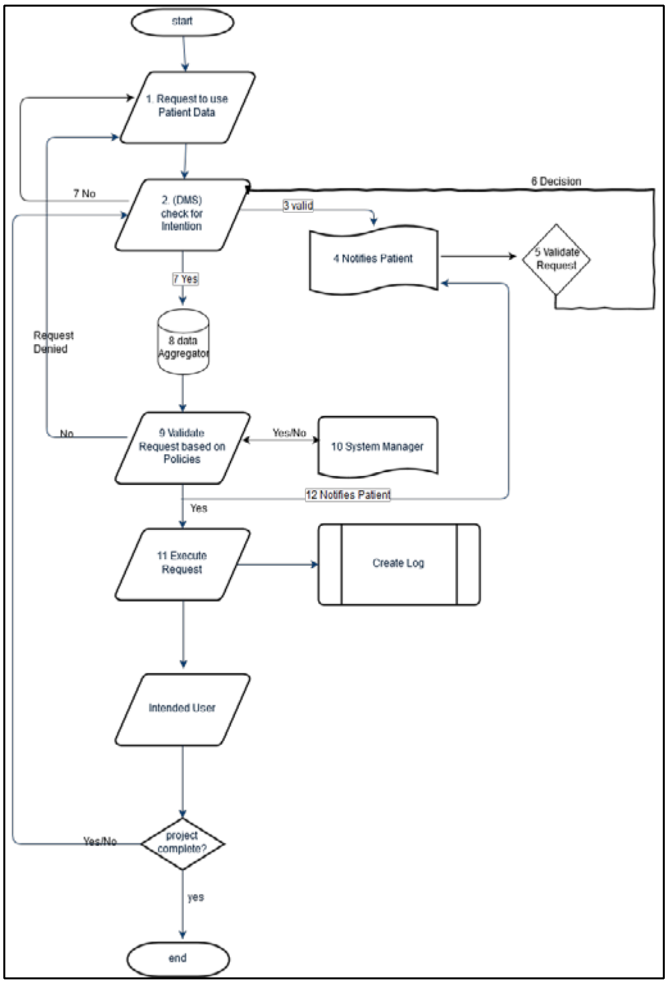


Figure 9-4 Working Principle of Proposed Data Privacy Model

IMPLEMENTATION

The implementation of the proposed model involves the formulation of rules and policies, data collection and aggregation, request to access data and creation and maintenance of access record-logs.

The governing policies are framed at three levels or working groups, comprising the healthcare utility, the patients and at the governing body as explained in the previous section. Each of the entities have their own requirements and accordingly set policies. For example, the doctors may share patients' symptoms and behavior for expert comments but the system would hide the personal data and identification; similarly, the patients would participate in guiding the usage of their data. The policies are generally depicted in the Open Digital Rights Language (ODRL) [22], which encourages the adoption of open international specifications for expressing policies in language. For data collection, aggregation and access, we will implant filters that will prevent restricted data access and maintain context-aware log entry. The model also incorporates a context aware security management scheme, which allows having virtual identities and including various agents to ensure trust, privacy, security and disclosed information. It authenticates uncompromised nodes and make decision on what to be shared keeping the patient aware of it.

CHALLENGES:

The proposed eHealth data privacy model would have to comply with the required scalability, heterogeneity and performance metrics assuring the data storage in the knowledge of the user and the concerned authorities.

The successful implementation of the proposed data privacy model in eHealth Big Data Analytics use cases requires to be overcome the challenges imposed by big data alone and also the adverse effects in healthcare sector.

Analyzing random as well as discrete data in eHealth will be complex and it will be difficult to maintain the exponential growth in the operation and computation time. The log maintenance will be difficult. Access grant against the query while maintaining its privacy will be a challenge. How an information is accessed, queried or stored including their log records will be a challenge. The major challenge for the implementation of the model is to accumulate and correlate the information coming from heterogeneous data sets.

CONCLUSION

The paper proposed a data privacy model in healthcare using big data analytics, added transparency in the data handling and accessing. The proposed model triggers the privacy issues in data aggregation and allowed access by maintaining logs and seeking due consents from the users who are the data owners. It also promotes the data sharing and risk mitigation in healthcare.

Future work will incorporate solutions to the imposed challenges in system scalability, interoperability, heterogeneity of data sets and implementation challenges.

REFERENCES

[1] Wang, W. and E. Krishnan, Big data and clinicians: a review on the state of the science. Journal Medical Informatics, 2014. 2: p. e1.

[2] Huser, Vojtech, and James J. Cimino. "Impending challenges for the use of Big Data." International Journal of Radiation Oncology• Biology• Physics (2015).

[3] Ball, Marion J., and Jennifer Lillis. "E-health: transforming the physician/patient relationship." International journal of medical informatics 61.1 (2001): 1-10

[4] "Data Breaches In Healthcare Totaled Over 112 Million Records In 2015." Ed. Dan Munro. N.p., n.d. Web. 28 Sept. 2016.

[5] Terry, Nicolas. "An eHealth diptych: the impact of privacy regulation on medical error and malpractice litigation." American journal of law & medicine 27 (2001).

[6] Weitzner, Daniel J., et al. "Information accountability." Communications of the ACM 51.6 (2008): 82-87.

[7] Hodge, James G. "Health information privacy and public health." The Journal of Law, Medicine & Ethics 31.4 (2003): 663-671.

[8] Campos, Maria João Magalhães Pereira. "Identity in eHealth-from the reality of physical identification to digital identification." (2012).

[9] J. J. Rodrigues, I. de la Torre, G. Fern´andez, and M. L´opez-Coronado, "Analysis of the security and privacy requirements of cloud-based electronic health records systems," Journal of medical Internet research, vol. 15, no. 8, 2013.

[10] By Greg Slabodkin. "Survey: No Cure In Sight for Healthcare Data Breaches." Information Management RSS. N.p., 2016. Web. 14 Sept. 2016.

[11] Zhao, X., and Johnson, M.E. (2008) ―Information Governance: Flexibility and Control through Escalation and Incentives,‖ Workshop on the Economics of Information Security, Hanover, NH

[12] Wilkowska, Wiktoria, and Martina Ziefle. "Privacy and data security in E-health: Requirements from the user's perspective." Health informatics journal 18.3 (2012): 191-201.

[13] Dimitra Liveri, Anna Sarri, Christina Skouloudi and ENISA. "Security and Resilience in EHealth: Security Challenges and Risks." Security and Resilience in EHealth: Security Challenges and Risks. European Union Agency for Network and Information Security (ENISA), 2015. Web. 13 Sept. 2016.

[14] N. H. Shah and J. D. Tenenbaum, "The coming age of data-driven medicine: translational bioinformatics' next frontier," Journal of the American Medical Informatics Association, vol. 19, no. e1, pp. e2–e4, 2012.

[15] L. P. Garrison Jr, "Universal health coverage–big thinking versus big data." Value in health: the journal of the International Society for Pharmacoeconomics and Outcomes Research, vol. 16, no. 1 Suppl, p. S1, 2013.

[16] Appari, Ajit, and M. Eric Johnson. "Information security and privacy in healthcare: current state of research." International journal of Internet and enterprise management 6.4 (2010): 279-314.

[17] NRC National Research Council (1997) ―For the Record: Protecting Electronic Health Information

[18] J. Feigenbaum, A. D. Jaggard, and R. N. Wright, "Towards a formal model of accountability," in Proceedings of the 2011 workshop on New security paradigms workshop. ACM, 2011, pp. 45–56.

[19] D. J. Weitzner, H. Abelson, T. Berners-Lee, J. Feigenbaum, J. Hendler, and G. J. Sussman, "Information accountability," Communications of the ACM, vol. 51, no. 6, pp. 82–87, 2008.

[20] healthcatalyst. "3 Best Practices for Payer-Provider Collaboration to Improve Patient Care." Health Catalyst 3 Best Practices for PayerProvider Collaboration to Improve Patient Care Comments. N.p., 2016. Web. 10 Oct. 2016.

[21] R. H. Sloan and R. Warner, "Developing foundations for accountability systems: Informational norms and context-sensitive judgments," in Proceedings of the 2010 Workshop on Governance of Technology, Information and Policies, ser. GTIP '10, ACM. New York, NY, USA: ACM, 2010, pp. 21–26.

[22] "Community & Business Groups." ODRL Community Group. N.p., n.d. Web. 27 Sept. 2016.

[23] Prasad, Ramjee, ed. My personal adaptive global NET (MAGNET). Berlin: Springer, 2010.

10. Research and Analysis on Floor Exposure due to Electromagnetic Radiation from Mobile Towers in Residential Areas of Kolhapur

Amar Renke, Department of electronics engineering, KIT's College of engineering, kolhapur, India
amarrenke@hotmail.com
Dr. Mahesh Chavan, Department of electronics engineering,KIT's College of engineering, kolhapur, India
maheshpiyu@gmail.com

ABSTRACT

The public concern about the possible adverse health effects of the human exposure to the electromagnetic radiation of cellular base station antennas has incremented in recent years. The investigation aimed to provide information for the variation of electromagnetic field exposure (power density and Electric field) radiated from antenna in the residential area in Kolhapur city. The paper summarizes the electromagnetic field (EMF) levels on different floors of a building due to electromagnetic radiation from cellular mobile base stations (CMBS). Electromagnetic field exposure was measured in culled buildings in Kolhapur area. EMF exposure was measured at different floors such as ground floor, first floor, terrace etc. of a building with the help of RF exposure meter KM 195. The measured floor exposure is then analyzed. The maximum value of power density recorded was 37511 µw/ m^2 and minimum 3.4 µw/ m^2. The measured values of EMF exposure were well below the ICNIRP reference levels.

Keywords— *cellular mobile base stations, electromagnetic field exposure, human exposure, power density, floor exposure, reference level, urban environment.*

INTRODUCTION

Cellular mobile towers are installed in an urban environment, consisting of a number of antennas on it. Even though there is a limit on a number of antennas on a single mobile tower, it is not followed by network operators. The antenna is an electromagnetic device which works on electromagnetic (EM) waves. It transmits and receives EM waves. An antenna has various important parameters such as directive gain, beam width, radiation pattern, operating frequency, and polarization. Antennas are classified as directional, sector and omnidirectional. The gain of the antenna magnifies the incoming EM signal and then radiates the power in the desired direction. Directional antennas only direct the signal in the desired direction. Whereas Omnidirectional antennas radiate power equally in all direction. Antenna gain depends on antenna radiation angles. The sector of an antenna is the angle in a horizontal plane where the power flux density is at least -3 dB with respect to the maximum power flux density [1][2][3][4]. The sector antennas having angle 1200 are widely used in GSM base stations. Such three antennas make a total angle of 3600 and cover the entire surrounding area. Sector antennas gain varies from 12 to 18dBi. Its length is from 1.5 to 2.5 meters. Omnidirectional antennas are used in highly populated areas. GSM uses vertical polarization hence all antennas adopt the vertical polarization [5][6].

Down tilting of the antenna is necessary for GSM [18][20]. Some antennas were down tilted with some angle. Such antennas were mounted with 900 with respect to horizontal plane. Such antennas are mechanically down tilted at the required angle so that all radiated energy goes to a coverage area of the required radius. Sector antennas with Horizontal 60, 90, 120, 180 and vertical 3…to 100 respectively are widely used [11].

The electromagnetic field generated by the base stations of the cellular mobile communication system is highly dependent on mechanical and electrical down tilting angles of antennas [6]. Actual values of the EM radiation should match with design values in the radiation pattern [22-25]. Exposure to RF field from a cell phone is short term but exposure to RF field emitted from cellular base stations is of long duration. Nowadays these base stations were mounted in densely populated areas in the urban environment. Actually according to norms antenna tower must be away from the residential area, more correctly it should be away from the residential area by 300 meters, but mobile tower operators, different network operators do not obey this. Thus people living in the building/apartments are exposed to EMF radiation. Hence people are asking questions about EMF exposure. Kolhapur is one of the well-developed city in recent years. So tall buildings, apartments and commercial business towers were built-up in the city. Thus quantification of power density and electric field in such tall building and apartments will be useful in determining the electromagnetic field (EMF) exposure levels of the general public in each floor of the building/apartments and this, in turn, determines whether the exposure levels are within the maximum permissible limits or not[12][13].

MATERIALS AND METHODS

A. MEASUREMENT PROCEDURE

Here the main aim is to measure electronic radiation in building/apartment, the distance between the building and mobile tower, the number of antennas on each tower etc. and then data is analyzed. Initially, electromagnetic field exposure is measured in terms of power density and electric field. Their units are µw/m2 and mv/m respectively. The device used to measure the EM radiation on different floors of the building is KM 195 three axes RF field strength meter. The KM 195 is capable of measuring the RF field exposure from base stations. The meter is calibrated precisely over the frequency range of 50MHz ~ 3.5GHz. There are different sources of electromagnetic field such as TV transmitters, Radio broadcast transmitters, and cellular mobile towers etc. Due to these transmitters, electromagnetic field exposure increases in surrounding areas and people get exposed to it. It measures electric as well as the magnetic field. KM 195 three axis exposure meter measures this EM radiation. The meter having units mV/m, V/m, mA/m, mA/m, mW/m2, mW/m2, mW/cm2 etc.

B. SITE SELECTION

Before measurement of EM exposure, we culled the measurement sites i.e. identified buildings at different locations in Kolhapur city [15]. Average floors on the identified buildings are around five. Exposure is quantified indoor and outdoor on each floor of a building.

Mobile tower is mounted on some of the buildings/apartments. The height of the antenna is around 5 to 10 meters when is mounted on the rooftop of buildings. Most of the buildings/apartments are selected in such a way that in front of that site there will be a mobile tower. Exposure was measured on each floor, inside the room and also on building a terrace. It is measured in µw/m2 and V/m. Total 5 buildings/apartments are selected for the floor exposure measurement. Different building sites selected for the floor exposure measurement and their average exposure are listed in Table 10-1.

Table 10-1 LIST OF BUILDING SITES AND AVERAGE EMF EXPOSURE

Building Location	**Table Column Head**	
	Average Power density µw/ m2	***Average Electric field v/m***
Hanuman Nagar	1902	666.09
I.T.I Kolhapur	3330	697.80
Devkar Panand	91.76	117.14
Hockey stadium	67.30	250.03
Ambai Tank	8192.86	2430.08

C. SITES SELECTED

First building site selected is near Hanuman Nagar consisting of six floors. Measured EMF exposure shows variation in exposure at each floor due to number of reasons such as location of mobile base station tower from building, at which side of the building antenna tower is located, what is the antenna tilt angle etc. in case of site 1 building highest exposure is at floor six, medium is on the first floor and low at remaining floors. This is shown in figure 1.0. Average power density and electric field at floor six is 1823 mv/m and 8830 µw/m2.

The second building site is close to I.T.I. Kolhapur. It also consists of six floors. Here floor 3 is more exposed and the exposure level is 5686 µw/m2 .lowest exposure is on the last floor which is 1075 µw/m2. On an average mobile tower, antenna covers almost all floors except floor six.

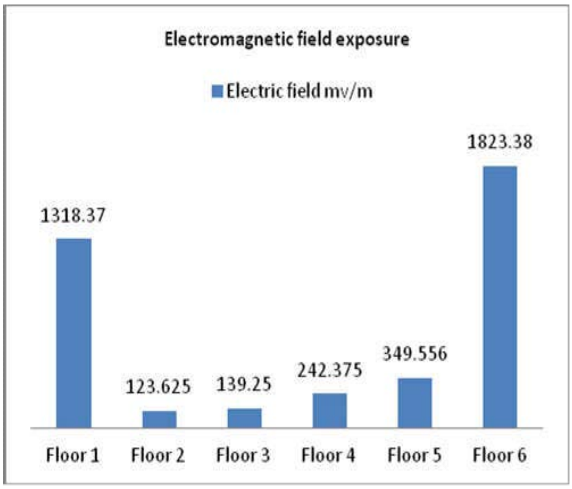


Figure 10-1 ELECTRIC FIELD INSIDE A 6-STOREY BUILDING AT THE MIDDLE OF THE ROOM.

The third building site is at the west side of Kolhapur i. e. Devkar Panand. 5 kilometers from a central place. Since the location of the mobile tower site is far from the building site exposure is less on the floors. Maximum exposure measured is 308.35 mv/m and the minimum is 26.71mv/m. The fourth site is at hockey stadium it is a 6 story building on which mobile tower antenna is mounted as shown in figure 2.0. More than 20 antennas are installed on the tower. More are used for voice and data communication and few for traffic transmission from one base station to another. Since the antenna is mounted on building itself, therefore, the exposure level found is less.

Figure 10-2 SIX STORY BUILDING SITE AT HOCKEY STADIUM.

The fifth site is Ambai tank near Rankala. The building consists of five floors. Highest power density is observed on floor 2 which is 88560 µw/m2 and the highest electric field is on the first floor which is measured as 12401 mv/m. The radiation standards accepted in some countries such as India is based on ICNIRP guidelines of 1998 for the safe power density of f/200, where frequency (f) is in MHz. Thus, for GSM-900 transmitting band (935-960 MHz), power density is 4.7W/ m2 and for GSM-1800 transmitting band (1810-1880 MHz), it is 9.2W/m2. Then 2010 DoT has reduced this level by 1/10th and revised the ICNIRP norms which are as shown in the following table.

Table 10-2 RADIATION NORMS.

Frequency	ICNIRP radiation norms	Revised DoT norms
900 MHz	4.5 w/m^2	0.45 w/m^2
1800 MHz	9.0 w/m^2	0.90 w/m^2
2100 MHz	10.5 w/m^2	1.05 w/m^2

Considering the ICNIRP guidelines, for instantaneous exposure to numerous frequency fields, the summation of all the radiation in particular surroundings must be taken into consideration. Thus, the addition of all the radiation from a mobile tower base station antennas serving two or more service providers' signal transmission must also be considered.

RESULTS AND DISCUSSION

The measurement results show that power density is more at the floor, where floor height and antenna height is the same and they are in the same line. Also, power density and electric flux were more in case of direct line of sight (LOS) buildings. According to the measurements, floor exposure was varying from ground floor to the top floor. Nature of graphics is changing it is not the same for all sites because the height and distance of transmitting base station are changing from the building/apartment under measurement. Measurement results showed that the antenna covers an area up to 20 meters height approximately floors from the ground to six are in coverage area and floors above six get less coverage. In short middle floors of a building get more EM exposure than others also it depends upon location and distance of the mobile tower from the building.

A. SITE 1 RESULTS

Site 1 is having six floors; this site is in Hanuman Nagar west side of Kolhapur district. The total number of antennas mounted is 19. Its height is around 100 feet. The distance between site 1 and mobile base station tower is 80 feet. Site 1 measured data is as shown in Table 10-3.

Table 10-3 AVERAGE EMF EXPOSURE AT SITE 1

No. of floors	Electromagnetic field exposure	
	Average Power density µw/ m2	Average Electric field v/m
Floor 1	**2224.5**	**1318.37**
Floor 2	**33.031**	**123.625**
Floor 3	**24.741**	**139.25**
Floor 4	**53.287**	**242.375**
Floor 5	**246.451**	**349.556**
Floor 6	**8830.38**	**1823.38**

From figure 10-1, it is seen that exposure was more at first and last floor. And goes on increasing from floor 2 to floor 6. This means that the antenna tilt is not adjusted properly. As exposure in maximum at floors 1 and 6 they are exposed more to the EMF. Average power density at floor 1 is 2224.5 µw/ m^2 and on floor 6 it is 8830.38 µw/ m^2. Power density at floor 6 is three times more than power density at floor 1.

B. SITE 2 RESULTS

Site two is also having six floors; this site is near to I.T.I. Kolhapur west side of Kolhapur district. Total number of antennas mounted is 22. Its height is around 80 feet. Distance between site 1 and mobile base station tower is 75 feet. Site 2 measured data is as shown in table 10-4.

Table 10-4 AVERAGE EMF EXPOSURE AT SITE 2.

No. of floors	Electromagnetic field exposure	
	Average Power density µw/ m2	*Average Electric field v/m*
Floor 1	4461.28	364.57
Floor 2	2867.42	34.92
Floor 3	5686.222	2459
Floor 4	3375.526	188.37
Floor 5	2515.33	871.1
Floor 6	1075.38	268.889

As compare to first site here distance between site and building / apartment is less, also antennas mounted on tower having direction towards the building site 2, antenna tilt angle is adjusted properly hence EMF exposure is more.

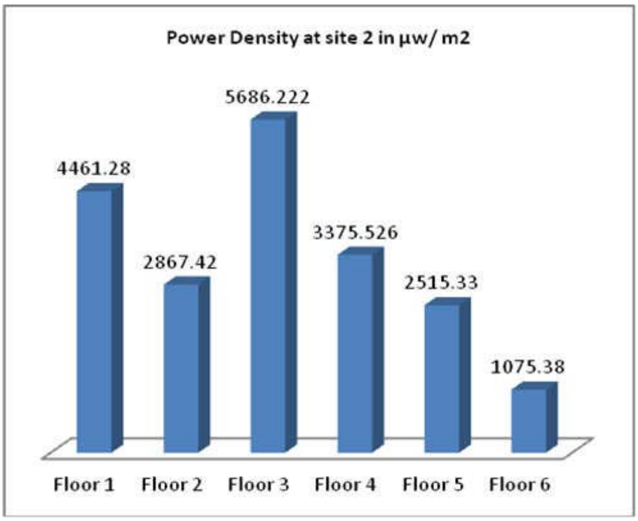


Figure 10-3 AVERAGE POWER DENSITY INSIDE A 6-STOREY BUILDING.

Figure 10-3 shows that floor 6 is having less EM exposure. Remaining floors get the power density level satisfactory. Power density is highest at floor 3. From figure, it can be concluded that floor 3 is in line with the transmitting antenna. In other words, the height of transmitting antenna and height of floor three is approximately same. Average EMF exposure for site 2 is 3330.19 µw/ m^2 and electric field is 697.80 mv/m.

Figure 10-4, shows that floors 2, 4 and 6 are having less electric field. Middle at floor 1 and 5. And high at floor 3. Here one can conclude that only floors 3 and 5 get the sufficient electric field exposure for remaining floors there is less EMF exposure. As electric field exposure is high at floor 3 therefore people living on this floor may face the problems of health effects due to excessive electric field.

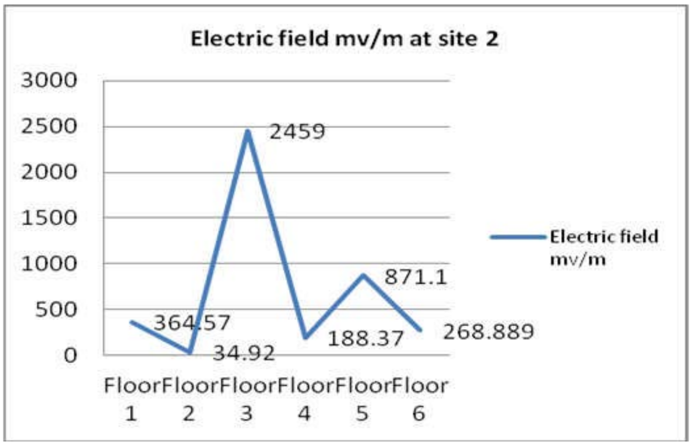


Figure 10-4 AVERAGE ELECTRIC FIELD AT A 6-STOREY BUILDING.

C. SITE 3 RESULTS

From figure 10-5 and 10-6, it is clear that the power density and electric field is high at floor six so they get more EMF exposure than other floors. Since site 3 is far away from building / apartment hence exposure, magnitude is less for both power density and electric field. As antenna tilt angle matches with floor six, therefore EMF exposure is more on this floor.

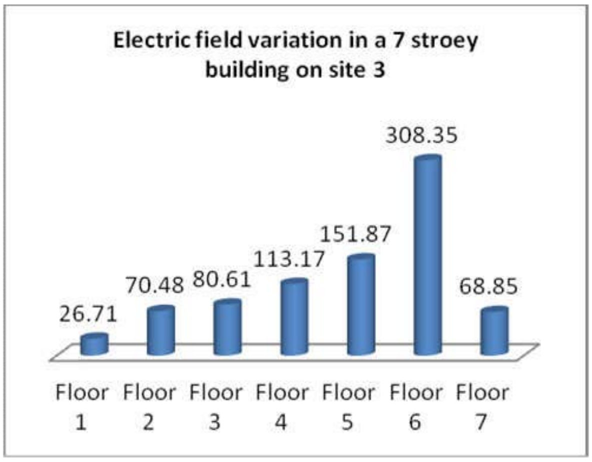


Figure 10-5 ELECTRIC FIELD INSIDE A 7-STOREY BUILDING AT DEVKAR PANAND

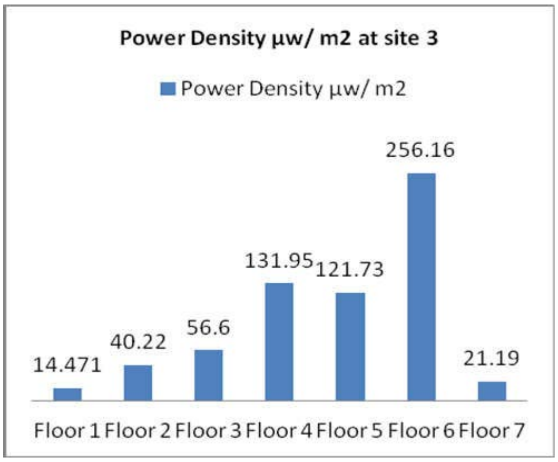


Figure 10-6 POWER DENSITIES INSIDE A 7-STOREY BUILDING AT THE MIDDLE OF THE ROOM.

Figure 10-7 shows electric field variation in a 7-storey building near hockey stadium. Here Electric field is maximum at terrace. In case of this site antenna tower is mounted on rooftop of a building.

After measurement of EMF exposure at all sites that is in all building / apartments it is found that people are complaining about the mobile tower, particularly in case of towers mounted on rooftop of the buildings. People are asking questions about the electromagnetic radiation from the antenna towers. Whether it is harmful or not? How to measure it? What should be its standard value? In addition, what to do if radiation is excessive? Etc.

D. OBSERVATIONS

- Electromagnetic field exposure from base station antenna towers is not same for all the floors in a building / apartment.
- Magnitude of electromagnetic field exposure is highly dependent on distance between mobile tower and building / apartment site, number of antennas on base station towers.
- Antenna tilt angle and its direction play an important role in electromagnetic field exposure on a particular floor.

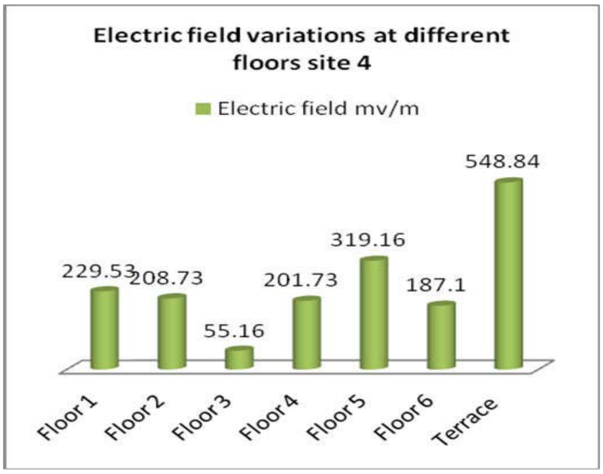


Figure 10-7 . ELECTRIC FIELD VARIATION IN A 7-STOREY BUILDING AT HOCKEY STADIUM

E. CONSOLIDATED FIGURES AND TABLES

Table 10-5 shows consolidated data of EMF exposure from all building / apartments sites.

Building / Apartment	Consolidated Electromagnetic field exposure				
	Average P.D. µw / m2	*Average E. field mv/m*	*No. of Antennas*	*Distance (feet)*	*Height (feet)*
Hanuman Nagar	1902	666.09	19	80	100
I.T.I. Kolhapur	3330	697.80	22	75	80
Devkar Panand	91.76	117.14	15	150	80
Hockey Stedium	67.30	250.03	17	0	125
Ambai Tank	8192.86	2430.08	24	50	100

As seen from the figure 6.0 in Ambai tank area EMF exposure measured were highest, medium at I.T.I Kolhapur and lower at Hanuman Nagar.

From figure 10-9 it is clear that percentage contribution of EMF exposure is more in case of Ambai tank and it is 60%. Followed by I.T.I site and Hanuman Nagar their contribution is 25 % and 14% respectively. Devkar Panand and hockey stadium sites are having lowest contribution in EMF exposure.

Measurements of the mobile base station antenna signals conducted from 10.00 AM to 5:00 PM local time in Kolhapur. The power radiated by base stations is extremely dependent on the number of subscribers making calls simultaneously. Therefore, the measured radiated power depends on local time, place, antenna direction, distance of measurement.

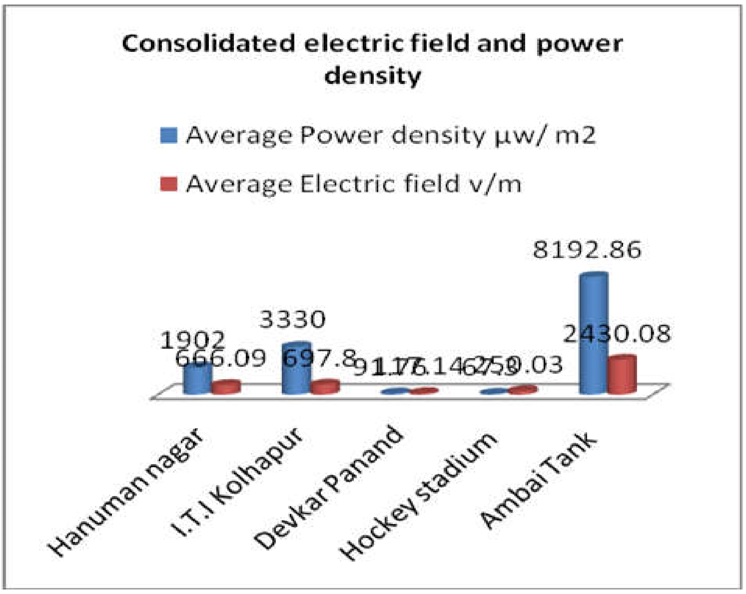


Figure 10-8 CONSOLIDATED ELECTRIC FIELD AND POWER DENSITY AT ALL SITES.

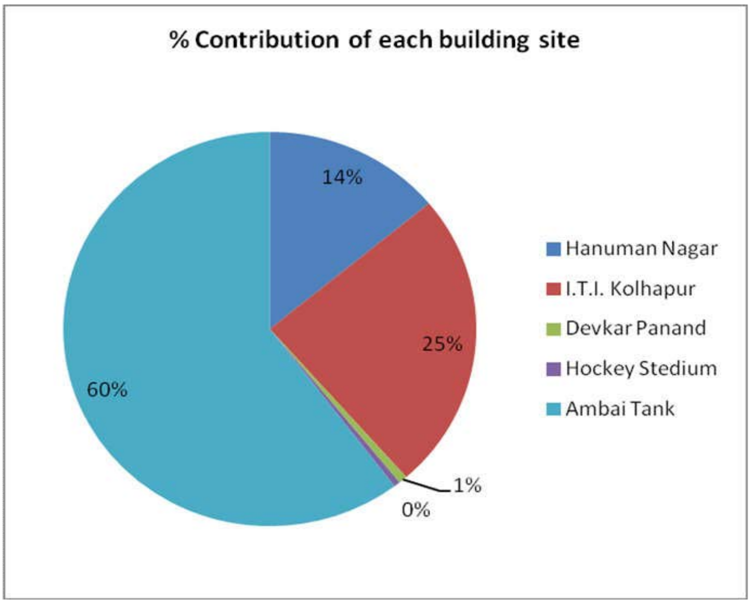


Figure 10-9 % Contribution of each building / apartment site

CONCLUSION

In this research work, measurements have been carried out at various places at distances about 100 feet away from the cell towers inside buildings / Apartments in Kolhapur. Total of 450 measurements has been taken at different buildings / Apartments sites in an urban environment. The results of this study show that average power density and electric field were 2582.23 µw/m2 and 804.02 mv/m respectively. This amount of power density is less than the standard reference level set by ICNIRP.

After analysis of measured EMF exposure at different buildings/apartments, it was concluded that EMF exposure at a particular floor depends upon the distance between mobile tower antenna and a building as well as the height of the mobile tower antenna.

If the height of a particular floor matches with mobile tower antenna height in that case EMF exposure was maximum at that particular floor. The maximum value of power density recorded was 37511 µw/ m2 which are higher than the standard reference level adopted by DoT that is 0.45 w/m2 and the minimum is 3.4 µw/ m2. The average power density and electric fields were 2582.23 µw/ m2 and 804.02 mv/m respectively, this value also exceeds the DoT reference level. All measured values of EMF exposure were well below the reference level set by ICNIRP and exceeds the national standard (DoT). The EMF exposure measured at each building site near base stations is useful for the local base station operators to install antenna properly and readjust EMF exposure in surrounding areas.

Therefore, many comprehensive studies are necessary for this country, to protect people from the risk of the exposure to this high power density of the radiation from mobile tower base stations installed especially in residential areas.

ACKNOWLEDGMENT

Author wants to give thanks to Department of technology, Shivaji University Kolhapur for providing laboratory facilities for the work. Also thanks to ETC department for providing the lab facility for the work. Finally thanks to the Dr. M S Chavan sir for their valuable guidance.

REFERENCES

[1] R. Buckus and P. Baltrènas, "Research and analysis of electromagnetic radiation from mobile telephone base station antennas in residential environment," *2012 19th International Conference on Microwaves, Radar & Wireless Communications*, Warsaw, 2012, pp. 171-175.

[2] P. Baltrénas and R.Buckus, "Research and assessment safety distance of TV electromagnetic fields", *International Journal of Occupational Safety and Ergonomics*, vol. 17, pp. 33-39, 2011.

[3] P. Baltrenas and R. Buckus, "The exploration and assessment of electromagnetic fields in duplicators", *Enviromental Engineering and Landscape Management*, vol. 17, pp. 89-96, 2009.

[4] P. Bemardi, M. Cavagnaro, S. Pisa and E. Piuzzi, "Human exposure to radio base-station antennas in urban environment", *IEEE Transactions on Microwave Theory and Techniques*, vol. 48, pp. 1996-2002, 2000.

[5] R. Cicchetti and A. Faraone, "Estimation of the peak power density in the vicinity of cellular and radio base station antennas", *IEEE Transaction on Electromagnetic Compatibility*, vol. 46, pp. 275-290, 2004.

[6] R. Cicchetti, A. Faraone and Q. Balzano, "A uniform asymptotic evaluation of the field radiated from collinear array antennas", *IEEE Transaction on Antennas and Propagation*, vol. 51, pp. 89-102, 2003.

[7] C. Damian and C. Fosalâu, "Sources of indoor noise and options to minimize averse human health effects", *Environmental Engineering and Management Journal*, vol. 10, pp. 393-400, 2011.

[8] A.Faraone, R. Yew-Siow Tay, K.H. Joyner and Q. Balzano, "Estimation of the average power density in the vicinity of cellular base-station", *IEEE Transactions on Vehicular Technology*, vol. 49, pp. 984-996, 2000.

[9] S.I. Henderson and M.J. Bangay, "Survey of exposure levels from mobile telephone base stations in Australia", *Biolelectromagnetics*, vol. 27, pp. 73-76, 2006.

[10] V. Hrvoje, "Wire antenna theory applied to the assessment of the radiation hazard in the vicinity of the GSM base station", *Serbian Journal of Electrical Engineering*, vol. 1, pp. 15-26, 2003.

[11] Raimondas, "Electromagnetic field in the workplace and living environment. Parameters values and measurements requirements of 10 kHz - 300 GHz frequency band", *Valst. Žinios [State's News]*, no. 29-1374, pp. 6, 2011.

[12] S.P. Loughran, A.W. Wood, J.M. Barton, R.J. Croft, B. Thompson and C. Stough, "The effect of electromagnetic fields emitted by mobile phones on human sleep", *Neuroreport*, vol. 16, pp. 1973-1976, 2005.

[13] M.A. Mangoud, R.A. Abd-Alhameed and P.S. Excell, "Simulation of human interaction with mobile telephones using hybrid techniques over coupled domains", *IEEE Transactions on Microwave Theory and Techniques*, vol. 48, pp. 2014-2021, 2000.

[14] S. Miclaus and P. Bechet, "Estimated and measured values of the radiofrequency radiation power density around cellular base stations", *Romanian. Joumal Of. Physks*, vol. 52, pp. 399-409, 2007.

[15] C. Olivier and L. Martens, "Optimal settings for narrow-band signal measurements used for exposure assessment around GSM base stations", *IEEE Trans. on Instrumentation and Measurement*, vol. 54, pp. 311-317, 2005.

[16] D. Poljak and N. Kovac, "A simplified electromagnetic-thermal analysis of human exposure to radiation from base station antennas", *Automatika*, vol. 45, pp. 11-17, 2004.

[17] R. Pocius, "The influence of downtilt of antennae directional diagrams on the formation of mobile network cells and estimation of electromagnetic field intensity", Elektronika Ir Elektrotechnika, vol. 64, pp. 31-36, 2005

[18] D. Wojcik, T. Topa and K. Szczepanski, "Absorption of EM energy by human body in the vicinity of GSM base station antenna", Journal of Telecommunications and Information Technology, vol. 32, pp. 3438, 2005.

[19] Amar. Renke and Mahesh. Chavan, "An investigation on residential exposure to electromagnetic field from cellular mobile base station antennas," Computing, Communication and Security (ICCCS), 2015 International Conference on, Pamplemousses, 2015, pp. 1-4.

[20] Amar Renke and Mahesh Chavan. Article: A Review on RF Field Exposure from Cellular Base Stations. International Journal of Computer Applications 104(12):9-16, October 2014.

[21] Amar Renke and Mahesh Chavan. Article: An Estimation of Electromagnetic Field Exposure from Cellular Mobile Base Station Towers in Densely Populated Residential Areas. Communications on Applied Electronics 4(3):5-9, January 2016. Published by Foundation of Computer Science (FCS), NY, USA.

11. About Problems and Requirements with Privileged Access and Authorization Management in Cloud-Based Multi-Tenant Networks

Marleen Steinhoff, Rakuten Mobile Inc., marleen.steinhoff@hm.edu
Sander de Kievit Rakuten Mobile Inc. sander.dekievit@rakuten.com

ABSTRACT

This paper gives an overview of the existing problems and requirements for privileged access to network functions in a virtual multi-tenant network. Cloud networks often use already existing solutions, and each solution is individually configured and build for different purposes. This leads to the following problems: First, using a variety of authentication methods leads to an inhomogeneous level of security for the different virtual functions in the network. Second, security policies differ from one solution provider to the other. Third, settings are set on different virtual functions locally and also on different layers of software which makes the authentication methods difficult to maintain. Simultaneously, by exploiting the authentication vulnerabilities, the possibility of attacks may increase. Thus, it is challenging, but crucial providing these network functions with secure access which includes strong authentication and holistic logging, in order to reduce the risk of incidents and detect attacks.

INTRODUCTION

Numerous companies in various sectors [1], [2], [3], [4] are transitioning to cloud-based solutions. The reason to do so is cost efficiency, scalability, and flexibility among others [5]. These cloudbased solutions, however, also need to be operated and maintained and therefore be accessible by system administrators. This paper underlines the challenges that emerge with access management in a cloud environment.

Cloud-based solutions can be separated into roughly two layers: the so-called “lower cloud” providing the hardware as well as the actual cloud infrastructure and the “upper cloud” which comprises of the network functions including software solutions from solution providers (SPs). The upper cloud also includes the application layer with the applications that can be actually used by an end-user. In this paper, we will use the words “in the cloud” to refer to the upper cloud and “cloud infrastructure” to refer to the lower cloud.

In order to build less expensive cloud-based networks quickly, using state-of-the-art solutions from other companies can be used. The resulting multi-tenancy is one of the main characteristics of cloud computing environments[1] [6].

Since solutions from different SPs provide and support many different authentication methods, authenticating users and giving them privileged access has become a complex issue. In addition, the users, like maintainers and developers, access the network from different entry points. The different channels used to connect to the functions in the network are complex to overview and to maintain. Furthermore, the 2019 Cloud Security Report analyzed that 31% of cybersecurity professionals have problems with setting consistent security policies in the cloud [7].

As the stability of the network depends on the availability of the functions within the network, the authorization of user actions after authenticating them is also an important factor. Users should not be able to perform critical actions to intentionally or unintentionally disable provided functions.

In case someone performed malicious actions, it’s essential to trace back those actions in order to restore the previous status, detect the entry point into the network and fix vulnerabilities. When different authentication

[1] defined by the National Institute of Standards and Technology

methods are used simultaneously, security measures such as logging can easily get bypassed, which leads to unauthorized access and incomplete or nonexistent logging.

Therefore, three main problems exist in cloudbased multi-tenant networks for privileged access management (PAM): An unpredictible amount of users from different environments access the network and need to get authenticated properly, the action has to be authorized for the requested resource, and actions on the virtual functions need to get logged securely without any exception for triggering alarms and for forensic purposes.

In this paper these problems are analyzed and the resulting requirements specified. Solutions for these problems have been developed already[2], but 72% of organizations still had public cloud related security incidents in the last year [7]. As a result, a more hollistic approach is needed to avoid incomplete security measures.

This paper is structured in the following way: Introduction, followed by the problems that occur in multi-tenant networks with regards to authentication and authorization, then resulting requirements are listed and finally it ends with the conclusion. The major problems are analysed in section II and the resulting neccessary requirements are explained in section III. Analysed problems are numbered (P + number) and the requirements refer to the problems they cover. Section IV summarises the main problems and requirements for a solution providing secure IDM (Identity Management) and PAM in a cloud network.

In this paper the following terms are used:

- multi-tenant networks: network build with seperate solutions, provided by different solution providers
- cloud provider: the owner of the cloud network
- cloud solution provider: builds, provides and maintains a software solution for the cloud network
- user: every subject or object connecting to a cloud solution from the tenant or cloud provider side, no end-users of the provided solution or network

PROBLEMS WITH ACCESSING CLOUD-BASED VIRTUAL FUNCTIONS

Most of the challenges cloud providers face about IDM and PAM are not neccessarily new in computer science, but the context has been drastically changed for cloud networks. This is due to heterogeneity in the provided solutions, the architecture of the virtual infrastructure itself, the distributed and decoupled character, and the increased amount of attack surfaces and complexity. Next to the well-known issues with IDM and PAM, cloud computing also comes with completely new categories of threats [11] challenging cloud and solution providers. The most relevant problems a cloud-based multi-tenant network comes with in terms of authentication and authorization are discussed in the following sections.

A. HETEROGENEITY IN CLOUD NETWORKS

Heterogeneity in cloud-based networks comes in different aspects: The variety of different solutions from different tenants used to build the cloud infrastructure, the different user groups accessing the network from various environments, and the different layers of infrastructure. These aspects create heterogeneity as well as complexity within the network. This heterogeneity further creates new problems regarding implementation and operation, making IAM (Identity and Access Management) one of the three main concerns existing for security improvement in cloud environments [12]. The problems that the different aspects of heterogeneity create are explained in the following subsections.

1) *Software Layers:* With cloud computing, new layers of software have been added to the infrastructure architecture. As every software layer needs to provide its own access methods for maintenance and change management on the layer itself, the provided remote access of the cloud layer increases the amount of possible vulnerabilities regarding access control and increases the complexity of the architecture in general. The increased complexity and additional authentication methods for the cloud layer increase the amount of potential

[2] Solutions for PAM in cloud environments such as from Entrust Datacard [8], BeyondTrust[9] or Saviynt[10]

vulnerabilities regarding authentication and authorization. Especially when access procedures are defined locally on the layer itself using weak authentication methods, these vulnerabilities can create a backdoor for attackers (P1).

Because efficient change management is a key factor in the success of a cloud environment [13], elements in a cloud network must be constantly changing, affecting every layer. Software is constantly changing as new features are added, faults are corrected, and code is restructured[14]. In the case of IDM and PAM, authentication protocols and cryptographic methods must also be supported to secure the authentication procedures. Therefore, authentication procedures not only have to be maintained, but also the changes have to be implemented (P2).

2) *Variety of software solutions:* Professor J. Joshi defined the heterogeneity of software solutions and hardware components as one aspect of heterogeneity in cloud environments [15]. As this paper focuses on authentication and authorization of users, hardware heterogeneity should not affect IDM and PAM procedures in cloud environments.

The heterogeneity of software solutions is created by the different solutions built for several purposes, e.g. business functions, management functions and security functions among others, built and provided from different SPs. The different needs require different authentication methods. One example is related to functions for logging purposes, these functions have to be tamper-safe and therefore require very strong authentication only for a very restricted selection of maintainers. A different authentication method is needed, when functions handle a large amount of users that stay logged in, e.g. for messaging software. Therefore, the virtual elements often have their own PAM solutions or interfaces implemented. The implementation is adapted to the functions' specific individual needs, including how often users access and use the service, how security-sensitive the software and stored data is and where the service is virtually and physically placed. In addition, different standards are used for authentication procedures depending on the individual needs and systems already in use (P3). The points mentioned above affect access management and security when the integrated solutions don't support the same access methods or when network settings, such as supported protocols or open ports, are set differently.

In case standards used in the network are not supported, the missing standards or interfaces have to be added and the settings have to be changed from every SP with hindsight. More likely, workarounds such as local authentication functions are implemented as the SPs already have invested significantly in their own authentication systems [12]. Also most services still rely on regular accounts [16], [17] stored locally on the cloud function itself making them susceptible to attacks (P4). This allows users as well as attackers to log into functions directly without using the official authentication methods. Consequently, workarounds and local logins can easily lead to incomplete logging when official authentication procedures are surrounded (P5). An incomplete logging makes it difficult or even impossible to trace back the path an attacker took within the network and what changes have been applied on the elements. For example, when the user logs in to a first function in the network using a central authentication procedure and then connects directly to another function using local credentials, the actions on the first functions will be logged properly, but the actions on the second function will most likely not be logged. A similar problem appears when the functions log executed actions, receiving the actual time from different systems (P6). Actions can't be traced back when the logs are generated using unsynchronized clocks.

Additionally, decentralized authentication also causes problems when changes on software are required. As the authentication software is installed on different functions, updating software and changing configurations takes a lot of effort and is extremely time-consuming. Furthermore, it's likely that changes are not holistically implemented which leads to vulnerabilities when some parts of the network still rely on previous versions (P7).

Even when a global authentication method is implemented for all functions in the network, a fall-back solution is needed when the main authentication method is out of service. These fall-back-solutions can act as backdoors for attackers when they enable an attacker to bypass the central authentication (P8). Especially when fall-back solutions are are defined locally, logging procedures can be completely circumvented (P9). In addition, locally defined or distributed user accounts are difficult to maintain, which can lead to unauthorized accounts existing on the elements and can create a backdoor for attackers (P10). As weak authentication methods act as an entry point into a network and compromise other functions, the easiest way into a network reduces the security level of the whole network.

The heterogeneity of software solutions in the network is not only chaotic, but also causes incompatibilities when using functions interconnected by coupling them. For IDM and PAM, these incompabilities come in two main aspects: Incompatible security policies and incompatible authentication methods. When different authentication methods are implemented and supported by the provided solutions, authenticating to a service and coupling it to another service can cause incompatibilities when the authentication methods from different SPs don't match [15] (P11). Consequently, either the elements trust already authenticated users once they are authenticated within the network, or the users have to get re-authenticated.

Incompatibility also appears in security policies, for example, when different password policies or protocols are allowed by different SPs. Different SPs define their own password policies, such as minimum required password length or allowed characters. The policies from different SPs vary and therefore don't provide the same level of security (P12).

Consequently, trust management between the implemented software solutions is fundamental for communicating policy together with validating and evaluating access credentials before trusting the other party [18]. This trust is essential not only between users and functions, but also between the functions themselves. If untrusted functions are allowed on the network and not validated, this can lead to vulnerabilities. Unknown functions can be placed in the network by an attacker when the authenticity is not validated (P13). Therefore, trust is one of the most concerned obstacles for the adoption and growth of cloud computing[19].

3) Different solution providers: When the network is not completely built by the cloud provider itself, solutions from other companies are used to build the network. This results in unclear roles and responsibilities in cloud networks [20] as responsibility is divided among different groups including the cloud user, the cloud tenant, and any third-party vendors [21].

While it is relatively clear who is responsible for the security of single provided functions, it is much more difficult to assign responsibilities for tasks that can influence the overall security of the network. The changes on authentication methods as they are needed to gain privileged access to every function in the network are an example. Even when the authentication method is considered as bug-free, it can cause vulnerabilities when the method is used in operation together with different elements in the network. As a result, it is unclear who takes responsibility of the overall security in the network (P14).

The same problem appears when changes have to be implemented, for example when providers want to apply software changes that affect the security of the cloud. The functions offered are provided by different companies as well as assigned to different teams within the company. The boundaries between responsibilities become blurred when it comes to the acutal assignment of tasks, for example, when the cloud provider chooses a framework, the solution is not configured for or when vulnerabilities need to get eliminated on the external provided software solution (P15).

Another problem that comes with the heterogeneity of solution providers is that the developers implementing the solutions are often not security experts, which leads to misconfigurations, buggy code and weak passwords exposing their services [22]. This is problematic when security-related functions as authentication or logging functions are implemented by developers without a review from security experts (P16).

4) Different user groups: Heterogeneity can also be found in the user groups since maintainers and developers of the cloud networks are coming from different companies with different backgrounds. As the users are connecting to virtual functions in the cloud remotely, authentication mechanisms are required to access the cloud through different entry points.

Even with properly maintained user accounts, the cloud provider does not know which persons or even objects use the privided accounts to access the cloud functions in the network. It is also not transparent to the cloud provider how SPs handle accounts, credentials and privileges on their side (P17).

As the users connecting to the cloud functions come from different environments, the amount of connecting users depends on the amount of solution providers as well as the number of people responsible for the project on the tenant's side. Therefore, the exact number of users is unpredictable in multi-tenant networks, which makes it challenging to avoid unauthorized users accessing the network or to avoid accounts of former users that are still accessible (P18).

B. CREDENTIAL MISUSE

For authentication of a user, it is checked whether a claimed identity corresponds to the actual identity on the basis of well-defined and unambiguous characteristics [23]. The characteristics in form of credentials are used to authenticate a user and therefore the key to remotely access every type of cloud network.

With regard to CSA's (Cloud Security Alliance) report "Top Threats to Cloud Computing - The Egregious 11", security incidents and data breaches can occur due to inadequate protection of credentials, failure to use multifactor authentication and failure to use strong passwords among others [24].

Using credentials that are easy to steal, guess or faked makes the access to a network vulnerable for attackers. In addition, authorized users from inside the network can misuse their access privileges. These attackers are known as malicious insiders. The problems behind both kinds of attacks, from inside and outside, are analysed in the following subsections.

1) External credential attacks: Almost every day, news about stolen user credentials, hacked databases and badly protected user accounts are reported. Also a report from (ISC)2[3] rated unauthorized access through misuse of employee credentials and improper access controls as the biggest perceived vulnerability to cloud security in their 2019 Cloud Security Report [7]. Once credentials are phished by attackers, it can lead to data breaches or misuse of access, financial damage through fines as well as a damage of reputation and customers trust.

The heterogeneity in the provided solutions as described in section II A 2), also affects the type of credentials used within the network. Even though the CSA and many other institutions [25], [26], [24], [20], [27] recommend the implementation of MFA (Multi-factor authentication) to protect sensitive data against unauthorized users, most organizations still heavily rely on passwords [17] (P19).

Passwords are easy to remember for users and simple to implement for SPs, but it leads users to reuse passwords accross different platforms and services or to write them down. Therefore, traditional authentication methods such as username and password are prone to password attacks and phishing and do not provide enough security in a cloud computing environment [25], [?]. Next to weak credentials, a lack of regular automated rotation of cryptographic keys, passwords and certificates leads to insufficient access management [24]

(P20). Once an attacker compromises credentials to an account, they can misuse the account as long as the credentials are valid. With credential rotation an attacker who already has access to the cloud network gets locked out.

But even when a secure authentication method is implemented troughout the whole network, an attacker can gain access to network functions using session hijacking. When the session is set up using URL rewriting or session tokens that get easily be stolen, an attacker can hijack the already existing session without having to authenticate (P21). In that case, a strong authentication method is being circumvented and doesn't offer secure access control against external attackers.

2) Malicious insiders: An insider is anyone in an organization with approved access, privilege or knowledge of information systems, information services, and missions [28]. Due to the previously mentioned multi-tenancy, many different groups of potential malicious insiders exist in cloud enviroments: cloud providers, solution providers and operations teams have access to the network and can misuse their access to the network. Malicious

[3] Non-profit-organization, Information System Security Certification Consortium

insiders aren't a new issue, but the possible damage by malicious insiders is often far greater then in non-cloud-environments. This is due to the fact that cloud architectures necessitate certain roles which are extremely high-risk [20] regarding their privileges. The fact that malicious insiders already have privileged access to the cloud and their components puts them in a very powerful position. Therefore, 30% of cybersecurity experts see malicious insiders as the biggest security threat in public clouds [7].

In order to perform attacks, malicious insiders can use their privileges to gain access to internal resources and their insider knowledge to adversely impact an organization. Knowing about the system and authentication vulnerabilities and system configurations allows insiders to perform attacks easily. Bypassing authentication can easily lead to surrounding logging procedures or leaking information without being detected (P22). These opportunities make malicious insiders extremely theatening: ENISA (The European Union Agency for Cybersecurity) rated malicious insiders with a high risk to cloud environments [20], the Cloud Security Alliance[4] listed malicious insiders as one main threats in the "The Egregious 11" [24].

Since the behaviour of a malicious insider is distinct from external intruders, they cannot be detected using traditional intrusion detection methods [28] (P23). Also the additional software layer as described in section II A 3) gives malicious insiders even more enrty points to obtain access and perform attacks. As a result of their privileges and insider knowlege in combination with a different behaviour from outside attackers, the opportunities for temptations and influence are much higher, while it gets more difficult to detect them.

REQUIRED MEASURES FOR CLOUD-BASED ACCESS MANAGEMENT

The essential requirements arising from the problems explained in chapter II are defined in this section. Together they constitute a set of fundamental requirements for a secure access management solution with a hollistic apporoach. Requirements starting with "I" are related to IDM,

"A" to PAM, "S" to Session requirements, "T" to Trust management, "L" to Logging and "C" to requirements regarding credentials and are written in italics. Problems defined in section II:

- P1: Authentication methods on different software layers creating backdoors for attackers.
    - *I5: A global access control policy for all elements shall be defined and accepted by all solution providers.*
    - *I4: Fine-granted access control systems shall be implemented.*
    - *I6: A security policy should be defined as the minimum required security level.*
    - *A5: A strong authentication method shall be implemented and reused within the network.*
    - *L1: Every security-related action shall be logged.*
    - *C2: The credentials shall have an expiration time.*
    - *C4: Credentials shall not be stored locally.*
    - *C5: Credentials shall be stored centralized, in a well-protected database.*
- P2: Authentication methods might have to be adjusted after changes in the environment
    - *A5: A strong authentication method shall be implemented and reused within the network.*
    - *A7: The central authentication method shall be easy to maintain and allows to apply changes easily.*
- P3: Different standards for authentication are used within the network
    - *I5: A global access control policy for all elements shall be defined and accepted by all solution providers.*
    - *T2: Secure authentication protocols should be defined for the whole network and no other protocols should be used.*
    - *A1: SSO should be implemented for functions from same network segment.*
    - *A3: Common account roles shall be defined for the whole network.*
- P4: Accounts and credentials are stored locally on the functions themselves

[4] the world's leading organization dedicated to defining standards in cloud computing security

- *I1: User accounts shall be stored centralized.*
- *I2: User accounts shall be maintained.*
- *I8: No local accounts shall exist on virtual elements.*
- *C2: The credentials shall have an expiration time.*
- *C4: Credentials shall not be stored locally.*
- *C5: Credentials shall be stored centralized, in a well-protected database.*

- P5: Workarounds are existing, resulting into incomplete logging
  - A5: A strong authentication method shall be implemented and reused within the network.
  - L1: Every security-related action shall be logged.
  - L2: Logs shall be pushed to a well-protected logging backend.
  - C4: Credentials shall not be stored locally.
- P6: Functions receive the actual time from different systems
  - L6: Synchronized clocks shall be used across components.
- P7: Incomplete applied changes and updates within the network
  - I1: User accounts shall be stored centralized.
  - A5: A strong authentication method shall be implemented and reused within the network.
  - A7: The central authentication method shall be easy to maintain and allows to apply changes easily.
- P8: Weak protected fall-back solutions create entry point for attackers
  - I3: A well-protected fall-back solution should be implemented.
  - I4: Fine-granted access control systems shall be implemented.
  - I5: A global access control policy for all elements shall be defined and accepted by all solution providers.
  - I6: A security policy should be defined as the minimum required security level.
- P9: Incomplete logging due to locally implemented fall-back solutions
  - I3: A well-protected fall-back solution should be implemented.
  - I5: A global access control policy for all elements shall be defined and accepted by all solution providers.
  - I6: A security policy should be defined as the minimum required security level.
- P10: Unauthorized, distributed accounts exist on in the network
  - I1: User accounts shall be stored centralized.
  - I2: User accounts shall be maintained.
  - I8: No local accounts shall exist on virtual elements.
  - A6: The amount of root and admin accounts shall be reduced.
  - T3: Users connecting to virtual functions from other network segments shall be reauthenticated.
  - L1: Every security-related action shall be logged.
  - L2: Logs shall be pushed to a well-protected logging backend.
  - L3: Logs shall be held for a sufficient time, depending on the business case and regulations.
  - C2: The credentials shall have an expiration time.
- P11: Authentication methods from different solution providers are incompatible
  - I5: A global access control policy for all elements shall be defined and accepted by all solution providers.
  - I6: A security policy should be defined as the minimum required security level.
  - I7: Stronger authentication methods shall be implemented for security-sensitive functions.
  - T2: Secure authentication protocols should be defined for the whole network and no other protocols should be used.
  - A1: SSO should be implemented for functions from same network segment.
  - A5: A strong authentication method shall be implemented and reused within the network.
- P12: Security policies from different solution providers are incompatible

- *I5: A global access control policy for all elements shall be defined and accepted by all solution providers.*
- *I6: A security policy should be defined as the minimum required security level.*

- P13: Unknown functions can be placed in the network
  - *T1: The functions shall authenticate against other elements using certificates.*
  - *T4: Users shall only be accepted when they got authenticated from trusted instances.*
- P14: Unclear responsibilities for the overall security in the network
  - *I5: A global access control policy for all elements shall be defined and accepted by all solution providers.*
  - *I6: A security policy should be defined as the minimum required security level.*
  - *A5: A strong authentication method shall be implemented and reused within the network. The cloud provider is responsible for this central authentication method.*
- P15: Assignment of tasks is complicated when changes have to be implemented *see P14*
- P16: Missing reviews from security experts *A8: New software and changes on existing software of security-related functions shall be implemented from or reviewed by security experts.*
- P17: Unclear security standards including the handling of accounts and credentials *I5: A global access control policy for all elements shall be and accepted by all solution providers.*
  - I6: A security policy should be defined as the minimum required security level.
  - A9: The implementation and configuration of provided solutions shall be documented by solution providers.
  - C1: A MFA authentication should be implemented.
  - C2: The credentials shall have an expiration time.
  - C3: Keys and certificates shall have automatic credential rotation.
- P18: Accounts of former users are still accessible see P10
- P19: Passwords used for authentication without MFA
  - A5: A strong authentication method shall be implemented and reused within the network.
  - C1: A MFA authentication should be implemented.
- P20: Missing rotation of keys and certificates in the network
  - C3: Keys and certificates shall have automatic credential rotation.
- P21: The authentication procedure allows session hijacking
  - S1: Strong session management shall be implemented without weak tokens or URL rewriting.
  - S2: The session shall be disabled after the user logged out.
- P22: Malicious insiders can bypass authentication methods
  - I5: A global access control policy for all elements shall be defined.
  - I6: A security policy should be defined as the minimum required security level.
  - I8: No local accounts shall exist on virtual elements.
  - A5: A strong authentication method shall be implemented and reused within the network.
  - L1: Every security-related action shall be logged.
  - L2: Logs shall be pushed to a well-protected logging backend.
  - L3: Logs shall be held for a sufficient time, depending on the business case and regulations.
  - L4: Logging management solutions should be used.
  - L5: Notification and alerting rules shall be defined, the logging alone is not sufficient.
  - L7: An incident response and recovery plan shall be defined including clear responsibilities for operators.
  - L8: A security operations team should be build in order to identify and analyze security threats and react to them in a timely fashion.
- P23: Malicious insiders cannot be detected using traditional intrusion detection methods
  - A2: User role and used authentication method should be validated before giving access.
  - A4: The least privilege principle shall be applied.

- A5: A strong authentication method shall be implemented and reused within the network. I5: A global access control policy for all elements shall be defined.
- I8: No local accounts shall exist on virtual elements.
- L1: Every security-related action shall be logged.
- L2: Logs shall be pushed to a well-protected logging backend.
- L3: Logs shall be held for a sufficient time, depending on the business case and regulations.
- L4: Logging management solutions should be used.
- L5: Notification and alerting rules shall be defined, the logging alone is not sufficient.
- L7: An incident response and recovery plan shall be defined including clear responsibilities for operators.
- L8: A security operations team should be build in order to identify and analyze security threats and react to them in a timely fashion.

CONCLUSION

In conclusion, the existing problems regarding authentication and authorization in cloud environments can be categorized into four topics: Authentication methods and credentials, security policies, responsibilities and logging.

For authentication, locally implemented authentication methods and fall-back solutions can compromise the security of network functions themselves as well as other functions in the network. Especially then when weak credentials as passwords are used. Different authentication methods are often used within cloud-based networks which can cause incompatibilities.

The main problem for security policies is that every SP has defined their own policies and built solutions fitting their own requirements, leading to an unclear level of security for the whole network. Differing security policies also result into a lack of trust in the network between functions and authenticated users as well as among the functions themselves.

Assinging tasks becomes challenging when responsibilities are not clear. This affects the overall responsibility for security within the network as well as responsibilities for tasks that have to be assigned. Changes will always have to be implemented, otherwise workarounds are built in order to provide the missing functionality.

Allowing many channels to access elements including workarounds in the network can easily lead to an incomplete or insufficient logging as it becomes then possible to bypass the official logging procedures.

These problems require measures in order to secure and control access in the network. These measures shall cover a strong authentication method using MFA that is reused within the network. Fallback solutions, in case the central authentication method is out of service, shall be stored in a well-protected and centralized manner, therefore not locally. The same applies for locally stored credentials as it opens backdoors for attackers. For authentication between functions against each other, certificates shall be used to proof the identity and establish trust. For authenticating users within the same network segment, SSO (singlesign-on) solutions shall be used. A proper logging framework shall be implemented to log all actions that are security-related. This framework includes logging management and forensic solutions with clearly defined notification and alerting rules.

Additionally, security policies shall be defined. These are mandatory for all providers in order to be able to provide solutions for the network. Furthermore, the solution provider shall make a documentation of the implementations and configurations set on the provided function transparent to the cloud provider .

Currently, numerous solutions from different providers are offered for IDM and PAM, which often includes the individual implementation by the provider. However, these rarely cover all the individual needs of a heterogeneous cloud network. It is therefore necessary to work on a solution that is flexible enough to be adapted to the different needs, configurations and used standards without creating security gaps.

APPENDIX

This paper has been written as part of an internship at Rakuten Mobile as a student from the Munich University of Applied Sciences.

REFERENCES

[1] The top cloud providers for financial services.
[2] Rakuten is building the world's first end-to-end cloud-native mobile network: Tareq amin.
[3] Volkswagen und microsoft treiben zusammenarbeit bei automotive cloud voran.
[4] Microsoft, bmw launch industrial cloud technology partnership.
[5] Mariana Carroll, Alta Van Der Merwe, and Paula Kotze. Secure cloud computing: Benefits, risks and controls. In *2011 Information Security for South Africa*, pages 1–9. IEEE, 2011.
[6] Timothy Grance Peter Mell. The nist definition of cloud computing.
[7] Holger Schulze. 2019 cloud security report.
[8] Cloud-based multi-factor authentication.
[9] Privileged remote access.
[10] Cloud privileged access management.
[11] John C. Grundy Amani S. Ibrahim, James H. Hamlyn-Harris. Emerging security challenges of cloud virtual infrastructure. *CoRR*, abs/1612.09059, 2016.
[12] P.G. Dorey and A. Leite. Cloud computing - a security problem or solution?
[13] Mukkamala R. Zubair M. Kaminsky D. AbdelSalam H., Maly K. Towards energy efficient change management in a cloud computing environment.
[14] Audris Mockus and Lawrence G Votta. Identifying reasons for software changes using historic databases. In *icsm*, pages 120–130, 2000.
[15] G.-J. Ahn H. Takabi, J.B.D. Joshi. Security and privacy challenges in cloud computing environments.
[16] Nelson Gonzalez, Charles Miers, Fernando Red´ıgolo, Marcos Simpl´ıcio, Tereza Carvalho, Mats Naslund, and Makan¨ Pourzandi. A quantitative analysis of current security concerns and solutions for cloud computing. *Journal of Cloud Computing: Advances, Systems and Applications*, 1, 2016.
[17] The 3 biggest problems with password policies.
[18] I. Lee O. Sokolsky J. M. Smith A. D. Keromytis W. Lee M. Blaze, S. Kannan. Dynamic trust management.
[19] Talal H. Noor and Quan Z. Sheng. Trust as a service: A framework for trust management in cloud environments.
[20] Daniele Catteddu and Giles Hogben. Cloud computing benefits, risks and recommendations for information security. [21] Michael Armbrust, Armando Fox, Rean Griffith, Anthony D. Joseph, Randy Katz, Andy Konwinski, Gunho Lee, David Patterson, Ariel Rabkin, Ion Stoica, and Matei Zaharia. A view of cloud computing. *Communications of the ACM,* 53(4), 2010.
[21] Yogesh Mundada, Anirudh Ramachandran, and Nick Feamster. Silverline: Data and network isolation for cloud services. In *HotCloud*, 2011.
[22] Claudia Eckert. *IT-Sicherheit- Konzepte - Verfahren – Protokolle*.
[23] Jon-Michael C. Brook et al. Top threats to cloud computing: Egregious eleven.
[24] R. K. Banyal, P. Jain, and V. K. Jain. Multi-factor authentication framework for cloud computing. In *2013 Fifth International Conference on Computational Intelligence, Modelling and Simulation*, pages 105–110, 2013.
[25] Owasp top 10 - 2017.
[26] Michaela Iorga. Challenging security requirements for us government cloud computing adoption.
[27] Mark Maybury, Penny Chase, Brant Cheikes, Dick Brackney, Sara Matzner, Tom Hetherington, Brad Wood, Conner Sibley, Jack Marin, and Tom Longstaff. Analysis and detection of malicious insiders. Technical report, MITRE CORP BEDFORD MA, 2005.

12. Where India Stands with Advancing Technology

Nidhi, Department of Business Science and Technology, Aarhus University, Denmark
nidhi@btech.au.dk
Albena Mihovska, Department of Business Science and Technology, Aarhus University, Denmark
amihovska@btech.au.dk
Ramjee Prasad, Department of Business Science and Technology, Aarhus University, Denmark
ramjee@btech.au.dk

ABSTRACT

The year 2019 has witnessed an exceptional increase in the adoption of the internet at a global level. The count of network nodes has increased up to 21.7 billion which was four when the first data packets were transmitted back in the year 1969 [1][7]. We have noticed the change in the pattern of how technology is being used. Today, an average of 74,500 GB of data is sent over the internet every single second. It has been noted that the overall growth has slowed down despite the fact that with each passing year millions of new users come online. The problem of last-mile connectivity still persists. A huge population all over the world is not yet connected.

With the 5G rollouts and trial, the expectation is to reduce the gap in connectivity and communication as much as possible. 5G aims to provide rural connectivity by establishing a digital infrastructure along with ultra high speed and energy-efficient services. As the world will migrate towards the fifth generation of telecommunication 5G, the bar of expectations is way higher than the successive generations. 5G holds the potential to affect life in all possible aspects; from health to education to businesses to economic growth etc. Expectation is that 5G will be the key to IoT and Industry 4.0. Smart cities, Industrial IoT, augmented reality, autonomous transport and digital health are just some of the exciting prospects that can be made real with the support of the 5G.

Keywords—*5G, Broadband Internet, Rural Connectivity, Indian Villages.*

INTRODUCTION

The internet always been at the intersection of challenges, risks and enormous oppurtuniities in various sectors. The new business approaches and initiatives are extracting the best from the internet adoption. Providing seemless connectivity will not only transform individual's life but it will add a huge percentage into the Nation's economy, digital ecosystem, education, health, etc. and will form the foundation for a sustainable solution. According to ITU, 2019 marks the first full year when more than half of the world has begun to participate online in the global digital economy [7]. 5G internet will cover up to 65% of the world's population by the end of 2025 [4].

A. WHAT IS 5G?

5G is amalgamation of technologies specified by 3GPP's varios releases[2]. It is expected that Release 16 will completely define 5G system. It will include variety of topics: Multimedia Priority Service, Vehicle-to-everything (V2X) application layer services, 5G satellite access, Local Area Network support in 5G, wireless and wireline convergence for 5G, terminal positioning and location, communications in vertical domains and network automation and novel radio techniques. Further items being studied include security, codecs and streaming services, Local Area Network interworking, network slicing and the IoT.

The mobile communication services will continue to cater to a wider business sector, public security and civil defense services. The fifth-generation cellular network technology has three main usages:

- Enhanced Mobile Broadband (eMBB) - standard consumer usage.
- Ultra-Reliable Low Latency Communications (URLLC) - used for mission-critical applications that require uninterrupted and robust data exchange.
- Massive Machine Type Communications (mMTC) - connects a large number of low-power devices in a wide area.

Under the flagship of IMT-2020, it will continue to develop 5G standards[3]. To evaluate the technologies and frequency bands for the next generation of mobile communication, 5G trials and pre-commercial activities are underway. It will be difficult to have a global standard for 5G as each participating country has its own definition, concepts for 5G speed and regulations for spectrum and transmissions.

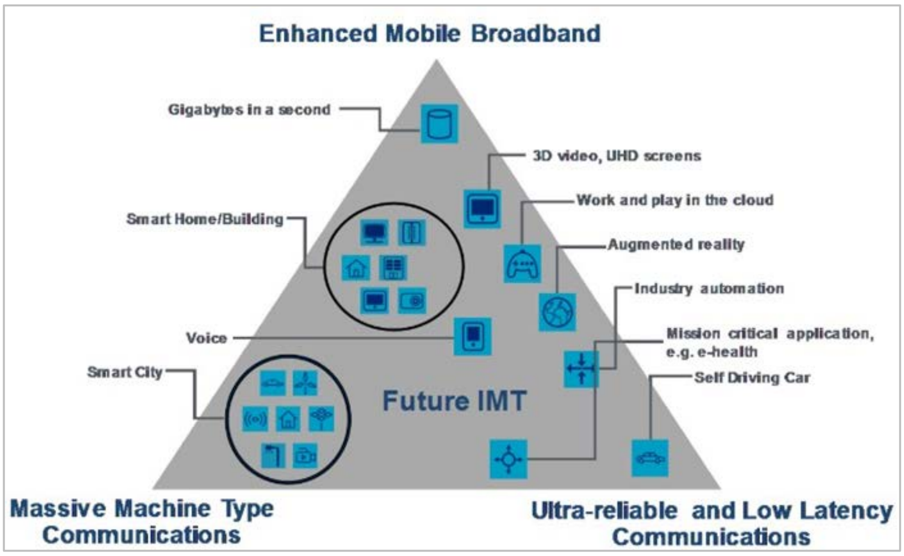


Figure 12-1 5G Usage Scenario [3]

B. USE CASES

To justify the hike in costs for 5G infrastructure and device, 5G mobile networks have stood on the capabilities which are beyond 4G networks. Some of the most promising use cases of 5G networks can be summarized as follows;

Smart automobiles- The autonomous vehicle (AV) will be critical as it connects people with near-zero latency and any lack can cause lives. This will be massive machine type communication with necessary high coverage and low power consumption.

Ubiquitous Broadband and media- Achievable user experience for high-quality broadband service both upload and download with seamless connectivity regardless of densification or extremely remote locations.

Critical services and infrastructure control- 5G brings high reliability and low latency required to control critical services and infrastructure. This unlocks new opportunities for public safety, government, city management, and utility companies.

Massive human-bond interaction- IoT will be accessible by everyone to include context-awareness in daily lives. It will fill the gap between human and IoT nodes and services.

Sensors network- Businesses will grow with the opportunities through monitoring, tracking and automation on a large scale - from connected farms and agriculture to smart cities and buildings.

Healthcare. The availability of low-latency connectivity in rural areas would revolutionize critical care treatment for individuals nationwide.

C. WHY 5G WILL BE CRITICAL?

5G networks will amalgamate high speeds with reliable infrastructure for mobile devices, which will form the cornerstone. Based on promises made 5G will provide an average download speed of minimum 1GBps, which is average of 12-30Mbps with the 4G networks. 5G is comprised of several technology projects in both communications and data center architecture, all of which must collectively yield benefits for telcos as well as customers, for any of them to be individually considered successful. The research and innovations are broadly catergorised into following categories:

Spectral efficiency– Since the spectrum and frequencies are limited, 5G tends to come up with solutions to optimize use of multiple frequencies and enhancing the coverage to extended distances.

Energy efficiency– 5G should propose economical and efficients ways in which it will not add an overhead costs and effort to reduce cooling costs and keeping the environment green.

Utilization– To afford the tremendous communications infrastructure overhaul that 5G may require, telcos may need to create additional revenue generating services such as edge computing and mobile apps hosting, placing them in direct competition with public cloud providers.

With the full-fledged 5G deployment, it is said that the wires will vanish from the communication mainstream be it fixed devices or autonomous vehicles. The problem of rural connectivity will be solved with the delivery of complete digital connectivity from the tip of the carrier network to the customer.

D. KEY FEATURES

The key features of 5G networks will include following and more;

- *Converged service for unified carriers*
- *Small cell infrastructure*
- The global technology economy

Once complete, the 5G transition plan would constitute an overhaul of communications infrastructure unlike any other in history. The paradigm shift from 4G to 5G is not so much to get faster as to make the wireless industry sustainable over the long term, as the 4G transmission scheme is approaching unsustainability faster than the industry experts predicted.

In 2020, a typical 5G smartphone will be similar to any smart device supporting both/either 5G non-standalone (NSA) and/or 5G standalone (SA) mode and have support for;

- 5G carrier aggregation
- Spectrum sharing
- Low-band FDD and mmWave frequencies (as well as mid-band)

STATE-OF-THE-ART

5G currently making an impact as it strengthens its grip over the global market and built its network across the world[4]. With its roll-out in South Korea, 5G subscription touched the figure in millions in just a few months and the expectations are that it will reach up to tens of millions globally with the start of 2020. 3GPP gained acceleration with 5G specifications for early delivery, forming a strong platform for other industries to flourish.

Presently, 2G, 3G, and 4G networks are dominant throughout in respect of the investments, traffic, and subscriptions. Thus the 5G networks are expected to improve and enhance existing networks for greater userexperience and performance for day-to-day business.

A recent survey [4] suggested that by 2025, some 65 percent of the world's population will be covered by 5G cellular networks which will generate 45 percent of the world’s total mobile data traffic. With the ongoing 5G network testing, development, trials, and deployments across the world, some 1.5 billion mobile users will have subscriptions with 5G services in that same time period, with average expected monthly data usage of 21GB per user as the faster networks allow more productivity and data consumption. That's about four times the amount of data expected to be consumed by the average user per month in 2018. It is expected the 5G adoption will be much faster than 4G. The stats estimates some 2.6 billion 5G subscriptions are expected by 2025 which in the case of 4G networks was about 1 billion subscriptions after six years. A total of 52 percent of all mobile subscriptions are now for LTE. 8.9 billion mobile subscriptions by the end of 2025, out of which around 90 percent will be for mobile broadband.

VoLTE is the foundation for enabling globally interoperable voice and communication services on 4G and 5G devices, providing high-quality services to consumers and business users. VoLTE subscriptions, estimated at 2.1 billion at the end of 2019, are projected to reach 6.4 billion by the end of 2025 and to account for more than 85 percent of combined LTE and 5G subscriptions.

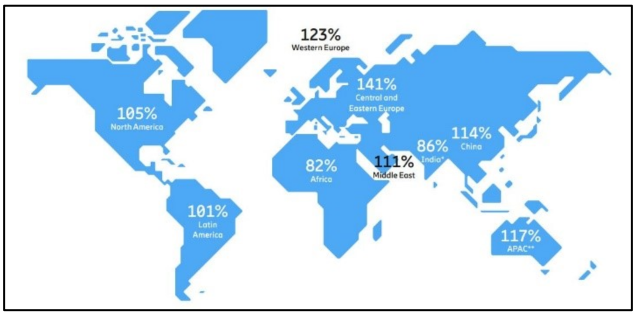


Figure 12-2 Subscription Penetration in 2019 [4]

A. 5G WORLDWIDE

Many operators and giants in telcos are involved in 5G trials since early 2018. Auction for spectrum in 28GHz bands followed by 24 started in November 2018. The FCC approved a plan to make more spectrum in the 37 GHz, 39 GHz, and 47 GHz bands available for the highest-speed communications tier for 5G wireless, called millimeterwave (mmWave). Following are some of the trials going around [6];

- 5GRIT a UK Government project is demonstrating technologies for rural connectivity and targeting to benefit farmers.
- *Verizon's* 5G Home, a broadband Wi-Fi service that bundles wireless phone with nolonger-cable TV service at a very pocketfriendly cost using wireless spectrum marked for 5G.
- *AT&T's "5G Evolution"* targets mobile devices under 4G LTE transmitter service upgraded to 5G specifications. The transmitters used frequencies over and above 4G LTE reserved frequencies to provide, in addition to those already being used, for greater multiplexing and presumably greater bandwidth, although phones
- *AT&T's "5G+"* a mobile hotspot service that uses a prototype of the very-high-speed mmWave technology that is being earmarked for 5G, in addition to existing 4G LTE.
- Many operators have live demonstrations in sports events such as:
    - Korea Telecom in the Winter Olympics in Pyeongchang (in February 2018),
    - Verizon in the super bowl game in the New York City (in February 2018)
    - Telstra at the Commonwealth Games in Gold Coast, Queensland in Australia (April 2018).

About 61 countries agreed on introducing reservd spectrum bands to support 5G trials and innovations for terrestrial services. These countries are in allocating spectrum for use through auctions. Finland, Germany, Italy, Ireland, Latvia, Spain and the UK have already completed auctions of 5G spectrum and thirteen other will complete auction by early 2020 [6][7].

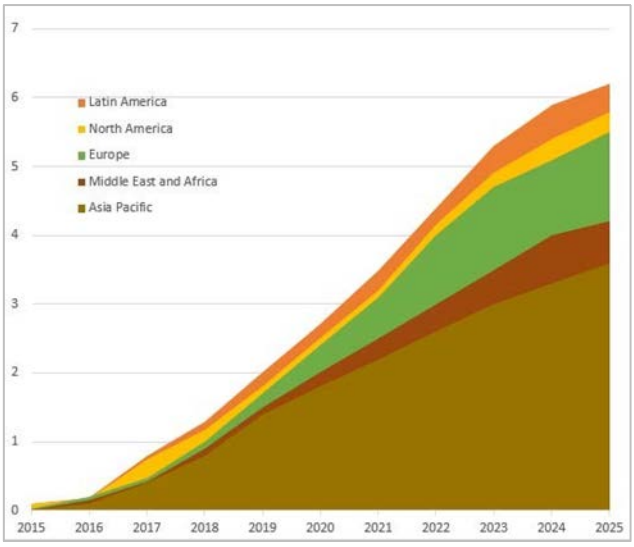


Figure 12-3 VoLTE subscriptions by region in billion

The rural communities long for a reliable connections that urban areas have enjoyed for the past decade. Ericsson partnered with Nex-Tech Wireless to enhance Kansasbased carrier's network to support 5G capabilities in addition to the launch VoLTE and Wi-Fi Calling services. Ericsson will exploit its cloud-based IMS solution and New Radio (NR) hardware and software.

Ericsson also alliance with the Rural Independent Network Alliance (RINA) Wireless to make 5G reach to American outskirts with existing Ericsson 4G Core and Radio Access Network (RAN) [4].

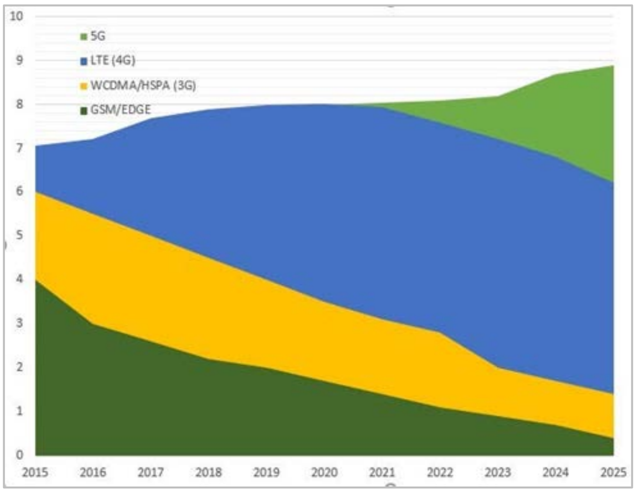


Figure 12-4 Mobile Subscriptions by Technology

B. 5G INITIATIVES INDIA

India is taking huge steps to have broadband connectivity throughout. Various government initiatives and policies have been supporting different companies to develop digital economies, fostering digital transformation in government services and digital transitions across all sectors [8]. To have digital ecosystem, high speed and ubiquitous internet is elementary.

The National Digital Communications Policy [11], 2018 was envoked to unravel the transformative power of digital communications networks - to achieve the goal of digital empowerment and improved well-being of the people of India. The policy aims to provide broadband to all, Digital Sovereignty and to established connected last mile. Digital India programme launched by Government aims to provide last mile connectivity to India's smallest towns and villages. The policy has envisaged attracting investments worth US$ 100 billion in the sector by 2022.

LWE BTS, a solution currently implemented in rural regions which provide Wi-Fi services. The Left wing Extremism (LWE) are the aeas in India categorized by poor socio-economic indicators [11]. The Wi-Fi infrastructure was installed at existing BSNL towers where Backhaul was provided by BSNL, through unlicensed radio channel.

The National Broadband Mission (NBM) launched December 2019, has the vision to fast track growth of digital communication infrastructure, bridge the digital divide, facilitate digital empowerment and inclusion and provide affordable and universal access of broadband for all by 2022. The mission also involves Development of Broadband Readiness Index to measure the availability of digital communications infrastructure, and foster conducive policy ecosystem within a State/UT [12].

TELECOMMUNICATION IN INDIA

In India, promotion of a competitive market for digital services, particularly for low-income consumers, saw the overall number of broadband subscribers reach 553.54 million as of April 30 2019 [9]. Airtel in India has also published a database showing all its 2G and 4G tower and network coverage data [10].

India is currently the world's second-largest telecommunications market with a subscriber base of 1.20 billion and has registered strong growth in the past decade and half [6]. As of January 2019, India has witnessed a 165 per cent growth in app downloads in the past two years. 4.8 billion downloads of mobile applications were registered in India in first three months of 2019. India ranks as the world's second largest market in terms of total internet users. The number of internet subscribers in the country increased at a CAGR of 45.74 per cent during FY06-FY19 to reach 636.73 million in 2018-19. Total wireless data usage in India grew 119.00 per cent year-on-year to 17,940,576 terabytes between April-June 2019. The internet subscribers reached 665.31 million till June 2019.

Further, India is also the world's second largest telecommunications market, total telephone subscriber base and tele-density reached 1,195.24 million and 90.52 per cent, respectively, at the end of September 2019.

In the India region, LTE subscriptions are forecast to increase by 150 million during 2019 and pass GSM/EDGE as the dominant technology. Mobile broadband technologies will account for 57 percent of mobile subscriptions at the end of the year, and the share of smartphone subscriptions is expected to have increased from 48 percent to 54 percent. As the transformation toward more advanced technologies continues in India, LTE is forecast to represent 80 percent of mobile subscriptions by the end of 2025. 5G subscriptions are expected to become available in 2022 and will represent 11 percent of mobile subscriptions at the end of 2025.

In the India region, the average monthly mobile data usage per smartphone has seen an extraordinary increase in recent years, becoming the highest in the world. A key factor has been the rapid adoption of 4G, boosted by a disruptive entrant in the market in 2016. Low prices for mobile broadband services, affordable smartphones and people's changing video viewing habits have continued to drive monthly usage growth in the region. Only 4 percent of households have fixed broadband, making smartphones the only way to access the internet in many cases.

As per a recent government data, Reliance Jio, on an average, has installed a telecom tower in every second village as against one in ten villages by BSNL. All other operators including Bharti Airtel, Vodafone India and Idea Cellular have put up a telecom tower in every fifth village.

At the end of November 2018, Reliance Jio had 2,63,775 telecom towers installed in 4,85,297 villages where it has offered services whereas Airtel had just 96,032 towers in rural areas covering 5,10,362 villages. Similarly, Vodafone Idea cover 471693 villages with 101704 towers. BSNL, the state-run operator, covers 430934 villages with just 43239 telecom towers.

In last three years, Airtel has extended its mobile services to 2686 villages, Vodafone Idea has extended to 83354 villages, BSNL has extended to 14052 villages, whereas Jio has extended the same to 305248 villages.

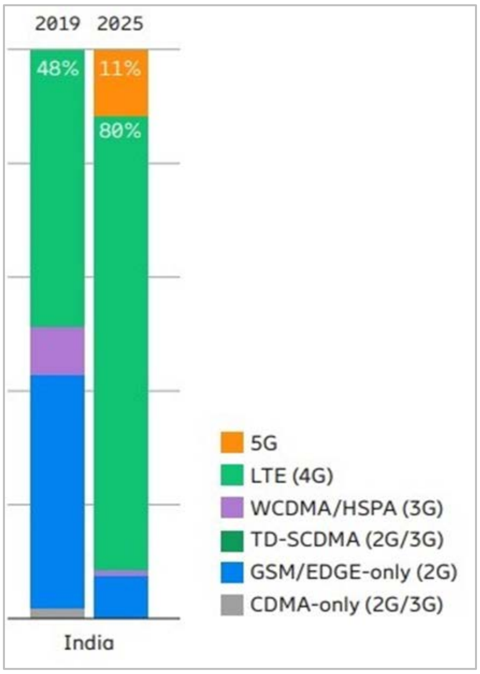


Figure 12-5 Technologies in Telecommunications

CHALLENGES AND POSSIBILITIES WITH INDIA

In defiance of considerable developments on the 5G facade, still India lacks network connectivity in most part of the parts. There are areas, which are technically termed as “Outage Zone” and we are no where closer for the 5G to be rolled out soon.

A. WHY INDIA FACING CHALLENGES FOR 5G

Over 43,000 inhabited villages in India do not have mobile phone services. The number of inhabited villages without mobile services stood at 43,088 as on July 27, 2018 (based on 2018 Survey) out of 5,97,618 inhabited villages in the country as per census 2011.

Villages can be classified as small, mid-sized or large based on area and population, and can be located in hilly or plain areas. And wireless network topology depends on factors like size of village, distribution of residential houses and terrain map of village.

Broadband technology allows high-speed transmission of voice, video and data over networks and ICT applications. This, along with community antennae, optical fibres, satellites and fixed mobile wireless technologies, can also be used in rural areas effectively. The ability to access the Internet can bring a positive impact on the rural society. However, there is a wide digital divide between urban and rural areas in India, because of uneven distribution of basic telecom infrastructure.

Further, poverty and lack of education are also factors responsible for the lack of advancements in wireless technology in rural areas. Social interaction can be obtained between urban and rural masses through social media channels such as Facebook, Twitter, WhatsApp and the like. Wireless connectivity in rural areas can also reduce poverty, create jobs, and increase skills and income of the population.

To overcome the lack of Internet connectivity for undeserved communities, Digital Employment Foundation and Internet Society jointly launched Wireless for Communities (W4C) initiative in October 2010. This project includes training rural communities on different wireless technologies, among others.

B. TELECOMMUNICATION REALITY IN INDIA

India has no dearth of technological and business innovations for rural areas. However, telecom policies and scams have created a negative impact on the growth of this sector in rural India. Certain policies have forced Internet service providers to rethink their investments there.

Spectrum plays a crucial role in delivery of 5G services. The Department of Telecommunications (DoT) has identified 35 MHz of spectrum in the 700MHz frequency band, and 300 MHz of spectrum in the midrange band of 3.3GHz to 3.6GHz. However, of the 35 MHz of spectrum in the low-frequency (sub-1GHz) band, Indian Railways has demanded 10 MHz, leaving only 25 MHZ for telecom operators. Even the 300 MHz of spectrum from the midrange band is not fully available for telcos. In this band, the space and defence departments have staked claim to 25 MHZ and 100 MHz units, respectively, leaving only 175 MHz of spectrum for telecom operators.

The Indian telecommunications sector has grown rapidly in the last few years. India now has the second largest network in the world, next only to China. In rural areas, tele-density was 56.87 per cent, at the end of August 2017, whereas in urban areas, it was 173.72 per cent.

To enable India’s transition into a digital economy and knowledge society, large investments in infrastructure, both in optical-fibre cables and towers, for wireless transmission are required. The government is committed to extending the reach of mobile networks to around 50,000 remote, rural villages, with support from Universal Services Obligation Fund (USOF). In addition, investments are being made to lay optical-fibre cables for high-speed broadband connectivity in rural areas.

Nine states seem to be holding back India's race to achieve full rural connectivity by 2019 with Assam, Jammu & Kashmir and Jharkhand topping the list, according to a central government assessment.

5G AND GLOBAL WARMING

In May 2017, AT&T President of Technology Operations Bill Hogg declared the existing wireless business model for cell tower rental, operation, and maintenance "unsustainable." Some months earlier, a J. P. Morgan analyst characterized the then-business model for wireless providers in Southeast Asia as unsustainable, warning that the then-current system has rendered it impossible for carriers to keep up with customer demand. And as research firm McKinsey & Company asserted in a January 2018 report, the growth path for Japan's existing wireless infrastructure is becoming "unsustainable," rendering 5G for that country "a necessity."

The world's telcos need a different, far less constrained, business model than what 4G has left them with. The only way they can accomplish this is with an infrastructure that generates radically lower costs than the current scenario, particularly for maintaining, and mainly cooling, their base station equipment.

Cooling and the costs associated with facilitating and managing cooling equipment, according to studies from analysts and telcos worldwide, account for more than half of telcos' total expenses for operating their wireless networks. Global warming (which, from the perspective of meteorological instrumentation, is indisputable) is a direct contributor to compound annual increases in wireless network costs. Ironically, as this 2017 study by China's National Science Foundation asserts, the act of cooling 4G LTE equipment alone may contribute as much as 2% to the entire global warming problem.

According to ITU, 2019 marks the first full year when more than half of the world has begun to participate online in the global digital economy. This year also marks the 30th birthday of the World Wide Web, and 25 years since the first e-commerce transaction.

CONCLUSIONS

It is a capital improvement project the size of the entire planet, replacing one wireless architecture created this century with another one that aims to lower energy consumption and maintenance costs. It's also a huge gamble on the future of transmission technology, doubling down on consumers' willingness to upgrade.

Once complete, the 5G transition plan would constitute an overhaul of communications infrastructure unlike any other in history. The paradigm shift from 4G to 5G is not so much to get faster as to make the wireless industry sustainable over the long term, as the 4G transmission scheme is approaching unsustainability faster than the industry experts predicted.

REFERENCES

[1] Shimeall, Timothy, and Jonathan M. Spring. Introduction to Information Security: a Strategic-Based Approach. Elsevier, 2014.

[2] Flynn, Kevin. "The MobileBroadband Standard." 5G In Release 17 – Strong Radio Evolution, 2019, www.3gpp.org/news-events/20985g-in-release-17-%E2%80%93-strong-radio-evolution.

[3] Standards, ITU. "5G: Fifth Generation of Mobile Technologies." 5G - Fifth Generation of Mobile Technologies, Dec. 2019, www.itu.int/en/mediacentre/backgrounders/Pages/5G-fifthgeneration-of-mobile-technologies.aspx.

[4] Report, EricssonMobility. "Ericsson Mobility Report." Ericsson Report Highlights Key 5G Numbers and Trends, 2019, www.csimagazine.com/csi/Ericsson-report-highlights-key-5Gnumbers-and-trends.php.

[5] Report, 5G Observatory. "Major European 5G Trials and Pilots." 5G Observatory, 2019, 5gobservatory.eu/5g-trial/major-european-5gtrials-and-pilots/.

[6] Report, GSA. "5G Spectrum for Terrestrial Networks - June 2019." GSA, 2019, gsacom.com/paper/5g-spectrum-for-terrestrialnetworks-june-2019/.

[7] ITU/UNESCO Broadband Commission for Sustainable Development. "The State of Broadband : Broadband as a Foundation for Sustainable Development." The State of Broadband : Broadband as a Foundation for Sustainable Development, Sept. 2019, www.itu.int/pub/S-POL-BROADBAND.20-2019.

[8] ITU/UNESCO Broadband Commission for Sustainable Development. "The State of Broadband : Broadband as a Foundation for Sustainable Development." The State of Broadband : Broadband as a Foundation for Sustainable Development, Sept. 2019, www.itu.int/pub/S-POL-BROADBAND.20-2019.

[9] Telecom Regulatory Authority of India. June, 2019. https://main.trai.gov.in/sites/default/files/PR_No.45of2019 .pdf

[10] Airtel. "OpenNetwork". https://www.airtel.in/opennetwork/

[11] DOT, GoI. "National Digital Communications Policy - 2018." Department of Telecommunication, 2018.

[12] DOT, GoI. "Home: Department of Telecommunications: Ministry of Communication: Government of India." Department of Telecommunications | Ministry of Communication | Government of India, 30 Dec. 2019, dot.gov.in/latestupdates/booklet-nationalbroadband-mission.

13. Smart Irrigation System with Alert

Abhijeet Kumar, Electronics and Communication Engineering B.I.T. SINDRI DHANBAD, INDIA abkr012@gmail.com
Abhishek Kumar Singh, Electronics and Communication Engineering B.I.T. SINDRI) DHANBAD, INDIA abhiksingh97@gmail.com
Anubhav Kumar Choudhary, Electronics and Communication Engineering B.I.T. SINDRI DHANBAD, INDIA acanubhav.001@gmail.com
Arvind Kumar, Electronics and Communication Engineering B.I.T. SINDRI DHANBAD INDIA aksingh738@gmail.com

ABSTRACT

The paper is inspired by the Smart Irrigation System Scheme of Government of India. The economic contribution of agriculture to India's GDP is steadily declining and agricultural growth in India is slow because of the poorly maintained irrigation system. The major problem is the absence of a cheap and reliable system for monitoring of soil's condition and this causes improper irrigation and wastage of water. This paper proposes a smart alert and irrigation system which monitors soil moisture and temperature using sensors and NodeMCU is used to send this data to the IoT platform and real-time monitoring can be done using smart phone or computer. The IoT platform analyses the data collected and send alert messages and controls the irrigation system according to the pre-set conditions

Keywords— *IoT, NodeMCU, ThingsBoard, TE215 sensor, DS18B20 sensor, MQTT*

INTRODUCTION

Irrigation is one of the most important steps in agriculture. Each and every crop needs water for its growth. Around 70% of the Indian economy is dependent on agriculture. Hence, advancement and implementation of new technology in this field can benefit a major part of society [1]. Digitization will also reduce human effort making the whole cultivation process more convenient. The proposed system involves figuring out the methods to measure the moisture content and temperature of the soil [2] and sending data to the cloud server for processing [3] and sending alert messages [4] to the farmer and activating irrigation system. The IoT technology comes to our solution where microcontroller and sensors like soil moisture sensor and temperature sensor are used [5]. IoT messaging protocol is used to send data read by the sensors to the IoT platform. IoT platform processes the data at the server end and appropriate instructions are executed. The benefit of the project is that it can be installed at any agriculture field or garden and realtime monitoring [6] of the soil's condition can be done and this will help us to stop wastage of water caused due to overirrigation and water logging. Thus, proper irrigation methodology can be developed and further machine learning can be implemented to enhance the growth of the plant in the coming future. This type of agricultural system is termed as Precision Agriculture [7].

LITERATURE SURVEY

The existing system uses Arduino Nano as microcontroller which requires separate Wi-Fi module also this system is a high-power consuming [8] and just does the monitoring [9] but the proposed methodology is using Node MCU which has inbuilt Wi-Fi module to connect with the server. This will reduce the total cost of equipment required as Node MCU is itself cheaper than the Arduino Nano board and additional Wi-Fi module is also not required. Node MCU also has less power consumption, which makes it more energy-efficient [9].

PROPOSED SYSTEM

The proposed system uses NodeMCU as a microcontroller, TE215 (Moisture sensor), DS18B20 (Temperature Sensor) and ThingsBoard as IoT Platform [10] and MQTT as IoT messaging protocol to send data to the cloud server [11]. The system generates alert messages and controls the irrigation system (On/Off of water pump) based on the analysis done by the ThingsBoard on the readings collected by the sensor in accordance to the pre-set conditions.

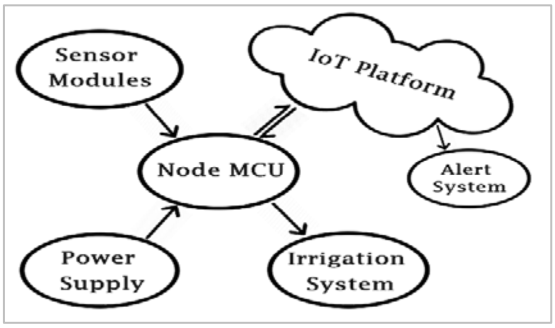


Figure 13-1 System Overview

A. THE CIRCUIT

The following diagram shows the connection of various components used in the system:

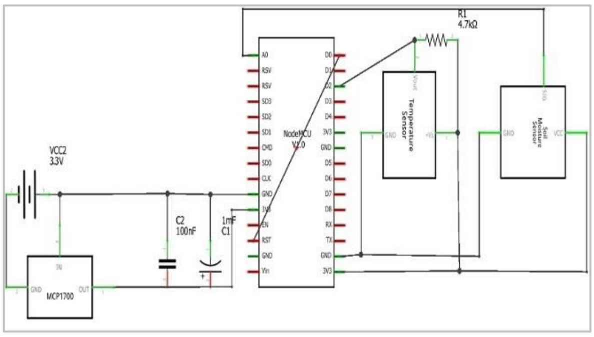


Figure 13-2 Circuit Connections for the System

B. NODEMCU

Node MCU is an open-source IoT platform. It includes firmware, which runs on the ESP8266 Wi-Fi SoC from Expressive Systems, and hardware, which is predicated on the ESP-12 module. The term "Node MCU" by default refers to the firmware instead of the dev kits. The firmware uses the Lua scripting language. The programming code is being written for ESP8266 Wi-Fi chip using Arduino IDE, for which installation of ESP8266 library is required.

Figure 13-3 NodeMCU

C. SENSORS

Soil moisture sensor (TE215) and Temperature sensor (DS18B20) are used in this system. The Soil Moisture Sensor measures the water content of soil using capacitance (by measuring the dielectric permittivity of the soil). While DS18B20 is a one-wire digital temperature sensor which can measure temperature from -55˚C to +125˚C with an accuracy of ±5%.

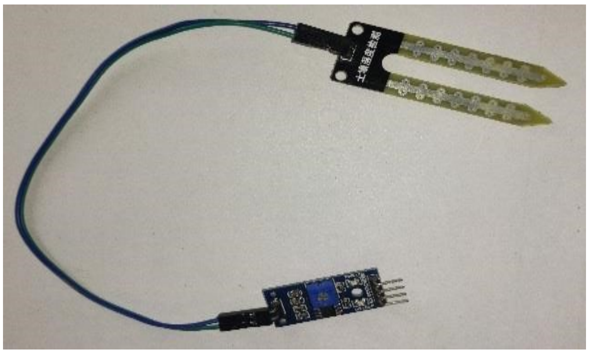


Figure 13-4 Soil Moisture Sensor (TE215)

Figure 13-5 Temperature Sensor (DS18B20)

D. POWER SUPPLY

The NodeMCU was supplied 3.3V as input using 3 AA Alkaline battery (2400mAh) along with LDO regulator and electrolytic and ceramic capacitor to maintain a stable input voltage. NodeMCU remains in sleep mode, activates for a few seconds, connects to internet hotspot and sends the reading of the sensor to the IoT platform and again goes into the sleep mode, thus leading to efficient utilization of power source.

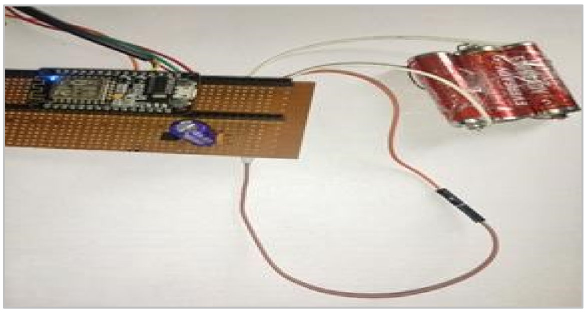


Figure 13-6 Power Supply Circuit

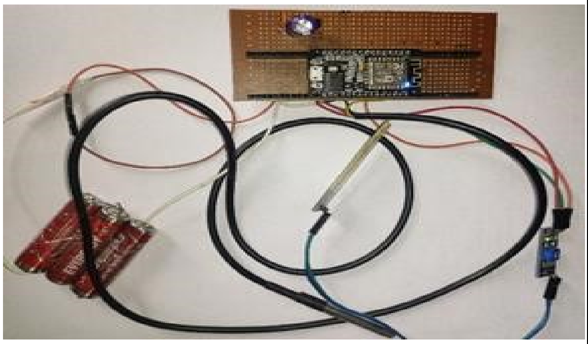


Figure 13-7 System Circuitry Setup

E. WATER PUMP

It is used to pump water to the desired location in the field according to the data from the sensors.

F. THINGSBOARD IOT PLATFORM

ThingsBoard is an open-source IoT platform for device management, data collection, processing and visualization of our IoT project. It supports both cloud and on-premises deployments and enables device connectivity via industry standard IoT protocols - MQTT, CoAP and HTTP. ThingsBoard combines scalability, fault-tolerance and performance and hence the chance of data loss is minimal.

G. WORKING

The sensors are placed at different locations in the field and these are connected to the NodeMCU. The whole system is placed in an internet hotspot zone and ESP8266 Wi-Fi SoC module in NodeMCU get connected to it. The NodeMCU sends the data to the IoT platform and real-time sensor reading is monitoring using a smartphone or computer. Whenever the pre-set conditions according to the crops are not fulfilled then alert messages are sent to the farmer through e-mail, text message and on Telegram app and NodeMCU also controls the irrigation system (On/Off of Water Pump).

RESULT AND CONCLUSION

The Soil moisture sensor (TE215) and Temperature sensor (DS18B20) sends the reading to the IoT platform at regular interval through the NodeMCU. The IoT platform- ThingsBoard stores the sensor reading and analyze it as per the pre-set conditions according to the crop and whenever the moisture content of soil goes beyond the required range, an alert mail and text message is sent to the owner and the water pump starts pumping water to the desired location on the field until it is in the required range and then the motor stops.

The alert mail and messages are sent using APIs (Twilio, SendGrid).

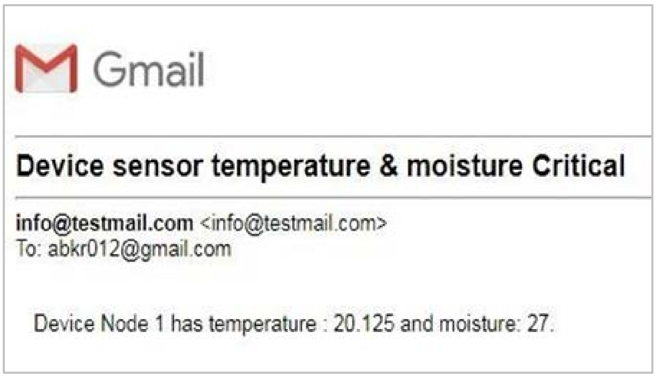


Figure 13-8 E-mail Alert

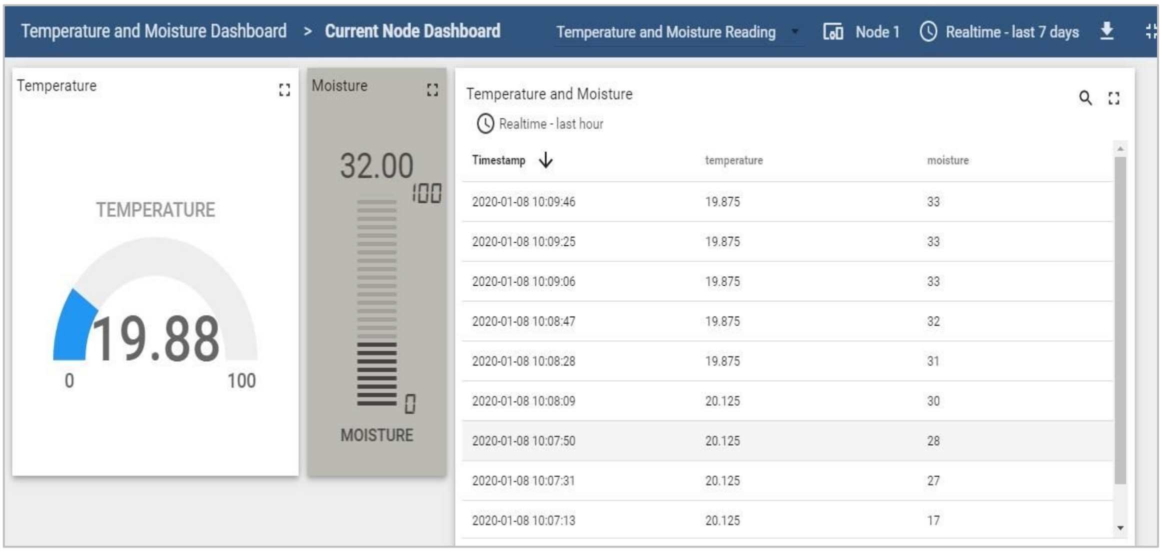


Figure 13-9 ThingsBoard-IoT Platform Dashboard showing sensor reading when the soil's moisture content is low.

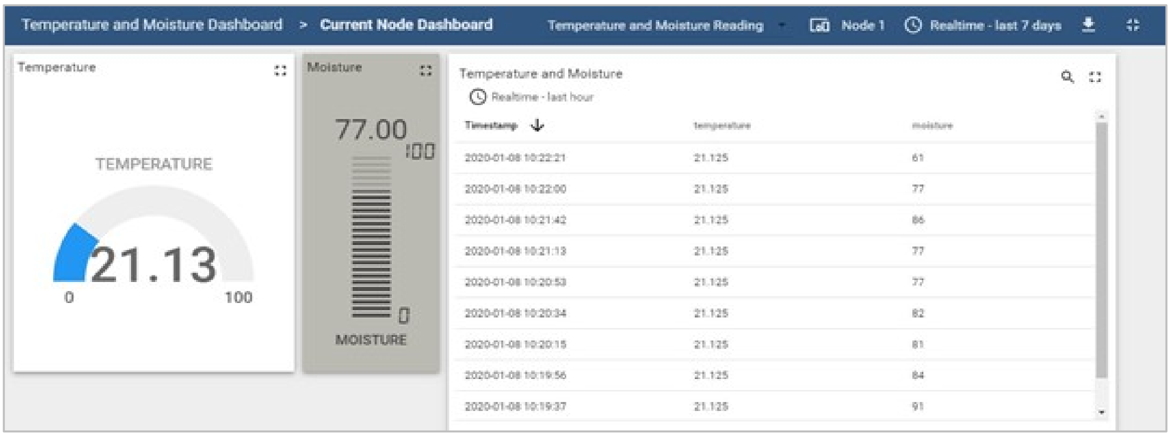


Figure 13-10 ThingsBoard-IoT Platform Dashboard showing sensor reading when the soil's moisture content is high.

The system is experimentally proven to work satisfactorily and monitors the values properly. The user not only gets real-time information but also previous data as well. It can be monitored from anywhere anytime by the authorized user.

FUTURE ASPECTS

The proposed system can be further extended to the application of drone for taking images of the crop and using image processing predicting the health of the crop and alerting the farmer about the pest affecting the crop and which pesticides to be sprayed. The drone can also replace the water pump used to irrigate the field. The concept of machine learning can be applied to the sensor's readings observed throughout the year and can predict the trend of field conditions throughout the year leading to the selection of suitable crop for the agricultural field.

REFERENCES

[1] Christopher Brewster, Ioanna Roussaki, Nikos Kalatzis, Kevin Doolin, Keith Ellis, "IoT in Agriculture: Designing a Europe-Wide Large-Scale Pilot", IEEE Communications Magazine, vol: 55, issue: 9, pp. 26-33, Sep. 2017.

[2] Olakunle Elijah, Tharek Abdul Rahman, Igbafe Orikumhi, Chee Yen Leow, MHD Nour Hindia, "An Overview of Internet of Things (IoT) and Data Analytics in Agriculture: Benefits and Challenges", IEEE Internet of Things Journal, vol: 5, issue: 5, pp. 3758-3773, Jun. 2018.

[3] Ji-chun Zhao, Jun-feng Zhang, Yu Feng, Jian-xin Guo, "The study and application of the IOT technology in agriculture", 2010 3rd International Conference on Computer Science and Information Technology, vol: 2, pp. 462-465, Jul. 2010.

[4] K. A. Patil, N. R. Kale, "A model for smart agriculture using IoT", 2016 International Conference on Global Trends in Signal Processing, Information Computing and Communication (ICGTSPICC), pp. 543-545, Dec. 2016.

[5] Gabriela Carrión, Monica Huerta, Boris Barzallo, "Internet of Things (IoT) Applied to an Urban Garden", 2018 IEEE 6th International Conference on Future Internet of Things and Cloud (FiCloud), pp. 155-161, Aug. 2018.

[6] Theerayod Wiangtong, Phaophak Sirisuk, "IoT-based Versatile Platform for Precision Farming", 2018 18th International Symposium on Communications and Information Technologies (ISCIT), pp. 438-441, Sep. 2018.

[7] Rahul Dagar, Subhranil Som, Sunil Kumar Khatri, "Smart Farming – IoT in Agriculture", 2018 International Conference on Inventive Research in Computing Applications (ICIRCA), pp. 1052-1056, Jul. 2018.

[8] K. Jyotsana Vanaja, Aala Suresh, S. Srilatha, K. Vijay Kumar, M. Bharath, "IoT based Agriculture System using NodeMCU", International Research Journal of Engineering and Technology (IRJET), vol: 5, issue: 3, pp. 3025-3028, Mar. 2018.

[9] C. Sai Kiranmal, M. Sumesh, "IoT based Smart Irrigation system using NodeMCU", International Journal of Soft Computing and Artificial Intelligence, vol: 6, issue: 1, pp. 55-57, May 2018.

[10] Thomas Lee Scott, Amma Eleyan, "CoAP based IoT data transfer from a Raspberry Pi to Cloud", International Symposium on Networks, Computers and Communications (ISNCC), pp. 1-6, Jun. 2019.

[11] Samudra Vishal Mukherji, Ritesh Sinha, Soumya Basak, Sambit Prasad Kar, "Smart Agriculture using Internet of Things and MQTT Protocol", 2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon), pp. 14-16, Feb. 2019.

14. A Comparative Analysis for Realization of Limit-Cycle Free 2D Digital Filters with External Disturbance

Kritika Awasthi, Department of ECE BIT Sindri Jharkhand: 828123, India kritika3awasthi@gmail.com

Ajit Kumar Behera, Department of Geology BIT Sindri Jharkhand: 828123, India ajitgeol.89@gmail.com

ABSTRACT

In this paper a comparative analysis for realization of limit-cycle free 2D digital filters with external disturbance has been done. We have done a comparative analysis of earlier reported criterion with an improved criterion which ensures asymptotic stability with guaranteed H_∞ performance with low computational complexity. In particular, improved criterion for elimination of overflow oscillations in two-dimensional (2-D) digital filters is described by Roesser model with saturation arithmetic and external interference. The criterion is represented in terms of linear matrix inequality (LMI). Specific examples are given to demonstrate the effectiveness of proposed criterion.

Keywords - *Two dimension digital filters, limit-cycle, Rosser model, linear matrix inequality*

INTRODUCTION

We analyze signals because it contains information and to obtain that information in more desirable form we perform signal processing. Thus signal processing is analysis, interpretation and manipulation of signals like sound, images, time varying measurement values and sensor data etc. [1]. When signals are transmitted, there is a possibility of signals being contaminated by some external noise. In order to retrieve the original signal at the receiver, suitable filters are to be used i.e. the signal is processed to obtain pure signal[1,2]**.** Digital signals are often desired to be processed to modify the characteristic carried out by such signals.

In idealized form, digital signal processing is the processing of discrete-time signals. Digital filter uses digital processer that performs for numeric computation on sampled values of signal to obtain the associated information with the signal [2,3]. The processer may be general purpose computer.

Digital filters are vital dynamical systems in signal processing that useful for handling out the discrete signals [2]. Due to enormous range of applications of digital filters, which include communications, seismographic data processing, speech processing, image processing, control systems etc. have more importance regarding its design and analysis [2-4]. It can be implemented in the field of geophysics specially in signal processing to acquire smooth seismic data for various types of complex geological structures beneath the earth surface [31]. In case of seismic survey, seismic noise (4D signal) is usually detected during acquisition of 2D signal [33]. To reduce that effect the 2D digital filters can be applied to obtain external noise free data.

A. TWO DIMENSIONAL DIGITAL SIGNAL PROCESSING

The field of two-dimensional (2-D) digital signal processing has been emerging rapidly in recent years. Images such as satellite photographs, radar and sonar maps, medical X-ray pictures and magnetic records are typical examples of 2-D signals that might need to be processed [2,3]. The types of processing that can be applied may range from enhancing the quality of signals to extracting certain useful features from them. A continuous 2-D signal is a physical quantity that is a continuous function of two real independent variables [3]. A discrete 2-D signal is a sampled version of continuous 2-D signal. 2-D discrete signal can be modified, reconstructed, reshaped or manipulated through filtering. This type of processing can be carried out by using 2-D digital filters [3,4].

2D digital filter can be characterized in terms of difference equations or state-space equations in two independent variables and in terms of matrices of transfer functions. When a 2-D digital filter is implemented in terms of either software on general purpose computer or dedicated hardware, signals must be stored and manipulated in registers of finite length [5]. When approximation step is carried out, transfer function coefficients are calculated, and they must be quantized before implementation of digital filter. The net effect of coefficient quantization is to introduce inaccuracies in amplitude response of the filter. Signal quantization can lead to other problems as well, such as generation of spurious parasitic oscillations, known as limit cycles [3, 5, 6, 28, 29].

Like 1-D digital filters and other types of systems, 2-D digital filters can be represented by state –space models [7-9]. In this approach a set of internal signals referred as state variables, is used to describe completely operation of filter. The technique is very useful in analysis, design and implementation of digital filters [10-13,26-30]. In this approach, the digital filters are characterized in terms of matrices, which are easy to manipulate. State space models for 2-D digital filters have been proposed by Attasi, Givone and Roesser, and Fornasini and Marchesini [3,5,8,9]. In this paper, Roesser model is used for the realization of the 2-D digital filter.

B. H_∞ FILTERING APPROACH

High-order digital filters are usually breakdown into various biquad filters at the time of hardware implementation. Among these biquad filters there exists some external interference which is unavoidable, and such interferences lead to disturbance [14-17]. Also in practical physical systems, statistical information on the signals is insufficient. When the statistical information about the external interference is insufficient, we can employ H_∞ filtering, energy-to-peak *($l_2 - l_\infty$)* filtering and peak-to-peak *(l_1)* filtering [18-19,29,30]. Such filtering techniques have been studied in filtering and control problems [20,26,27]. In H_∞ filtering approach, the external interference is assumed to be energy bounded and the energy-to-energy gain is minimized or below a prescribed level. In $l_2 - l_\infty$ filtering the external input interference signal assumed to be energy bounded and the output signal to be peak bounded [21-24].

In this paper, we have done a comparative analysis of established criterion proposed in [25] with an improved criterion which ensures asymptotic stability with guaranteed H_∞ performance with low computational complexity. The paper is organized as follows. Section 2 introduces the system under consideration. A comparatively improved LMI criterion for H_∞ stability of two dimensional digital filters with saturation overflow nonlinearities and external interference is proposed in Section 3. In Section 4, a numerical example is given to illustrate the effectiveness of the proposed results. Finally, the paper is concluded in Section 5.

SYSTEM DESCRIPTION

Consider the following two dimensional digital filters:

$$\begin{bmatrix} x^h(i+1,j) \\ x^v(i,j+1) \end{bmatrix} = f\{\begin{bmatrix} y^h(i,j) \\ y^v(i,j) \end{bmatrix}\} + \begin{bmatrix} w^h(i,j) \\ w^v(i,j) \end{bmatrix} = \begin{bmatrix} f^h(y^h(i,j)) \\ f^v(y^v(i,j)) \end{bmatrix} + \begin{bmatrix} w^h(i,j) \\ w^v(i,j) \end{bmatrix} \tag{1}$$

$$\begin{bmatrix} y^h(i,j) \\ y^v(i,j) \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \mathrm{x} \begin{bmatrix} x^h(i,j) \\ x^v(i,j) \end{bmatrix} \tag{2}$$

$$f^h(y^h(i,j)) = \left[f_1^h\left(y_1^h(i,j)\right), \dots, f_m^h\left(y_m^h(i,j)\right)\right]^T$$

$$f^v(y^v(i,j) = \left[f_1^v\left(y_1^v(i,j)\right), \dots, f_n^v\left(y_n^v(i,j)\right)\right]^T$$

$$y^h(i,j) = \left[y_1^h(i,j), \dots, y_m^h(i,j)\right]^T$$

$$y^v(i,j) = \left[y_1^v(i,j), \dots, y_n^v(i,j)\right]^T$$

Where
$x^h(i,j) \in R^m$ is horizontal state vector,
$x^v(i,j) \in R^n$ is vertical state vector,
$w^h(i,j) \in R^m$ is horizontal external interference,
$w^v(i,j) \in R^n$ is vertical external interference,
$y^h(i,j) \in R^m$ is horizontal output vector,
$y^v(i,j) \in R^n$ is vertical output vector.
$f^h(.)$ is horizontal overflow nonlinearity ,
$f^v(.)$ is vertical overflow nonlinearity .
$A_{11} \in R^{m\times m}$, $A_{12} \in R^{m\times n}$, $A_{21} \in R^{n\times m}$ and $A_{22} \in R^{n\times n}$ are state matrices.

The overflow arithmetic to be considered presently is the saturation arithmetic given by;

$$f_1^h\left(y_1^h(i,j)\right) = \begin{cases} 1 & if\ y_k^h(i,j) > 1 \\ y_k^h(i,j) & if -1 \le y_k^h(i,j) \le 1 \\ -1 & if\ y_k^h(i,j) < -1 \end{cases} \tag{3}$$

k=1,2,…,m,

$$f_1^v\left(y_1^v(i,j)\right) = \begin{cases} 1 & if\ y_k^v(i,j) > 1 \\ y_k^v(i,j) & if -1 \le y_k^v(i,j) \le 1 \\ -1 & if\ y_k^v(i,j) < -1 \end{cases} \tag{4}$$

$$k = 1,2,\dots,n$$

Given a level $\gamma > 0$, the purpose of presented work is to establish a new LMI criterion such that the 2-D digital filter (1)-(2) with $w^h(i,j) = 0, w^v(i,j) = 0$ is asymptotically stable and

$$\frac{\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\left[x^{h^T}(i,j)K_1x^h(i,j)+x^{v^T}(i,j)K_2x^v(i,j)\right]}{\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\left[w^{h^T}(i,j)K_1w^h(i,j)+w^{v^T}(i,j)K_2w^v(i,j)\right]} < \gamma^2 \tag{5}$$

Under zero boundary conditions for all nonzero $w^h(i,j)$ and $w^v(i,j)$ where K_1 and K_2 are positive symmetric matrices. Parameter γ is called the H_∞ norm bound or the interference attenuation level. In this case, the two dimensional digital filter (1)-(2) is said to be asymptotically stable with a guaranteed H_∞ performance γ.

MAIN RESULT

A H_∞ stability criterion for the 2-D digital filter (1)-(2) is given in the following theorem.

A. THEOREM 1

For a given level γ>0, if there exist symmetric positive definite matrices K_1 $K_2, L, and\ M,$ positive diagonal matrices $D_1$and D_2 such that

$$\begin{bmatrix} \phi_{1,1} & \phi_{1,2} & A_{11}^TD_1 & A_{21}^TD_2 & \mathbf{0} & \mathbf{0} \\ \phi_{2,1} & \phi_{2,2} & A_{12}^TD_1 & A_{22}^TD_2 & \mathbf{0} & \mathbf{0} \\ D_1A_{11} & D_1A_{12} & L-2D_1 & \mathbf{0} & L & \mathbf{0} \\ D_2A_{21} & D_2A_{22} & \mathbf{0} & M-2D_2 & \mathbf{0} & M \\ \mathbf{0} & \mathbf{0} & L & \mathbf{0} & L-\gamma^2I & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & M & \mathbf{0} & M-\gamma^2I \end{bmatrix} \prec 0 \tag{6}$$

where

$\varphi_{1,1} = K_1 - L$, $\varphi_{1,2} = \mathbf{0}$, $\varphi_{2,1} = \mathbf{0}$,
$\varphi_{2,2} = K_2 - M$

Then the 2-D digital filter (1)-(2) is asymptotically stable with guaranteed H_∞ performance γ.

B. COMPARISON WITH THE EXISTING CRITERION

In section 3, a criterion for H∞ stability of 2-D interfered digital filters is presented. The criterion ensures elimination of overflow oscillations in 2-D digital filters described by Roesser model. In [25] the criterion is reported with eight unknown variables however the proposed criterion ensures asymptotic stability with guaranteed H_∞ performance considering six unknown variables. Thus the proposed criterion is numerically simpler as compared to the criterion proposed in [25].

ILLUSTRATIVE EXAMPLE

To illustrate the applicability of proposed theorem given in section 3, we now consider the following example.

Example 1

Consider the 2D digital filter described by (1)-(2) with following parameters

$$A_{11} = \begin{bmatrix} -0.1 & 0.9 \\ 0.39 & 0.4 \end{bmatrix} \qquad A_{12} = \begin{bmatrix} 0.01 & -0.5 \\ 0 & 0.35 \end{bmatrix}$$

$$A_{21} = \begin{bmatrix} -0.15 & 0.1 \\ 0.3 & -0.1 \end{bmatrix} \qquad A_{22} = \begin{bmatrix} 0.1 & 0.23 \\ 0.8 & 0.03 \end{bmatrix}$$

$$\boldsymbol{w^h}(i,j) = \begin{bmatrix} n^1(i,j) \\ n^2(i,j) \end{bmatrix} \qquad \boldsymbol{w^v}(i,j) = \begin{bmatrix} n^3(i,j) \\ n^4(i,j) \end{bmatrix}$$

where $n^1(i,j), n^2(i,j), n^3(i,j)$ and $n^4(i,j)$ are mutually independent white noises with mean 0 and variance 0.1. Let the disturbance attenuation level $\gamma = 0.4$

By solving LMI (6) using Matlab LMI toolbox we obtain the following feasible solutions:

$$K_1 = \begin{bmatrix} 0.0013 & -0.0001 \\ -0.0001 & 0.0013 \end{bmatrix} \qquad K_2 = \begin{bmatrix} 0.0066 & -0.0027 \\ -0.0027 & 0.0038 \end{bmatrix}$$

$$\mathrm{L} = \begin{bmatrix} 0.0191 & -0.0013 \\ -0.0013 & 0.0294 \end{bmatrix} \qquad \mathrm{M} = \begin{bmatrix} 0.0596 & 0.0050 \\ 0.0050 & 0.0307 \end{bmatrix}$$

$$D_1 = \begin{bmatrix} 0.0296 & 0 \\ 0 & 0.0296 \end{bmatrix} \qquad D_2 = \begin{bmatrix} 0.0618 & 0 \\ 0 & 0.0618 \end{bmatrix}$$

Thus according to theorem 1, the system under consideration is asymptotically stable.

Example is taken from [25] and it was shown that the given 2-D digital filter described by (1)-(2) is feasible for 6 unknown variables as compared to 8 unknown variables that are taken in [25].

CONCLUSIONS

A comparative evaluation of presented criterion with the one proposed in [25] is made. It is found that the criterion assures improvement over the criterion proposed in [25] as it shows reduction in numerical complexity. The usefulness of the presented criterion is demonstrated with the help of numerical example. The possible extension of presented approach to establish a criteria for H_∞ stability of m-D (m>2) interfered digital filters appears to be an interesting problem for future investigation. These digital filters can be implemented in the seismic survey to minimize the noise during acquiring of data.

REFERENCES

[1] Signal processing[Online] Available https://en.wikipedia.org/wiki/Signal_processing

[2] A. Antoniou, Digital Signal Processing, McGraw-Hill, Toronto, 2016.

[3] W.S. Lu, Two-dimensional digital filters, Vol. 80, CRC Press, 1992.

[4] D. Schlichtharle, Digital filters: Basics and Design, Springer-Verlag, Berlin, Heidelberg, 2000.

[5] H.J. Butterweck, J.H.F. Ritzerfeld and M.J Werter, "Finite wordlength effects in digital filters: a review", EUT Report No. 88-E-205, Eindhoven University of Technology, Eindhoven, 1988.

[6] T.A.C.M. Classen, W.F.G. Mecklenbräuker, and J.B.H. Peek, "Second-order digital filters with only one magnitude-truncation quantizer and having practically no limit cycles", Electronics Letters, Vol. 9 No. 22, 1973, pp. 531-532.

[7] J.H.F. Ritzerfeld, "A condition for the overflow stability of second-order digital filters that is satisfied by all scaled state-space structures using saturation", IEEE Transactions on Circuits and Systems, Vol. 36 No. 8, 1989, pp. 1049-1057.

[8] R.P. Roessor, "A discrete state space model for linear image processing," IEEE Trans.Automat.Control, 1975, pp. 201-10

[9] E. Fornasini, G. Marchesini, "Doubly indexed dynamical systems: state space models and structural properties," Math.Syst.Theory, 1978, pp.1259-72.

[10] T. Li, N. Sun, Q. Lin, and J. Li, “Improved criterion for the elimination of overflow oscillations in digital filters with external disturbance,” Advances in Difference Equations, Vol. no. 197, 2012, pp. 1-6.
[11] D. Liu, and A.N. Michel (1994), “stability analysis of state space realizations for two-dimensional filters with overflow nonlinearities,” IEEE Trans.Circuits Syst., U 41, 1994, pp. 127-137.
[12] N.G. El-Agizi, M.M. Fahmy, “(1979), Two-dimensional digital filters with no overflow oscillations,” IEEE Trans. Acoust. Speech Signal Process., 1979, pp. 27465-469.
[13] H. Kar, “a new sufficient condition for the global asymptotic stability of 2-D state-space digital filters with saturation arithmetic," Signal Process, 2008, pp. 8886-98.
[14] V.Singh, “Global asymptotic stability of 2-D state-space digital filters with saturation arithmetic: modified approach,” Signal Process, 2008, pp. 881304-1309.
[15] C.K. Ahn, and P. Shi, “Dissipativity analysis for fixed-point interfered digital filters”, Signal Processing, Vol. 109, 2015, pp. 148-153.
[16] P. Kokil, and S.S. Shinde, “An improved criterion for peak-to-peak realization of direct form interfered digital filters employing saturation nonlinearities”, COMPEL-The International Journal for Computation and Mathematics in Electrical and Electronic Engineering, Vol. 34 No. 3, 2015a, pp. 996-1010.
[17] Y. Tsividis, “Mixed Analog-Digital VLSI Devices and Technology,” World Scientific, 2002.
[18] J. Monteiro, and R.V. Leuken (Eds.) (2010), “Integrated Circuit and System Design: Power and Timing Modeling, Optimization and Simulation,” Springer, 2010.
[19] C.K. Ahn, and P.S. Kim, “New peak-to-peak state-space realization of direct-form interfered digital filters free of overflow limit cycles,” International Journal of Innovative Computing, Information and Control, Vol. 9 No. 8, 2013, pp. 3285 3291.
[20] C.K. Ahn, and Y.S. Lee, “Induced l∞ stability of fixed-point digital filters without overflow oscillations and instability due to finite wordlength effects”, Advances in Difference Equations, Vol. 2012 No. 51, 2012, pp. 1-7.
[21] H. Gao, and C. Wang (2003), “New approaches to robust l2 − l∞ and H∞ filtering for uncertain discrete-time systems,” Sci. China Ser. F 46(5), 2003, pp. 355–370
[22] C.K. Ahn, “l2-l8 stability criterion for fixed-point state-space digital filters with saturation nonlinearity,” International Journal of Electronics, Vol. 100 No. 9, 2013a, pp. 1309-1316.
[23] C.K. Ahn, “IOSS criterion for the absence of limit cycles in interfered digital filters employing saturation overflow arithmetic,” Circuits, Systems and Signal Processing, Vol. 32 No. 3, 2013b, pp. 1433-1441.
[24] C.K. Ahn, “l_2-l_∞ stability criterion for fixed-point state-space digital filters with saturation nonlinearity,” International Journal of Electronics, Vol. 100 No. 9, 2013a, pp. 1309-1316.
[25] C.K. Ahn, “Two dimensional digital filters described by Roesser model with interference attenuation,” Digital signal processing, Vol.23 No. 4, 2013c, pp. 1296-1302.
[26] P. Kokil, and H. Kar, “An improved criterion for the global asymptotic stability of fixed-point state-space digital filters with saturation arithmetic,” Digital Signal Processing, Vol. 22 No. 6, 2012, pp. 1063-1067.
[27] W.L. Mills, C.T. Mullis, and R.A. Roberts, “Digital filter realizations without overflow oscillations,” IEEE Transactions on Acoustics, Speech and Signal Processing, Vol. 26 No. 4, 1987, pp. 334-338.
[28] T. Ooba, “Stability of discrete-time systems joined with a saturation operator on the statespace,” IEEE Transactions on Automatic Control, Vol. 55 No. 9, 2010, pp. 2153-2155.
[29] V. Singh, “A new realizability condition for limit cycle free state-space digital filter employing saturation arithmetic,” IEEE Transactions on Circuits and Systems, Vol. 32 No. 10, 1985, pp. 1070-1071.
[30] A. Lepschy, G.A Mian,. and U. Viaro, “A contribution to the stability analysis of second order direct-form digital filters with magnitude truncation,” IEEE Transactions on Acoustics, Speech and Signal Processing, Vol. 35 No. 8, 1987, pp. 1207-1210.
[31] P. Steffen, “1984. Two-dimensional digital filters for geophysical applications: A simple design method leading to an easy implementation,” Signal processing, 7(3), 1987, pp.293-320.
[32] R. Smith, A. Bakulin, M. Jervis, and A. Alramadhan, “Comprehensive seismic monitoring of an onshore carbonate reservoir: a case study from a desert environment,” In Active Geophysical Monitoring , Elsevier, 2020.

15. Performance Evaluation of Existing Interference Mitigation Techniques under Designed Interference Environment

Mrs. Shilpa Vikas Shinde[1*] , Dr.Santosh S. Sonavane[2]

[1] Asst Prof E&TC Dept, ViMEET, Khalapur, India, Research Scholar, GHRCOE, Wagholi, India.

[2]Director School of Mechatronics Engineering, Symbiosis Skill & Open University, Pune, India. Research Guide GHRCOE, Wagholi, India.

**Corresponding author E-mail: shilpavikasshinde@gmail.com*

ABSTRACT

According to the latest report, 10% people in India die because of cardiovascular diseases. This mortality rate can be reduced by using state of art technology which can give early warning signs of such attacks. Thus, Wireless Body Area Network (WBAN) arrangements where remote patient monitoring is made possible can help in this context. Also, WBAN can reduce the cost of hospitalization and ensure comfort level of the patient. This paper is an outcome of our ongoing research to design robust Wireless body area network for remote patient health monitoring system. Our previous work confirmed that designed WBAN can be extremely useful for remote patient monitoring, however WBAN are prone to interference. Interference is a phenomenon of overlapping wireless ranges of WBANs thus there is a need to test performance of designed WBAN under interference. Interference reduces the reliability of the transmission of the data, the throughput and increases the power consumption. In WBAN vital body parameters are sensed and transmitted wirelessly to the health service provider. Any delay in transmission of the data due to interference could be dangerous for patients' health. Thus, the efforts should be made to mitigate interference.

Thus, performance of the designed WBAN under the influence of interference is reported in this paper. For performance analysis, three parameters i.e. delay, power consumption and throughput are considered. Also, effectiveness of two existing, concurrent Interference Mitigation Techniques (IMT) is evaluated for the interference reduction for Designed WBAN. First, the designed WBAN is tested under Interference environment without mitigation technique. Later on, a performance of SCA (Smart Channel Assignment) and ITLS (Interference Aware Traffic Priority Based Linked Scheduling) interference mitigation algorithms are tested under same interference environment and comparative statements are made. Purpose of such comparative analysis is to find the scope of development of new or better IMT for designed WBAN.

Keywords: *Interference Mitigation, ITLS, SCA, WBAN.*

INTRODUCTION

The health monitoring is useful to monitor condition of critical organs and to provide immediate medical attention to reduce undue risk of life. Traditionally, this is being done at hospitals by using on body wired sensors [1]. For such wired monitoring patient has to be admitted in hospital, and wear various on body sensors; limiting the movement of the patient. The wireless health monitoring provides remote sensing and enhanced mobility [1], and comfortable life for a patient as need to get hospitalized is minimized [1],[2]. A Wireless Body Area Network (WBAN); which is a subset of Wireless Sensor Network (WSN) is composed of a short range communication and low power sensors placed on or around a human body. A WBAN system consists of biomedical sensor nodes for monitoring physiological data such as temperature, blood pressure, electrocardiography (ECG), electroencephalography (EEG), electromyography, and heart rate. These sensors may be wearable or implanted devices that collect and transmit vital signals to the coordinator. The collected data can then be forwarded to health service provider for necessary action [1].

Considering the population of India, health infrastructure is always going to be limited. Thus, alternative arrangements where remote patient monitoring is made possible can help to reduce burden on health infrastructure. Moreover, Wireless Body Area Network (WBAN) can reduce the cost of hospitalization and ensure comfort level of the patient. In India, 10% of people die every year, because of heart attack [3] and it is considered as a leading cause of death in India [4, 5]. The severity of the problem can be minimized by efficient heart rate monitoring; to give early warning signs of the heart attack. Thus, the main motivation of this research is to design WBAN as per the IEEE 802.15.6 standard for the heart rate monitoring.

It is the fact that the humans are active and for daily routines they move from one place to another place. Thus, the sensor devices associated with arms, legs, et al., on a human body are also mobile. Thus, having static WBAN is almost impractical. Thus for realistic studies, mobility of the WBAN must be considered. It can also be understood that the mobility can be anywhere; say in hospitals, offices or market place. It is the great possibility in near future that in many practical environments such as hospitals, offices, schools etc. multiple WBANs can co-exist. Such coexistence of WBAN assisted due to mobility causes overlapping of communication ranges. This is called as interference. Interference reduces the reliability of the transmission of the data, the throughput and increases the power consumption. In WBAN, vital body parameters are sensed and transmitted wirelessly to the health service provider. Any delay in transmission of the data due to interference could be dangerous for patients' health. Thus, the efforts should be made to mitigate interference. Since, interference causes degradation of a network performance, there is a need to test performance of designed WBAN under interference and to mitigate it.

From the referred literature [3, 4, 5], it is understood that heart rate and pulse rate are the good indicators of heart disease. *Accordingly, we have designed WBAN consisting three sensors and one hub (discussed in detail in the section 3).* Our experiments and simulation with designed WBAN confirmed that it can be really useful for remote patient monitoring, however it has to be tested under interference environment. *Thus, performance of the designed WBAN under the influence of interference is investigated and reported in this paper.* For network performance analysis, three parameters viz. delay, energy consumption and throughput are considered. *In addition, an effectiveness of two existing, concurrent Interference Mitigation Techniques (IMT) (discussed in detail in the section 3) is evaluated for the interference reduction for Designed WBAN.* The designed WBAN is first tested under interference environment without any mitigation technique. Later on, SCA (Smart Channel Assignment) and ITLS (Interference Aware Traffic Priority Based Linked Scheduling) interference mitigation algorithms are applied and performance is tested under the same interference environment and comparative statements are made. *An objective of such comparative analysis is to find the scope of development of new or better IMT for designed WBAN.* The rest of the paper is arranged in the different sections. In the section II, previous interference mitigation studies are reported with important interference mitigation techniques. In the section III, methodology and simulation environment used for this research is discussed. Simulation results are discussed in the section IV followed by concluding section V.

LITERATURE REVIEW

In the literature many studies have reported that the interference of any form causes data collision [6],[7], beacon loss [8],[9] and affects on signal quality which results in loss of reliability and increases power consumption of the network. Overall the interference causes network performance degradation. It is understood that the researchers have used various parameters to identify interference; average packet reception ratio (PRR) and SINR values [6], the SINR, emitting power, and temporal model [7], beacon delivery ratio (BDR) [8], The transmission efficiency (TE) and BDR [9], The received power of each sensor and packet length [10], the network traffic [11], and transmission schedule [12]. Different authors have proposed different IMTs, in the following section we have listed out few which are applicable for the current research.

Authors [13] proposed an Almost Blank Subframe (ABS) algorithm. The proposed algorithm measures the load of network and provides load balancing technique. It has two gateways called as healthy gateway and WBAN gateway. It has a subframe called as a mandatory ABS subframe used for load management. System performance was improved due to load balancing technique.

In this algorithm interference caused by other nearby devices can also be avoided by using ABS gateway. In this Technique Range Extension (RE) index is used to show Range Extension which is an indicator of availability of devices. When more devices enter in the range of WBAN, RE will increase and which will indicate interference.

In [14] authors uses multihop routing for better performance of WBAN. It shows improvement in battery life, connectivity and reliability of the network. Author performed experiments for heavy and real interference situation. This environment was used to analyze effect of transmission frequencies, packet size and transmit power They proposed a adaptive algorithm which adjust dynamically it’s parameter with received power indicator.

In [15] authors presented a parameter adjustment method for improving reliability of communication in WBAN which suffers high interference. This method includes packet size reduction, bake off time and CCA period reduction. In [16] authors presented a Dynamic channel assignment scheme for interference avoidance named as Dynamic Channel allocation Scheme for Interference Mitigation (DCAIM). In this paper, authors classified area of each WBAN as relay region which was synchronized by relay. In this technique each Regional Group creates a table of Interference Sensors and this will be broadcasted to all nearby sensors. So sensors from Interference sets were allocated orthogonal channels and all other may use same time slot. In this technique time division multiplexing was used.

In [17] authors divided data transmitted by sensors in two types as Primary Users (PU) which are delay sensitive and other as Secondary Users (SU) which are throughput sensitive. All bandwidth was divided for PU and SU. The bandwidth was fairly allocated for critical data. Particle Swarm Optimization (PSO) approach was utilized for transmission power optimization. It was modeled as mathematical model as a Linear Programming Problem (LPP) and PSO was implemented for interference mitigation.

In [18] authors, presented a Smart Channel Assignment (SCA) interference mitigation algorithm. This algorithm considered co-existing WBANs. In these algorithm coordinators of coexisting WBANs offers orthogonal channels for each WBAN. So total channel bandwidth was divided equally into time slots equal to total WBAN numbers and each slot of respective WBAN was further sub divided in to sensor nodes of that WBAN network. After orthogonal channel assignment interference set was formed based on table of received power of each sensor. Then coordinator broadcasts its interference list to form interference set. Nodes with interference were arranged with same time slot as per their previous allocation. Remaining time slots are equally divided into other nodes without interference.

In [19] authors, presented Interference Aware Traffic Priority Based Link Scheduling (ITLS). This is an interference mitigation algorithm used for coexisting WBAN environment. In this algorithm orthogonal transmission was used between all WBANs and total time slots were equally divided into sensors. All WBAN coordinator creates Interference Sensor Group (ISG) and Non Interference sensor Group and initialize a scheduling vector. All sensors are assigned with priority. Along with traffic priority weighted interference of each sensor was calculated. ITLS algorithm was executed at coordinator of each WBAN, Contention Value (CV) used to define weight constraints at each time slot. The active sensor with highest CV and priority was selected.

In summary, the purpose of the mitigation schemes is to guarantee that WBANs operate stably even in highly populated and interference-prone situations. These schemes must be suitable equipped with interference detection as well as overcoming techniques to ensure network performance. The interference mitigation technique must be designed or satisfy the needs to be effective. These parameters mainly include system throughput, power consumption, Quality of Service and Reliability. One by one these parameters are discussed below.

A. SYSTEM THROUGHPUT

The system throughput is related to the data rate and packet delivery ratio. In general it is understood that the higher system throughput leads to the more reliable communication. It is a fact that the Mobile and high-density WBANs adversely affect bandwidth utilization. Thus, the signal loss may result in a dangerous situation for patients in healthcare applications. Thus reliability in sending vital signals from a human body to the server is critical. So, a requirement of any mitigation scheme is to maximize system throughput.

B. ENERGY CONSUMPTION

For a long lifespan for the sensor nodes, energy efficiency or consumption is important. The power capacities of WBAN sensor nodes are limited due to the small size of their batteries. In interference scenarios, the power consumption of a WBAN increases because of contention to access the channel, retransmission, and the idle listening channel. Thus, interference mitigation algorithms must consider the minimization power in a WBAN as a main objective.

C. QUALITY OF SERVICE (QOS)

All WBANs have specific QoS requirements for each type of sensor or application. QoS depends on bit error rate (BER) or the nature of transmitted signal (Heart rate). In interference, WBANs with a high QoS constraint should have a high priority to access the channel and low BER.

D. RELIABILITY

Reliability is considered in terms of packet delay and probability of packet loss. It should be as low as possible. The convergence time is a time in which WBANs return to normal operation. For the more effective the interference mitigation scheme; the convergence time must be low to reduce delay

. From above discussion, it is concluded that the best interference mitigation technique will have maximum system throughput, minimization power, a high QoS or low BER and low convergence time. Considering above discussion, we have considered three parameters to compare performance of Interference mitigation technique viz. throughput, delay and energy consumption.

In this research, we have used IEEE 802.15.6 MAC protocol which supports dynamic resource allocation based interference mitigation techniques. We found SCA and ITLS are channel allocation methods which have been recently tested for Interference studies. Thus, for practical convenience, we chose to compare these two concurrent methods for mitigation performance for designed WBAN.

METHODOLOGY

Following flowchart shows methodology used for the research. In the subsequent section each part is discussed in detail.

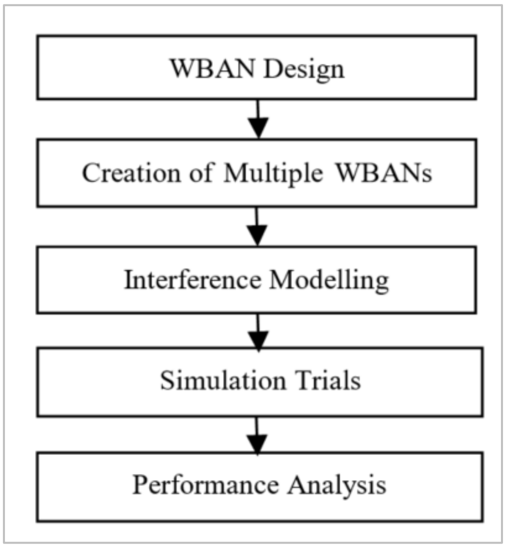


Figure 15-1 Flowchart for Methodology

A. WBAN DESIGN

The main motivation of this research is to contribute to heart rate monitoring by developing WBAN as per the IEEE 802.15.6 standard. Since, the heart rate and pulse rate are the good indicators of a heart disease, we selected these two sensors. In addition, the third sensor for body temperature monitoring is introduced to the network. Each sensor, thus independently monitors vital signatures and communicates to the central Hub as shown in fig. 2a. A single hop star topology was found suitable and selected for connecting all sensors with the hub. These three sensors nodes will be communicating with a single hub as shown in fig. 15-2.

The node-0 is a heart rate sensor mounted close to heart, node-1 is a pulse rate sensor mounted near to right-hand wrist and node -2 is a temperature sensor mounted on the left hand. A central node 3 represents Hub. Accordingly, the WBAN network is designed in NS2 (simulated environment) as shown in fig. 15-3. Accordingly, a program for four nodes is written.

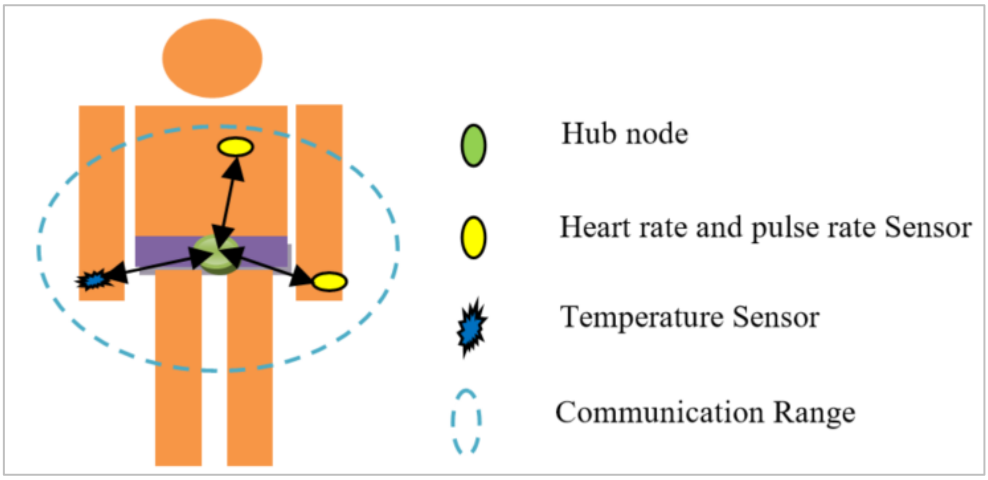


Figure 15-2 WBAN network placed on a human body

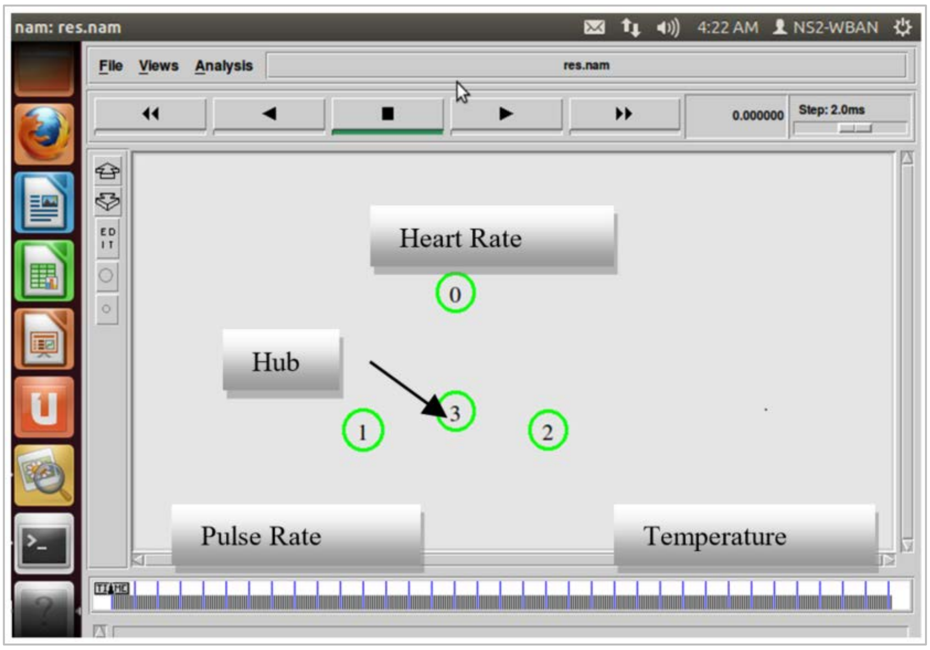


Figure 15-3 WBAN in NS2

B. CREATION OF MULTIPLE WBANS AND INTERFERENCE MODELLING

Since the paper focuses on effect of interference on network performance, thus it was necessary to create an interference environment. The interference environment is created by considering multiple WBANs coexisting at a single place having area of 100 x100 meters. We considered 50 coexisting WBANs initially in the first set of simulation to create interference environment. Each WBAN in the interference environment was similar to the model discussed in WBAN design section. However, every WBAN has different mobility pattern. For example, some WBANs are static where person is standing at a particular place and some are moving with different speeds to replicate walking. To simulate real time crowd environment, we kept on adding 50 WBANs in each trial up to 300 WBANs. This replicates the situation where many WBANs communication ranges overlaps with each other. Thus, we tried to replicate real life situation where 300 WBANs can co-exist; thus we created interference model.

C. SIMULATION STUDIES

Network design in NS2 contains a Frontend and Backend structure. The frontend is used to design a WBAN. The designed network contains three nodes and one hub, thus four nodes are created. We used MAC 802.15.6 protocol. Following Table 15-1 show all simulation parameters. The simulation environment consists of 100 m x100m area. As discussed in previous section, initially 50 WBANs with random mobility scenario were created. Initial energy, transmitter and receiver energy values were maintained as mentioned in the Table 15-1. We conducted the simulation trial for 100 seconds and then analyzed the results by applying the awk script to the output file of the program. We fixed the same data rate for all sensors. To check the network configuration a test run was carried out. The designed network worked successfully and the desired output is obtained which confirmed that all nodes, hub and wireless links are working properly. Simulations are carried out for three parameters viz. throughput, delay, and power consumption.

Table 15-1 Network Simulation Parameters

Network Area	1000 x 1000
Type of Network	WBAN
Number of WBAN	50-300
Number of Body Sensors in Each WBAN	3
Velocity	1.5 m/s
MAC	802.15.6
Simulation Time	100 second
Initial Energy	0.5 J
Transmitter energy consumption	16.7 nJ
Receiver energy consumption	36.1 nJ
Interference Mitigation techniques	SCA, ITLS

D. PERFORMANCE ANALYSIS

Objective of the paper is to evaluate effectiveness of interference mitigation techniques to mitigate or minimize interference. As discussed in section II, the best IMT would improve throughput with less energy consumption and less delay. Thus the first trial run was conducted without any IMT and the results are tabulated for throughput, delay, and power consumption and this data was used to compare with results obtained by trial run by applying SCA, ITLS interference mitigation techniques.

RESULT AND DISCUSSION

In this section, we will discuss network performance under interference environment with and without interference mitigation techniques. The performance parameters are throughput, energy consumption and delay analysis.

A. THROUGHPUT ANALYSIS

Following fig. 15-4 shows throughput analysis and Table 15-2 shows throughput analysis comparative for different Interference Mitigation Techniques. From fig. 3, it was observed that as we increase number of WBANs, the throughput goes on reducing. We have taken readings by varying number of WBANs from 50 to 300. Due to coexistence of these many numbers of WBANs in particular area, 84% decrease in throughput for AODV protocol was observed. Thus, we can conclude that co-existence of multiple WBANs decreases throughput. However, efforts should be made to improve throughput by applying interference mitigation technique. So, we took reading by applying mitigation techniques and checked whether it has an impact on throughput. When we applied ITLS mitigation technique throughput reduction was improved and it was 49.55% and for SCA throughput was even better and reduction was observed up to 46.66%. With these results, we can conclude that throughput will be better if we use mitigation technique for better performance. In general, SCA has shown marginally better throughput performance than ITLS.

Following table 15-2 provides throughput analysis for multiple WBANs in interference environment. It can be seen that throughput is increased considerable with IMT as compared to without IMT. SCA has shown better performance than ITLS.

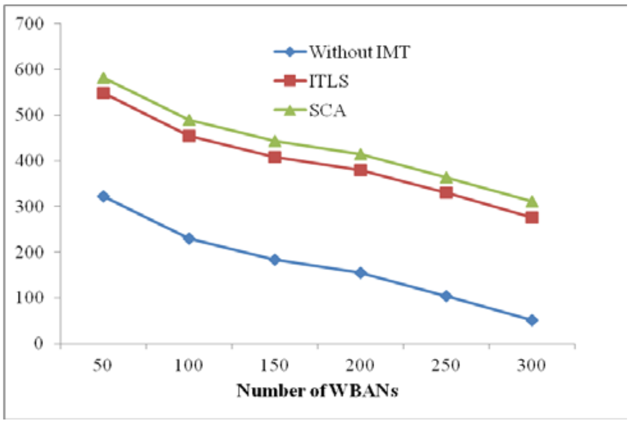


Figure 15-4 Effect of increasing number of WBANs on throughput for different Interference Mitigation Techniques

Table 15-2 Throughput analysis comparative for different Interference Mitigation Techniques

Number of WBANs	Without IMT	ITLS	SCA
50	322.1	547.66	581.54
100	229.45	455.01	488.89
150	182.92	408.48	442.36
200	154.26	379.82	413.7
250	104.44	330	363.88

300	50.72	276.28	310.16

B. DELAY ANALYSIS

Following fig.15-5 shows Delay analysis and Table 15-3 shows Delay analysis comparative for different Interference Mitigation Techniques. From fig. 15-6, it was observed that as we increase number of WBANs the delay goes on increasing. From readings, when no mitigation technique was applied then there was 7.167% increase in delay without IMT. We intended to check effect of applying mitigation techniques. We found improvement in delay due to IMT. When we applied, ITLS mitigation technique, delay was improved to 6.05% and for SCA delay was 6.1%.

With these results, we can conclude that delay goes on increasing as we increase number of WBANS. By applying mitigation technique, delay was reduced and performance was enhanced. ITLS and SCA have similar effect on delay, so no clear distinction can be made between these two techniques. Both techniques can be tested for more number WBANs beyond 300 to get this distinction; which is beyond the scope of this research. From fig. 4 it was observed that there was gradual increase in delay up to 250, whereas sudden increase in delay is observed beyond 250 WBANs.

Following table 15-3 provides delay analysis for multiple WBANs in interference environment. It can be seen that delay is decreased considerably with IMT as compared to without IMT. ITLS has shown marginally better performance than SCA.

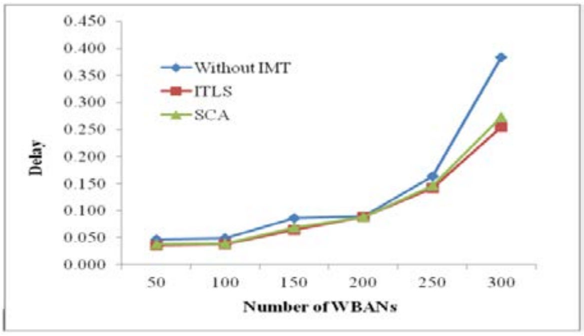


Figure 15-5 Effect of increasing number of WBANs on delay for different Interference Mitigation Techniques

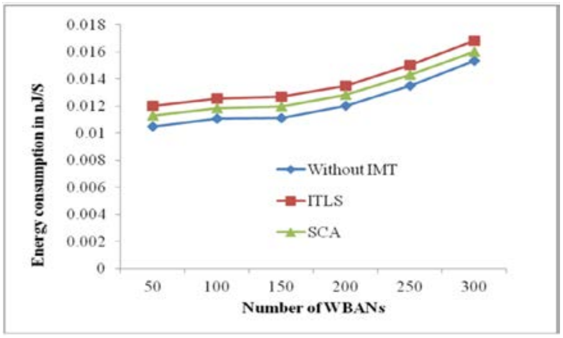


Figure 15-6 Effect of increasing number of WBANs on energy consumption for different Interference Mitigation Techniques Initially

Table 15-3 Delay analysis comparative for different Interference Mitigation Techniques

Number of WBANs	Without IMT	ITLS	SCA
50	0.047	0.036	0.038
100	0.049	0.038	0.039
150	0.087	0.065	0.068
200	0.089	0.089	0.089
250	0.164	0.142	0.146
300	0.383	0.255	0.273

C. ENERGY CONSUMPTION ANALYSIS

The fig. 15-6 shows energy consumption analysis and Table 15-4 shows energy consumption analysis comparative for different Interference Mitigation Techniques**.**

Table 15-4 Energy consumption analysis comparative for different Interference Mitigation Techniques

Number of WBANs	Without IMT	ITLS	SCA
50	0.011	0.012	0.011
100	0.011	0.013	0.012
150	0.011	0.013	0.012
200	0.012	0.014	0.013
250	0.014	0.015	0.014
300	0.015	0.017	0.016

CONCLUSIONS

Without Interference Mitigation Technique (IMT), we observed large reduction in the throughput. With the application of IMT, considerable improvement in throughput is observed. Thus, it is concluded that for better network throughput in interference environment use of IMT is recommended. From delay analysis, it is concluded that delay goes on increasing as we increase number of WBANS. With an application of IMT delay was reduced considerably as compared to without IMT. Thus, we can conclude that with mitigation technique delay can be reduced and network performance can be improved.

It is understood that IMT improves throughput and delay however it increases energy consumption of the network. Results have shown that this increase in energy is marginally more with IMT than without IMT. Considering, importance of WBAN for monitoring the patient's vital parameters, it is essential to have lesser delay, and better throughput. Although, energy consumption is compromised with IMT, it is strongly recommended to use IMT. Comparing SCA and ITLS, we found that both techniques were effective to maintain better throughput, lesser delay, and marginally higher energy consumption. However, difference between these two IMTs is marginal. Thus, we see need of better improved IMT which can have comparatively better results for designed WBAN.

REFERENCES

[1] Hao, Y., & Foster, R. (2008). Wireless body sensor networks for health-monitoring applications. Physiological measurement, 29(11), R27.

[2] Osseiran, A., Braun, V., Hidekazu, T., Marsch, P., Schotten, H., Tullberg, H., ... & Schellman, M. (2013, June). The foundation of the mobile and wireless communications system for 2020 and beyond: Challenges, enablers and technology solutions. In Vehicular Technology Conference (VTC Spring), 2013 IEEE 77th (pp. 1-5). IEEE.

[3] Prabhakaran, D., Jeemon, P., & Roy, A. Cardiovascular diseases in India: current epidemiology and future directions (Circulation, 133(16) , 2016), pp. 1605-1620.

[4] http://www.indiaspend.com/wp-content/uploads/storify_620.png

[5] Gupta, R., Mohan, I., & Narula, J. Trends in coronary heart disease epidemiology in India. (Annals of global health, 2016).82(2), pp. 307-315.

[6] Jin, Z.; Han, Y.; Cho, J.; Lee, B. A Prediction Algorithm for Coexistence Problem in Multiple-WBAN Environment. Int. J. Distrib. Sens. Netw. 2015, 2015, 1–8.

[7] Hernandez, M.; Miura, R. Coexistence of IEEE Std 802.15.6TM-2012 UWB-PHY with Other UWB Systems. In Proceeding of the IEEE International Conference on Ultra-Wideband (ICUWB), Syracuse, NY, USA, 17–20 September 2012; pp. 46–50.

[8] Liang, S.; Ge, Y.; Jiang, S.; Tan, H.P. A Lightweight and Robust Interference Mitigation Scheme for WBSNs in Realistic Environments. In Proceeding of the IEEE Wireless Communications and Networking Conference, Istanbul, Turkey, 6–9 April 2014; pp. 1697–1702.

[9] Mahapatro, J.; Misra, S.; Manjunatha, M.; Islam, N. Interference-Aware Channel Switching for Use in WBAN with Human-Sensor Interface. In Proceeding of the 4th International Conference on Intelligent Human Computer Interaction (IHCI), Kharagpur, India, Dec. 2012; pp. 1–5.
[10] Movassaghi, S.; Abolhasan, M.; Smith, D. Smart Spectrum Allocation for Interference Mitigation in Wireless Body Area Networks. In Proceeding of the IEEE International Conference on Communications (ICC), Sydney, Australia, 10–14 June 2014; pp. 5688–5693.
[11] Jamthe, A.; Mishra, A.; Agrawal, D.P. Scheduling Schemes for Interference Suppression in Healthcare Sensor Networks. In Proceeding of the IEEE International Conference on Communications (ICC), Sydney, Australia, 10–14 June 2014; pp. 391–396.
[12] Kim, E.J.; Youm, S.; Shon, T.; Kang, C.H. Asynchronous Inter-Network Interference Avoidance for Wireless Body Area Networks. J. Supercomput. 2013, 65, 562–579.
[13] Roy C. Park ·Hoill Jung ·Sun-Moon Jo ABS Scheduling Technique for Interference Mitigation of M2M Based Medical WBAN Service
[14] Essafi Sarra Coexistence Improvement of Wearable Body Area Network (WBAN) In Medical Environment etc.
[15] Essafi Sarra Performance improvement of the Wireless Body Area Network (WBAN) under interference
[16] Mohamad Jaafar Ali etl (2016) Dynamic Channel Allocation for Interference Mitigation in Relay-assisted Wireless Body Networks
[17] A Novel Bio-inspired Algorithm for Increasing Throughput in Wireless Body Area Network (WBAN) by Mitigating Inter-WBAN Interference
[18] Movassaghi, S., Majidi, A., Jamalipour, A., Smith, D., & Abolhasan, M. (2016). Enabling interference-aware and energy-efficient coexistence of multiple wireless body area networks with unknown dynamics. IEEE Access, 4, 2935-2951.
[19] Le, T., & Moh, S. (2016). An interference-aware traffic-priority-based link scheduling algorithm for interference mitigation in multiple wireless body area networks. Sensors, 16(12), 2190.

AUTHORS PROFILE

Mrs. Shilpa V Shinde had completed Bachelor in Engineering (Electronics) in 2005 and Master of Engineering. (Electronics) in 2011 from Shivaji University, Kolhapur. She is currently a PhD student of Savitribai Phule Pune University (SPPU), Pune India. Her research areas are Wireless Body Aare Network, Wireless Sensor Network and Image processing. She had published 16 national, international papers in various journals. She has total 12 years of teaching experience. She is currently working as Asst. Professor in E&TC Department ViMEET, Khalapur, and Research Scholar at GHRCOE, Wagholi, SPPU,

Dr. S. S. Sonavane had completed BE (Electronics) from University of Pune, M.E. (Electronics) from BAMU, Aurangabad and PhD (Electronics Engg.) from IIT, Dhanbad in 2009. He is having 19 years of experience in educational field. Currently he is working as Director School of Mechatronics Engineering, Symbiosis Skill & Open University, Pune, India. Research Guide GHRCOE, Wagholi, India. He worked as Director of Dr. D Y Patil Technical Campus, Lohegaon, Pune for last 6 years. He had also served as First officiating Vice Chancellor of Ajeenkya DY Patil University at Lohegaon, Pune. He has published 2 books at International level (Austria and one in Germany) and more than 75 International and National publications. He is the registered PhD guide in University of Pune and other NITs. He had successfully completed two Research Projects funded by University of Pune.

16. Electrical Impedance Analysis on Orange During Storage and Ripening

Pritika Singh, Department of Electronics & Communication Engineering,
BIT Sindri, Dhanbad, Jharkhand-828123 (India)
***Email*:** singhpritika03@gmail.com

ABSTRACT

This paper describes the physiological changes that occur in fruits during the storage and ripening period, using EIS technique. Electrical Impedance Spectroscopy technique as clear from the name is used to analyze the electrical properties of the fruits and thereby assists a lot in investigating the relationship between the Nyquist plot obtained from the impedance spectroscopy and the equivalent circuit. Electrical equivalent circuit has been modeled relative to the Nyquist plot obtained. Followed by modeling of electrical equivalent circuit the suitable fit has also been obtained. In the present work Non destructive technique has been used for estimating the impedance of orange. Here in this paper, Electrical Impedance Spectroscopy (EIS) studies on orange tissues has been conducted over a wide range of signal frequencies starting from 50Hz and ending up to 1MHz.The number of points between start to end frequency are 100. The Nyquist plot obtained for the orange tissue sample shows that the electrical equivalent circuit of the tissue sample contains a Constant Phase Element. Variations in weight of the fruit with ripening have also been analyzed in this paper. The impedance as well as the weight measurements was monitored once a day for six days.

Keywords—*Non–destructive technique, Electrical Impedance Spectroscopy.*

INTRODUCTION

Fruits are rich source of nutrition and contribute a lot in human healthy diet. Fruits are not only known for their colorful appearance and flavor, but they also serve a lot as a source of energy, vitamins, minerals, and dietary fiber [1-3]. Day by day with the increased standard of living demands for fresh fruits in markets is also increasing. Thus before bringing the fruits to market it must be assured that the fruits that are to be sold are free of damage. As the physiological conditions of fruits are greatly influenced by certain environmental factors such as temperature, humidity, and hence it is necessary to monitor the changes in the physiological status of fruits. Damage in fruits may be due to various reasons (surface injuries, impact bruising, vibration bruising etc.)[3]. If the damage is external i.e. due to fall from height or chilling injury, it is visible but sometimes the damage is internal and cannot be seen. Therefore technique of physiological assessment is not always possible and hence in order to check the internal properties of fruits a very popular technique called impedance spectroscopy (EIS) or AC impedance has been used.EIS technique has proved its usefulness not only in the biological field but also in the field of Chemistry. All the biological tissues are composed of complex impedance [4]. Complex impedance consist of both the resistive and the capacitive elements [5].Electrical impedance measurements were also conducted in some agricultural products such as in apple [6-7], nectarines [8-9], persimmon fruit [10], Kiwifruit [11], cucumber [12-13] ,graut citrus [14], potato [15], banana [16], avocados [17] and many others. Due to conductive behavior of the fruits it has been possible to perform the EIS technique on fruits as well. Electrical impedance spectroscopy (EIS) measures the electrical properties of subject of interest as a function of frequency.EIS technique for quality assessment of fruits has been advantageous over technique of physiological assessment for quality determination because of being simple and non-destructive [18-20].Thus impedance is a complex quantity and changes with variations in the signal frequencies.EIS technique is used for measuring the impedance, of the biological tissue and thereby reveals the electrical properties of the biological material. By analyzing the impedance of the biological material it is possible to relate the measured electrical values of the subject under test to their physiologic equivalents. The analysis of EIS measurements at different frequencies assists a lot in understanding the intrinsic properties of the sample of intrest.EIS technique has been in use since several years for investigating the fundamental electrical properties of subject of interest and has proved itself as useful tool in detecting the changes in behavior under different physiological conditions. Due to EIS technique it has been possible to built electrical models of the measured material in the form of an electrical circuit consisting of resistors and capacitors and analyze its response to alternating current source signals of variable amplitude and frequency [21].EIS technique is very powerful and easy to use and provides information about all the passive components i.e. resistive, capacitive and inductive within very short span of time with the help of appropriate equivalent circuit model [22]. Modeling of electrical equivalent circuits is very much necessary in order to characterize experimental frequency response of impedance [23][24].Once the Equivalent electrical circuit is obtained it is important to obtain the best possible fit in order to obtain the best values of the unknown parameters of the circuit. But before building any electrical model, it is necessary to be familiar with the investigated sample structure.

BASIC STRUCTURE OF PLANT CELL

The word ‘cell’ was first coined by British scientist Robert Hook in the year 1665. All the living objects either plant, animal or human bodies are comprised of cells and tissues. Body of every organism is made up of cell, and each cell arises from pre-existing cell. Cell is the basic structural and functional unit of life. Plant cells are eukaryotic cells which contains membrane bound organelles and nucleus. Generally plant cells are larger than animal cells and are mostly similar in size but different in structures. Plant cells are similar to animal cells in being eukaryotic and they have similar cell organelles. Basic cell structure consists of cell membrane also known as plasma membrane bounded by a rigid cell wall made up of cellulose and chitin. The basic function of the cell wall is to provide shape to the cell. Cell membrane is thin, elastic, living, double layer, and permeable membrane, made up of protein and lipid molecules. The basic function of cell membrane is to regulate the movement of molecules inside and outside the cells. The presence of molecules inside is responsible for the conductive properties of biological tissues. The basic cell structure mainly comprises three important elements which are cell membrane, intracellular fluids and extra cellular fluids. Cell membrane maintains ion concentration gradient between the intracellular and extra cellular spaces. The extracellular fluids conduct at high frequency as well as low frequency range, whereas the intracellular fluids show the conductive property only at high frequency range. The intracellular fluids containing the cytoplasm and nucleus shows resistive behavior to the alternating current signal. The cell membrane consists of a layer of a layer of non-conductive lipid material sandwiched between two layers of conductive protein molecules and hence it behaves like a capacitance contributing a capacitive reactance to the alternating current path [25].Hence the equivalent circuit model of the biological samples is comprised of intracellular fluid resistance, extracellular fluid resistance and a cell membrane capacitance.

A. MATERIALS AND METHODS

The experiments were carried out on a matured unripe orange which was brought from local market. The experiment was carried out for six days. A big green orange was chose and stored at room temperature till ripening. Impedance measurement was done using Impedance Analyzer. The readings were taken at the frequency range starting from 50Hz and ending upto1MHz.Experiments was carried out using non-destructive technique. Electrical contact with the orange was made using ECG electrode. Before placing the ECG electrodes, the orange was cleaned properly with distilled water. The position of ECG electrodes was arranged properly for accurate reading. A constant current source of 1mA was applied, and the number of points taken was 100.Application of constant current source is very much important for estimating the impedance of the sample of interest. Impedance of the orange was estimated by measuring the voltage source that developed on account of constant current source injection through the electrodes. Experiments were performed using two-terminal method.

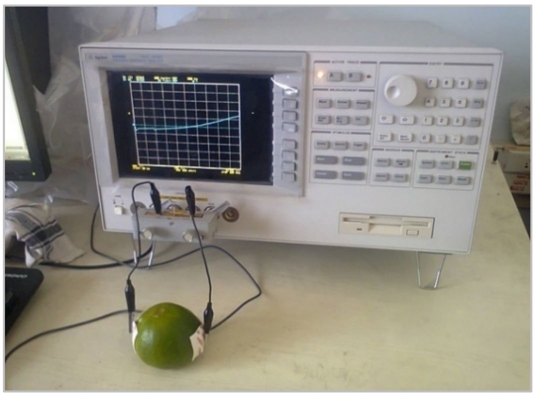


Figure 16-1 Experimental Setup for impedance measurements.

The surface electrode through which the current is injected is called the current electrode or driving electrode and the one on which the frequency dependent ac potential is measured is called the voltage electrode or the sensing electrode.Here in these Experiment two terminal methods was used where two electrodes were used for impedance measurement and hence current injection and voltage detection was conducted with the same pair of electrodes. The Experimental setup for obtaining the impedance parameters as a function of frequency of orange tissues has been shown in Fig.16-1 Weight of orange was also measured till the orange was not overripe, as the overripe fruit is not desirable. So the weight was measured for six days using weight measuring instrument. Both the impedance as well as weight measurements were monitored once a day for six days.

CONSTANT PHASE ELEMENT (CPE)

In biology, an equivalent circuit model is a circuit yielding the same impedance as a biological tissue in a given frequency domain. The most commonly used model to characterize electrical properties in tissues is composed by two resistors and capacitor which behaves like a CPE where the capacitor has a Laplace variable with an exponent called fractional power(pseudo capacitor). As, tissues composed of many cells produces time constant distribution therefore Cole-Cole plot is described as distorted semicircle in a vertical direction. Thus in order to model this distorted semicircle, Constant Phase Element was introduced. The Constant phase element (CPE) is a non-intuitive circuit element that was discovered while looking at the response of real-world system.CPE can provide a useful modeling element, even if the true nature of the system is known. An ideal CPE is defined as an element whose admittance or impedance has constant phase over the entire frequency band from 0 to ∞ and that is why the name given is constant phase element [26].The ideal CPE is a two- terminal network. Impedance of an ideal CPE is given by.

$$Z_{CPE} = \frac{1}{Q(s)^{\alpha}} \tag{1}$$

Where j is the imaginary unit and ω is the angular frequency in $s = j\omega$. The parameters α and Q in the CPE impedance are the exponent factor and the CPE constant respectively. CPE exponent is the factor within the range of 0 to 1 which describes time constant distribution in the system. When $\alpha = 1$ the system is described by a single time-constant and the parameter Q has units of capacitance; otherwise, Q has units of $s^{\alpha} / \Omega cm^2$ Its name is in the reference to the phase angle, which is independent of frequency and dependent only on the order α, given as $\alpha\frac{\pi}{2}$. The values of α from experimentally calculated are typically in the range of $0 < \alpha < 1$.

RESULTS AND DISCUSSIONS

It is observed that at the end of six days of monitoring the weight decreases each day with ripening as shown in Fig.16-2. After this, result of impedance parameters $Z(\omega),\ R(\omega),\ X(\omega), \theta(\omega),$ with respect to the signal frequency is shown in fig.16-3, 16-4, 16-5 and 16-6 respectively.

It is observed from fig .16-3 that the magnitude of impedance of 1st day is higher at low frequencies and then decreases slowly as the frequency increases. On the 2nd day of observation again the same variation with respect to frequency is observed but with increased magnitude of impedance as compared to 1st day.

Similarly on the 3rd and 4th day there was slight increase in the magnitude of impedances as compared to the 1st and 2nd day but on the 5th and 6th day it is observed that there is greater rise in magnitude of impedances as compared to other days. Larger variations are seen in magnitude of impedances of different days at lower frequencies whereas at higher frequencies the variations are very less. Variations in magnitude of impedances are very high on the 5th and 6th day of observation.

Again in Fig.16-4 the variations in magnitude of resistance for different days are seen with respect to frequency. The variations in magnitude of resistance are found almost similar as that of variations in magnitude of impedance up to six days of observations.

Here again the magnitude of resistance as seen on the 1st day is high at low frequencies and then decreases slightly with increase in frequencies. On the 2nd day again the magnitude is found high at low frequency and then decreases slowly as the frequency increases but with higher rate as compared to the 2nd day.

Similarly, the variations increases on the 3rd and 4th day of observation but again rapid variations in magnitude of resistances with frequencies is seen on the 5th and 6th day of observations as compared to other days. Observation up to six days from the fig. reveals that every day the magnitude of resistance goes on increasing.

Now in fig.16-5 variations of reactance with respect to frequencies up to six days is shown. It is observed from the fig. that the magnitudes of reactance on 1st day increases gradually at lower frequencies and at the frequency range of 500 Hz-600Hz it attains its maximum position thereby forming a peak and then again starts decaying constantly at higher frequencies.

On the 2nd day of observation again the magnitude of reactance increases with increase in frequency, attains maximum value in the frequency range of 500Hz-600Hzand then again decreases constantly with increasing frequencies but the magnitude of reactance increases as compared to the 1st day. Same variations in magnitude of reactance with frequency is observed up to four days but every day a little increase in peak is observed. But on the 5th and 6th day of observation it is seen that there is rapid increase in the peak of 5th and 6th day as compared to the other four days. Thus it can be concluded from the fig.16-5 that every day the reactance increases with increase in frequencies attains maximum value at frequency range (500Hz-600Hz) and starts decaying at a constant rate thereafter but at the same time it is also observed that the value of reactance increases continuously with days.

Fig.16-6 shows the variation of phase angle (theta) with respect to the applied frequency response. On the 1st day of observation it is seen that the phase angle value increases constantly with frequency, attains maximum value in the frequency range of 70-80 kHz and starts decaying and decays constantly at higher frequencies.

Similarly on the 2nd day the variations in theta with respect to frequency are same but the values of theta increases compared to the 1st day.

On 3rd day the variation of theta with frequency is almost same but the value of theta decreased compared to the 2nd day and hence the curve of 3rd day falls down the 2nd day at lower frequencies but again in the frequency range of 40-50KHz the values of theta becomes almost the same and hence the two curves overlaps in this range and thereafter the values of theta for the 3rd day increase with respect to the 2nd day at higher frequencies.

On the 4th day the theta rises slowly at lower frequencies region attain the peak somewhere in the frequency range (60-70 KHz) and then gradually decreases thereafter with increasing frequencies. On 5th day value of theta increases as compared to other days at lower frequency regions and then somewhere in the range of (50-60 KHz) attains nearly same values as that of 4th day and thereafter decreases very rapidly at higher frequency regions.

The curve of the 6th day as clear from fig.16-6 is same as that is seen that the values of theta of 5th and 6th day are very near to each other at lower frequency regions and then increases rapidly and attains peak at 55kHz and then decrease gradually at higher frequency regions.

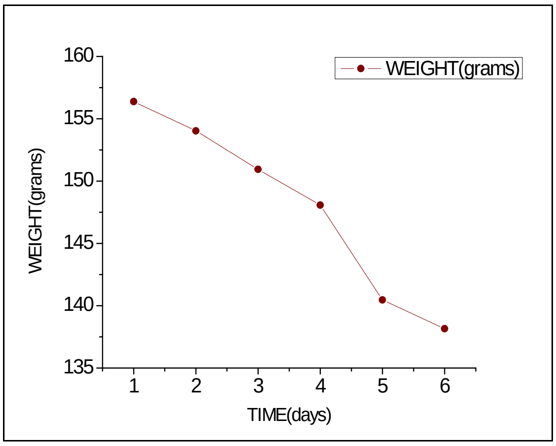


Figure 16-2 Variations in weight with ripening

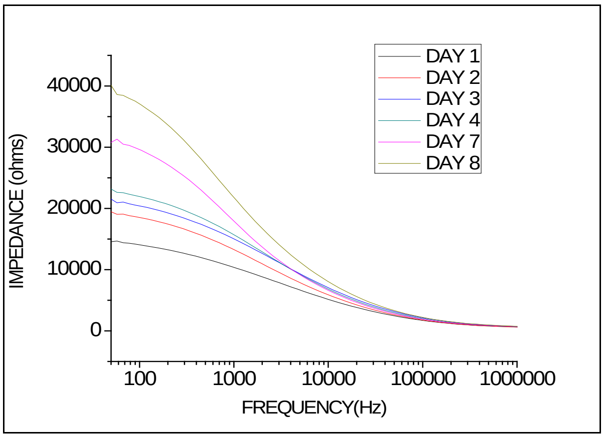


Figure 16-3 Variations in impedance with frequency for different days

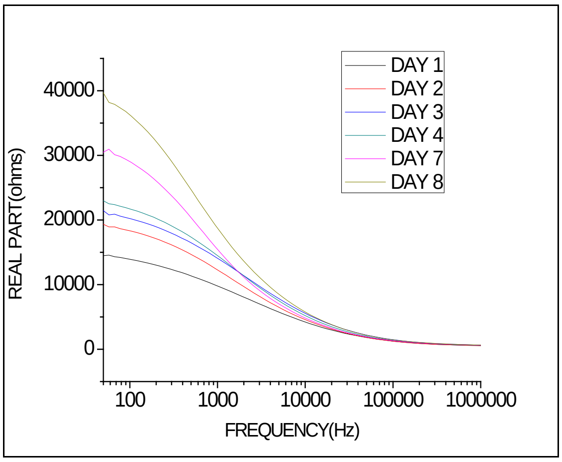


Figure 16-4 Variations in real part with frequency for different days.

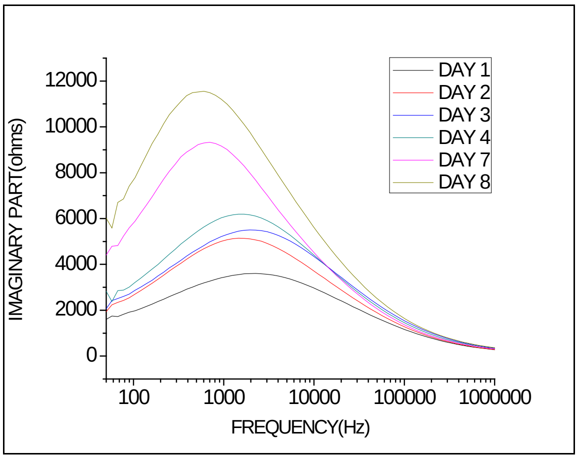


Figure 16-5 Variations in imaginary part with Frequency for different days.

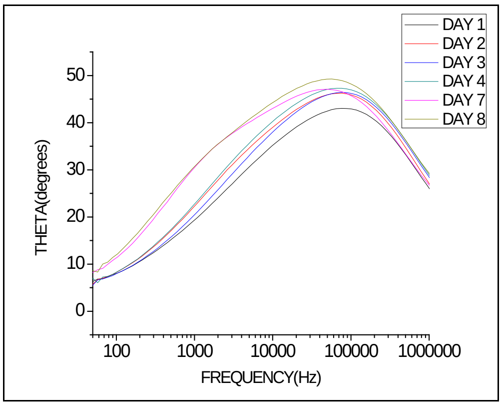


Figure 16-6 Variations in Phase angle (theta) with frequency for different days.

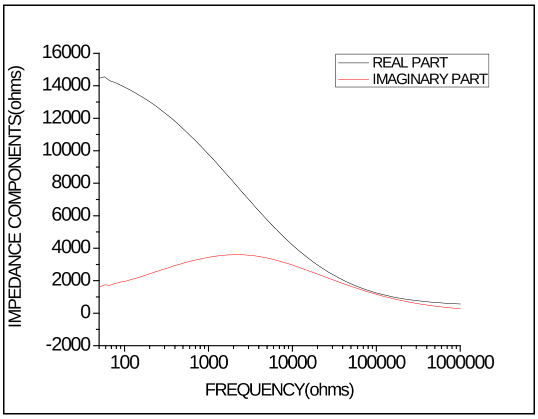


Figure 16-7 Variation of impedance components with frequency.

Fig 16-7. Shows the variations of the real (resistance) as well as the imaginary (reactance) part of the electrical impedance with respect to the applied frequency response. It is very clearly observed from the fig. that the variations in both the real as well as the imaginary part of the complex impedance is greater at lower frequencies and very less at higher frequencies. The Nyquist plot obtained for the orange tissue is one complete semicircle. The Nyquist plot obtained for the orange tissue demonstrates that the equivalent model of the tissue sample contains a constant phase element (CPE).Fig.16-8.shows the electrical equivalent model of orange.

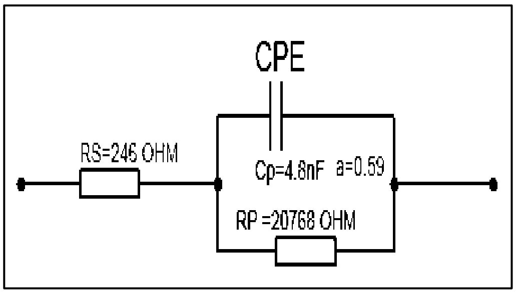


Figure 16-8 Equivalent model of orange.

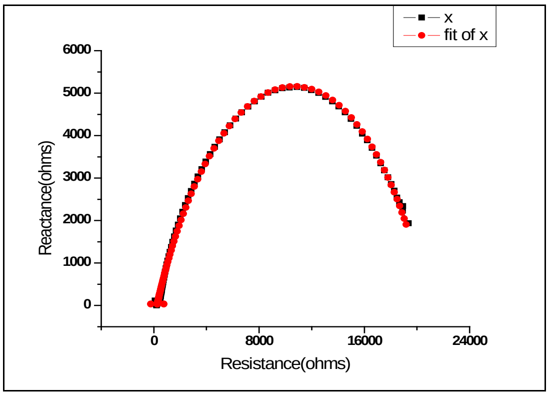


Figure 16-9 Nyquist plot fit of orange showing the relationship between reactance and resistance.

Here R1 is the series resistance, R2 is the parallel resistance, and C1 is the capacitance and α is the Constant phase element. Once the Equivalent model is obtained seeing the Nyquist plot, it is helpful to fit the experimental data with that model. Here non-linear fitting has been done using the origin pro 8 software. Fig.16-9 shows the Nyquist plot and its fit. The dotted points of black color represent the experimental results and the dotted points of red color are the fitted results. From the fitted results we get the values of R1, R2, C1 and α as 235Ω, 15789Ω, 5.04nF and 0.56 respectively.

Table 16-1 Day wise variation in electrical parameters alongwith standard error

Sl. No.	ELECTRICAL PARAMETERS	STANDARD ERROR
DAY 1	R_s = 234Ω R_p= 15789Ω C_p=5.04nF CPE(α)=0.56	12.28089 56.05283 5.2E-11 0.00268
DAY 2	R_s = 246Ω R_p=20768Ω C_p=4.9nF CPE(α)=0.59	10.4847 50.719 3.1E-11 0.00188
DAY 3	R_s = 247Ω R_p=22789Ω C_p=3.6nF CPE(α)=0.59	16.49941 73.86186 3.3E-11 0.00259
DAY 4	R_s =247Ω R_p=24623Ω C_p=4.1nF CPE(α)=0.60	11.27265 54.07745 2.44E-11 0.00172
DAY 7	R_s =333Ω R_p=34947Ω C_p=6.3nF CPE(α)=0.60	21.78491 118.71724 5.06E-11 0.0028
DAY 8	R_s = 266Ω R_p=44883Ω C_p=5.6nF CPE(α)=0.60	20.73482 168.93582 4.8E-11 0.00212

CONCLUSIONS

In summary we can say that the variations in electrical properties of orange tissues are monitored here. It is concluded from the above results that the, electrical parameters of orange tissue including impedance, resistance ,reactance and phase angle shows large variations in the lower frequency range ,however at higher frequencies also slight variations are observed. It is observed from the above results that the impedance parameters decrease with increasing frequency but increases continuously with days. Thus it is concluded that according to the tissue properties the magnitude of Z (ω), R (ω), X (ω) and θ (ω) are changed with the change in frequency and hence the nature and behavior of any biological tissues can be closely distinguished by plotting the impedance parameters with respect to the applied signal frequency. Moreover from the equivalent electrical model obtained for orange it is also observed that the value of constant phase element (CPE) remains almost constant.

ACKNOWLEDGMENT

I would like to acknowledge the regular support, invaluable suggestions, motivations and resources by Mr. Atanu Choudhary, Assistant Professor, Department of Electronics & Communication Engineering, NIT Agartala.

REFERENCES

[1] Brady, C.J.1987.Fruit Ripening.Annu.Rev.Plant Physiol., 38:155-178.

[2] Eskin, N.A.M. (ed.).1991.Quality and Preservation of Fruits.CRC Press, Boca. Raton, FL, 212PP.

[3] Gross, J.1987. Pigments in Fruits. Academic Press, Inc., Orlando, FL, 303PP.

[4] Ackmann JJ, Complex Bioelectric Impedance measurement System for the Frequency Range from 5 Hz to 1 MHz, Annals of Biomedical Engineering. 21:135-146, 1993.

[5] Ackmann JJ, Seitz MA., Methods of complex impedance measurements in biologic tissue, Crit Rev Biomed Eng. 1984; 11(4): 281-311.

[6] Cha K, Chertow GM, Gonzalez J, Lazarus JM, and Wilmore DW, Multifrequency Bioelectrical impedance estimates the distribution of body water, J Apple Physiol. 1995; 79:1316-1319

[7] Jackson, P.J., Harker, F.R.,' Apple Bruise Detection by Electrical Impedance Measurement', HortScience 35(1), 104-107.

[8] Harker, F.R., Maindonald, J.H. 1994a. Ripening of Nectarine Fruit. Plant Physiol.106, 165- 171.

[9] Harked, F.R., Dunlop, and J. 1994b. Electrical Impedance Studies of Nectarines during Cool stage and Fruit Ripening. Postharvest Biology and Technology 4, 125-134.

[10] F. Roger Harker and Shelley K. Forbes, 'Ripening and development of chilling injury in Persimmon fruit', New Zealand Journal of Crop and Horticultural Science, 1997, Vol.25: 149-157.

[11] Bauchot, A.D., Harker, F.R., Arnold, W.M. 2000. "The Use of Electrical Impedance Spectroscopy to Assess the Physiological Condition of Kiwifruit", Postharvest Biology and Technology 18, 9-18.

[12] A. Inaba, T. Manabe, H.Tsuji and T. Iwamoto, 'Electrical Impedance Analysis of Tissue Properties Associated with Ethylene Induction by Electric currents in Cucumber (Cucumis sativus L) fruit, Plant Physiol. (1995) 107: 199-205.

[13] X. Liu, Q. Fang, S. Zheng, I. Cosic and P. Cao, 'Electrical impedance spectroscopy Investigation on Cucumber Dehydration' International Society for Horticulture Science Acta Horticulture 804: Europe-Asia Symposium on Quality Management in Postharvest Systems – Eurasia 2007.

[14] J. Juansah, I W. Budhiastra, K.Dahlan and K.B. Seminar, 'Electrical behavior of Garut Citrus Fruits during ripening changes in Resistance and capacitance models of internal Fruits', IJET-IJENS Vol: 12 No: 04, August 2012 .

[15] R. I. Hayden, C. A. Moyse, F. W. Calder, D. P. Crawford, D.S. Fensom, 1969. "Electrical Impedance studies on potato and alfalfa tissue," Journal of Experimental Botany, vol 20, No 63, pp 177–20.

[16] A. Chowdhury et al,'studying the Electrical Impedance variations in Banana ripening using Electrical Impedance Spectroscopy (EIS)' 3rd International Conference on Computer Communication, Control and Information Technology (C3IT-2015) [Accepted]

[17] R. C. Bean, J. P. Rasor, G. G. Porter, 1960. "Changes in electrical characteristics of Avocados during ripening," California Avocado Society, Yearbook vol 44, pp 75-78.

[18] J. Juansah, I W. Budhiastra, K.Dahlan and K.B. Seminar,'the prospect of electrical Impedance spectroscopy as Non-destructive Evaluation of Citrus Fruits acidity, IJETAE, Vol 2, Issue 11 November 2012.

[19] A.R. Varlan, and W. Sansen, 1996. "Nondestructive electrical impedance analysis in fruit: Normal ripening and injuries characterization," Electro-Magneto biology, vol 15, pp 213– 227.

[20] E. Vozáry, and P. Benkő, 2010. "Non-destructive determination of impedance spectrum of Fruit flesh under the skin," Journal of Physics: Conference Series, vol 224, no 012142.

[21] H. P. Schwann, "Electrical properties of tissue and cell suspensions: mechanisms and Models," Proc. IEEE Adv. Biol. Med. Soc., vol. 1, pp. A70-A71, Aug. 2002.

[22] Retheep Raj, Nikhil Binoy C, 2013. "Bio Impedance Spectroscopy for the Assessment of Quality of Fruits by Constructing the Equivalent Circuit." International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 11, and November - 2013, ISSN: 2278-0181.

[23] Cole KS, Electric phase angle of cell membranes, J Gen Physiol.1932; 15:641-649.

[24] B.K. Van Kreel, N. Cox-Reyven and P. Soeters, 'Determination of total body water by multifrequency bioelectric impedance: development of several models', Med. Biol. Eng.Comput., 1998, 36, 337-345.

[25] Tushar Kanti Bera, 'Bioelectrical Impedance Methods for Noninvasive Health Monitoring', Journal of Medical Engineering Volume 2014, Article ID 381251.

[26] Bryan Hirschorn,, Mark E. Orazem,, Bernard Tribollet,Vincent Vivier,Isabelle Frateur, and Marco Musianid, 'Constant-Phase-Element Behavior Caused by Resistivity Distribution Films',journal of The Electrochemical Society, 157_12_C452-C457_2010_0013-4651/2010/ 157 _12_/C452/6/$28.00 © The Electrochemical Society.

[27] F. Gómez, J. Bernal, J. Rosales and T. Cordova, 'Modeling and Simulation of Equivalent Circuits in description of Biological Systems - A Fractional Calculus Approach', journal of Bioelectrical impedance, vol.3. (2012).

17. Anatomization and Perception of Mental Disorder Because Usage of Online Social Network Data

Aaradhana Arvind Deshmukh Phd student,Aarhus University, Denmark
aadeshmukh@sinhgad.edu
Albena Mihovska, Department of Business Science and Technology, Aarhus University, Denmark
amihovska@btech.au.dk
Ramjee Prasad, Department of Business Science and Technology, Aarhus University, Denmark
ramjee@btech.au.dk

ABSTRACT

There is an excessive growth in the usage of social networking sites. Because of this an increasing number of social network mental disorders (SNMDs), such as Cyber-Relationship Addiction, Information Overload, and Net Compulsion, have been recently reported. Passively observed symptoms of these mental disorders lead to a delayed clinical intervention. In this paper, the authors argue that mining online social data provides an opportunity to find out SNMDs at an early stage. The mental state cannot be observed directly from online social data because of that it is difficult to identify SNMDs. Our approach, instead of relying on the self-revealing of those mental factors via questionnaires proposes a new system, namely, the Social Network Mental Disorder Detection (SNMDD). Our system is evaluated through a user study with number of users of the network. We perform a feature analysis and also apply SNMD in large- scale data sets and analyze the characteristics of the three types of mental disorder. We will be providing text area and a questionnaire to calculate the depression level. On the basis of depression level we will be providing basic solution which includes books, videos, music, foods, exercises, and also chatbot and messenger to overcome some easy situations.

Index Terms—*social network, mental disorder detection, feature extraction, Decision Tree classifier.*

INTRODUCTION

Mental disorder is becoming a threat to people's health now a days. With the rapid pace of life, more and more people are feeling mentally disturbed. It is not easy to detect the user's mental disorder early enough[1,4] .With the penetration of web-based social networking, individuals are used to share their day by day activities and interact with friends, making it possible to use online social network data for mental disorder detection[2]. In our system, we find that the user's disorder state is closely related to that of his/her friends in social media, and we employ a large-scale dataset from real-world social platforms to systematically study the correlation of user's disorder states and social interactions. We first define a set of mental disorder-related textual, visual, and social attributes from various aspects. Though mental disorder itself is non-clinical and common in our life, excessive and chronic disorder can be rather harmful to the people's physical and mental health[3]. The user's social interactions on social networks contain useful cues for stress detection.

Social psychological studies have made two interesting observations. The first is mood contagion: a bad mood can be transferred from one person to another during social interaction. The second social interaction: people are - known to the social interaction of the user. With the advancement of social networks like Twitter, Facebook and Sina Weibo, an ever increasing number of people share their every day events and moods, and interact with friends. Due to the influence of - Facebook post content attributes and social interactions become enhance factors for mental disorder detection[5],[6].

Clinical depression is a serious condition that negatively affects how a person thinks, feels, and behaves. In contrast to normal sadness, clinical depression is persistent, often interferes with a person's ability to experience or anticipate pleasure, and significantly interferes with functioning in daily life. Untreated, symptoms can last for weeks, months, or years; and if inadequately treated, depression can lead to significant impairment, other health-related issues, and in rare cases, suicide.

After detecting a disorder level, the system can recommend hospitals to the user for medical advice, with reference to a Google map and how to take precaution for avoid disorder.

MOTIVATION

These days, many people spend a large portion of time on the Internet, whether it is for work, social interaction, gathering information, or entertainment. There is a fine line between what can be considered a healthy amount of Internet usage, and what is kn own as addiction disorder [10],[11]. Disorders may contain online relationship addiction, net compulsion, information overload. Because of online social relationship there may be issues like physical absence of the person, identity issue, people may get addicted to a virtual relationship with wrong person. Likewise, the compulsive usage of social networking sites may lead to problem of addicted behavior towards net-gaming[11]. People who are net-gaming addicts cannot stop playing games (e.g. PUBG players) on the Internet.

Information overload addicts are addicted to the unlimited information that can be found on the Internet. They spend countless hours reading and organizing data they find, often times developing obsessive-compulsive tendencies. Information overload addicts will work less productively in their careers and especially in their personal lives. So, to overcome all these problems there is a need of automatic detection of these mental disorders.

Today, the identification of potential mental disorders often falls on the shoulders of supervisors (such as teachers, employers, or parents) who can observe the aforementioned symptoms better than others but only passively. There are very few notable physical risk factors, the patients usually do not actively seek medical or psychological services to reduce these symptoms. Passive observation of symptoms of an increasing number of social network mental disorders (SNMDs) is resulting in delayed clinical intervention. It is desirable to have the ability to actively detect potential SNMD users on OSNs at an early stage.

STATE OF ART

K. Rameshwaraiah, et al. [1] presented a system for detecting the users' psychological stress states from the users' weekly social media data, leveraging tweets' content as well as users' social interactions. To fully leverage both constant and social interaction information of users' tweets, we proposed a hybrid model which combines the factor graph model (FGM) with a convolution neural network (CNN).

Experimental results show that the proposed model can improve the detection performance by 6-9 percent in F1-score. By further analyzing the social interaction data and, it is possible to discover several intriguing phenomena.

Huijie Lin et al. [2] showed that long –term stress may lead to many severe physical and mental problems. Traditional psychological stress detection usually relies on the active individual participation, which makes the detection labor-consuming, time-costing and hysteretic.

A novel method is proposed for detecting psychological stress from micro blog utilizing cross-media micro blog data; Three-level system is construct to formulate the problem, and propose a middle-level representation according to psychological and art theories, which can narrow the gap between low-level cross-media features and high-level stress semantics; here designed a Deep Neural Sparse Network based classification model to solve the problem of sparse in cross-media data.

Author's investigate the social correlations in psychological stress to further improve the detection performance. Jennifer Golbeck, et al. [3] Users' Big Five personality traits can be predicted from the public information they share on Twitter. Our subjects completed a personality test and through the Twitter API, we can collect publicly accessible information from their profiles. After processing this data, we found many small correlations in the data. Using the profile data as a feature set, we were able to train two machine learning algorithms - ZeroR and Gaussian Processes to predict scores on each of the five personality traits to within 11%

- 18% of their actual value. With the ability to guess a user's personality traits, many opportunities are opened for personalizing interfaces and information.

After surveying this paper questions about how to present trusted, socially-relevant, and well-presented information to users. Andrey Bogomolov, et al. [4] The goal of this paper was to investigate the automatic recognition of people's daily stress from three different sets of data: a) People activity, as detected through their smart phones;b) Weather conditions; and c) personality traits. The problem was modeled as a 2-way classification one. The results convincingly suggest that all the three types of data are necessary for attaining a reasonable predictive power. As long as one of t hose information sources is dropped, performances drop below those of the baselines.

Automatic stress detection based on mobile phone data can take advantage of the extensive usage and diffusion of these devices, it can be applied in several real world situations and it can be exploited for a variety of applications that are delivered by means of the same device.

Sho Tsugawa, et al. [5], Depression has become recognized as a major public health problem around the world. Aim was to establish a method by which to recognize depression by analyzing the large-scale records of users' activities in social media. The extensive evaluation of effectiveness of a user's social media activities is used for estimating degree of depression. The degree of depression of Twitter users can be measured using the results of a web-based questionnaire. Several features are extracted from the activity histories of Twitter users. By using these features, we construct models for estimating the presence of active depression. Features obtained from user activities can be used to predict depression of users.

Comparing with [1-4] above references learning robust uniform features for cross- media social data by using cross auto encoders take a more time. Feng-Tso Sun, et al. [6]; A multimodal approach is used to model the mental stress activation affected by physical activities using accelerometers, ECG, and GSR sensors. Accelerometer data is necessary to improve mental stress detection in a mobile environment. Here Decision Tree classifier has the best performance using 10-fold cross validation. This activity-aware scheme for mental stress detection can facilitate the development of many affective mobile applications using physiological signals (e.g., stress management, affective tutoring, and emotion-aware human computer interfaces).

Repeated information in relevant answers requires the user to browse through a huge number of answers in order to actually obtain information. Liqiang Nie, et al. [7]; A medical terminology is used to present an assignment scheme to bridge the vocabulary gap between health seekers and healthcare knowledge.

A novel scheme is used to code the medical records by jointly utilizing local mining and global learning approaches. However, the local mining approach may suffer from information and low precision, which motivates us to propose a global learning approach to compensate for the insufficiency of local coding approach. Extensive evaluations on a real world dataset demonstrate that this scheme is able to produce promising performance as compared to the prevailing coding methods. In [7] problem faces about investigation how to flexibly organize the unstructured medical content into user needs-aware ontology by leveraging the recommended medical terminologies.

Kimberly s. Young [8], some people get addicted the internet in same way to drugs or alcohol, online social users get addicted to. Research among sociologists, psychologists, or psychiatrists has not formally identified addictive use of the Internet as a problematic behavior. this study developed a brief eight-item questionnaire referred to as a Diagnostic Questionnaire (DQ), which modified criteria for pathological gambling to provide a screening instrument for classification of participants.

Gap found in briefing of techniques to better incorporate multi-word terms and out-of-vocabulary words; advanced Natural Language Processing (NLP) techniques for learning word relations from free-form text; evaluation of latent concept relation suggestion, and predicting the type of relations. Yuan Zhang, et al. [9] focused on human emotion is one important part, which is affected by the dynamics of social networks. They proposed a system that consists of MoodCast method based on a dynamic continuous factor graph model for modeling and predicting users' emotions in a social network. Based on the information history MoodCast learns a discriminative model for predicting users' emotion status at time t. For model learning, it uses a Metropolis-

Hastings algorithm to obtain an approximate solution. Experimental results on two different real social networks demonstrate that the proposed approach can effectively model each user's emotion status and the prediction performance is better than several baseline methods for emotion prediction.

Young Min Baek, et al. [10]; tested the effect of Social Networking Sites (SNS) on the users' psychological condition, in terms of subjective loneliness, interpersonal trust, and SNS addiction. This study distinguishes types of SNS relationships, and investigates their relationships with social isolation, interpersonal trust, and SNS addiction. A gap was found in parallelization, which is considered in our algorithm in order to scale it up further.

Katherine Chak, et al. [11] found that some patterns of internet use are associated with loneliness, shyness, anxiety, depression, and self-consciousness. Here, the study attempted to examine the potential influences of personality variables, such as shyness and lack of control, online experiences, and demographics on internet addiction.

Results indicated that the higher the tendency of one being addicted to the Internet, the shyer the person is, the less faith the person has, the firmer belief the person holds in the irresistible power of others, and the higher trust the person places on the chance in determining his or her own course of life.

Kiwon Kim et al. [12], defined Internet Addiction (IA) as a psychological dependence on the internet, regardless of the type of activities once logged on. The aim of this study was to investigate the association between suicide attempts and sleep among community-dwelling adults with IA. Among adults with IA, poor sleep quality was found to be associated with more severe IA and lifetime suicide attempt. A variety of poor sleep quality indexes associated with IA were shown in [12] and the association showed a positive correlation with IA severity.

The disadvantages of this proposed system is that, this is a cross sectional study, using questionnaires and interview depending on subjective memory therefore; there are limitations to objective measurement related to sleep. This is overcome in our proposal. Based on the assumption that Net-generation has unique characteristics, the study in [13], examined (1) how internet addicted differ from the non-addicted and (2) how these attributes, together with the seductive properties of the Internet, are related to Internet addiction.

Internet addicted are also strongly linked to the pleasure of being able to control the simulated world in online games.

John T. Cacioppo, et al. [14], showed that network linkage data from the population-based Framingham Heart Study can be used to trace the topography of loneliness in people's social networks and the path, through which loneliness spreads through these networks.

Results indicated that loneliness occurs in clusters, extends up to 3 degrees of separation, is disproportionately represented at the periphery of social networks, and spreads through a contagious process. An important implication of this finding is that interventions to reduce loneliness in our society may benefit by aggressively targeting the people in the periphery to help repair their social networks. By helping them, we might create a protective barrier against loneliness that can keep the whole network from unraveling.

To achieve this it is required to make a process of data collection required as a combination of manual and automatic effort in order to produce satisfactory results. Budhaditya Saha, et al. [15], showed that mental illness has a deep impact on individuals, families, and by extension, society as a whole. Co-occurring mental health condition provides the focus for our work on classifying online communities with an interest in depression. Input to the system model is psycho-linguistic features expressed in the posts.

A joint modeling system was formulated in order to classify mental health-related co-occurring online communities from these features. Empirical validation of the model is performed on the crawled dataset where our model outperforms recent state-of-the-art baselines. Result showed the potential of social media and online communities in the early screening and monitoring of mental health-related communities with an interest in depression.

Rohizah Abd Rahman, et al. [16] performed a literature survey of mental health detection techniques for OSN (Online Social Network) users. It was shown that there may be possibility that mental health detection techniques are not limited to one language. However, it was used only Twitter as their OSN platform for data collection instead of other types of OSN.

Helmut Appel, et al. [17], showed that the co-occurrence of depression and envy is both plausible and empirically established. In a quasi-experimental online study, depressed and non-depressed participants indicated their self-esteem and were then presented with specifically set up Facebook profiles that were either attractive or unattractive. The connection between depression and envy was demonstrated with an experimental elicitation of envy for the first time. The results strongly suggest that low self-esteem and consequent feelings of inferiority play a crucial role in depressed individuals' elevated levels of envy. This paper proposes a system for early detection of the condition and referral to the qualified medical staff.

PROPOSED SYSTEM ARCHITECTURE

For early detection of mental disorders we propose a new system called Social Network Mental Disorder Detection (SNMDD) by mining online social data. We formulate the task as classification problem to detect three types of social network mental disorder using machine learning system:

- Cyber-Relationship Addiction, which shows addictive behavior for building online relationships.
- Net Compulsion, which shows compulsive behavior for online social gaming or gambling.

Information Overload, which is related to uncontrollable online surfing. The proposed architecture of SNMDD system for mental health detection consists of several steps such as social network, data extraction, data pre-processing, features selection, data classification using machine learning algorithms and early mental health detection. Figure 17-1 illustrates the proposed architecture of SNMDD system.

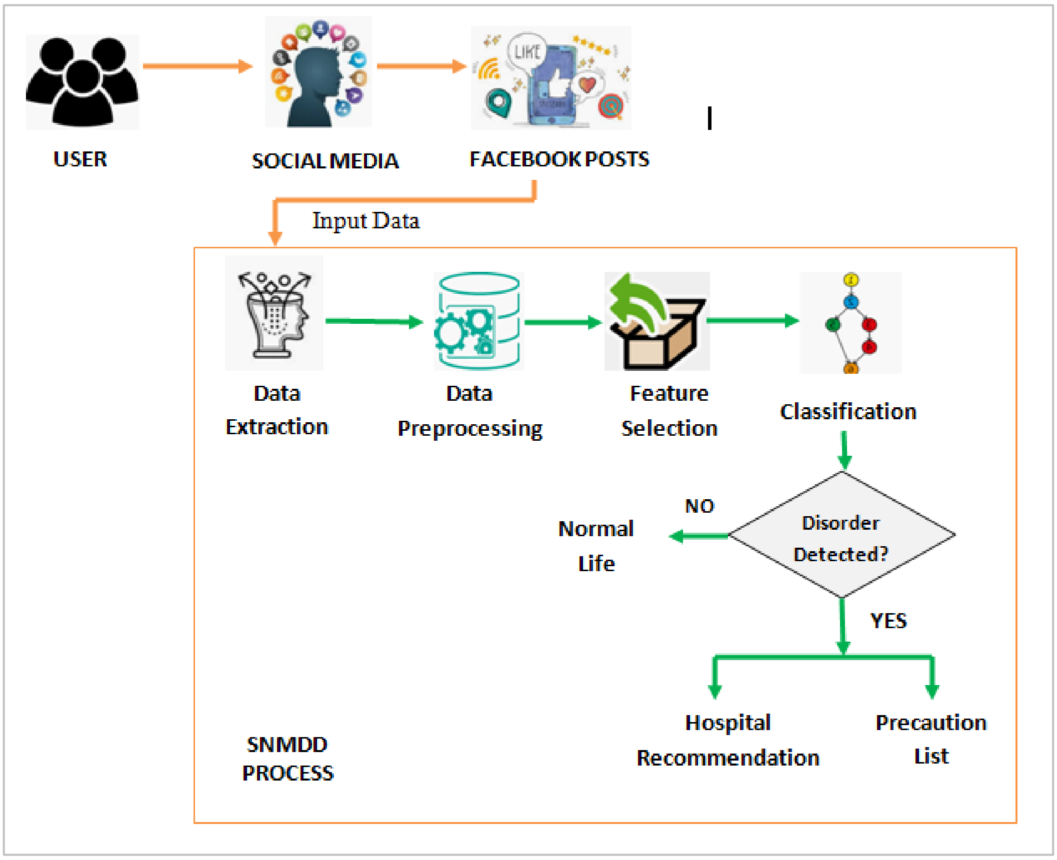


Figure 17-1 System Architecture

In our proposal, we fill the gap of the following constraints:-

- A novel hybrid model - a factor graph model combined with Convolution Neural Network.
- Deep sparse neural network used for trained the data sets
- Machine learning algorithms - ZeroR and Gaussian Processes
- An ensemble of tree classifiers based on a Random Forest algorithm
- Support Vector Machine classifier also implemented for seamless results
- Continuous factor graph model

Steps:

- ➢ The users are online social users i.e. Facebook users and the - input to the SNMDD process is the social posts of the users e.g. Facebook posts.
- ➢ The SNMDD process is the consists of the users several steps for the detection of mental disorder:-
- ➢ Data extraction is the process of data retrieval from various sources. Here SNMDD process extract data from online social media i.e. Facebook data.
- ➢ Data preprocessing is the data mining technique which is used to transform raw data into understandable format.
- ➢ In this step, the tokenization process is performed to convert sensitive data into unique set of characters that retain all essential information without compromising security.
- ➢ The feature selection process is also known as variable selection or attributes selection process.
- ➢ This is the process of selecting a subset of relevant features.
- ➢ In the SNMDD process the following features are retrieved-
- ➢ PR (Personal Relationship), SC (Social Comparison), checkAvgLogin, checkPostLikes, checkFriendRequest, checkTimeSpend, age, prediction, NC (Net Compulsion), CRA(Cyber Relationship Addiction) and IO(Information Overload).
- ➢ In 'classification' we categorize data into given number of classes. The main goal of a classification problem is to identify the category/class to which a new data will fall under.
- ➢ In the SNMDD process, the classification phase categorizes data into two classes i.e. whether user is a normal user or user with mental disorder. A decision tree algorithm is used as classifier. The outcome of the decision is whether mental disorder detected or not detected.
- ➢ If mental disorder is detected then user gets recommendation of nearby hospital and precaution list.

REALISTIC METHOD

We formulate the disorder detection task as classification problem.

The general motive of using Decision Tree is to create a training model, which can be used to predict a class or value of target variables by learning decision rules inferred from prior data (training data).

Input: Symptoms Set

Output: Disease Set

Algorithmic Steps:

- ✓ Create dataset
- ✓ Tokenize data
- ✓ Select feature from tokenized data
- ✓ Create root node for the tree
- ✓ If (all inputs are positive, return leaf node positive) If Else (if all inputs are negative, return leaf node negative)
- ✓ Else (Some inputs are positive and some inputs are negative, check condition (Positive¿ negative——Positive ¡negative), then return result)
- ✓ Calculate the entropy of current state H(S)
- ✓ For each attribute, calculate the entropy with respect to the attribute X denoted by H(S, X)

- ✓ Remove the attribute that offers highest value from the set of attributes
- ✓ Repeat until we run out of all attributes or the decision tree has all leaf nodes.

The entropy of the current state H(S)

$$\boldsymbol{H(S) = \sum_{c \in C} - p(c) \log_2 p(c)} \quad \text{---------- (1)}$$

Where,

S is current data state for which entropy is being calculated.

C is set o classes in S (C = yes or no).

P(c) is the proportion of the number of element in c to the number of elements in set S

Select the attribute which has maximum value of IG(S, X), we use (2):

$$\boldsymbol{IG(A, S) = H(S) - \sum_{t \in T} p(t) H(t)} \quad \text{---------- (2)}$$

Where,

H(S) is entropy of set S.

T is subset created by splitting set S by attribute A.

$p(t)$ is the proportion of number of elements in t to the number of elements in set S

$H(t)$ Is entropy of subset t.

RESULTS AND DISCUSSION

In the following, we compare the SVM classifier to the supervised learning approach used in SNMDD (i.e. Decision Tree classifier) for single accurate prediction result. Best classifier for any task is it-self task dependent. As shown in Table 17-1, the accuracy of the decision tree classifier is more (i.e. 86%) than support vector machine classifier used in existing system (i.e. 72%).

Table 17-1 Comparison between classification techniques

Sr. No.	Existing System	Proposed System
Algorithm	Support vector machine	Decision Tree
Accuracy	72%	86%

In the proposed SNMDD system as shown in Figure 17-2, the value of precision is 50%, value of recall is 58%, value of F-measure is 53.70% and accuracy is 86% .

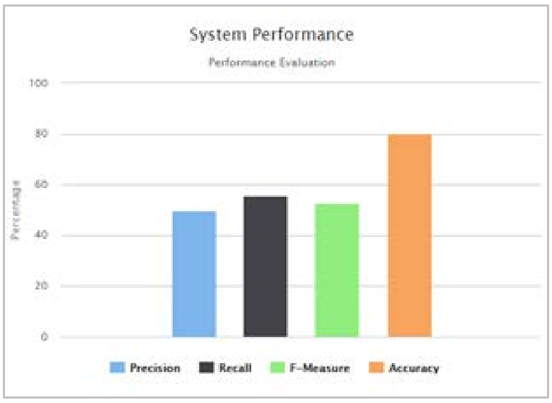


Figure 17-2 System Performance

The system performance was evaluated using the following parameters :

1. Precision =

Precision is the fraction of relevant instances among the retrieved instances

It is the ratio of correctly predicted positive observation to the total predicted positive observations as give by (3):-.

$$\frac{\boldsymbol{TP}}{\boldsymbol{TP+FP}} \times \mathbf{100} \qquad \textbf{------- (3)}$$

Where, TP is true positive

FP is false positive

2. Recall =

Recall is the fraction of relevant instances that have been retrieved over the total amount of relevant instances. It is the ratio of correctly predicted positive observation to the all observations in actual class –yes.

$$\frac{TP}{TP+FN} * 100 \qquad \textbf{------- (4)}$$

Where, TP is true positive

FN is false negative

3. F-Measure =

F-Measure is a measure of a test’s accuracy. The F-Measure is defined as the weighted harmonic mean of the test’s precision and recall.

F1 score is the weighted average of Precision and Recall.

$$\mathbf{2} * \frac{(\boldsymbol{Precision} * \boldsymbol{Recall})}{\boldsymbol{Precision+Recall}} \qquad \textbf{------- (5)}$$

4. Accuracy =

Accuracy is the most intuitive performance measure and it is simply a ratio of correctly predicted observations to the total observations.

$$\frac{(\boldsymbol{TF+TN})}{(\boldsymbol{TP+FP+FP+FN})} \times \mathbf{100} \qquad \textbf{------- (6)}$$

Where, TP is true positive

FP is false positive

TN is true negative

FN is false negative

In proposed SNMDD system as shown in graph 1, value of precision is 50%, value of recall is 58%, value of F- measure is 53.70% and accuracy is 86%.

The proposed SNMDD system detects three types of mental disorders i.e. cyber relationship addiction (CRA), net compulsion (NC) and information overload (IO). Figure 17-3 shows that among the total users of SNMDD system, 10% of the users are addicted to cyber relationship (CRA), 5% of the users are addicted to a net compulsion (NC) and 11% of the users are addicted to information overload (IO).

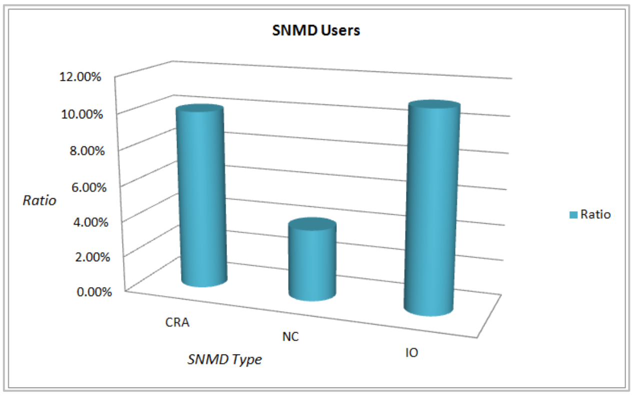


Figure 17-3 Analysis of SNMD Types

CONCLUSION

A system was proposed that consequently recognizes potential online users with SNMDs. Accordingly, we displayed a structure for recognizing clients' Mental Disorder states from clients' per day online networking information, utilizing Facebook post' content just as clients' social associations. Utilizing a genuine internet based life information as the premise, we considered the connection between users' Mental Disorder states and their social collaboration practices.

REFERENCES

[1] Dr.K.Rameshwaraiah, A. Ramakanth. Detecting Stress Based on Social Interactions in Social Networks. @IJRTER-2017

[2] H. Lin, J. Jia, Q. Guo, Y. Xue, J. Huang, L. Cai, and L. Feng. Psy- chological stress detection from cross-media microblog data using deep sparse neural network. In proceedings of IEEE International Conference on Multimedia Expo,2014.

[3] Jennifer Golbeck, Cristina Robles, Michon Edmondson, and Karen Turner. Predicting personality from twitter. In Passat/socialcom2011,Privacy, Security, Risk and Trust, pages 149156, 2011

[4] Andrey Bogomolov, Bruno Lepri, Michela Ferron, Fabio Pianesi, and Alex Pentland. Daily stress recognition from mobile phone data, weather conditions and individual traits. In ACM International Conference on Multimedia, pages 477486,2014.

[5] Sho Tsugawa, Yusuke Kikuchi, Fumio Kishino, Kosuke Nakajima, Yuichi Itoh, Hiroyuki Ohsaki. Recognizing Depression from Twitter Activity. CHI 2015, Crossings, Seoul, Korea.

[6] Feng-Tso Sun1, Cynthia Kuo1,2, Heng-Tze Cheng1, Senaka Buthpitiya1. Activity-Aware Mental Stress Detection Using Physiological Sensors. MOBICASE 2010, LNICST 76, pp. 211–230, 2012.

[7] Liqiang Nie, Member, IEEE, Yi-Liang Zhao, Mohammad Akbari, Jialie Shen, Member, IEEE,Tat-Seng Chua, Senior Member, IEEE. Bridging the Vocabulary Gap between Health Seekers and Healthcare Knowledge. AUGUST 2013.

[8] K. Young. Internet addiction: the emergence of a new clinical disorder, Cyberpsychol. Behav., 1998.

[9] Yuan Zhang, JieTang, Jimeng Sun, Yiran Chen, and Jinghai Rao. Moodcast: Emotion prediction via dynamic continuous factor graph model. 2013 IEEE 13th International Conference on Data Mining, pages 11931198,2010.

[10] Y. Baek, Y. Bae, and H. Jang. Social and parasocial relationships on social network sites and their differential relationships with users' psychological well-being. Cyberpsychol. Behav. Soc. Netw., 2013

[11] K. Chak and L. Leung. Shyness and locus of control as predictors of internet addiction and internet use. Cyberpsychol. Behav., 2004.

[12] K. Kim, H. Lee, J. P. Hong,M. J. Cho, M. Fava,D. Mischoulon, D. J. Kim, and H. J. Jeon. Poor sleep quality and suicide attempt among adults with internet addiction: a nationwide community sample of Korea. PLOS ONE, 2017

[13] L. Leung. Net-generation attributes and seductive properties of the internet as predictors of online activities and internet addiction. Cyberpsychol. Behav. Soc. Netw., 2004.

[14] J. Cacioppo, J. Fowler, and N. Christakis. Alone in the crowd: themstructure and spread of loneliness in a large social network. J. Pers. Soc. Psychol., 2009.

[15] B. Saha, T. Nguyen, D. Phung, and S. Venkatesh. A system for classifying online mental health-related communities with an interest in depression. IEEE Journal of Biomedical and Health Informatics, 2016

[16] Rohizah Abd Rahman, Khairuddin Omar, Shahrul Azman Mohd Noah and Mohd Shahrul Nizam Mohd Danuri. A Survey on Mental Health Detection in Online Social Network, 2016.

[17] H. Appel, J. Crusius, and Alexander L. Gerla. Social comparison,envy, and depression on facebook: a study looking at the effectsof high comparison standards on depressed individuals. Journal of Social and Clinical Psychology, 2015.

18. Wi-Fi for Affordable Broadband & 5G in Rural Areas

Kishore K Thakur[1], Ramjee Prasad[2]
CGM, BSNL, Jharkhand, India1,
CTIF Global Capsule , Aarhus University, Herning Denmark[2] cgm_jhk@bsnl.co.in[1],ramjee@btech.au.dk[2]

ABSTRACT

The importance of Internet in our lives today cannot be overemphasized. So much so that access to Internet has been declared a fundamental right of citizens in several countries such as Finland, Spain, and Greece [1]. In most of the developed countries, high-speed Internet connectivity is enabled through wired communication infrastructure such as Fiber-to-the-Home (FTTH) and Very high bit-rate Digital Subscriber Line (VDSL). Unfortunately, the situation is not particularly encouraging in developing countries due to non-availability of such a pervasive communication infrastructure. The difference in the fiberdeployed-to-population ratio across developed and developing countries further underscores this disparity; while this ratio is 1.2 in USA, it is barely 0.1 in India [2]. Owing to this inadequacy of fiber/DSL availability, cellular access technology has emerged as the primary broadband access mechanism in developing countries.

However, the penetration of cellular network is limited in rural areas as its deployment becomes unviable due to challenges such as low average revenue per user, sparse population density, and intermittent availability of electricity. This situation leaves majority of the rural people unconnected thereby creating a massive rural urban digital divide. The next generation cellular system along with the use of unlicensed Wi-Fi Technology can bridge this divide if we overcome the above-mentioned challenges. However, since the Fifth Generation (5G) cellular technology has focus on requirements such as 10 Gbps data rate, 1 ms latency, and very high speed mobility, the problems of coverage and affordability are likely to persist, further widening the digital divide [3]. This article explains how Wi-Fi is being used for affordable high speed broadband in rural areas. A successfully implemented case study of Jharkhand state is also presented, and it can be adopted as reliable business model for 5G or 5G type services in rural areas.

Keywords *: Broadband, Wi-Fi, 5G*

INTRODUCTION

We are stepping into a new age of mobile communication where everything is expected to be connected: high-speed information sharing shall be enabled between all kinds of devices, i.e cell phones, tablets, smart watches and wearable's, at any time and no matter where we go. Thus, to meet the everincreasing user demand in high data rate service with seamless connectivity, 5G wireless access must extend far beyond the previous generations of mobile networks with revolutionary solutions utilizing new radio access technologies.

A cross-nation study of mobile broadband affordability in ethic perspective pointed out that affordable broadband internet connectivity should be considered as a vital aspect in social justice and 5G is at the danger of losing its next million users entirely without affordable wireless access. It is widely observed in global map the close relation of internet connectivity gap and GDP growth gap between urban and rural communities. The rapid growth in internet connectivity and mobile internet access has accelerated the economic boost in the urban communities around the world, and it in turns leads to improvements in public service sectors, such as education, health, and banking, and attract investment in business and industrialization, which motivates further development of the region. Thus there is an urgent need for continuous efforts from governments and information and communication community to devote in development of mobile broadband access network and related researches to connect the remote rural areas.

Mobile access to internet in all areas is considered to be one important component of social justice that cannot be compromised due to economic reasons, just as the equal rights to other important resources for everyone like water, electricity and education. Low revenue per user in rural area compared with case in urban scenarios has been dragging down the development of mobile network in rural areas for years. With growing attention and support from governmental and academicals filed, In this scenario our Government should motivate network operators to better drive network development in rural areas, by proposing and evaluating cost efficient solutions targeting rural scenario.

Rural areas of countries continue to be sparsely covered and are not considered as a viable business case by telecommunication operators. Recent growth of tele-density in urban areas, fuelled by mobile technology, has shown that the digital gap between rural and urban areas has widened. Rural population needs to be provided with mobile telephony with data and wireless broadband access in addition to simple voice mobile telephony, by connecting remote areas to the broadband core networks. Choosing efficient, cost-effective and fast-deployment technologies – whether wired or wireless networks – will improve digital accessibility.

The key challenges for the provision of telecommunication services in rural areas are driven by both technological and economic considerations. Setting up backhaul connectivity remains a high-cost exercise. Erratic power supply or complete lack of power sources is a major barrier, wherein Solar Power supply is increasingly becoming a viable alternative. But the requirement to maintain alternate backup systems raises capex costs substantially.

There is a gap in internet adoption between rural and urban areas and a lack of infrastructure is responsible in many cases for this division. In 2019, enabling digital connectivity in rural areas is still an underlying issue for the developing nations, however there are upcoming developments in place to ensure there are a range of technologies that can deliver next generation connectivity.

To achieve country-wide Internet access is an important goal to sustain the progress of our societies. Nevertheless, there is important gap between the urban and rural areas in terms of Internet Connectivity that is mainly due to a lack of interest by Internet Service Providers (ISPs) in deploying a wired infrastructure in these areas; such lack of interest is expected to be maintained since the estimated Return of Investment (ROI) is not attractive. Also, it is widely accepted that new information and telecommunication technology are needed to alleviate a wide range of obstacles for economic and social development in rural areas. This is particularly true for internet accessibility, since it offers a global platform for retrieving and sharing information. During past few years, there has been a remarkable progress in the most developed countries in terms of telecommunications facilities. However, outside the main urban areas, there are significant handicaps that make Internet connectivity a complex and costly task.

THE POSSIBLE SOLUTIONS

Knowing the fact that there is no business case for the telecom operators in rural areas. So, there arises a question – Are we prepared for that and how this rural-urban digital divide will be bridged? Actually, objective is to reach the bottom of India’s digital pyramid with the inclusion of these far-flung rural areas, **Digital India programme** of Govt. of India is really helping to bridge the digital divide, but lot is still to be done. It is the fact that rural Indians have been increasingly getting online and are expected to catch up with urban India by 2020 where 48% of the online population will be from Rural India. But such trends would exist during 5G also? That we have to check.

The penetration of the broadband networks in such remote and rural areas demands new thinking and methods to make the broadband network operations economically viable. Suitably modified deployment architecture needs to be explored to address the rural broadband internet requirements and innovative business model developed to operate in a sustainable mode. Actually, the connectivity requirements of the rural areas are very different from that of the urban areas. Thus, in order to make rural broadband connectivity better feasible and have better penetration in the un-served and under-served remote and rural areas, **we need low cost, indigenous and high-performance solutions**.

A. TESTED SOLUTION OF JHARKHAND:

One of the best solutions which is already implemented in Jharkhand state by provisioning of LWE BTS in rural areas, (funded by Govt. of India)and provisioning of Wi-Fi services on these LWE towers & around, (sponsored by Jharkhand state government) is a perfect solution or can be a Business model also. A detail report of this solution implementation in Jharkhand state is given in **section- 4** and further 5G or 5G type services can also be given with the help of latest Wi-Fi in pockets of rural areas based on this or similar models.

POSSIBILITY OF ROLLOUT OF 5G OR 5G TYPE SERVICES IN RURAL AREAS:

It is useful and timely to pose the question on the future of communications - a future that talk of 5G & also goes beyond 5G. Notably, it is also important to understand which technology disruptions are required to enable ‘Wi-Fi Technology’ not only to survive but also to thrive in an increasingly competitive technology and business landscape for affordable solutions.5G is the next big revolution in mobile connectivity, is expected to be able to handle the increasing traffic related to the higher need for mobile data. The 5G wireless technology aims at providing better mobile broadband connectivity and speed for a wider range of customers.

The cellular technology is mostly an urban technology that has been unable to serve rural areas in same manner. This is because the traditional cellular models are not economical for areas with low user density and lesser revenues. In 5G cellular networks, the coverage dilemma is likely to remain the same or increase only, thus widening the rural-urban digital divide further. It is about time to identify the root cause that has hindered the rural technology growth and analyse the possible options in 5G architecture to address this issue. We firmly believe that it can be accomplished.

Our aim is to ensure the availability of Internet in a costeffective manner. This is only possible if the 5G rural model adopted is able to attract the attention of service provider in the first place. By focusing on cost effectiveness, parameters such as throughput and latency can be compromised because these are managed according to the user requirements and are not deemed critical for a new user located at a remote/sparsely populated area. In addition, the infrastructure cost has also to be practicable because the vendor would never risk a huge sum for a pilot project. Since the profit-loss breakeven point would occur at lower revenues, therefore more rural population would be encouraged to reap the benefits of low-cost Internet. Once the rural access to Internet gains momentum and results an increase in number of users, the core problem would be addressed and would subsequently be wiped off the ‘investment blacklist’ from a service provider’s perspective, then the increased rural demand would motivate the service providers in facilitating the users with better connectivity and improved performance that would invariably lead to technological advancement in the rural areas and bridge this technology gap [4].

In the recent years, there has been a significant growth of cellular wireless communications. Despite this growth, a large part of the world is still deprived of broadband connectivity. For example, in India, while the number of cellular subscribers is over 1.2 Billion, the broadband penetration is mere 600 million [5]. Moreover, the broadband penetration in rural areas is even marginal. It is estimated that 3-4 Billion population of the world still do not have access to Internet. Using existing cellular wireless systems including Third Generation (3G) and Fourth Generation (4G) technology, there are significant challenges in providing broadband access. These include - High capital and operations expenditure with low Average Revenue Per User (ARPU), lack of affordable backhaul, energy cost which is worsened by lack of reliable power supply and geographic accessibility including issues such as right of way.

These challenges require a re-thinking on developing next generation wireless system for connecting the unconnected world. Mobility is not a major driver for designing such systems, rather fixed primary broadband access is the most important requirement. A simplified IP based network architecture with dynamic spectrum sharing and a low-cost wireless backhaul can set the vision of 5G for Rural Areas for connecting the unconnected [6].

While affordable fixed access can be provided using a dense deployment of IEEE 802.11 based Wi-Fi Hotspots, one of the major impediments for widespread deployment of such Hotspots is the lack of connectivity to Wi-Fi access points.

Fiber [7] connectivity in terms of backhaul is limited in such countries and may currently reach only at designated points in a town or city. In such a scenario, the problem of connecting the core network to the access network can be addressed using wireless middle-mile network as shown in Figure 18-1.

This paradigm opens up several directions for technology solutions. These include dynamic spectrum sharing for multioperator co-existence, scalable control and management of such access and middle mile network through software defined network controller among others.

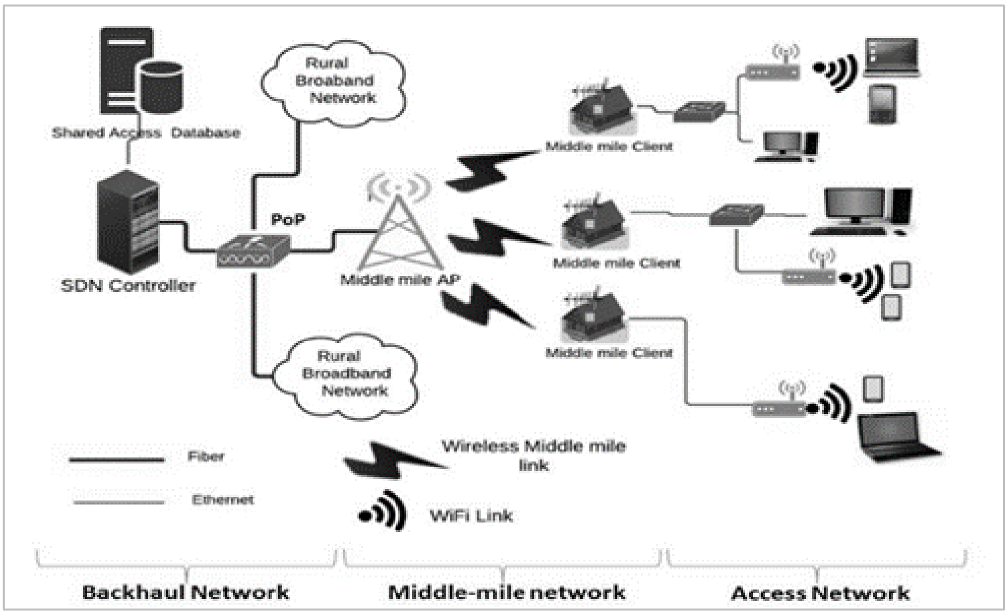


Figure 18-1 - Envisioned Architecture for Backhaul Issues

To enable a broadband access network that is calibrated according to rural connectivity requirements. We can consider a tiered wireless communication network involving a Core Network and an Access Network as shown in Fig 18-2 below. Access Network facilitates last mile connectivity to end-users, whereas Core Network provides connectivity with the external data network. In some scenarios, Access Network may also provide connectivity with the external data network. Access Network, considered here, is heterogeneous in nature, i.e., it consists of a Macro Base Station (BS) and a number of Wi-Fi Access Points (WLANs). The Macro BS is collocated with the PoP which is available in the vicinity of the given rural area. and provides blanket coverage to the end users in a large geographic area. Owing to the clustered settlement of people in rural areas, Wi-Fi Access Points are deployed only in clusters.

IEEE 802.11 based Wi-Fi Access Points can be chosen for the last mile as it facilitates fixed high-speed broadband access to the end-users in a cost-effective manner. The major challenge in designing the Access Network is to backhaul the traffic generated by WLAN APs. This is enabled via wireless Middle Mile Network that connects the WLAN APs to the PoP. The architecture proposed here (Fig 2) mirrors the rural population distribution and helps in efficient delivery of services to the users.

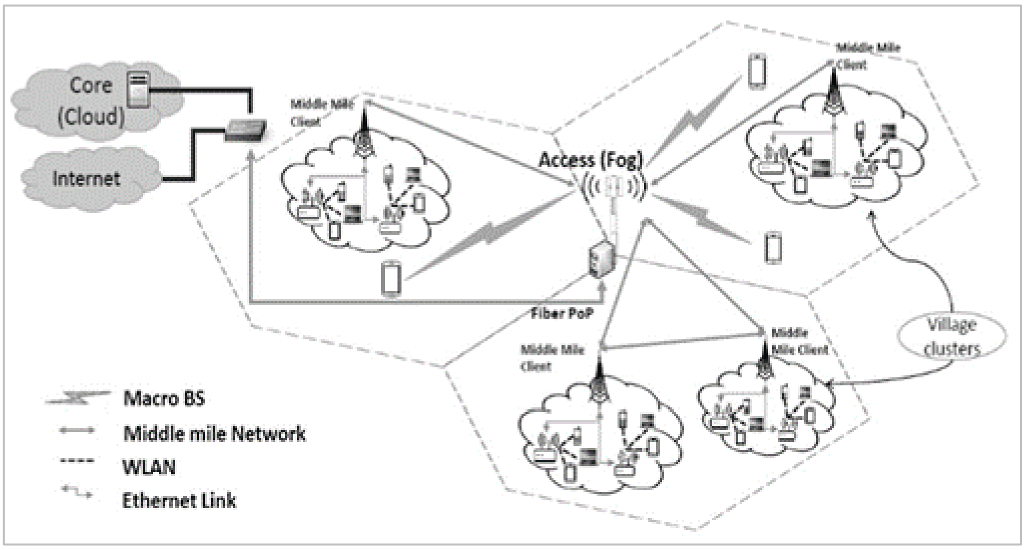


Figure 18-2 Deployment Architecture for 5G in rural

There's a lot of work happening in Wi-Fi industry around how do you take Wi-Fi connectivity and make it work better, but also make it work better in conjunction with other technologies whether they come from the Wi-Fi side of things, the broadband side to connect people, or the narrowband side to connect things. 5G [8], which is expected to make its debut in fixed-wireless form in 2019/2020, also the 802.11ax chipsets are already being announced and products are likely to hit the market soon. We have to ensure their commercial rollout, and whatever roadmap or arrangement we take should have concurrent milestones.

Here are some other reasons why Wi-Fi will continue to thrive in a complimentary way along with the launch of new cellular technologies like 5G:

The Wi-Fi market is growing, not shrinking. According to an international survey report by **Market stand Markets**,

the global Wi-Fi market will be worth 33.6 billion by 2020. Wi-Fi traffic, from both mobile and Wi-Fi-only devices, will account for more than 50 percent of total IP traffic by that time.

Also, Wi-Fi understands dense deployments. The 5G future is dense. Grids will be composed of small cells and ubiquitous antenna to enhance capacity and coverage - a scenario that Wi-Fi already understands. Also, the rural Last Mile connectivity is possible using WLANs only because Wi-Fi provides best implementable business strategies for rural & remote geographies. The detailed Scheme is shown in Figure 18-3.

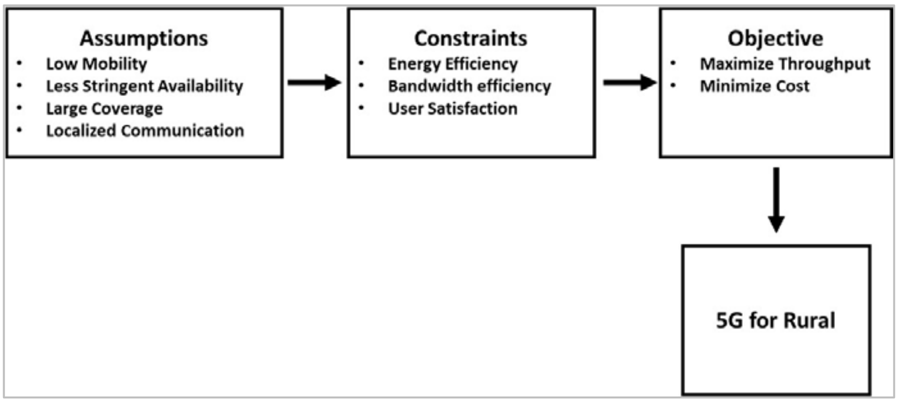


Figure 18-3 Wireless Broadband Network for Rural Connectivity Aimed at providing affordable primary broadband connectivity to rural areas

WI-FI SERVICES IN LWE AREAS OF JHARKHAND [9]

The Left wing Extremism (LWE) affected areas in India are characterized by poor socio-economic indicators. Lack of infrastructure development has been identified as one of the causes for its backwardness. Telecom connectivity (both voice & data) would help in fostering economic development of the region and enable security forces to deal effectively with extremism in their areas.

In recent years, mobile connectivity has emerged as one of the transformational phenomena. Mobile telephony has transformed access to communication in emerging markets. But rural areas have traditionally been no-go for incumbent telecos as far as Data Connectivity is concerned due to perceived lack of a business case. Today, almost 90% of the country's population is covered by mobile phone signals, yet there are still two third of the population who don't have access to voice and data connectivity.

Earlier, reaching out to the rural areas presented particular technology and economic challenges. Solutions that worked typically well in urban settings – copper, fibre, cable and mobile – were unreliable in rural areas or prohibitively expensive. For example, premises near bigger town, small towns and villages are often too dispersed to make the rollout of fast fixed-line solutions economically viable. In these, there are limits on asymmetric digital subscriber line (ADSL) speeds and also, the cost per premise for fibre to the node (FTTN) is several thousand dollars. At the same time, rural areas are not remote enough to justify satellite technology's incremental cost per unit of performance. So, we came out with our quite efficient and innovative technological solution which made the use of unlicensed Wi-Fi Technology.

On August 20, 2014, the Union Cabinet approved the extension of mobile telephonic services to 2,199 locations affected by Left Wing Extremism (LWE) in the states of Andhra Pradesh, Bihar, Chhattisgarh, Jharkhand, Maharashtra, Madhya Pradesh, Odisha, Telangana, Uttar Pradesh and West Bengal. The Project was executed by Bharat Sanchar Nigam

Limited (BSNL). BSNL through VNL has already installed towers at these locations giving a network coverage to many villages as well as camps of security forces. BSNL has created 782 GSM sites in the un-connected areas of the state of Jharkhand under LWE project phase-I.

These 782 sites are pure 2G GSM BTSs indigenously developed by VNL, equipped with solar panels and last mile RF connectivity to take care of any outage due to fibre cut & power failures. These BTSs are low power equipment designed to cope up to 72 hours of "black out" environment also. Initially even GPRS service was not provided. So with commission of these towers though very good mobile services were made available in these in-accessible areas, but without any data services.

Traditionally entering a typical rural area for private telecom operators' means not just capex & opex issues but the perception of existing hostility in these regions make the organisation vulnerable and think twice before they enter these areas. But On initiative of BSNL, state government came forward for viability gap funding for provision of WiFiservices at these LWE towers with revenue gap funding. After that BSNL with GoIP&Blue-Town (as technology partner of GoIP) took this project on revenue share basis.

BSNL & state government initiative to promote an alignment between technology, demand, standards & regulations has enhanced efficiency in network reach into zero data access regions. Now people living in these regions have access to better education, better and timely medical services all because of BLUETOWN's efforts as Managed Hotspot Service Provider (MHSP) with BSNL, which complimented the Govt. initiatives to bridge the Digital Access deficit.

WI-FI BROADBAND ACCESS ON LWE TOWERS PROJECT: DATA LIMITATION OF EXISTING LWE 2G SERVICES

As on these existing 2G GSM BTSs, there are 48 timeslots for voice and data both. Effective speed of data is only 20Kbps. This speed was not sufficient for data communication and cashless transaction. As Govt. of Jharkhand is trying to expand digital network in rural areas so that the mass can get benefit of e-Governance services. For effective implementation of Digital India scheme, data speed should be high. Hence, Govt. of Jharkhand decided to install Wi-Fi hotspots in those areas using existing mobile towers.

The objectives of this project were:

- High speed connectivity to citizens
- Provisioning of data connectivity to Govt. offices
- Penetration of Digital India Programme in LWE areas.

BSNL issued the Work Order in 2016 for setting up, own and operate Wi-Fi Hotspots at public places through BSNL POP on Revenue Share basis to GOIP, in turn to Blue-Town business & Technology partner.

Project was monitored directly by DoIT (Government of Jharkhand) or the agency authorized by DoIT. DoIT or its authorized agency will inspect working of Wi-Fi system.

A. RESPONSIBILITIES OF BSNL-BLUETOWN PARTNERSHIP FOR THE PROJECT

Roles and responsibilities of BSNL-BLUETOWN and the activities expected to be carried out in the process are summarized below:

- BSNL ensured Internet Bandwidth of 2Mbps with Public IP Addresses at all the LWE Locations.
- BLUETOWN Installed operated and maintained the equipment required to create Wi-Fi hotspots at these LWE sites.
- Uptime SLA: Uptime of 98% is guaranteed, as below:
  - Avg. annual uptime>= 98% full payment
  - Avg. annual uptime>=92% and <98%, 4% shall be deducted
  - Avg. annual uptime<92%, full 10% payment shall be deducted at the end of year.
- Revenue Sharing: BSNL will share the revenue (received from the Jharkhand State Government i.e. Bulk Revenue and any revenue received from Retail Customer Recharges i.e. Retail Revenue) as per the Work Order Referred above.
- All DoT Guidelines: Regarding Wi-Fi Hotspots and user interfaces and records were to be maintained.
- BLUETOWN have to provide dashboard for monitoring of the function of Wi-Fi system.

B. THE SOLUTION PROVIDED FOR THIS PROJECT:

All the Wi-Fi network equipment's such as antennas, Access Points and Controller are utilizing the BSNL towers and Backhaul infrastructure. The special equipment integrated is a miniaturized, low-powered and low-cost Wi-Fi Access Point Controller powered by solar panel and rechargeable

SMF batteries. The power requirement of 3APs and a Controller being less than 20 Watts only, the system can work up to 30 hrs. Without any charging. The AP Controller provides the functionalities of Power control, Charge control, RF control, Content server, bandwidth management, quality, security and authentication management as well as POE for APs. In its functionality, it is similar to BTS of a cellular network and facilitates the creation of a managed Wi-Fi Hotspot, while utilizing off-the –shelf outdoor APs.

The innovative solution deployed is summarised, as below:

Outdoor Solution – Everything on Tower

- Access Point Controller (Housed in an IP67 weather proof outdoor box)
- 3 weather-proof Sector Antenna assembly located on BSNL existing Tower. This includes the following components
  - 120 Degree Sector Antennae's (3 in Number)
  - Bandpass filters (3 in Number)
  - 2.4 Ghz Access Points (3 in Number)
  - Backplates to support the Antennae assembly (3 in Number)
  - Antennae Mounts

- o Solar Power system including the following: Solar Power Unit with Batteries (Housed in an outdoor IP67 box); Solar Panel; Solar Cables & Connectors.
- o 4th Access Point with an OMNI/Sector Antennae (as per requirement) to be installed at a location upto 1 Kms (like a school, PHC or GP etc.) away from the tower
- o Internet backhaul was provided by BSNL using existing network.

C. SALIENT FEATURES OF THE PROJECT:

- Range of 0.5 Km radius with 15meter tower height and 0.3 Km radius with 5meter (rooftop) mast was achieved, while restricting the APs power to permissible limits.
- System can sustain for 30 hrs. Without availability of any electricity and can charge itself through solar panel beyond that.
- All the requirements of Authentication were achieved through pre-paid coupons or OTP based authentication through mobile connection.
- Users experience has been better than 3G Data connection even it can be said as 4.5G like experience.
- Use of miniaturized SMF batteries in the project having 30 hrs capacity without charge.
- Miniaturized, integrated Wi-Fi Access Point Controller powered by solar power which were capable of handling:
    - o AAA Authentication
    - o Bandwidth Management & RF Control
    - o Power Control & Battery Management
    - o Remote Access for system maintenance
- Extremely low voltage (16V) and power consumption (20W) of access point controller and outdoor access point.
- Use of existing infrastructure of BSNL to reduce the CAPEX.

D. GENERAL NETWORK ARCHITECTURE:

The Figure 18-4 network architecture was implemented at the LWE sites most of which are located in remote areas. The Wi-Fi infrastructure was installed at existing BSNL towers where Backhaul was provided by BSNL, through unlicensed radio channel.

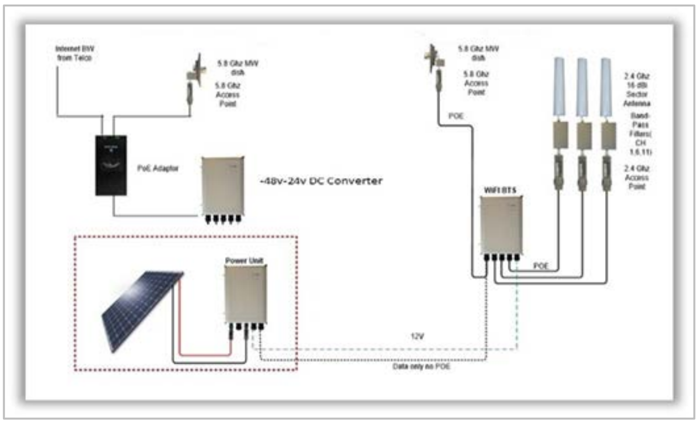


Figure 18-4 LWE Architecture

E. PROMOTIONAL AND EDUCATIONAL EFFORTS:

- As the project is funded by state government under viable gap funding. So, the opening page is designed for state government.
- Figure 18-5 shows, Wall painting Banners and Posters were used for proper knowledge awareness in public in addition to those Leaflets were also distributed for value addition.

- Organization of road shows& door to door campaign to do survey as well as spread awareness of services with practical demonstration of how villagers can use different government schemes & e-commerce services.

Figure 18-5 Posters, Banners, Leaflets for Knowledge Awareness

CONCLUSIONS:

Success of this project has vindicated our belief that there is a sustainable business case for Broadband in Rural parts of the country whereas the incumbent Telco's are not there yet as they are concentrating in the urban areas and it has been showcased that this LWE project, was mainly possible because of our innovative solution (Low cost, Low maintenance, Low power and our "Managed Service" based business model.

BSNL-BLUETOWN partnership vision & mission would enable the people living in rural areas with no data connectivity to the world of Internet at an affordable price. Also, with each hotspot being created there was one job also that was created as a local person would be required to do the sales/marketing & basic maintenance of the Wi-Fi hotspot.

This synergy strategy amongst manufacturers, R&D centres, and service providers for achieving efforts for deployments into the remotest parts of the country would eventually lead to a roadmap for Grand India Dream. Because a good connectivity is citizen right, they say, not a privilege.

REFERENCES

[1] https://www.diplomacy.edu/blog/right-access-internet-countriesandlaws-proclaim-it

[2] Broadband Infrastructure for Transforming India https://www2.deloitte.com/in/en/pages/technology-mediaandtelecommunications/articles/broadband-infrastructure-fortransformingindia.html

[3] I. Vision, "Framework and overall objectives of the future development of IMT for 2020 and beyond," International Telecommunication Union (ITU), Document, Radio communication Study Groups, 2015.

[4] A. Kumar, A. Karandikar, G. Naik, M. Khaturia, S. Saha, M. Arora, and J. Singh, "Toward enabling broadband for a billion plus population with TV white spaces," IEEE Communications Magazine, vol. 54, pp. 28–34, July 2016.

[5] Telecom Regulatory Authority of India, the Indian Telecom Services Performance Indicators, October-December, 2018,

[6] New Delhi, India, 4th April, 2019

[7] L. Chiaraviglio, N. Blefari-Melazzi, W. Liu, J. A. Gutierrez, J. Van De Beek, R. Birke, L. Chen, F. Idzikowski, D. Kilper, J. P. Monti, et al., "5G in rural and low-income areas: Are we ready?," in ITU Kaleidoscope: ICTs for a Sustainable World (ITU WT), 2016, pp. 18, IEEE, 2016.

[8] Connecting the Unconnected: Towards Frugal 5G Network Architecture and Standardization by Meghna Khaturia, Pranav Jha and Abhay Karandikar

[9] https://www.qorvo.com/resources/d/qorvo-5g-or-wi-fi-6-11axwhite-paper

[10] Long Tail - Walking the Extra Mile on Rural Broadband Business by Satya N. Gupta ISBN-10: 1684665841; ISBN-13: 9781684665846

19. “The Multi Business Model Innovation Brain”

Peter Lindgren,
CGC - Aarhus University, Business Development and Technology, Denmark
peterli@btech.au.dk

ABSTRACT

Businesses have until today put most emphasis and practice on human leadership of Business Models and Multi Business Model Innovation. However, advanced technologies integrated in Business Models and Multi Business Model Innovation processes introduce a new leadership and management agenda. Fast development of sensorsoring, persuasive and virtual Business Models will soon be operating autonomously primarily by machines. Businesses will be able to, build Multi Business Model Innovation competence and advanced Multi Business Models Innovation Brains capable to innovated and operate Business Models in even different types of Business Model Ecosystems. This will change the classical way of how business performed leadership of Business Models, operated and innovated Business Models. It will also open up to new Multi Business Model Innovation potential and create a new generation of Business Models, new practice of Multi Business Model Innovation.

The paper is a first attempt to propose a conceptual Multi Business Model Brain and How it could operate supported by advance wireless and sensor technologies. The paper discuss how the Multi Business Model Innovation Brain can be evolved and how artificial intelligence technologies, deep learning, persuasive technologies, Multi Business Model Innovation pattern analysis and archetypes will be important supporting tools to the Multi Business Model Innovation Brain.

Keywords: *The Multi Business Model Innovation Brain, Advanced Business Modelling, AI, Deep Learning, Business Model Innovation, Sensors, Persuasive Technologies, Physical, Digital, Persuasive and Virtual Business Models*

INTRODUCTION

In today’s digital age artificial Intelligence (AI) and Deep Learning (DL) in a world of persuasive business models (BM) [2] could potentially propose all possible archetypes of BM´s. Multi Business Model Innovation (MBMI) Processes and corresponding interaction archetypes patterns of any BM interactions can be carried out with

- Human Intermediary BM Interaction
- Machine Intermediary BM Interaction
- Mix of Human and Machine Intermediary BM Interaction

MBMI patterns analysis, MBMI Library combine with AI and DL could potentially support a MBMI Brain in its leadership and management of BM´s and MBMI in any Business Model Ecosystem (BMES) Interrelated BM Interaction.

There seems therefore to be enormous potential of constructing a MBMI Brain embedded, supported and operated with AI, DL, MBMI pattern analysis, MBMI Library and advanced sensor technology. Many businesses are trying already to do this (AMAZONE, FACEBOOK, GOOGLE, APPLE), but the majority of businesses are just able to “seeing”, “sensing” and realizing MBMI in a classical human based MBMI form.. These businesses are mainly – compared to the above mentioned - capable of using very simple BMI tools and frameworks – often “of and from the past”. These businesses are leading MBMI not supported by machines. This puts them into a very critical position in the future, when larger and larger part of MBMI is taken over by machines and machines that can work especially faster than human brains.

These businesses MBMI approaches and tools seems not capable and able to “tailor made” MBMI fast and flexible enough in a world of 5 and 6G. They have very large difficulties to adapt to BMES´s and BM´s that change very fast. They are in other words not prepared to lead BM´s and MBMI of the future – meeting competition with changing, persuasive and virtual BM´s. They are not advanced enough to support creating, capturing, delivering, receiving and consuming the real potential of MBMI and related BMES [3] in the right time, to the right cost and at the right performance [11]. However, their seems to be a lack of knowledge about MBMI Brains constructions in these businesses – and ***How could a generic MBMI Brain be constructed?***

A CONCEPTUAL MODEL FOR MBMI BRAIN INTERACTION WITH BM´S AND BMES

A conceptual model for a MBMI Brain´s environment were earlier described in our article - Advanced Business Model Innovation Supported by Artificial Intelligence, Deep Learning, Multi Business Model Patterns and a Multi Business Model Library [8]. However, the construction of the MBMI Brain was not covered and the article did not provide an overview of the requirements to a MBMI Brain. In this articles we intend to increase the approach to cover a combination of digital, virtual and physical representations of BM´s supported by a MBMI Brain.

Conceptualizing on the perspectives to construct and implement a MBMI Brain, in this context, will mean explaining the vision of the MBMI Brain construction. How it will be able to create, capture, deliver, receive and operate BM´s with a mix of human and/or machine interaction physically, digitally, virtually, simultaneously and autonomously. The MBMI Brain could hypothetically - at an optimum - propose and operate any BM in any BMES anytime, anywhere to anybody and anything. A conceptual model in figure 19-1 shows the MBMI Brain working in its Business Model Ecosystem (BMES) together with MBMI AI, MBMI Machine Learning and MBMI Deep Learning. MBMI Library and MBMI Pattern analysis support and continuously update BM´s archetypes and combination of BM´s based on the "learning" gain through the interaction with BMES´s.

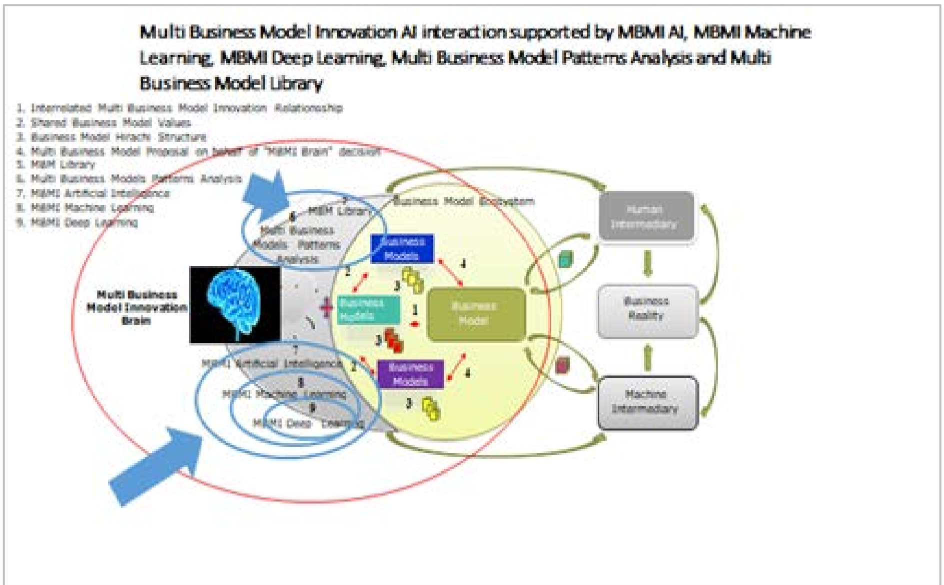


Figure 19-1 The MBMI Brains Interaction with Business Model Ecosystems with Human and Machine interaction inspired by [1], [6], [8]

THE MBMI BRAIN

The MBMI Brain is as proposed earlier [8] supposed to be supported by MBMI Artificial Intelligence (AI), MBMI Machine Learning, MBMI Deep Learning (DL), a MBMI Library and MBMI Patterns analysis. These parts are expected to be special "centers" and "tools" placed outside the core MBMI Brain. Human and/or machine based sensors interacting in the BMES business reality – "at the frontend" in the BMES - as indicated in figure 19-1 with the red circle continuously operating known BM´s and learning new BM´s. Sensors adapt and transmit sensor data to the MBMI Brain through tangible and intangible relations. These parts lays outside the core MBMI Brain and the MBMI Brain operate on behalf of these data transmitting backwards and forwards through the MBMI´s Brains relations to the Business BM´s in the respective BMES´s. MBMI AI, ML and DL algorithms help to optimize and suggest change of existing BM´s and help propose new BM´s directly to the responsible person or/and machine in the business to pass on to e.g. the user and/or customer. Based on other BM´s success in other BMES´s MBMI AI, ML and DL algorithms will support implementing of change into the business reality based on its analysis carried out together with the MBMI pattern analysis and available BM´s and combination of BM´s in the MBMI library.

A. MBMI Artificial Intelligence (AI)

MBMI Artificial Intelligence we define as a broader umbrella under which MBMI Machine Learning and MBMI Deep Learning come. In Fig. 19-2 we sketch how we expect MBMI AI, MBMI Machine Learning and MBMI Deep Learning are related with each other and interact with the MBMI Brain.

Inspired by Poole [14] AI can in relation to MBMI be defined as the study of "intelligent MBMI agents": any MBMI device that perceives its BMES and takes actions that maximize its chance of successfully achieving its Business objectives".

Inspired by Russell [15] and Kaplan [24] we further developed AI related to MBMI by characterizing MBMI AI as "a MBMI system's ability to interpret external data from the BMES and learn from such data to use those learnings to achieve specific objectives and tasks through flexible adaptation of the offered BM´s".

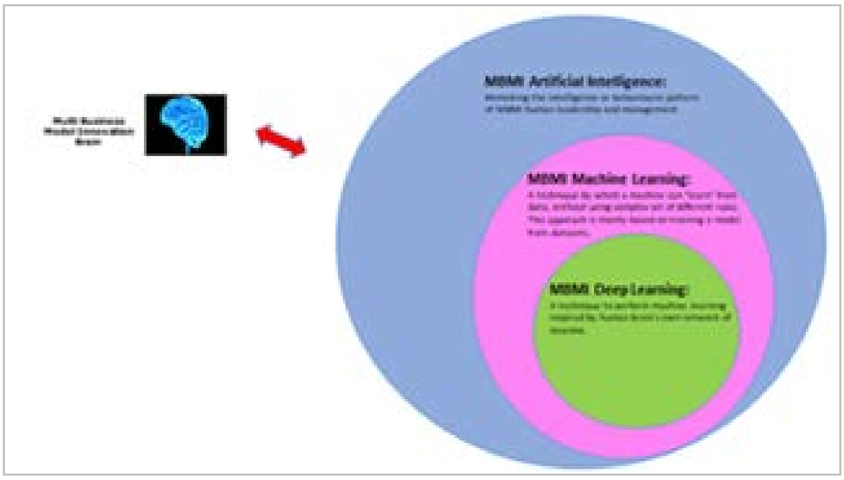


Figure 19-2 he MBMI Brains Interaction with MBMI AI, MBMI Machine Learning and MBMI Deep Learning inspired by [1], [6], [8]

Artificial Intelligence related to MBMI can be called MBMI machine intelligence in contrast to the MBMI human intelligence displayed by managers responsible and caring out MBMI. The term MBMI AI can be used to describe machines (or computers) that mimic "cognitive" functions that humans associate with the human mind, such as "learning" and "problem solving" related to MBMI [16]. As machines become increasingly capable of operation MBMI, tasks considered to require human "MBMI intelligence" are removed from human MBMI Managers to machines. Hereby also, inspired by the literature on AI true MBMI AI can be defined as

"whatever BM and combination of BM´s that hasn't been done and introduced to the any BMES yet"

and then is moved to hypothetically machines. Inspired by McCorduck [17] "the MBMI AI effect" is yet extremely difficult to machines to carry out 100% as it includes elements that still distinguish humans to other species and machines. MBMI AI – we propose can be divided into three different types:

- Analytical MBMI AI
  - Analytical MBMI AI has characteristics consistent with cognitive intelligence; generating a cognitive representation of the BMES and using learning based on past BMES experience, BM archetypes and MBMI to form future MBMI decisions.
- Human-inspired MBMI AI

- Human-inspired MBMI AI has elements from cognitive and emotional MBMI intelligence; understanding human emotions, in addition to cognitive elements, and considering them in their decision making on BM and MBMI.

- Humanized MBMI AI
  - Humanized MBMI AI shows characteristics of all types of competencies (i.e., cognitive, emotional, and social intelligence), is able to be self-conscious and is self-aware in interactions.

The challenges of MBMI AI research include MBMI- reasoning, knowledge representation, planning, learning, language processing, perception and the ability to change and manipulate BM´s and combination of BM´s – persuasive multi business modelling [18]. General MBMI intelligence is among the MBMI Brains field's long-term goals [7] including MBMI statistical methods and patterning, computational MBMI intelligence, and traditional MBMI symbolic AI. Many tools is expected to be used in future MBMI AI, including versions of search and mathematical MBMI optimization, artificial MBMI neural networks, and MBMI methods based on statistics, probability and economics – including both monetary, nonmonetary and mix of such value propositions and value formulas. The MBMI AI field is expected to be a cross interdisciplinary field and will draw upon computer science, information engineering, business mathematics, business psychology, business linguistics, business philosophy, business intelligence and many other fields related to MBMI.

The field of MBMI AI is found on the assumption that human MBMI intelligence can be so precisely described that a machine or more machines together can be created to simulate humans "MBMI Intelligence". This raises, however a philosophical discussion about the nature of the mind and the ethics of creating "MBMI artificial beings" endowed with human-like MBMI intelligence. These issues has not been explored yet much by myth, fiction and philosophy but we consider MBMI AI to be a potential danger to MBMI human driven business, if it progresses unabated. Others believe that MBMI AI, unlike previous technological revolutions, will create a risk of mass unemployment. [19]

In latest years, MBMI AI techniques have developed and experienced a resurgence following and supported by concurrent advances in computer power – quantum computing, access to large amounts of data, and increased BM theoretical understanding; evolving MBMI AI techniques have become an essential part of yet a limited group of some businesses. However, AI in MBMI has been lacking behind and is still on a very early stage that has to be developed further in the next coming years.

MBMI Deep learning can be defined inspired by [39][20][21] as deep MBMI structured learning or hierarchical MBMI learning and can be regarded as part of a family of MBMI machine learning methods based on MBMI artificial neural networks. MBMI Learning can be supervised, semi-supervised or unsupervised. Deep learning MBMI architectures such as deep MBMI neural networks, deep MBMI belief networks, recurrent MBMI neural networks and convolutional neural MBMI networks can be expected in the future to be applied to all fields including MBMI machine based vision, audio, speech, taste, smell, sound and feel recognition [4]. MBMI language processing, MBMI social network filtering, MBMI machine translation, MBMI bioinformatics, MBMI design, MBMI medical image analysis, MBMI material and service inspection, where they will continuously produce BM proposals and combination of BM proposals comparable to and in some cases superior to human MBMI managers [42][43].

MBMI Artificial Neural Networks (MBMIANNs) can be inspired by information processing and distributed communication nodes in biological systems. MBMI brains could have various differences from biological brains. Specifically, MBMI neural networks tend to be able to be static and symbolic, while the biological MBMI brain of most living physical Businesses and BMES should be formed as dynamic and analog inspired by [22][45][46].

B. The MBMI Library

The Multi Business Model Library is proposed to consist of two parts

- A library of Business Model Archetypes
- A library of Archetypes of combination of Business Models divided into 3 categories

- Incremental – small changes in BM dimensions and combinations of BM´s [13]
- Radical – Radical changes in BM Dimensions and combinations of BM´s [13]
- Disruptive – Disruptive changes in BM Dimensions and combinations of BM´s [13]

The Multi Business Model library will host or be a memory like a “MBMI knowledge home” including all previous known BM archetypes and combination of BM and their construction related to BM portfolio, BM dimension and BM component level as seen in figure 19-3 beneath.

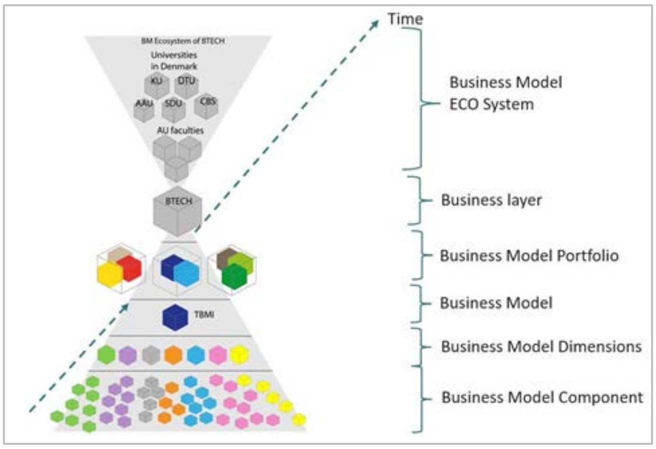
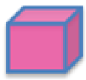
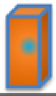
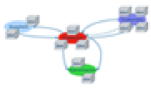


Figure 19-3 Levels of MBMI and combination of BM´s Inspired by Andersen et all [12]

Table 19-1 The Multi Business Model Library

 The Multi Business model Library	Incremental	Radical	Disruptive
Business model archetypes [28].			
Archetypes of combination of Business Model´s [17].			

The MBMI Library will continuously learn and adapt new archetypes of BM´s and new archetypes of combinations of BM´s. Today there is still very little solid literature and knowledge on generic BM´s and combination of BM´s, which could help us or in the future machine based MBMI Brain to identify best possible BM archetype to any specific BMES context.

Literature on combination of BM´s is still lacking and this is something that is important to be added to the existing BM literature and our conceptual model [8]. There is further very little research on lifetime of BM and combination of BM´s over lifetime related to BMES context. The choice of generic BM and combination of BM in a certain life stage of a BM, combination of BM and BMES is highly interesting to investigate.

C. The Multi Business Model Patterns Analysis

The Multi Business Models Patterns Analysis is expected to consist of:

Existing known MBM pattern typologies

A MBMI pattern is a set of MBM data that follows a recognizable form, which MBM analysts and tools then attempt to find in the current data. A pattern is a regularity in the BMES, in human-made, machine-made or a mix of Human- and Machine-made MBM design. The MBM pattern typologies will be able to support choice of BM and combination of BM related to lifetime of BM and BMES. In abstract, the MBMI Pattern typologies will give support to the MBMI Brain on how a MBMI design could look like on behalf of the available MBM data and BMES context. As such, the hypotheses is that the elements of a pattern of the life of a BM or a life of a combination of BM´s – could repeat in a predictable manner. A MBMI pattern is a kind of pattern formed of “geometric shapes” of the lifecycle of a BM or the lifecycle of a combination of BM´s and typically repeated like a typical BM or combination of BM´s life cycle design. Any of the senses of the MBMI Brain model embedded in the BMES as shown in fig 19-1 may directly observe or register valuable pattern data for MBMI pattern analysis.

MBMI process typologies.

The Business Model Innovation (BMI) process typologies inspired by Taran [9] – Open proactive, Close Proactive, Open Reactive and Closed Reactive BMI process typologies - can be identified for single BM´s. BMI typologies are hereby already available today but MBMI process typologies for innovation of combination of BM are however not available today and still needs to be investigated to find out

- What different MBMI process typologies exists?
- How businesses can design new, novel and innovative BM´s in combination?
- open proactive, close proactive, open reactive and closed reactive and not least defensive MBMI processes inspired by Martins et all 2015 [10].
- Combinations of BMI typologies is far more complex to classify and study than single BMI, because it is like leading a chess game with many pawns, where single BMI process are just played with one pawn.

THE MBMI BRAIN´S CONSTRUCTION

Some basic characteristics seems to be vital to be present inside a MBMI Brain.

A. The MBMI Brain must be able to sense data, operate and make decisions on behalf of these data, which it receives from where the BM´s meet and interact with other BM´s in their respective BMES - the business reality as shown in the conceptual model fig 19-1.
B. The MBMI Brain must also be able to act on - what is really going on in the BMES and how the BM is performing. Sensor data will include valuable information that the MBMI Brain must be able to receive and capture from sensors – either human or machine based sensors.
C. The MBMI must have tangible and intangible relations to sensors embedded in the BMES and BM´s to be able to receive data – “values” – from the sensors.
D. The MBMI Brain must be able to work with the data and create new data to the BM´s. These data have to be delivered back to the BM´s again through the tangible and intangible relations so they can be received and consumed by BM dimensions.
E. The MBMI Brain must be able to download, see and sense MBMI data in real time. It must act as a “downloading”, “seeing” and “sensing” – “organ” – and at the same time be able to “calculate” – and do algorithms on behalf of MBMI data given, delivered and available. On behalf of these deliver back communiation and change request to BM´s in realtime.
F. The MBMI brain have at the same time to be “creative” and be able to create and capture new or changed data to later value its business BM´s in the respective BMES´s. The last is considered a difficult part to fulfillment of the MBMI Brain - a very difficult request that up to now have only been reserved and possible for humans. The MBMI Brain should be able to address broad, open-ended and ambiguous BM problems like developing competitive business model strategies.
G. The MBMI Brain has to be able to ” act and do” on behalf of its MBMI Brain process and let the solution and related data be transmitted and communicated back to the BM´s in the BMES.

The complete MBMI process that the MBMI Brain must be able to take care of and operate on are shown in fig 19-4.

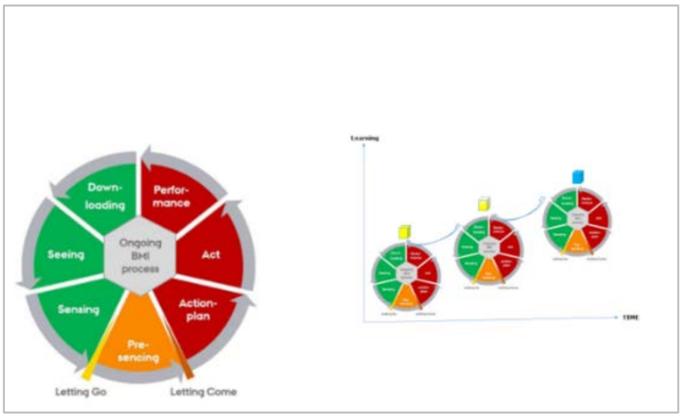


Figure 19-4 MBMI Brain Process inspired by Andersen et all [23]

As can be seen in the figure 19-4. the MBMI Brain has to be able to continuously improve and innovate the value proposition of the BM to the user or/and the customer in accordance to what it learns from the interaction process.

A simplified model of a pure human bond MBMI Brain process and a pure machine based MBMI process are explained with 2 case example in figure 19-5. for an insurance BM case including two BM – one BM for police signing and one BM for repair and for a cosmetic BM case in figure 19-6.

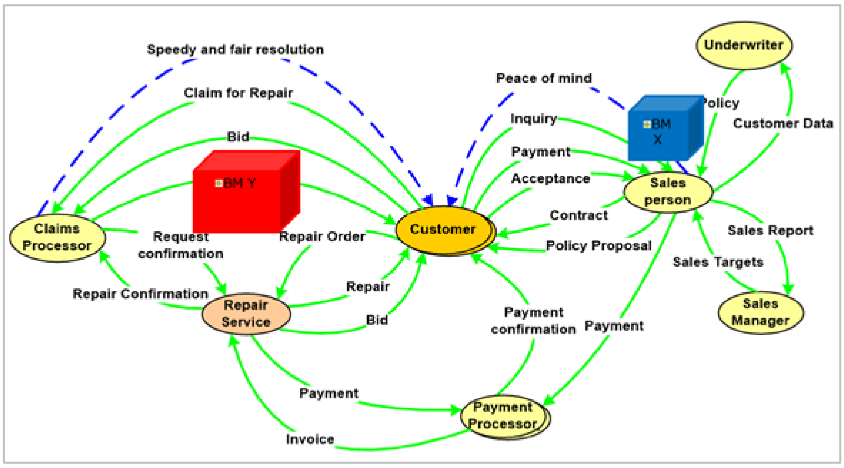


Figure 19-5 Two BM´s on an insurance business operating with tangible and intangible relations to the two BM´s receiving and sending data (values) backwards and forwards between the insurance business and the customer

In the above shown example the two BM are operated as pure Human based MBMI process "using the Brain" of a two humans (claims processor and sales person) to act-do and lead the two BM´s operation and MBMI process. However, it could be equally operated as a machine based MBMI operation and process. The role of humans hereby will play a diminish role in business modelling and in their place machines, algorithms and "passive MBMI management" will become more and more important. Practice.

L'Oreal one business that have entered this new MBMI praxis as it expanded in 2019 its Virtual Try-On Service BM to adapt the trend to become among several cosmetics businesses turning to augmented reality and artificial intelligence to boost sales and its business models value proposition.

ModiFace, a company acquired by L'Oreal in 2018, has augmented reality and artificial intelligence technology that lets shoppers virtually try on makeup using their phone.
PHOTO: L'OREAL SA

Figure 19-6 pure machine based MBMI process embedded with Augmented reality and AI is shown [24]

L'Oréal´s U.S. subsidiary rolled out this BM that lets shoppers use their phone's camera to simulate various hair-color shades from L'Oréal products Garnier Nutrisse and Garnier Olia using augmented reality technology. Using the Google Lens image-recognition mobile app, made by Google Inc., shoppers can point their phone cameras at the hair-color boxes to activate the virtual try-on service. The application identifies the product and color and then activates the virtual try-on service, powered by technology from ModiFace, a business that L'Oréal acquired in 2018 for an undisclosed amount. Customers can use the feature anywhere the two Garnier products are sold, but 500 participating Walmart Inc. stores will have signs near the products demonstrating on how the virtual try-on service can be used. [24]. The last showing an example of a mix physical, digital and virtual value proposition output of a mix human- and machine based MBMI operation and process.

When online and in-store customers use the advanced technologies that lets them virtually try on in this case beauty products before purchasing them, L'Oréal have seen three times the rate of customers purchasing their BM´s. L'Oréal has been working with Modiface's augmented reality technology since 2012, and decided to buy the business after coming to appreciate its potential and considering this technology to be a critical MBMI competence to have for L'Oréal in the future.

"We realized that AR and AI would really change the consumer experience for L'Oréal and the BMES," L'Oréal Chief Digital Officer Lubomira said. "We decided that partnership was not enough. We really wanted to source that competence and capability internally." [24] Another example of how we can expect business at the core business level to be changed on the competence level.

"It is difficult to determine how certain products, especially hair color, will look on a person until they try them on. There's a real advantage to guiding your consumer to find the right color," Ms. Rochet said.

And while retailers may offer makeup samples in stores, customers might not have time to try on multiple shades and wipe them off, or they might not want to experiment with samples that have already been used. 'Oréal is among several cosmetics businesses turning to augmented reality and MBMI AI to boost sales. Cosmetics retailers that offer similar virtual try-on services include Ulta Beauty Inc., which recently acquired two startups that specialize in augmented reality and AI, and Sephora, owned by LVMH Moët Hennessy Louis Vuitton SE.

Sales for L'Oréal between January and September of 2019 were about €22 billion, up by about 8% compared to the same period in 2018. The business said in October that one of the main drivers of growth was increased e-commerce sales, which grew about 49% during the first half of 2019 compared to the same period last year. In other words growth in sales is in both the physical and the Digital BMES of the cosmetic BMES. Shoppers are spending more on L'Oréal products online, partly thanks to ModiFace's technology.

A customer using the ModiFace tool typically tries on more than 20 different shades of makeup, Ms. Rochet said. Clicking a “try on” icon next to a product lets the app use the customer’s laptop or phone camera to generate a preview. Simulations of makeup and hair color have gotten more true-to-life with advancements in quality of the camera on smartphones, as well as processing power in the phones, said Parham Aarabi, chief executive of ModiFace, “It took a long time for the technology to get better,” Mr. Aarabi said.

Websites such as Amazon.com Inc. and Sephora also allow shoppers to virtually try on L’Oréal makeup products including lipstick, eye shadow and foundation using ModiFace’s technology, Mr. Aarabi said. The same feature is also offered on in-store tablets at bricks-and-mortar stores including Sephora.

The ModiFace technology uses an AI system called a neural network technology to automatically identify parts of the user’s face and apply the right shade of makeup on the right part of the face. Mr. Aarabi said. The AI systems also analyze the background lighting to simulate the makeup color correctly. Neural networks are composed of layers of interconnected artificial “neurons” that automatically learn about the features of a specific object based on large amounts of training data.

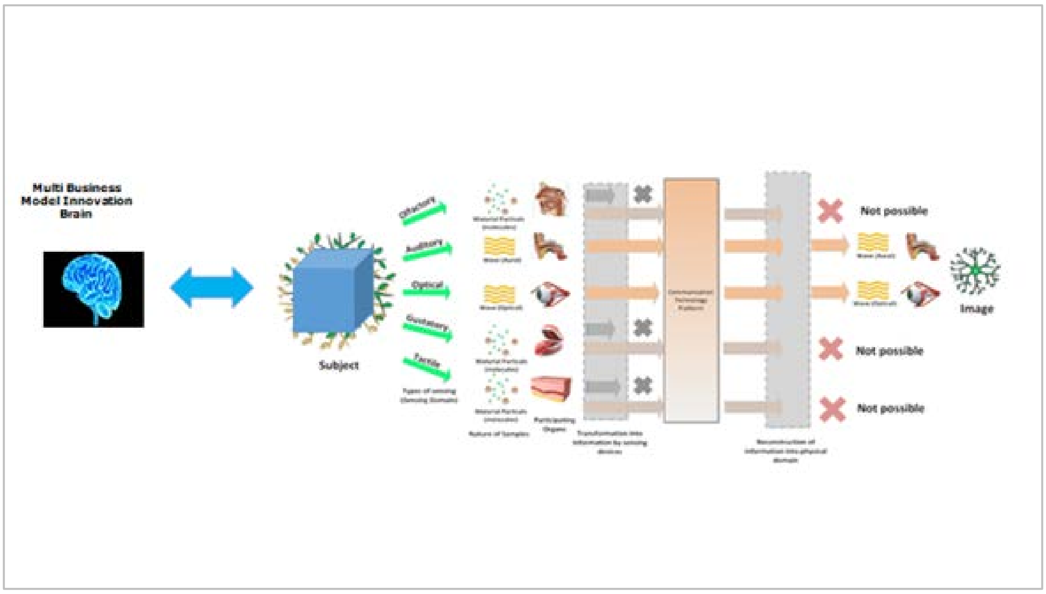


Figure 19-7 Machine supported MBMI brain process with a mix of human and machines based MBMI leadership, management and advanced sensor technologies inspired by [26] [27] [28]

Reports from other BMES in September 2019 document the same trend e.g. that the pot of passive equity assets MBMI operation and process measured at a stock of $4.3 trn exceeded that operated by humans [25]. The ability to create such MBMI systems with multiple layers has led to advances in several sensor technology research areas e.g. speech recognition and computer vision. Still we have not identified pure machines based “MBMI brain´s” that are able to sense all 5 senses. Smell, taste and touch is still a challenge but several research labs are experimenting with these sensors to be built in to BM´s. In figure 19-7. we show an example on how we conceptual expect future MBMI brains to operate including all senses in the near future.

A. How can the MBMI Brain be inspired by The Human Brain?

A first inspiration to construct a MBMI Brain could naturally be adapted by studying and imitating one of the most advanced sensing organs in our world – the human brain. The human brains sensor part and its ability to downloading, seeing and sensing its environment and even its own body – and not least its creativity part – where the human brain do the sensing part of the MBMI process – is a very good basis and inspiration for the future constructing of a MBMI Brain. The Human Brain make the human and the body act and do through relations and make the body live its life as its “strategy moves” along its life. The human sensors measurement systems helps continuously the human brain to measure the human bodies performance – “downloading” and “seeing” - let it interacts according to and with the environment, machines, spices and humans around – “sensing” and “act and do”. This is “at first glimpse” a perfect competence and capability to adapt 1 to 1 into the MBMI Brain. As an inspiration an illustration of the human brain is shown in figure 19-8. , showing the brains 5 critical senses – smell, hearing, touch, vision and taste.

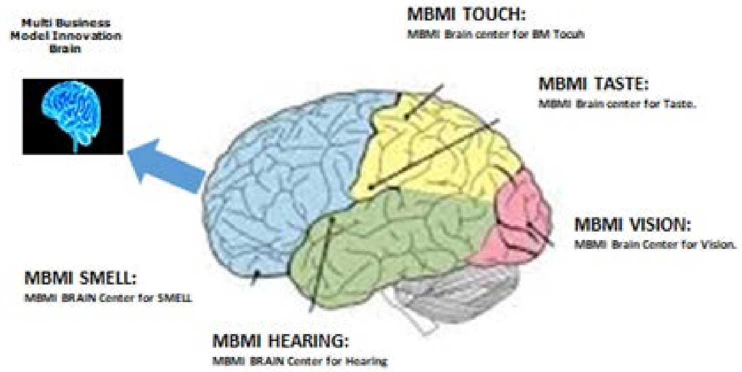


Figure 19-8 The MBMI human brain and its 5 sensing centers [29]

The human brains 5 sensor centers that each receive, capture, translate, analyze, create and deliver sensor data is a good starting point and vision for the construction of the MBMI brain. A manifold and different types of “human sensor centers” receives data from sensors placed different strategical places in the human body and support the Human Brain with performance measurements – e.g. data for touch, taste, vision, hearing, smell. The human brains sensor centers and the sensors collaboration enables the brain to “understand” and “react” on all kinds of sensor data. However the MBMI Brain together with its sensors could potentially be constructed even more advanced in the future to become more intelligent and different than the Human Brain. In other words overcoming the barriers, weaknesses, threats and limits of the human based MBMI brain – combining the advantage of the human and the machines competences and capabilities.

Drawing an analogy to our proposed future MBMI Brain construction - we propose in this construction attempt that the MBMI Brain has initially the same sensors, sensor centers and communication systems, competences and capabilities built into the MBMI Brain construction as the human brain.

With its 5 sensor centers that will be able each to receive, capture, translate, analyze, create and deliver sensor data from both human and machine based sensors it will allow the MBMI brain to have more advanced sensor functionality than the pure MBMI Human Brain as it would be able to access more data as the human MBMI brain and managers brain have and can access. At the same time when supported by quantum computers the MBMI Brain will even be able to operate faster than the pure human MBMI brain.

With its 5 sensor centers that will be able each to receive, capture, translate, analyze, create and deliver sensor data from both human and machine based sensors it will allow the MBMI brain to have more advanced sensor functionality than the pure MBMI Human Brain as it would be able to access more data as the human MBMI brain and managers brain have and can access. At the same time when supported by quantum computers the MBMI Brain will even be able to operate faster than the pure human MBMI brain.

One of the core difference to humans compared to other species and yet also machines is that humans can be creative. According to David Englemann [30] humans have a litle expansion of the coretex part in front of its brain and human brain got a lot more of it than other species. That lets to more space between input and output, which means that humans take more time to work with the in and out data – “thinking” - about the data in- and output before it act. Other species are much more reflective.

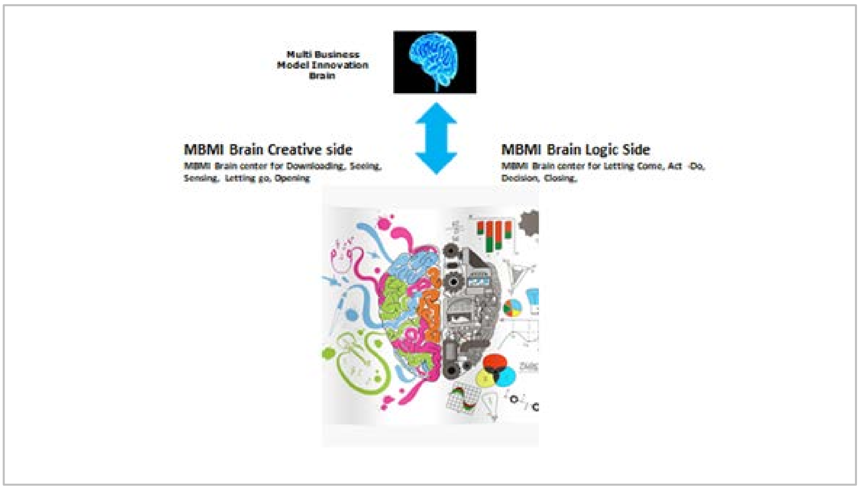


Figure 19-9 The creative and the logic side of the MBMI Brain embedded inspired by Reebooble.com [47]and Saghaug et all [56]

The Human Brain enables humans “to unhook from time and think about future” – “simulate What IFs”. Humans are constantly rehearsing, trying out and predicting possibilities. This enables humans “to let its hypothesis to die in its head” [48].

“Creativity is the humans biological mandate” [48]

Humans when creative – or doing MBMI - actually spend very little time on here and now. However research, shows that todays business managers and employees spend very little time on MBMI and strategic MBMI, because they are forced to and taught to spend most time on operation, routines and daily work. Some of previous findings shows that many businesses spend 85 – 95% of their time on operational task.

Data sensed by humans “gets matched up” with other things and what comes out is constantly what the human brain spin out of the world around – the BMES that the BM is living in - and is experienced by the MBMI Brain. Humans continuously keeps doing this process in the same way if they are not forced or motivated to do opposite – which we can construct the MBMI Brain to do. This is what we call “pushing the MBMI process to go the opposite way as the clock does” and basically push the cognitive process the opposite way in 3 MBMI processes:

1. Binding
2. Breaking
3. Blending

In the construction of a MBMI Brain we need to consider how to develop a platform to enable the MBMI Brain to do so - both in the creative and the logic processes. We have to construct the MBMI Brain to go “opposite way as the clock” which is yet not possible to do by machines and often very difficult for many human brains, as they most often try to “drive” the easiest route. However, there is no easy route to the best MBMI Brain construction and the superior BM´s. MBMI Brain activity demand high focus to the human brain and demands. Much energy has to be provided to power the MBMI Brain processes. Measuring the brain activity in the brain when sensing or working with something new or different shows clearly that MBMI Brain activity requires access to much energy. We therefore also have to consider from where and how to power the MBMI brain.

If we continuously keeps on learning the MBMI Brain our past and “feed” it with both the human and machines knowledge one basic fundament or platform for creativity and creating “bobbles”, ideas, concepts, prototypes is established. Equivalent to what the humans brain in an MBMI Manager can do, if they have skills for this and are well trained. Knowledge – and most bobbles and ideas – some say all – are created generously out of our past knowledge – and learning. New bobbles and ideas does not come out of “the blue sky”. Every bobbles and idea evolves and have a history to it – are based on learning.

That’s why it is important that the MBMI Brain can “download” the business and its related BM´s history to create the fundament for the new or different BM and also “see” from the outside its history and impact on other BM´s. It is the basic for MBMI learning – “the raw material” to all MBMI.

“What we do with machines is that when we stuff data into them they come out later with data on that”

The human brain is however nothing like that [48] and a future MBMI Brain should not be constructed just as a machine that we stuff MBMI data into and it then just come out with data on that. It should be better and much more advanced – and more advanced than the human brain and definitely todays machines brain.

Therefore, let´s begin our approach on the MBMI Brain construction by downloading, seeing and sensing all the advantage of both humans and machines “brains” together and then merge these observations and build on the top of this knowledge. The aim is to create a new Brain – A MULTI BUSINESS MODEL INNOVATION BRAIN – that is better, faster, more flexible and dynamic – and strategic smarter.

B. How can the MBMI Brain construction be inspired by “machines brains”?

When Advanced machine based and related sensors embedded in each BM start acting in the different BMES – the BM´s environment together with AI and Machine Learning will provide us with mega data. These data can be put into computers – or machines – and then they can analyze these and come out with results according to the rules or programs put into them or “learned them”. The sensors can be attached to and embedded in humans, species and/or in machines as part of the one or more BM´s operating in the BMES as indicated in figure 19-10.

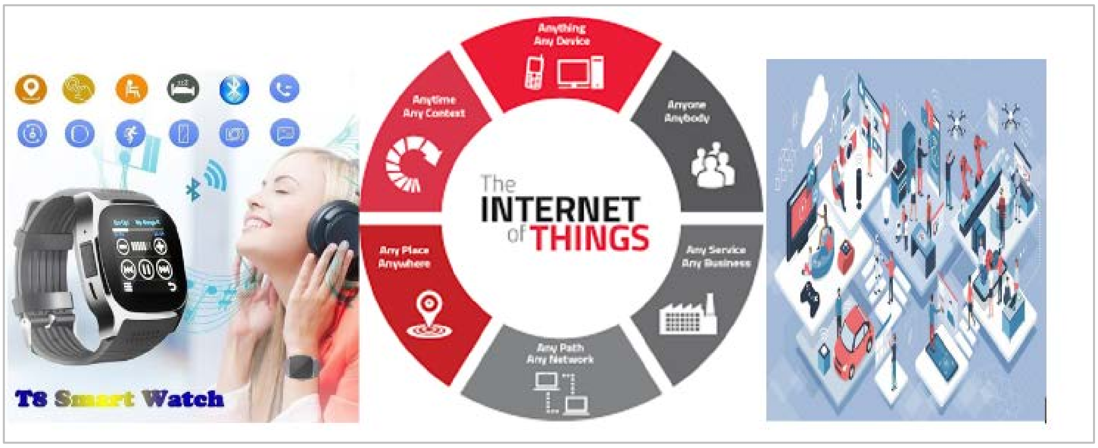


Figure 19-10 Sensors embedded in any Business Model with anything, anyone, anybody, any place, any time, any context inspired by [31],[32],[33]

With AI, machine learning and deep learning the machines can begin to learn more and come closer to be what is regarded as being intelligent. The MBMI Brain has however to communicate, navigate and sense continuously through tangible and intangible relations as shown in figure 19-5, enabling that the MBMI Brain receives and delivers data. The relations are however maybe the most important and vital to the construction of the MBMI Brain. The MBMI Brain has to be able to receive and deliver data – and value to the BM´s though the relations. If the MBMI Brain and its related BM´s are constructed with autonomous and intelligent sensors that are able and allowed to act autonomously, then the value proposition capturing, creating, delivering, receiving and consumption process can take place decentralized or autonomous to the MBMI Brain – but only if there is relations. The MBMI brain can hereby save time and can focus on receiving and/or delivering data e.g. to change strategically a BM or change a combination of BM´s. The MBMI Brain can be constructed to use more time to strategic leadership of MBMI than human management and operation of MBMI

As the MBMI Brain becomes more and more advanced through continuous MBMI learning, it will be able to take over more and more MBMI tasks – and even strategic tasks of MBMI from the human management responsible for MBMI. Thereby not just do routine MBMI tasks, but also advanced dynamic, persuasive and virtual MBMI tasks. This will increase the speed of changing or innovating the BM´s and combination of BM´s even more. The human being will be challenges on MBMI to keep up with speed of MBMI but also to think out strategic best choice of a BM construction and/or combination of BM´s. MBMI practice will face a situation equal to when big blue played the chess game against the world champignon chess player Mr. Garry Kasparov 22 years ago.

Figure 19-11 Picture 1.: and Picture 2.: Mr Garry Kasparoy playing and loosing to the IBM Super Computer Deep Blue

In defeating Kasparov on May 11 1997, the machine called "Deep Blue" made history as the first machine to beat a human world champion in a six-game match under standard time controls. Kasparov had won the first game, lost the second and then drawn the following three. The computer was continuously learning and updating its "knowledge home" – exactly what we expect the MBMI brain will be able to do in the future. When Deep Blue took the match by winning the final game, Kasparov refused to believe it - what we could expect business managers also will do when the MBMI Brain is reality and really come into operation in the near future.

It appeared that AI 22 years ago had reached a stage where it could outsmart humanity – at least at a game that had long been considered too complex for a machine. Bigdata, MBMI AI, MBMI ML, and MBMI DL in combination 22 years later combine with MBMI library and MBMI Pattern analysis lead by a strong, rigid, un human like commitment to cold, hard logic in a MBMI Brain have already begun to demonstrate human creative style of thinking and learning [30]. The application of MBMI simple rules on a grand scale seems already to have been reached in some businesses and BMES – especially in ICT, ecommerce and social media BMES. The face of Kasparov's emotional behavior in Picture 2 seems soon also to be reality for managers responsible for businesses MBMI, if they do not convince their businesses to invest heavily in MBMI Brain technology to support them in their MBMI processes.

As more and more business will realize and accept that MBMI has to be carried out differently and to use MBMI constructions with MBMI Brains - future MBMI will expectively become quite disruptive, more dynamic, agile and faster related to previous MBMI forms and types. This will eventually adapt more risk to the businesses [31]. However the risk of MBMI will become less if the different MBMI Brains commence to act with incremental MBMI [23] under controlled forms. If the MBMI Brains begins to act autonomously then the MBMI process can in worst case get out of control.

DISCUSSION

Sensors, wireless, persuasive, AR and Virtual technologies in businesses everyday MBMI will change BM and BMES - and will continue to develop exponentially [4] and create new types of MBMI. Numerous software and sensor innovations attempt to enhance the MBMI creating, capturing, delivery, receiving and consumption process and capability. When an internet user googles some BM of interest – shoes, sailboat, house for sale – the MBMI Brains have already for several years analyzed the data received from the sensors and few seconds later pushed promotion not just on the first website – first BMES - entered by the user but also to several other websites – BMES´s - that the user enterers afterwards. In figure 19-12 and illustration of this is shown where the MBMI BRAIN of German Lloyd business push BM value propositions through newspaper BMES (BT) e-newspaper, music channel (Youtube BMES) webpages, E - Shopping Mall (Boost.com - BMES) and direct through own loyalty E-commerce site (Lloyd.com).

How will these frameworks, tools and persuasive BM´s impact and enable managers responsible of MBMI to do better and more strategic MBMI in the future? When advanced technologies [6] and advanced MBMI Brains "melt" and work together - meaning that BMs will act anywhere with anybody, anything, anytime and in any BMES – either physical, digital or virtual. Hereby the potential for business MBMI Brain increase tremendously because the individual BM´s value proposition becomes more tailor made to the user, customer, network partner and not least the Business.

By the introduction of a MBMI Brain construction, it will be possible to play more and more advanced "games" of MBMI – and faster MBMI games. The MBMI Brain would be able to combine the business different BM´s and play them together in the best value formula combination in the preference of the business. This has previously been carried out by managers responsible for MBMI – like a football manager setting the team and shifting the players through the game in accordance to how they perform, how they performed together, how the opposite team played the game and how the game proceeds.

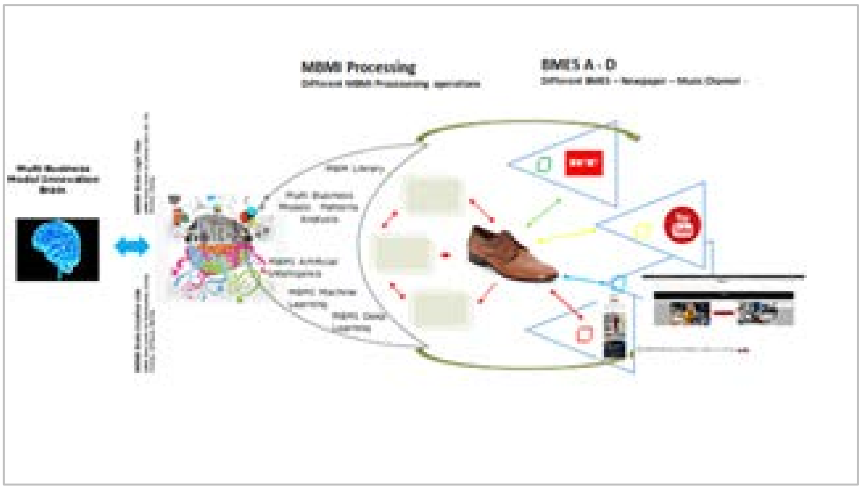


Figure 19-12 Illustration of MBMI Brains working in different BMES

A MBMI Brain would change the MBMI game from purely human controlled to machine based controlled – or even a combination of human and machine based MBMI leadership. One effect of implementing a MBMI Brain is that the potential to the individual business increase as it is now able to offer the business BM´s to a larger group of users and customers in the BMES – but even also to vertical and horizontal BMES [24]. If different MBMI Brains collaborate - complement each other even also including competitors acting together [24] – acting in coordinated swarms of BM´s - then the user, customers and network will be able to experience better, more advanced and more precise value propositions. In other words "the cake" becomes larger and the BMES increases or even melt together.

The BM community will definitely be pushed to adapt MBMI Brains and related advanced technologies to be able to act faster, change strategic mindset more often and technological MBMI setup within split seconds. While the advance MBMI technologies grows mature, businesses will be more and more dependent on their MBMI Brains setup. That will enable them quickly to get a deep understanding of how BM´s and BMES really works and is expected to work in near future – and do the MBMI Pattern analysis together with choosing the most suitable BM archetype.

Businesses have continuously to know how their BM´s are operating (AS IS BM´s) and how they should be constructed (TO BE BM´s) and this makes business very dependent on the relations to the BM´s and the sensors embedded in their BM´s. That is the reason why we see heavy investments in advanced sensor technologies integrated with wireless technology systems [25]. Businesses have to continuously know how and what their BM´s really can "do and act". Simulations of BM´s and combinations of BM´s becomes hereby important MBMI support tools together with AI, DL, MBMI Pattern analysis and MBMI library.

The proposed conceptual model consists of the MBMI AI, MBMI ML and MBMI DL section, which represents the interaction between MBMI DL patterns analysis, the BM and combinations of BM´s, the humans and the machines. The Multi Business Model Library will over time, consist of all existing known Business model Typologies, typologies of combination of BM´s and typologies of MBMI processes within the business – a “Knowledge Home” for MBMI. This is equal to the chess player Mr. Kasparov or Deep Blue computer from IBM – who and which based their play on their knowledge in the human brain and Deep Blues knowledge.

A MBMI Brain will become required competences of many Businesses in the future and when fulfilling this requirement – also eventually become a core competence to some businesses [26]. The Multi Business Model library, The Multi Business pattern analysis, MBMI AI, MBMI ML and MBMI DL systems surrounding the MBMI Brain will continuously adapt new types of business models and combination of Business Models. They will be “learning” MBMI as they operate. From the above mentioned the conceptual model for the construction of a MBMI Brain must have 4 key supporting sections as described above:

- “Artificial Intelligence
- “Deep Learning”
- “Business Models patterns analysis
- “Multi Business Model Library”

The MBMI Brain – inside the MBMI Brain – must also have “sensor center” or more sensor centers. System(s) taking care of the reception and processing of sensory information. Information - received through “the MBMI Brains relations” in the conceptual model, and directly to the centers of the brain exposed to the values running forwards and backwards through the relations to the BM´s and between BM´s.

The MBMI brain will be able to receive, interpret and deliver information from its special senses responsible for vision, smell, hearing, taste and touch. However, the MBMI Brain is challenged as it has to deal not just with one sensor signal, but with mix motor and sensory signals. These have to be integrated and understood by the MBMI Brain as the MBMI brain will receive data and has to send data back coordinated from and to a mix of BM´s. The last “bit” is challenging – and would expectedly also be why one MBMI Brain could be developed to be more intelligent than another one – and hereby perform core competence to one business related to other businesses.

Though, we fully recognize that much more research has to be carried out to extent our understanding of the MBMI Brain´s construction it gives us a hypothetical basis to begin experimenting and do verifications on the different proposed components and prototypes of the MBMI Brain. At the same time more archetypes of AI and DL for MBMI, add to archetypes of BM, combination of BM´s, MBMI process archetypes as a kind of MBMI knowledge home will be verified and possible to add and built finally the first MBMI Brain. On behalf of AI, DL, Multi Business Model Innovation library and Multi Business Model patterns analysis we are however just in the very beginning of building and understanding the foundation of a MBMI Brain in our new CGC LAB. Our own estimate is that it will take another 3 – 5 years to develop a functioning construction of a prototype of the MBMI Brain including sensor and relations.

CONCLUSIONS

MBMI Brains support by AI, DL and advanced sensor technologies are and will be increasingly developed and integrated in Businesses BM´s and MBMI operation. This will created not just a new generation of BMs but also new combination of BM´s – never seen before. With the support of MBMI Brains businesses will be able to find BM´s archetypes and combinations of BM´s not seen before.

The MBMI Brain will allow development of BMs operating and innovating autonomously in all types of physically, digitally and virtually layers of the business, BM, combination of BM, MBMI processes and BMES. Hereby the agenda and practice of MBMI will change disruptively and humans and machines will come to play a very different role together in MBMI – with more power to the machines and MBMI Brains. The paper in this context elaborated on a conceptual model for how a generic MBMI Brain could be constructed and how it could look like. Different examples/illustrations/analogies to human brain and other brain constructions were discussed to show how we expect future MBMI Brain and operations will be constructed and operate. The paper describes the importance of the relations of the MBMI Brain – relation between the MBMI Brain, its expected sensor centers and its supporting tools, knowledge centers, BM´s and The MBMI Library, The MBMI Pattern Analysis center, AI, ML and DL. If these tangible and intangible relations cannot be created, captured, connected and opened for value transformation then the receiving and consumption process cannot take place.

The MBMI Brain is expected to be “the central organ” – or “spider” - of any business in the future and a vital part of its “nerve system”. With the manifold of tangible and intangible relations forming the value transformation system in “the business internal and external nerve system” the MBMI Brain strategically will lead all MBMI activities of the business. The MBMI Brain will take care of all MBMI processing, integrating and coordination of the information it receives from related sensors. The MBMI Brain will analyze, create and deliver value back to each BM´s dimensions and components – either it is human and/or machine based BM´s and make decisions as to the instructions sent to the rest of the business as illustrated in figure 19-12.

FURTHER RESEARCH

In our review of the current multi business model innovation literature and the previous proposed conceptual we found a gab in current body of knowledge, even the current understanding of the MBMI process have not been investigated to its full extent. We propose a further study, supported by the advanced technology and MBMI Knowledge in our Global spread CGC Lab´s, in understanding the MBMI Brain, its environment and the success factors, before extending the MBMI process with any further digitalization factors. Secondly, we propose to use the output of the previously suggested study in conjunction with the proposed MBMI conceptual model [1], [2], [8] and extend the MBMI process with further digitalization in the areas of interaction archetypes and interaction archetypes patterns of the conceptual model. We will further investigate the impact of the exponential growth of these BM´s and advanced MBMI technologies discussed in our future research at the MBMI and Technology research lab at CGC.

REFERENCES

[1] Valter, P., Lindgren, P., and Prasad, R. (2017) Artificial intelligence and deep learning in a world of humans and persuasive business models, GWS 2017 Proceedings IEEE Explorer, (in press).

[2] Valter, P., Lindgren, P., and Prasad R. (2018) The consequences of artificial intelligence and deep learning in a world of persuasive business models. IEEE Aerospace and Electronic Systems Magazine, 33, 80-88.

[3] Lindgren, P. (2016) The business model ecosystem. Journal of Multi Business Model Innovation and Technology, 4, no. 2, 61-110.

[4] Prasad, R. (2016) Knowledge home. 2016 International Conference on Advanced Computer Science and Information Systems (ICACSIS), IEEE Explorer.

[5] Lindgren, P., and Rasmussen, O. H. (2018) The business model relation axiom. In: River Publishers Series in Multi Business Model Innovation, Technologies and Sustainable Business (eds), The Multi Business Model Innovation Approach Part 1, pp 119-147.

[6] Lindgren P., (2018) The Multi Business Model Innovation Approach – Part 1 River Publishers

[7] Beqiri, G. (2014), Innovative business models and crisis management, Procedia Economics and Finance, Vol. 9, pp. 361-368.

[8] Lindgren P, (2019) Advanced Business Model Innovation Supported by Artificial Intelligence, Deep Learning, Multi Business Model Patterns and a Multi Business Model Library · Wireless Personal Communications DOI: 10.1007/s11277-019-06260-x

[9] Taran, Y., Harry Boer, Peter Lindgren A business model innovation typology 2015, I : Decision Sciences. 46, 2, s. 301-331 31 s.

[10] Martins, L. L., Rindova, V. P., & Greenbaum, B. E. (2015). Unlocking the hidden value of concepts: A cognitive approach to BMI. Strategic Entrepreneurship Journal, 9, 99–117.

[11] Lindgren P., (2003) Network based High Speed Product Innovation River Publishers - Author: Peter Lindgren, Aarhus University, Denmark ISBN: 9788793519275 e-ISBN: 9788793519053

[12] Andersen, G.K., Susan Durst, Per Valter and Peter Lindgren (2019) Collaborative knowledge sharing and knowledge generation in Multi Business Model Innovation processes - A three-dimensional Knowledge Ecosystem Proceedings IFKAD Conference 2019

[13] Lindgren P. (2018) Disruptive, Radical and Incremental Multi Business Model Innovation Conference Paper · November 2018 DOI: 10.1109/GWS.2018.8686679 Conference: 2018 Global Wireless Summit (GWS)

[14] Poole, David; Mackworth, Alan; Goebel, Randy (1998). Computational Intelligence: A Logical Approach. New York: Oxford University Press. ISBN 978-0-19-510270-3

[15] Russell, Stuart J.; Norvig, Peter (2003), Artificial Intelligence: A Modern Approach (2nd ed.), Upper Saddle River, New Jersey: Prentice Hall, ISBN 0-13-790395-2

[16] Russell, Stuart J.; Norvig, Peter (2009). Artificial Intelligence: A Modern Approach (3rd ed.). Upper Saddle River, New Jersey: Prentice Hall. ISBN 978-0-13-604259-4.

[17] McCorduck, Pamela (2004), Machines Who Think (2nd ed.), Natick, MA: A. K. Peters, Ltd., ISBN 1-56881-205-1

[18] Lindgren P. and Katharina Wuropulos (2017) Secure Persuasive Business Models and Business Model Innovation in a World of 5G Wireless Personal Communications October 2017, Volume 96, Issue 3, pp 3569–3583

[19] Prasad Neili (2019) AI a job creator or job killer 4 in 1 conference Key note speech at CGC Denmark.

[20] Schmidhuber, J. (2015). "Deep Learning in Neural Networks: An Overview". Neural Networks. 61: 85–117. arXiv:1404.7828. doi:10.1016/j.neunet.2014.09.003. PMD 25462637.

[21] Bengio, Yoshua; LeCun, Yann; Hinton, Geoffrey (2015). "Deep Learning". Nature. 521 (7553): 436–444. Bibcode:2015Natur.521..436L. doi:10.1038/nature14539. PMID 26017442

[22] Marblestone, Adam H.; Wayne, Greg; Kording, Konrad P. (2016). "Toward an Integration of Deep Learning and Neuroscience". Frontiers in Computational Neuroscience. 10: 94. doi:10.3389/fncom.2016.00094. PMC 5021692. PMID 27683554

[23] Andersen, G, Peter Lindgren, Jane Flarup (2019) Business Model Innovation Process Management in a Business Model Innovation Continuum Wireless Personal Communications WIRE-D-19-00379 ISSN 0929-6212

[24] World Street Journal (2019) https://www.wsj.com/articles/loreal-expands-virtual-try-on-service-11576776586?mod=hp_minor_pos4 20-12-2019

[25] Morgan Chase (2019) US Equity Strategy & Global Quant Research, EPFR in Economist October 5th – 11th 2019

[26] Lindgren P. and Katharina Wuropulos (2017) Secure Persuasive Business Models and Business Model Innovation in a World of 5G Wireless Personal Communications October 2017, Volume 96, Issue 3, pp 3569–3583

[27] Prasad Ramjee, Sudhir Dixit (2017) Human Bond Communication: The Holy Grail of Holistic Communication and Immersive Experience ISBN: 9781119341338 |Online ISBN:9781119341451 |DOI:10.1002/9781119341451 John Wiley & Sons, Inc.

[28] Tayaba Iftikhar, Hasan Ali Khattak, Zoobia Ameer, Munam Ali Shah, Faisal Fayyaz Qureshi, Muhammad Zeeshan Shakir (2019) Human Bond Communications: Architectures, Challenges, and Possibilities Published in IEEE Communications Magazine 2019

[29] https://www.google.com/search?tbm=isch&sa=1&ei=MYZKXa-wL8WqrgSRy6fgAg&q=brain+and+senses&oq=brain+and+sens&gs_l=img.3.0.0j0i8i30j0i24l4.92604.95391..99089...0.0..0.108.830.6j3......0....1..gws-wiz-img.......0i67.ma2eqJNwLQE#imgrc=BaheBWXQofSeiM:&spf=1565165222814

[30] Englemann David https://www.youtube.com/watch?v=8tN3J_V-J5w

[31] https://m.kikuu.com/product/1164848

[32] https://webility.ca/solutions/internet-of-things-smart-devices/

[33] Jurgens Brett (2019) https://www.pioneeringminds.com/prepare-your-home-for-iot-smart-devices/ Forbes

20. Use of Digitization in Rural

Umesh Sah, Director IT & eGov, CEO Jharkhand Communication Limited & CEO ABVIL at Govt of Jharkhand, India

"The soul of India lives in its villages." Mahatma Gandhi. The Indian economy is predominantly rural with over two-thirds (65.97 %) of its population and workforce residing in rural areas. Rural India contributes a substantial part of the total net value added in many sectors, with an overall 46% contribution to our national income. With a population of 833 million people residing in 640,867 villages, it is projected that, by 2050, more than half of India's population will still be rural, despite rising urbanisation. Thus, the growth and development of the rural economy is imperative for inclusive development and overall growth of the country. Apart from this Urban India is not able to provide proper space livelihood and proper amenities to increasing population. The report speculates that by 2050, the urban population will have increased to 87.7 million and the rural population will account for 78.3 million people. However, this overhaul will take place somewhere after 2045 itself, suggests the data. The urban population of India has seen a rise from 17.1 per cent to 29.2 per cent between 1950 and 2015. Meanwhile, the rural population declined from 82.9 per cent (in 1915) to 2015's 67.2 per cent. The speculation for the year 2050 suggests that the urban-rural segregation will be 52.8 and 47.2 with a difference of 5.6 per cent.

Within a decade of globalization, the rate of urbanization increased by one-third of its previous growth. This has resulted in stress on the country's urban conglomerations.

Rural FMCG market accounts for 40 per cent of the overall FMCG market in India, in revenue terms. Businesses in India are optimistic about growth of the country's rural consumer markets, which is expected to be faster than urban consumer markets. The report highlights the better networking among rural consumers and their tendency to proactively seek information via multitude sources to be better informed while making purchase decisions. With increasing contribution to development and exposure to needs, the buying capacity of rural Indians has taken a sharp upward turn. However, rural consumers have a strong value-formoney orientation, significant local cultural affinity, and a more conservative financial outlook. Their purchasing aspirations are often constrained by easy availability. Digitisation and technology can facilitate access and availability of more and more services and products be made available to meet the rising aspirations of the underserved and unreached rural India. This is being driven strongly through the government's Digital India programme. One of the key enablers is the growing internet penetration, expected to grow from 25% in 2016 to 55% by 2025.

Only 38% of the 117,200 branches of scheduled commercial banks are working in rural areas, and a meagre 40% of the households have bank accounts. Thus, India is home to 19% of the world's unbanked population. Financial inclusion is an important priority of the government. This gap at the last-mile is being filled by banks through a combination of finance and technology enabled by business correspondent agents.

India is an agrarian economy with agriculture supporting 60% of our population. Indian agriculture is highly dependent on human labour and good rainfall. While most developed economies have mechanised farming and reduced dependency on rains through state interventions and good planning, Indian farmers still plod along with obsolete farming techniques to support a growing population. Yet the contribution of this major sector to GDP has been steadily declining and currently stands at 15%. On the other hand farmers don't have access to market their product on current prevailing rate. Farmers need timely information about farm production, pest control, inventory management and tracking. Farmers also need Climate-Smart Precision Farming to avoid rain dependency.

In 2012, only 27 percent of adult Indian women had a job, or were actively looking for one, compared to 79 percent of men. Rural jobs have been decreasing and not enough rural women have been able to make the transition to working in urban areas. India could boost its growth by 1.5 percentage points to 9 percent per year if around 50% of women could join the work force. India's maternal mortality rate is high and accounts for 20 percent of global deaths occurring due to preventable causes related to pregnancy and childbirth. In India Infant Mortality rate is 29.848 which is worse than Bangla Desh (24%) and Sri Lanka (7.1%).

Digitization can facilitate some of the key needs of **rural** India including governance services, banking and financial services, educational and healthcare services, mobile/DTH recharge, e-ticketing services, online shopping, etc.

A. EGOV SERVICES :

Following major services are being provided to rural citizen after digitization.

- ***eDistrict Services***- Under this services citizen can apply online for Birth Certificate , Death Certificate, Residential Certificates, Caste Certificates and other certificates and can get it within prescribed timeline. This has eliminated and helped them to get all relevant certificates from their villages and they can devote their valuable times in study/farming/other household activities and can increase productivity.
- ***PDS:*** In its bid to better target subsidies and ensure leakage-free distribution of foodgrains, the government used automated ration shops. This helped to extend benefits to needy at the same time it also helped to eliminate bogus beneficiary and Govt saved around 5000 Cr yearly. This fund is being used in other development work.
- ***PMJAY(Ayushman Bharat):*** The scheme's aim is to provide cashless hospitalization to 50 crore Indians (mostly rural) to the extent of Rs 5 lakh per family in any hospital in India. All this at no cost to the individual. This is possible due to digitization of individual records.
- ***Land Record Digitization:*** A complete computerised compilation of land data, starting from the original owner to the present status of land, including an image of the property and the landowner for identification purposes, will reveal the total area of land owned by a person. Making land records available to all is helping to contain/check property frauds. This is also helping rural mass to know all record in a single click. Land registry mutation and fee payment can be done from village center itself.
- ***MGNREGA(Job Guarantee to Rural People):*** Digitization has helped to reduce false job cards and beneficiary can get payment directly to their account through DBT.

B. USE OF DIGITIZATION IN AGRICULTURE

- ***Expert Advice:*** In this project the village information centre (VIC) receives information by voice, mail and SMS with help of IMD/ISRO/CSIR. Farmers receive advice on rotation of crops, fertilisers and pesticides. Digitization technology can be used for on-farm sensing technology to records various soil, environment and crop parameters and uses artificial intelligence and data science to make on-farm predictions. Some of the major benefits we can get from Climate-Smart precision farming are -
  - Costs savings in terms of water, energy, fertilizers, and pesticides. * Product losses prevention by controlling weather conditions to adequate harvest times. Optimizing farmers daily tasks by automating processes.
  - Getting real-time alerts about crop's conditions to make adjustments to reach optimal growth conditions.
- ***Marketing Support:*** It is helping farmers and buyer through Real Time Price Discovery, Better Price Realization For Producers, Reduced Transaction Cost For Buyers, Stable Price and Availability to Consumer. In April 2016, Govt launched eNAM (National Agriculture Market), an online platform for farmers that integrates agricultural markets online, allowing farmers and traders alike to view all Agriculture Produce Market Committee-related information and services, commodity arrivals and prices, and buy and sell trade offers, thus helping farmers bid for the best prices across markets.

C. USE OF DIGITIZATION IN RURAL EDUCATION SYSTEM

- ***Improvement in Quality Education:*** Recent numbers point out that there are 97,273 single teacher schools in India, which account for about 8.8 percent of the total schools in the country. These obstacles don't just lead to poor quality of education, but also contribute to high dropout rates in rural schools—nearly 50 percent by the age of fourteen.
  Education can be digitised in rural areas by providing multimedia teaching tools to teachers and engaging students through learning methods that utilise digital tools, such as smart-boards, LCD screens, videos, etc., to teach them different concepts. By making it possible for one teacher to deliver information remotely across several locations, interactive digital media will also help address the shortage of teachers in these schools. Some of the state has started doing this.
- ***Monitoring of Attendance :*** Attendance of teacher as well as student can be monitored through GIS based APP.

D. USE OF DIGITIZATION IN RURAL HEALTH SYSTEM

India has a lower than average doctor to patient ratio, which is further skewed by concentration of medical facilities in the urban centers. medical professionals through Telemedicine.

Availability of care: The impact of digitization holds strong significance for rural services as there is a huge dearth of hospitals with modern facilities and quality medical practitioners. Accessibility to healthcare setups and unavailability of doctors is a huge concern in rural India.

Quality healthcare services through digital devices can now reach small towns and villages through local health camps and/or Primary Health Centers, as small portable devices now provide accurate health readings. Advanced telemedicine: Digital devices, that provide real time health readings, negate the requirement of manual intervention for diagnosis like heart monitoring, Blood Pressure data, sugar levels amongst others vital statistics and offer continuous data management while providing access to quality medical practitioners through connected devices.

Access to timely specialist and super specialist advice: Digital Devices, can substitute the need for physical presence of specialist medical practitioners and large medical setups across the underdeveloped interior locations of the country, providing similar services at reduced costs. This can be an effective low-cost solution given the existing network of primary healthcare centers and district hospitals which can be leveraged.

Affordable care: The cost of quality treatment is quite high in India with majority of leading hospitals located in major metros or Tier I locations. Government aided hospitals cannot cater to the rising population and growing need of medical assistance across all age groups. Portable medical devices, available at affordable costs, help monitor health readings from the comfort of one's home negating the need to travel and visit hospitals for every small medical need. These devices can be shared through mobile apps with doctors and concerned family members and can be continuously monitor through connected devices.

GIS based Ambulance Services: Using GIS 108 Ambulance services are being provided to rural people. It is quick and cost effective. Rural citizen can be connected to nearest health care system and during transportation expert care can be also be provided through call center.

E. USE OF DIGITIZATION FOR WOMEN EMPOWERMENT AND FAMILY WELFARE IN RURAL AREA

Women and child Health Recording and timely assistance: A 6.15 per cent reduction since the last survey figures of 2014-2016 has been observed in Maternal Mortility Rate. ASHA workers are using Smart Phones and Mobile APP to provide following data :

- Identifying and registering new pregnancies, births and deaths,

- Mobilizing, counselling and supporting the community to demand and seek health services and connecting to doctors at block/district level
- Identifying, managing or referring cases of illness
- Tracking and completing timely immunizations sessions, health records to provide timely assistance

Women Empowerment: Women in Rural area using Smart Phone to sell their products to middle level system and getting money directly into their account.

F. USE OF DIGITIZATION FOR RURAL ECOMMERCE:

Now using technology rural producer can also connect their product through Amazon, Flipcarts etc

21. Digital India: How to Make India a Truly Connected Nation

Tilak Raj Dua, Vice Chairman, Global ICT Standardization Forum for India (GISFI), and Chairman, ITU-APT Foundation of India, New Delhi, India
tilakrajdua@gmail.com

INTRODUCTION

The 'Digital India' initiative was launched by Hon'ble Prime Minister, Shri Narendra Modi in 2015 and after a lapse of 4-5 years, there have been significant improvements in all of its facets such as, in the creation of digital infrastructure, electronic delivery of public services, financial inclusion and in enhancing digital awareness and literacy.

Further, 5G and new technologies and applications such as AI, AR/VR, IoT/M2M, Cloud computing, big data analytics, machine learning etc can unleash new economic opportunities and societal benefits giving it the potential for being a transformational force for Indian society. It can help the country leapfrog the traditional barriers to development as well as advance the 'Digital India' vision. The cumulative economic impact of 5G on India can reach one trillion USD by 2035.

Mobile has already played a central role in realizing the ambitions of the Digital India initiative, and will also be central to realizing the NDCP-2018 goals to 'Connect India', 'Propel India' and 'Secure India'. The key strategic objectives of NDCP 2018 planned to be achieved by 2022 are:

- Broadband for all
- Creating 4 Mn additional jobs in the digital communication sector
- Enhancing the contribution of the digital communications sector to 8% of India's GDP from ~6% in 2017
- Propelling India to the top 50 nations in the ICT Development Index of ITU from 134 in 2017
- Enhancing India's contribution to global value chains
- Ensuring digital sovereignty

However, a number of challenges need to be addressed if India is to achieve the NDCP-2018 objectives and see the significant investments from telecom sector. The following figure depicts telecom evolution in India over the years:

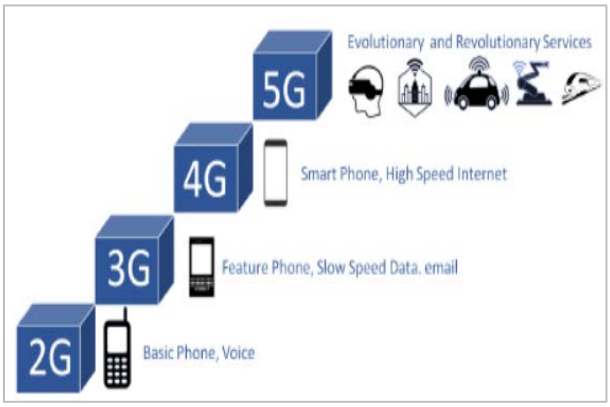


Figure 21-1 Telecom evolution in India

At present, India has around 1.2 Bn mobile and 655 Mn internet subscribers, making it the 2nd largest digital communications market in the world as of Oct'2019. India has witnessed a major technology transformation in the last 4-5 years and has emerged as the 2nd fastest digital adopter among 17 major digital economies. The Indian telecom sector continues to grow rapidly and as per the National Digital Communications Policy-2018, digital communications sector is expected to contribute 8% to GDP by 2022 as compared to 6% to GDP in 2017. As per GSMA Intelligence report, India will top seven countries who will account for half of new subscribers to 2025.

Smartphone users in India use their smartphones frequently to access and consume a range of digital services and content. In a number of areas, Indian smartphone users score well above the global average. While the number of users is significantly lower, there is a clear appetite in India to access government services through apps and online. In the area of digital commerce, India is broadly in line with global averages but lags significantly behind leading markets such as China. The rapid adoption of smartphones means that by 2025 it will be the 2nd largest smartphone market, with almost 1 Bn devices.

The rapid and unprecedented proliferation of the mobile phone, the internet, social media platforms, and the rapid expansion of digital payments, data consumption and generation across India indicate that the data economy and digital technologies and services are no longer the prerogative of the privileged few; but empowering more than a billion Indians.

This rapid growth has been propelled by both public and private sector alike. India's lower-income states are bridging the digital divide, and the country has the potential to be a truly connected nation in next 4-5 years i.e. by 2025. All Indian stakeholders will need to gear up to the opportunities and challenges of being a connected nation.

Higher speed networks and the growing base of smartphones have fueled rapid growth in data volumes in the Indian market; the increased viewing of video content is an important factor in India, as in many other markets. The TRAI has highlighted that mobile data usage per month in India increased from 39 petabytes in June-2016 to 4,178 petabytes in September-2018. Ericsson estimates that in 2018 India generated more traffic than the whole of Western Europe, with total data volumes set to increase 4x by 2024.

		% of global new additions
	India	24%
	China	8%
	Pakistan	4%
	Nigeria	4%
	Indonesia	3%
	US	3%
	Brazil	3%

Source: GSMA Intelligence

Figure 21-2 New Users

2025 rank	Country	Smartphone connections, 2025 (m)	Change in rank since 2018
1	China	1,458	=
2	India	983	=
3	Indonesia	410	↑1
4	US	346	↓1
5	Brazil	204	=
6	Russia	190	=
7	Japan	176	=
8	Pakistan	146	↑14
9	Nigeria	143	↑11
10	Bangladesh	133	↑11

Figure 21-3 Global Smartphone Users

Public sector is one strong catalyst for India's rapid digitization. Aadhaar has become the largest single digital ID programme in the world—and a powerful catalyst of digital adoption more broadly in India. Today, more than 1.2 Bn Indians have Aadhaar digital identification, up from 510 Mn in 2013.

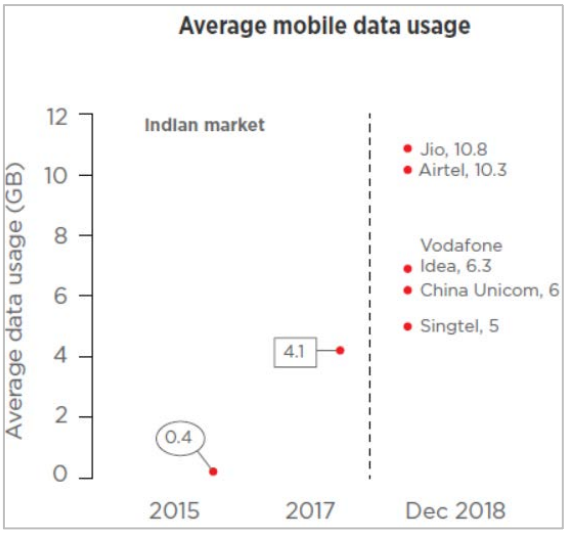


Figure 21-4 Average Mobile Data Usage

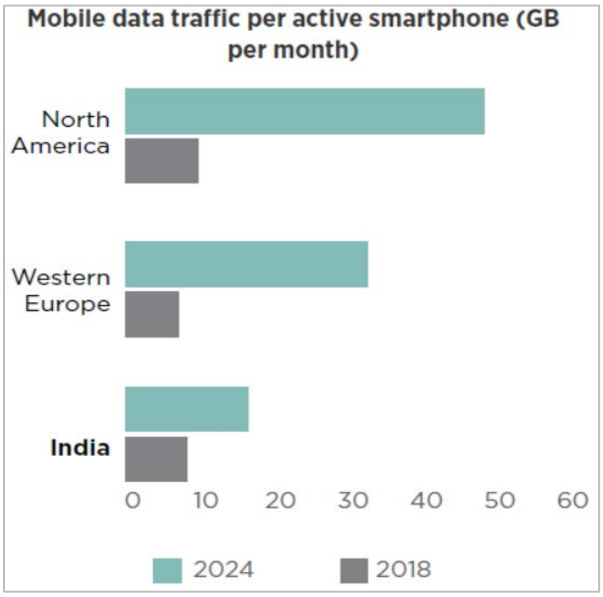


Figure 21-5 Mobile traffic per user

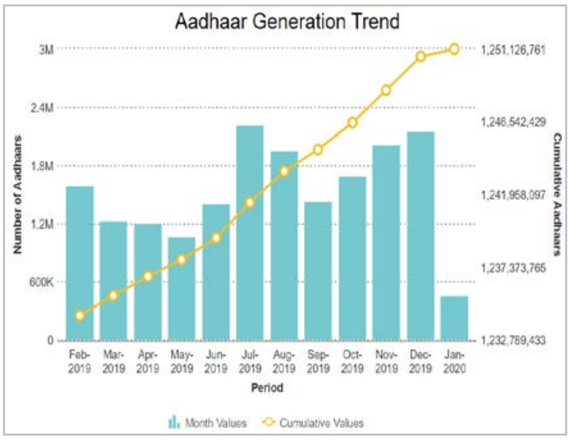


Figure 21-6 Aadhaar Generation Trends

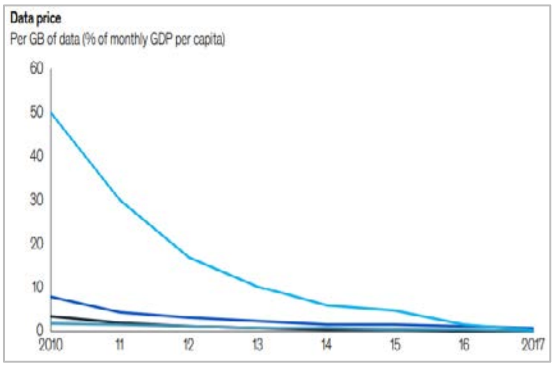


Figure 21-7 Data Price

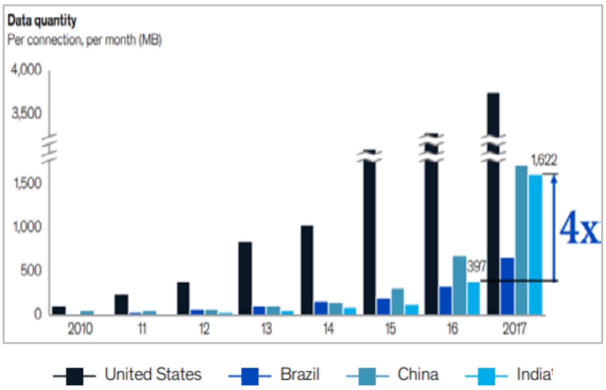


Figure 21-8 Data quantity per connection

Also, the Goods & Service Tax Network (GST), commenced from 2017 bringing all business transactions involving around 10.3 Mn indirect taxpaying businesses onto one digital platform, created incentive for businesses to digitize their operations.

Coming to the Private-sector, innovations has helped digital services to reach millions of consumers. Competition in mobile services has triggered further innovation and competitive pricing across the sector. Data costs have dropped by more than 95% since 2013: the cost of one gigabyte fell from 9.8% of per capita monthly GDP in 2013 to 0.37% in 2017. As a result, monthly mobile data consumption per user has grown up to 152% annually, more than 2x the rates in US and China.

With both public and private sector contribution to the digital usage, India's States have also started to bridge the digital divide. Low-income States have shown the fastest growth in digital infrastructure and services. Citizens in such States can now read the news online, order food delivery via a phone app, video chat with a friend, shop at a virtual retailer, send money to a family member through their phone, or watch a movie streamed to a handheld device.

Even after these digital advances, these States have a lot of further scope to grow in digital terms as only around 40% of the population has the broadband connection as of now. Despite the growth of m-banking and financial inclusion, majority of retail transactions are still in the form of cash as many businesses are still reluctant to adopt the digital payments in all their transactions.

DIGITIZATION OF BUSINESSES

India's businesses have a relatively uneven pattern of digitization, as compared to the adoption by consumers. As per the Survey from McKinsey Global Institute, Differences in digital adoption within sectors are greater than those across sectors.

As per the survey, sectors like transportation and construction are considered resistant to technology and sectors such as ICT, education, healthcare, financial services, manufacturing have more digitized firms on average.

Leading digital companies in India adopt strategies that make them stand out from their peers in several ways. They centre their strategies on digital, let digital technologies shape how they engage with customers, and invest more heavily in digital than their peers. Digital leaders also make digital investment a priority.

Small businesses are closing the digital gap with larger firms and are ahead of them in accepting digital payments. While the large companies having high investment capabilities, invest in new technologies such as Artificial Intelligence (AI) and Internet of Things (IoT), growing high-speed internet connectivity and shrinking data costs are opening digital opportunities for many small-business owners and sole proprietors. Infact the small companies/ businesses are ahead of large companies in accepting digital payments.

CHALLENGES FOR DIGITAL INDIA

The Digital India programme, launched in 2015, has made significant progress in implementation of the various initiatives. However, some challenges are being faced during the execution which need to be addressed on priority.

The challenge for Digital India is to provide last mile connectivity to India's smallest towns and villages. Digitizing these inhabitations require massive investments in digital infrastructure. While the government has a role in making investments, bulk of this investment and innovation must come from private sector may be in the form of Public-Private partnerships.

Success of Digital India further depends on the innovative policy and enabling framework that government creates. It is equally important that apart from being an investor, the government must also act as an innovation and investment enabler and plays that role well.

Inadequate Digital Infrastructure: The biggest challenge faced by Digital India programme is slow and delayed digital infrastructure development. India's digital infrastructure is inadequate to tackle growing increase in digital transactions.

Regulatory Uncertainty: The private participation in government projects in India is poor because of long and complex regulatory processes and commercial unviability. Various proposals issued by the Govt. are not picked up by competent pvt. Sector as they are commercially unviable. Some of such projects include providing mobile/telecom connectivity to uncovered villages in LWE, remote areas, Andaman & Nicobar Island etc

Central-State Coordination: There is still a large gap in alignment between Central and State Government in various policy initiatives such as the taxation, Right of Way, restrictions of placement of infrastructure, mandatory provision for availability of Government land and building for installation of telecom infrastructure etc

Rural Investment: There is a wide digital divide between urban and rural India. Till now funds have not been deployed effectively to meet the cost of infrastructure creation in rural areas. There is no incentive for operators to invest in rural and remote areas where the scope of returns is very less.

Unclear Policy Framework: Taxation and regulatory policies have proved to be a major bottleneck, such as M&A and FDI policy in telecom sector. There is no Single Window Clearance process for faster timebound approvals. At present, M&A applications take around 2-3 years for approval by the nodal department due to lack in inter-departmental coordination. Further, there is no clarity on the process and timeframe for processing the applications.

Digitization of Services and Digital Literacy: While the digital services and content are becoming available in local languages, there is still a lot of content and government services which do not support local languages.

Awareness & Education: Creating an awareness about benefits of Digital India scheme among common masses is also a great challenge. There is a need for upskilling/reskilling of existing resources to be able to meet requirement for rollout and operations of 5G and various upcoming technologies.

Breach of Privacy: Fear of cybercrime and breach of privacy has been deterrent in adoption of digital technologies. Most of the technology including cyber security tools are imported. We do not have requisite skills to inspect these for hidden malwares.

ROBUST DIGITAL INFRASTRUCTURE - KEY TO ACHIEVING "DIGITAL INDIA"

Indian Telecommunication Sector has been at the core of social and economic development of this country and telecom infrastructure sector has been the bedrock for a Digital Economy. Telecommunication and Telecommunication Infrastructure is the backbone of 'Digital India', where future technologies like mobility, analytics, cloud, Internet of Things (IoT), Machine to Machine (M2M) Communications are playing a key role in implementing the Digital India vision.

The government has taken several initiatives to improve the digital infrastructure in the country which are in various stages of implementation. These initiatives extend beyond physical infrastructure and also address software and security infrastructure as all the three aspects are required in tandem to ensure the success of Digital India.

A robust telecom infrastructure will play a key role in seamless connectivity, which is the essence of true "Digitization." It is imperative to develop 'state of the art' network architecture just like other infrastructure facilities such as water, sewage, railway, roads and transportation etc. as telecommunication services nowadays have become an integral and essential necessity of our daily lives.

The overall development of telecommunication services in the past few decades has been phenomenal with the help telecom infrastructure supporting these services at the backend. With the government's thrust on Digital India and Smart Cities, it is needless to say that industry will unfold more new business avenues in the forthcoming time.

Creation of a robust telecom infrastructure will help the country to leap-frog in a knowledge driven economy by enabling the requisite telecom infrastructure for future technologies like Artificial Intelligence, Block chain, IoT and M2M etc.

To boost the potential of the Digital India vision, a defined policy framework for digital infrastructure was required. With this vision, the NDCP-2018 was hence formulated and gazette notified by the Department of Telecommunications, Government of India in Oct'2018.

Initiative	Description
Bharatnet	Broadband Access to 2,50,000 Gram Panchayats (GPs) through a network of Optical Fibre Cable
Smart Cities	Creation of 109 Smart Cities by 2022 Rs 5Bn allocated to every city over 5 years for this project
Common Service Centres (CSC)	CSCs through which e-governance and related services will be made available to villages
Post Office Digitization	Digitization including setting up centralized data centres, networking of all post offices & enabling digital payments
Universal Access to Mobile	Mobile access to more than 55,600 villages that do not have mobile coverage
Public Wi-Fi	Creation of public Wi-Fi hotspots in India to enable citizens to access content without depending on mobile data
India Stack	It is a set of open APIs that enables development of payment-enabled applications, using Aadhaar as the base for authentication
National Cyber Coordination Centre (NCCC)	MeitY has planned to set up a center to safeguard India's cyberspace against potential threats

Figure 21-9 Initiatives taken

REFRESHED "DIGITAL INDIA"

The Prime Minister has recently set a new national goal of India becoming a 5 trillion-dollar economy by the year 2025, and there is little doubt that the refreshed 'Digital India' programme will play a critical role in realizing this audacious ambition. What is really exciting is that the realization that India's digital transformation saga has only just commenced. The creation of a nationwide digital infrastructure, allied with potential new technologies such as AI, Big Data, AR/VR, IoT/M2M are expected to raise sectors that affect the well-being of every Indian, ranging from agriculture, health care, education, transportation, logistics, banking and finance etc. Indeed, there is practically no aspect of modern life that cannot be improved by the application of intelligent digitization. India is striving to become one of the early adopters of 5G technology, and it's rollout is expected to open multiple possibilities and opportunities.

NATIONAL DIGITAL COMMUNICATIONS POLICY, NDCP-2018, A STEP IN THE RIGHT DIRECTION

NDCP-2018 is a truly transformational and comprehensive policy document. It has embarked upon a journey to fulfil the information and communication needs of citizen. The policy has rightly envisaged the achievement of this objective through "Connect India, Propel India and Secure India" missions.

The key strategic objectives of NDCP 2018 planned to be achieved by 2022 are:

- Broadband for all
- Creating 4 Mn additional jobs in the digital communication sector
- Enhancing the contribution of the digital communications sector to 8% of India's GDP from ~6% in 2017
- Propelling India to the top 50 nations in the ICT Development Index of ITU from 134 in 2017
- Enhancing India's contribution to global value chains
- Ensuring digital sovereignty

The NDCP 2018 recognizes the importance and urgency of a strong infrastructure and has recommended to accord telecom infrastructure the status of critical and essential infrastructure. Keeping in view the growing importance of broadband in order to achieve the "Digital India" dream, the NDCP 2018 has set up ambitious goals under "Connect India" mission as:

- Broadband coverage at 50Mbps to every citizen
- 1Gbps connectivity to all Gram Panchayats by 2020 & 10Gbps by 2022
- 100 Mbps broadband on demand to all key development institutions
- Fixed line broadband access to 50% households
- Unique mobile subscriber density of 55 by 2022 and 65 by 2022
- 5 Mn wi-fi hotspots by 2020 and 10 Mn by 2022
- Connectivity to all uncovered areas

KEY RECOMMENDATIONS UNDER THE NDCP-2018

Enhancement of Scope of Telecom Infrastructure Providers: In the converged environment, there is need of independent infrastructure players which will ensure orderly and stable growth of infrastructure. Further, it will also bring in economy of scale and the cost effectiveness due to the sharing of infrastructure at the backend. Infrastructure Players must have an active role in the provisioning of common duct, in-building solutions, pubic Wi-Fi etc. Government has recognized the role of Infrastructure Providers in achieving the Digital India vision and hence, recommends in the NDCP-2018 for the enhancement of Scope of Infrastructure Providers (IP-1) to promote and incentivize deployment of common sharable digital infrastructure.

Fiberization: Tower fiberization will also play a key role for rollout of 5G and other emerging technology and services to achieve Digital India. As of now, 25-30% of towers are fiberized and this needs to be taken up to at least 70% of the towers considering growing demand of data and deployment of 5G, in line with the targets set up by NDCP-2018 up to year 2022. One of the Strategies identified in NDCP for implementing "Fibre First Initiative" under the NDCP is "Facilitating Fibre-to-the-tower programme to enable fiberization of at least 60% of telecom towers thereby accelerating migration to 4G/5G". NDCP has set the stage for achieving full digital inclusion by declaring fiber as a critical public utility.

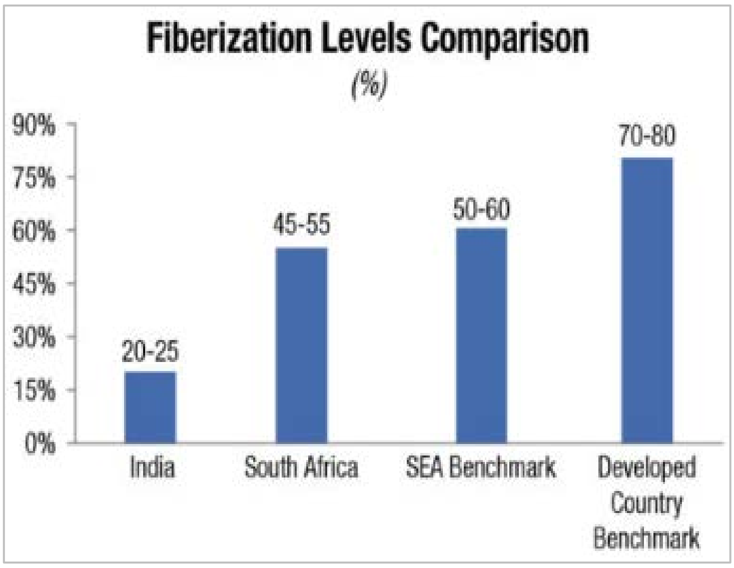


Figure 21-10 Fiberization Levels Comparison

NATIONAL BROADBAND MISSION (NBM)

The recently launched National Broadband Mission (NBM) by Hon'ble Minister of Communications, Government of India on 17th December 2019, has the vision to fast track growth of digital communication infrastructure, bridge the digital divide, facilitate digital empowerment and inclusion and provide affordable and universal access of broadband for all by 2022.

It also includes taking OFC connectivity to 50 Lac Km from the current 22 Lac Km and deploying 10 lac mobile towers from the present 5.8 lac sites, with 70% fiberization in the next 3-4 years. It aims to connect 600,000 villages across India at an estimated outlay of INR 7 trillion including a 10% contribution from the state reserve (USOF) over a period of next 3-4 years.

Annual Implementation Plan of National Broadband Mission as prescribed by the Government is as follows:

Table 21-1Annual Implementation Plan of National Broadband Mission

	Years				
	1	**2**	**3**	**4**	**5**
Connectivity to villages (%)	50	60	100		
Broadband speeds (Mbps)	4	10	25	30	50
Fiberization (Lakh Kms)	24	27	30	40	50
Towers (in lakhs)	7	8	10	12	15
Tower Fiberization (%)	35	45	55	65	70
Mapping of Fiber (%)	10	40	60	80	100

Further, the NDCP-18 also envisages an investment of around USD100 Bn over the next 3-4 years in the telecom sector in order to achieve the objectives of the policy. It is estimated that most of the required investment is estimated to be done in creating the digital communications infrastructure as below:

Table 21-2 required investment is estimated to be done in creating the digital communications infrastructure

Infrastructure Component	Investment (U$ Bn)
Telecom Tower	**35**
OFC Cable	**30**
Spectrum, R&D etc.	**35**
Total	**100**

This envisaged investment of $100 Bn is to be catalyzed largely by the industry, with Government contributing around 10% of this through the Universal Service Obligation Fund (USOF).

COLLABORATIONS BETWEEN CENTRAL, STATE GOVERNMENTS & OTHER STAKEHOLDERS

NDCP-2018 recommends various other strategies which can be implemented only if all such key players come together to meet the objective. Areas where collaboration is required are as follows:

- Provision of common duct infrastructure in municipalities, rural areas and national highways.
- Amending National Building Code of India (NBC), for making telecom installations and the associated cabling and in-building solutions mandatory in all commercial, residential and office spaces.
- Collaborative institutional mechanism between Centre, States and Local Bodies for Common Rights of Way, standardization of fees, taxes, costs and timelines.
- Recognizing communication systems as essential critical infrastructure at par with other connectivity infrastructure like Roadways, Railways, Waterways, Airlines etc.
- Extending incentives and exemptions for the construction of telecom towers. Promoting and incentivizing deployment of solar and green energy.

SPECTRUM

Effective spectrum management is critical to support the investment required to further expand mobile services once 5G and other new technologies and bandwidth intensive applications such as AR/VR, Gaming comes into the market. Adequate spectrum at right prices is needed to meet the rapid increase in demand particularly for data services and enhance the quality and coverage.

5G needs spectrum within three key frequency ranges to deliver widespread coverage and support all use cases. The three ranges are: Sub-1 GHz, 1-6 GHz and above 6 GHz. The recently concluded World Radiocommunications Conference (WRC-2019) in November'2019 has identified additional spectrum suitable for 5G. These additional frequency bands identified for IMT-2020, includes 24.25-27.5 GHz, 37-43.5 GHz, 45.5-47 GHz, 47.2-48.2 and 66-71 GHz bands, which will be used to enhance mobile broadband, ultra-reliable and low-latency communications.

For India, these decisions are also consistent with the ambitious goals as pronounced under NDCP-2018 such as providing 1 Gbps connectivity to all gram panchayats of India by 2020 and 10 Gbps by 2022 and universal broadband connectivity at 50 Mbps to every citizen. The strategies to achieve these goals include:

- Making adequate spectrum available to be equipped for the new broadband era:
    - Identifying and making available new Spectrum bands for Access and Backhaul segments for timely deployment and growth of 5G networks.
    - Making available harmonized and contiguous spectrum required for deployment of next generation access technologies
- Promoting Next Generation Access Technologies in India through:
    - Recognizing mid-band spectrum, particularly the 3 GHz to 43GHz range, as central to India's strategy for Next-Generation Networks
- Enabling Hi-speed internet, Internet of Things and M2M by rollout of 5G technologies:
    - Ensuring availability of spectrum for 5G in <1 GHz, 1-6 GHz and >6 GHz bands

The recent announcement of the government to provide a two-year moratorium on the payment of spectrum dues is a positive step, but given the financial stress, issues surrounding the price of spectrum for forthcoming 4G & 5G spectrum auction needs to be resolved by Govt. on priority basis. The operators owe over Rs 3 lac crores in spectrum costs alone. High reserve prices for the impending auctions could raise these costs substantially.

Some of the other policy reforms towards transparent spectrum allocation, optimal pricing of spectrum, allocation of spectrum for microwave access and backbone, allocation of E&V bands and spectrum sharing and leasing regimes to optimize utilization would be critical.

NEW BUSINESS OPPORTUNITIES FOR DIGITAL INFRASTRUCTURE PROVIDERS IN INDIA

Indian Telecom Infrastructure industry has been one of the pioneers in Infrastructure Sharing Globally, resulted in significant operational efficiency and cost saving for industry. Over the years, pooling/sharing of towers and passive infrastructure – providing integrated Neutral Host platforms for service providers, has found success in the market. Currently, Indian tower companies (TowerCos) are amongst the largest telecom infrastructure companies across the globe. The transformation witnessed by the telecom industry is opening new business avenues for TowerCos.

The Tower Industry has witnessed promising growth with no. of towers increasing from ~2,50,000 (2008) to ~5,80,000 (2019). The tenancy ratio had jumped from 0.9 (FY08) to 2.13 (FY18). Sector's overall operating margin was in the range of 43-44% in the past 4-5 years majorly driven by rental and energy margins expansion.

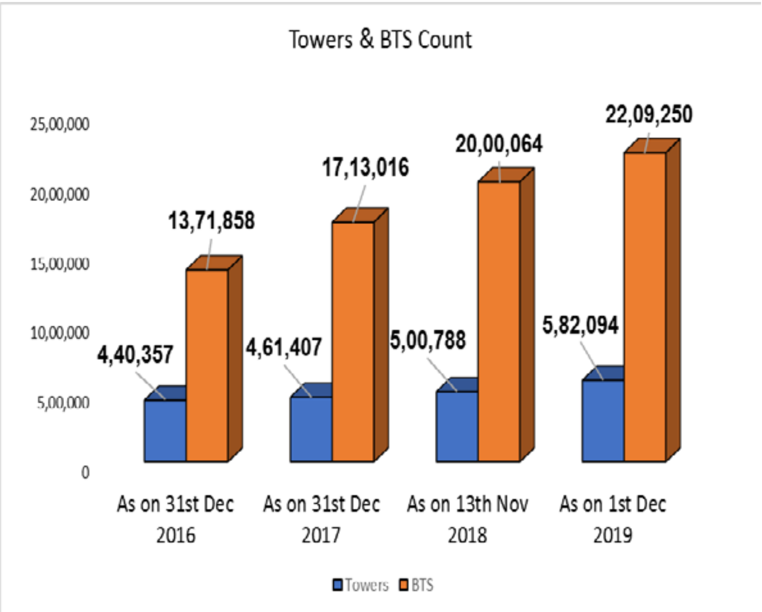


Figure 21-11 Towers and BTS count

Indian telecom market has shrunk from 10-12 player market to a mature 04 player market. Carrier neutral TowerCos business has limited prospects in a market with lower no. of players. Indian Telecom market is expected to witness 5x increase in mobile data traffic during 2018-24, which is giving rise to the demand for new infrastructure and services.

Impeding launch of new technologies such as 5G, AI, IoT/M2M has changed the infrastructure requirement for telcos. There is a need for denser network along with increase in fiber penetration. In the coming years, telecom infrastructure will not only have macro tower sites, but also small cells, fiber, wi-fi and in-building solutions (IBS). Bandwidth intensive applications such as IoT/M2M and VR/AR will demand network densification and deployment of small cells making the network more heterogeneous.

These small cells will also require fiberization of towers due to operational complexities of using microwave backhaul. The Infrastructure demands of the sector are evolving and TowerCos can leverage their expertise to explore adjacent opportunities that fit in their core competencies. Some of the opportunities are Fiber, Small Cells, Wi-Fi, Smart Cities, IoT and Data Centres.

Additionally, TowerCos can also explore other business opportunities from their existing assets, sites and extending their service expertise to other sectors. New Business Opportunities for IP-1 due to monetization of Adjacencies entailing **investment of around U$ 13,285 Mn by IP-1** during the year 2019-2023:

Fiber – Neutral Host/FTTx: Government Programs such as BharatNet and Smart Cities & new technologies such as 5G, AI, IoT are adding to the demand of fiber deployment and also necessitate 100% tower fiberization. An independent TowerCo will be more suitable for deployment in line with global developments.

Small Cells – Telecom networks are transforming towards densification to support the data surge demanding huge no. of indoor & outdoor Small Cells. IP-1 expertise in RoW and Sharing model makes them the best choice for Small Cell deployments.

Wi-Fi – Lack of monetization models hindering the growth of public Wi-Fi in India. Neutral host like IP-1 can provide shared infra supporting multiple operators, make biz model profitable for all stakeholders

IoT – TowerCo can venture into building IoT networks in unlicensed bands. Telco can lease coverage from TowerCos and use it along with their network to support range of IoT use cases.

Smart Cities – Smart City Mission launched in 2015 aims to build 100 Smart Cities which involves setting up of huge ICT infrastructure. TowerCos experience of priority RoW for installing Smart Poles & fiber needs to be leveraged.

Data Centre –The data centre market is poised to witness robust growth at CAGR of 8.4% over 2018-2023 due to exponential growth in data traffic. As data centre is capital intensive biz and depend on leasing capacity to enterprise, IP-1 may be allowed to set-up data centres as well.

Monetization of Existing Assets:

Co-location of Data Centre on tower site for edge computing – Low latency & high throughput applications such as AR/VR, robotics, remote surgery etc leading to requirement of edge computing which enables data processing/computing at distributed locations near the network edge rather than centralized hub at distant location. Tower sites are best suited for co-location of micro data centres.

Advertisement on site structure – The TowerCo site are well-suited to leverage their distributed locations at highways or densely populated areas to co-locate billboards for advertising.

EV Charging Points – In line with global interest, India is actively considering EV to reduce dependency on oil imports and reduce pollution. TowerCos are well-suited to provide EV charging infrastructure on their existing distributed site locations.

Field Maintenance (L1) –Outsourcing L1 support to TowerCos has several benefits to telcos like cost saving on repeated site visits, management of various network elements.

Providing Space for Warehousing & Cold storage – TowerCos can leverage their existing land assets with reliable power supply, security and air-conditioning to provide space for warehouses and cold-storage.

Power-as-a-service – IP-1 have expertise in managing & optimizing costs in different topographies, climate and grid power availability scenarios. Therefore, IP-1 are in compelling position as energy/power management solution provider and providing power-as-a-service.

SUGGESTIONS AND WAY FORWARD

Digital India program will be successful if we are able to achieve the policy changes needed to make the infrastructure, applications and services to reach to all the population and sections of the society. Few of the suggestions to make Digital India a reality is:

- Centre-State Collaboration: Alignment of Telecom Infrastructure Policies of all States with the Indian Telegraph Right of Way (RoW) Rules 2016 notified by the Central Governments.
- Financial Incentive for Investments: Promoting and incentivizing further investment in Digital Infrastructure. Benefits of "Infrastructure Status" needs to be extended to Telecom Infrastructure sector to ensure various financing options for them.
- Rationalization of Taxes: Standardization of Fees, taxes and other levies across the States for creation of infrastructure.
- Enhanced Private Sector participation: Private sector should be encouraged for development of last mile infrastructure in rural and remote areas. To encourage private sector, there must be favorable taxation policies, Single window and timebound clearance of projects and other financial incentives.
- Spectrum availability: Adequate contiguous spectrum needs to be made available by the Government to the industry at reasonable prices in suitable frequency bands for rollout of 5G and new technologies.
- User-friendly Content: Digitization of government services to create content. This mission needs content and service partnerships with telecom companies and other firms.
- Public Awareness: Massive awareness programme to educate and inform the citizens, especially in rural and remote areas, about the benefits of internet services to increase the growth of internet usage.
- Data Protection: Ensuring the maximum connectivity with minimum cyber security risks. Adequate measures and policy interventions to ensure safety and security of online data of citizens.

CONCLUSION

India now represents the 2nd largest internet user base in the world. This provides a significant opportunity to transform the lives of the citizens through digital technologies.

The Digital India program is likely to further benefit the citizens over the next few years by generating employment opportunities, increasing speed and quality of service delivery and enhancing social and financial benefits. Businesses will benefit by realizing higher productivity, an improved ease of doing business and a boost in innovation and investments. The adoption of next generation technologies under Digital India such as 5G, AI, Big Data analytics, IoT and machine learnings will further boost productivity.

While the usage of smartphones and the internet has increased, digital literacy and awareness is still low and is an area that requires enhanced focus. The government has initiated several programs such as National Digital Literacy Mission (NDLM) and Skill India program to increase IT awareness and literacy. To further strengthen the development of infrastructure, services, capacity building and enhance their impact, the government needs to take steps across multiple functional areas as suggested above.

22. Optimising Indian Railways Infrastructure by AI

Chandrika Prasad[1] and Sudhanshu S Jamuar[2]
[1] Managing Director, PNCS Rail Consultancy, Former Adl Member Signal Indian Railway Board), Noida [2] Professor, IIIT Delhi, New Delhi

ABSTRACT

The pressure on the Indian railway networks has increased due to higher demand for mobility and growth in India's population over past several decades. There have been efforts to build more tracks, run more trains on the same networks, and to increase the number of coaches per train. Building more tracks or increasing the number of coaches or increasing the number of trains are coupled with high infrastructure cost. These measures have potential to solve the problem, but they come with added vulnerability in safety in running the system. Indian Railways with its investment of over 500000 Cr is presently struggling to make its Operating ratio (expenditure / earning) below 100 %. During the last 166 years of its operation many technological input has been made on its

Infrastructure, Locomotives and Rolling stock but its Train Control practices have remained Conventional – locally controlled and experience based. The developments in the area of signal processing, communication systems and artificial intelligence (AI) etc. has great potential for applications in Indian Railway right from ticketing to movement of trains, maintenance etc. The potential of AI has been felt in different applications like predicting delays, preventive maintenance of tracks and rolling stocks, forecasting algorithm for railway system. It should be possible to do more with the use of AI by intelligently using the hardware with efficient software. This includes greater information sharing, lower latency, and cleverer algorithms. Such improvements fall squarely within the ambit of AI. This paper highlights the potential contributions of AI towards improvement of India's railway system and how the application of recent technological advancement in Information Science and Artificial Intelligence can bring a change in the train operation scenario at a railway station and Control Centre and add to the profitability of Indian Railways.

Keywords: *Indian railway, Signaling, Artificial intelligence, Signal maintenance*

INTRODUCTION

The Indian Railway (IR) system is a government-owned entity, and its network is the fourth largest railway network in the world by size having route length of 115000 kilometres [1]. It runs around 11000 trains everyday having 7000 passenger trains and ferries 23 million passengers per day and transports 3 MT freight. Train operation on 7312 stations of Indian Railways is controlled from 66 control centres located all over its network. The economic impact of this transportation system is enormous. In the fiscal year 2017-18, IR carried 8.26 billion passengers and transported 1.16 billion tonnes of freight, and generated a revenue of close to 2 trillion INR [2] and two third of this revenue was generated through freight movement. Apart from the benefits delivered to its users, it employed in excess of 1.3 million people in 2017 [2]. The railway system is a giant economic machine needing constant maintenance and repair. Furthermore, it is under increasing stress to deliver even greater value as the demand for cheap, efficient transport grows year on-year.

Signal failure is one of the major cause for accidents in running of trains causing loss of lives, infrastructures etc. The signaling system is vital for safe train operations and the railways completely depend on the health of its signaling assets along with real time information. The failure of signals is one of the major reasons for train accidents and delays. Currently, remote monitoring of signaling is operational in Britain. Aiming to reduce the possibilities of signal failure, Indian Railways has undertaken remote condition monitoring of the system. This is a new approach for the national transporter to predict failures through the effective use of artificial intelligence (AI). Currently, the railways follow a manual maintenance system and adopt find-and-fix methods [3 -6].

A key reason to introduce AI is to effectively follow a predict-and-prevent approach. The system entails the collection of inputs on a pre-determined interval and sending them to a central location. As a result, any flaws or problems in the signaling system would be detected on a real time basis and rectified in order to avoid possible delays and mishaps. The system envisages data transfer through a wireless medium (3G, 4G and high-speed mobile) and data based on these inputs will be utilized, with help of Artificial Intelligence (AI), for predictive and prescriptive Big Data analytics. This will enable prediction of signaling asset failures, automated self-correction and informed decisions on intervention strategies, said the official. The railways have decided that trial be taken up in two sections of Western Railway and South Western Railway at AhmedabadVadodara and Bengaluru-Mysuru. Depending upon the feedback, the system would gradually be extended to other sections. There has been extensive studies with regard to scheduling of trains and minimizing fatalities all over world [7 – 12]. In next few paragraphs, we will discuss about present system and then give our suggestion for the signal monitoring using AI.

CONTROL CENTRE

Indian Railways divides its operations into zones, which are further sub-divided into divisions, each having a divisional headquarters. There are a total of 18 zones and 73 divisions [13]. Every division has a Control Centre for train operations, where all the trains in the division are controlled and monitored. There are different types of control rooms such as engineering control, mechanical control etc. which coordinate with operating control and employees of the respective department. At the Signaling Control Centre, the arrival / departure information of trains from station masters of his section are plotted on the section Train Chart and the movement of trains are monitored. In recent years Train Charting is getting automated by using Data Loggers. The Controller takes into account, the train actual arrival status, arrival /departure schedules as given in the published time table and any priority order for the train movement. Based on his own experience the Controller gives instruction to Station Master for movement of the train at his station. Thus the entire process of scheduling the movement of trains is completely human experience based conventional. The Controller at the conventional Control Centre of Indian Railways has no modern technological aid / support system in his train operation decision making. He also has no radio communication with drivers running the train on his section except on some important trains.

STATION OPERATION

Train Operation on Indian Railways are conventional. A bird's eye view of the Ghaziabad railway station is shown in Figure 22-1. Ghaziabad railway station is on the Kanpur-Delhi section of HowrahDelhi main line, Howrah-Gaya-Delhi line and New Delhi-Moradabad-Lucknow line. It has 6 Platforms and handles 241 Halting Trains, 2 Originating Trains and 2 terminal Trains. Local Electric trains also run regularly from Ghaziabad for stations like Old Delhi station, Hazrat Nizamuddin station and Anand Vihar. Local trains, which run on a regular interval, are EMUs, MEMUs, and Passengers Local trains. They start in early morning hours and run until midnight.

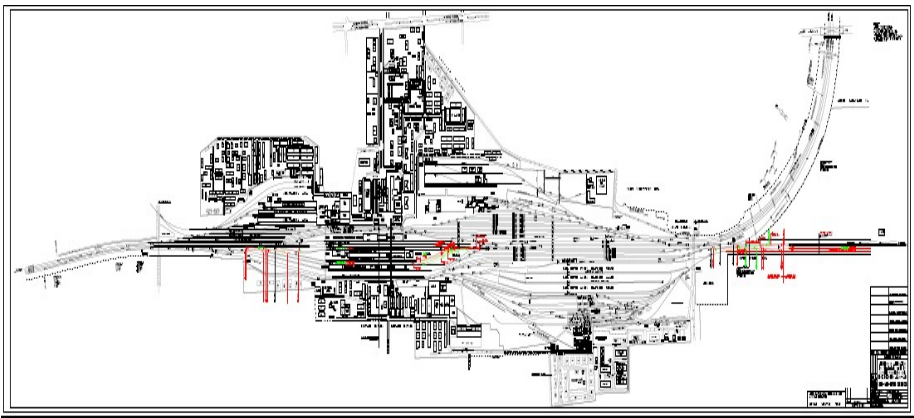


Figure 22-1 View of Ghaziabad Railway station of Indian Railways

Train operation at each station is in stand alone mode with exchange of block working with neighboring stations situated 8-10 km apart. Station Master controls the train operation within his station limits i.e. Home Signal to Advance Starter Signal in each direction based on specific instructions from Control Centre.

To control train operation by station masters, signaling panel (Figure 22-2) station panel/VDU key Board (Figure 22-2) are provided. It enables him to set the route and give Signal for reception/ dispatch of the trains, the line to which the train is to be received or dispatched, priority of train at junction station, stoppage timing at the station, waiting time etc. This is all experience based and manual, which is likely to have errors.

Figure 22-2 Signaling Panel at IR station

Figure 22-3 VDU and Key Board based Station Control at EI station

STATION MASTER

There are Station Master at each station and he directs and control the movement of trains passing by his station. The Station Master (SM) is responsible for arranging reception and dispatch of all trains and other shunting movements in accordance with the latest issue of G&SR's, Block Working Manual and Operating Manual. He also has control for shunting in between the arrival/departure of trains or during slack period as frequently as possible to the maximum extent. He shall test the interlocking gears of the station to ensure safe operation of trains and to avoid any conflicting movements.

SM attends Section controller command promptly and furnish the controller with the arrival and departure of trains at his station well in time. The command from Section controller has to adhered. Any noncompliance would be treated as dispute provided they do not contravene any G&SR's , SWR's or otherwise leads to any kind of unsafe working.

SM will promptly attend all accidents and assist in relief measures and enquiry. He shall ensure that all failures are brought to the notice of the S&T maintainer immediately and entries made promptly in Signal failure register. He must also see that proper Disconnection / Reconnection memo is issued without loss of time.

From above paragraphs, we observe that SM is under stress all the time and there is a possibility of error in attending to above function resulting in accidents and loss of lives.

MAINTENANCE OF SIGNALLING ON INDIAN RAILWAYS

Presently based on Time schedule laid down in Indian Railways signal Engineering Manual, maintenance of Signalling systems is carried out on Time Schedule basis. Over 4000 stations Data loggers have been provided to record the status of Signalling systems and send it to Control Centre /Test Room. Where as in all developed countries, Remote Condition Monitoring and Condition Based Maintenance using artificial intelligence are being used.

NEW TECHNOLOGICAL DEVELOPMENT ON INDIAN RAILWAYS

Although Indian Railway have got new technology installed to modernize its infrastructures, but it is limited to a few sections. The trial is going on these installations and if successful, these modernization will be installed all over country. Some of the installations are described now.

A. CENTRALIZED TRAFFIC CONTROL

Centralized Traffic Control (CTC) has been recently installed in Tudla section using GSMR Train Radio Communication system. It has been installed over 2500 Kms of Indian Railways where voice communication between Controller /Station Master and Driver has been provide. A view of the CTC is shown in Figure 22-4. It has visual several displays with computer control to monitor the real life movements of trains. The operator looks at the real time movement of a train on monitor and control its future course of actions.

Figure 22-4 CTC Control Centre at Tundla

B. TRAIN MANAGEMENT SYSTEM (TMS)

Train Management System has been introduced at Mumbai Control Centre for Suburban services. It is very similar to CTC control and manages the movement of suburban trains in Mumbai. TMS is already being used in control of Metro trains. The control room is shown in Figure 22-5.

Figure 22-5 Train Management System at Mumbai

C. ETCS LEVEL 2 SYSTEM

In ETCS Level 2 system there will be visual display of train movement at Control stations as well as at Sectional control stations on a Video Display Board. This is illustrated in Figure 22-6. In this system, the Sectional Controller will also be able to control the reception & dispatch of trains at way stations. Indian railway has initiated the process for installation of ETCS Level 2 systems on 635 Kms route on Vizianagaram – Palasa, Yerraguntla - Reniguntla, Jhansi - Bina, Nagpur - Badnera sections.

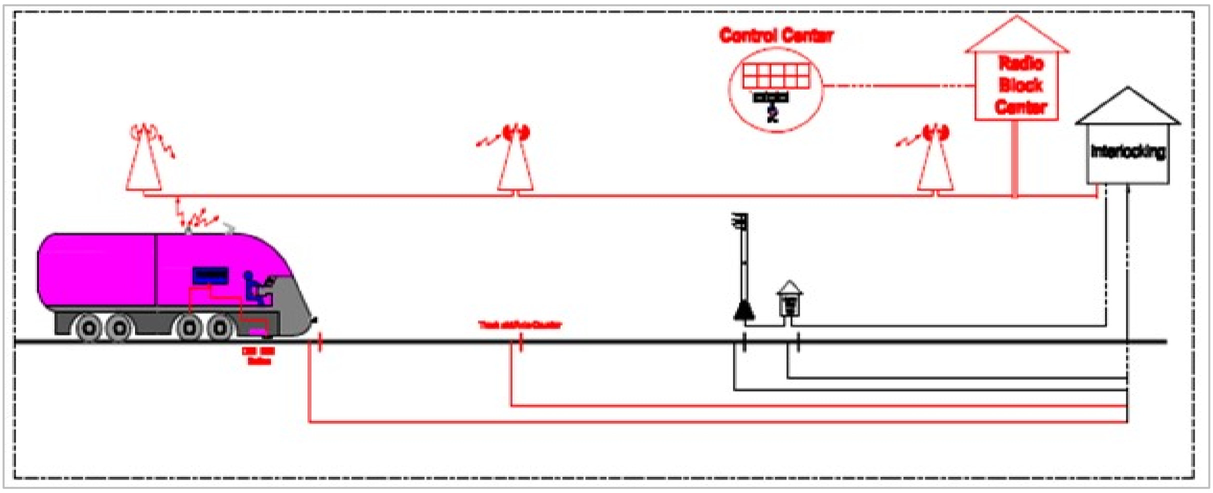


Figure 22-6 Future Control Centre after introduction of ETCS level2

In order to monitor the status of Track occupancy, the data on occupancy of tracks are either collected manually or by using data logger at stations on Indian Railways by point machine operation, signal aspects etc. The status report is sent to Station and Control Centre using digital transmission and Networking. AI can be used in efficient running of trains without failure [14,15].

In future Artificial intelligence (AI) and machine learning Systems will be the buzz word in the train operation. It's going to be used widely in operation and control of train movements.

While the train is in movement, the train knows its location and the track by identifying known infrastructures and remembering it by using Machine Learning and Artificial Intelligence. Visual referencing plays an important role in identifying the known infrastructures. It checks and anticipates any registered infrastructure. AI keeps most processor power looking for abnormal infrastructure operations; e.g. obstruction or trespassing person. Thus relieving drivers looking for abnormalities in train movements.

The rail environment is different to road environments. Longer distance sensors & new algorithms are required to support rail operations. Advanced sensors are needed to gather information. AI brings operations, IoT and imaging together to completely the picture. The information are collected from GPS, inertial navigation, odometers, radars, LIDARs, cameras, and ultrasound sensors. The sensor data is integrated to create a digital virtualization of the operating environment for deeper processing. AI is used to monitor the total environment. Figure 22-7 shows a futuristic locomotives with all the accessories for AI and machine learning.

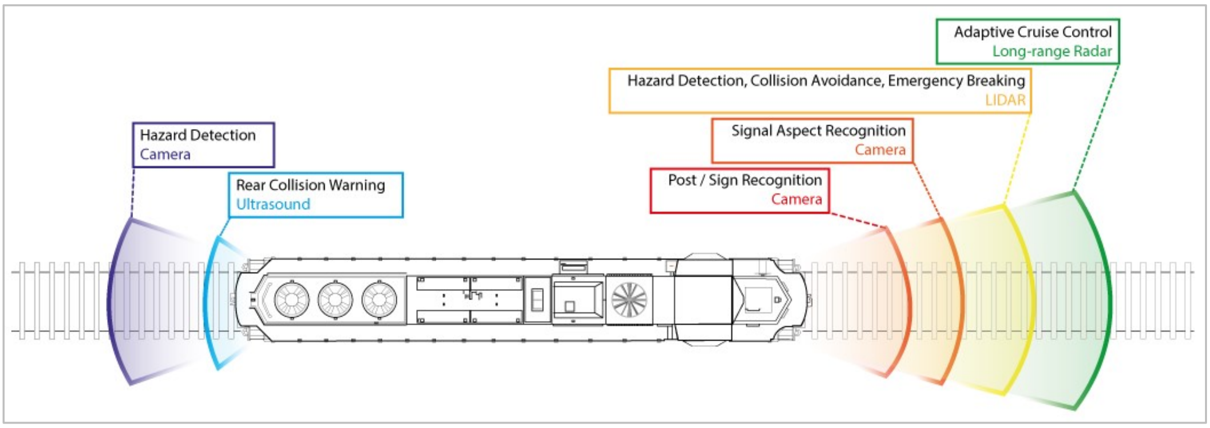


Figure 22-7 Future locomotive with all accessories

Artificial intelligence and machine learning provide the capability for a rail system to autonomous identify objects and hazards, rather than simply act to pre-set rules which are insufficient in complex systems. AI requires a deep learning processing pipeline as appropriate for rail operations. Deep learning involves detection, localization, awareness, dynamics and monitoring. Detection requires multiple sensor types applicable to rail as illustrated in Figure 22-7.

Visual, spatial and navigational data (GPS, inertial & odometer) data integration with known infrastructure are needed for localization. GPS alone may not be accurate enough in multiple track areas. Image processing allows multiple track segmentation and it can be used to generate route reference record. This allows on board decision making possible.

Signal and sign recognition, signal types, colored light are needed for train awareness. Neural networks allows continual learning of differences. The system must be aware of detected data using machine learning and how these data are interpreted. Dynamics involves managing and checking actual operations against allowed operations. It is necessary to monitor the train running parameters by checking the reports.

Track Detection consists of algorithms which identifies the tracks, provides track identification because the camera is orientated along the center line of travel, built off the existing body of work on autonomous cars. This will help in improving the GPS accuracy by localizing efficiently because we know where we are on the track.

Geographical information are obtained from pre-recorded geographic information obtained from GPS points located at some fixed distance, level crossings and aspect locations. This is helped by GPS data streaming, video streaming and display information on particular object of interest as we approach that object. OEMs of Rail Technologies in countries abroad have developed advanced sensors based remote monitoring, data analysis and prediction using latest development in Information Sciences and Artificial Intelligence in Rail sectors. Some examples are followings:

Thales (ThalesMan): A fully integrated mobile asset management product aimed at engineering and maintenance teams, back-office control staff and other key business users.

Siemens (On Track): An integrated suite of monitoring products that enables operators to access performance data about key assets such as power supplies, points operation, level crossings, track circuits and signaling.

Bombardier (Orbita): An integrated suite of monitoring products that enables operators to access performance data about key assets such as power supplies, points operation, level crossings, track circuits and signaling.

IBM (Smarter Railroad): IBM has set up a new Global Rail Innovation Center that is working on solutions to increase capacity and utilization and reduce congestion. These solutions include mobile-based condition monitoring, preventive maintenance and trainbased systems.

Via Telemetry (µWEAVE): A Web-based monitoring and middleware platform that can be configured to monitor any remote asset via the Internet and GPRS networks so that remote assets can be managed centrally and the data then used automatically by corporate business applications.

Balfour Beatty (AssetView): This performs a diagnostic process and predicts certain asset failure modes by generating statistical reports that can be used for preventive maintenance planning.

Lloyd’s Register (GOTCHA): This is a track-based asset monitoring system with postanalysis and decision support. It enables informed decision-making on asset management actions — especially in maintenance and renewal activities. Optional plug-ins to the Gotcha system are pantograph monitoring, axle bearing monitoring and sound measurements.

CDS Rail (Asset Watch): This is a fully scalable monitoring solution capable of gathering data from all railway trackside asset types and providing usable information through one central system.

Strukton Rail (POSS Online Monitoring): This tool provides comprehensive, real-time insight into the status of rail systems, based on the data from its measuring and monitoring systems. This helps spot possible defects before they occur.

Indra (DaVinci System): This package integrates all control, supervision and communications systems required to manage and monitor the operation of a high-speed railway network.

Alstom (Iconis): This orchestrates operational functions and traffic management through Iconis ATS for urban automated train supervision, Iconis CTC for main lines and Iconis SCADA for infrastructure monitoring, in conjunction with interlocking and automated train control (ATC) subsystems.

Invensys (Avantis): Working in partnership with Invensys Operations Management (IOM), Invensys Rail provides the highest levels of monitoring and predictive maintenance incorporating techniques that enable moving from “find and fix” to “prevent and predict” maintenance. The software enables real-time decision support and analysis of trends in the operation of signalling and other railway equipment.

Modern sensor based data monitoring, Data Analysis and application of AI for Signaling, Track, OHE and rolling stock systems will enable us to predict the system deterioration in advance and introduction of predictive maintenance. The application of modern sensor based data monitoring, data analysis and application of AI will greatly improve punctuality of train services, sectional capacity and reduce equipment failures. With these application the shape of future Train Control and infrastructure maintenance will take a new shape as visualized in Figure 22-8.

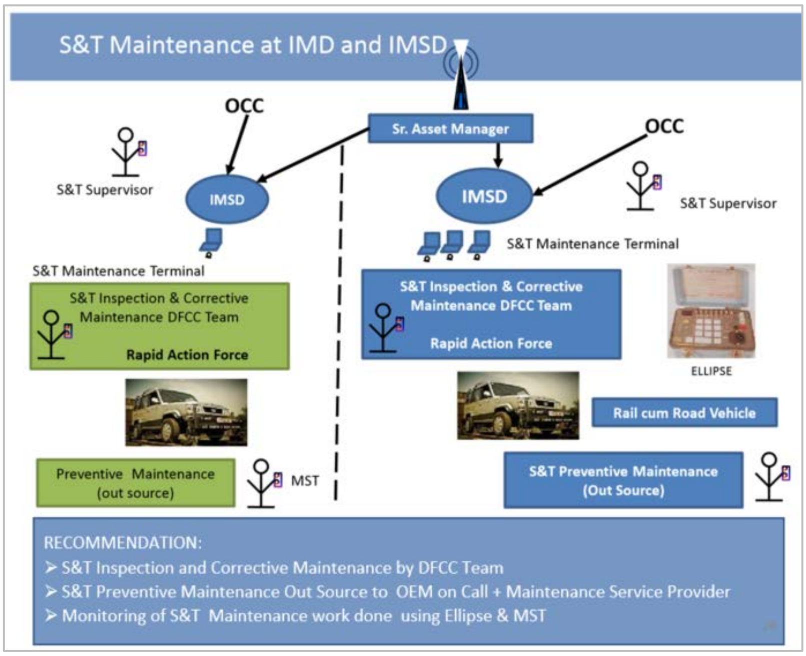


Figure 22-8Block diagram of train control and infrastructure maintenance

CONCLUSION

Artificial Intelligence is already a reality for several applications. It has proven its value by doing high complex tasks that humans could never comply or doing simple tasks very efficiently. Programming and teaching an AI can be a lot cheaper and faster than classical logical programming. AI should never be allowed to have full authority in critical functions because it's likely to fail as well. An alternate algorithm must be provided in the critical function operation. Use of AI in Indian Railway is likely to reduce infrastructures because with a train location and performance are being easily managed on board. This in turn will not distract the driver's attention. The system will incorporate continuous machine learning because with each run master data sequence used for track reference by a locomotive's computer systems are getting improved. The data on hazards & changes in real-time from all locomotives operating on a route can be easily shared with other rail users, which is completely absent in present scenario. The train control can be separated from infrastructure systems by use of AI resulting in ultimate interoperability that a locomotive is able to independently operate over any line. Finally with a never distracted drivers's assistant and technology based operation of autonomous trains in future is going to have improved safety.

REFERENCES

[1] Ministry of Railway. Indian Railways Statistical Publications 2016.

[2] Ministry of Railway. Indian Railways Budget Document 2018-19.

[3] Indian Railways general and Subsidiary Rules

[4] Indian Railways Station Working Rules

[5] Indian Railways Signal Engineering Manual

[6] Indian Railways Telecommunication Manual

[7] G. Raghuram, ''Turnaround' of Indian Railways: A Critical Appraisal of Strategies and Processes"(PDF), Working Paper No.2007-02-03, Ahmedabad, India: Indian Institute of Management, (February 2007).

[8] G Bocchetti, F Flammini, C Pragliola, and A Pappalardo. Dependable integrated surveillance systems for the physical security of metro railways. In 2009 Third ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC), pages 1–7. IEEE, 2009.

[9] R Bornd¨orfer, M Reuther, T Schlechte, K Waas, and S Weider, Integrated optimization of rolling stock rotations for intercity railways. Transportation Science, 50(3):863–877, 2015.

[10] A Caprara, M Fischetti, P Toth, D Vigo, and P Guida. Algorithms for railway crew management, Mathematical programming, 79(1-3):125–141, 1997.

[11] F Flammini, A Gaglione, F Ottello, A. Pappalardo, C Pragliola, and A Tedesco, Towards wireless sensor networks for railway infrastructure monitoring. In Electrical Systems for Aircraft, Railway and Ship Propulsion, pages 1–6. IEEE, 2010.

[12] H Khadilkar. A scalable reinforcement learning algorithm for scheduling railway lines. IEEE Transactions on Intelligent Transportation Systems, 20(2):727–736,

[13] http://www.indianrail.gov.in, "Indian Railway's zone's & their divisions with heaquarters" (pdf), Archived (PDF) from the original on 17 April 2012. Retrieved 23 February 2018.

[14] https://www.linkedin.com/pulse/artificial-intelligence-railway-applications-alexandre-pirespmp- Alexandre Pires, Artificial Intelligence in Railway Applications

[15] Derel Wust, Using Machine Learning for Safer and More Efficient Train Operations, NVIDIA GTC 2018, San Jose, CA 2018

23. Cryptography on Digital Implementation with Steganography Techniques

Harsh Sahay, Assistant Professor ,Department of Computer Science and Engineering

DAV Institute of Engineering and Technology,Betla Road Palamau,Daltonganj,

822126,India sahayharsh53@gmail.com

ABSTRACT

Cryptography can be implemented by digital circuits. The messages those are sent are passed through digital circuits. Digital design generates cipher text. This cipher text is hidden by steganography techniques and are sent to the networks. To the receiver side by the reverse process of steganography generates cipher text and by the process of decryption original message is received to the receiver side.

Keywords— *Cryptography, Steganography, Digital Design*

INTRODUCTION

In recent trends internet provides communication between peoples, defense personals, gives facility to electronic payment and many others. This is reason behind much concern of privacy, identifying theft, security etc. Recently, due to the large losses from illegal data access, data security has become an important issue for public, private and defense organizations.

In order to protect valuable data or information from unauthorized access, illegal modifications and reproduction, various types of cryptographic techniques are used. [1]There are two kinds of cryptography symmetric key cryptography and asymmetric key cryptography. In symmetric key cryptography same key is used between the sender and receiver. While in asymmetric key cryptography two different keys (public key and private key) are used between sender and receiver for encryption and decryption.RSA is most famous asymmetric cryptography algorithm. Some security services can be implemented using cryptography. Cryptography, a word with greek origin, means secret writing. To the science and art of transforming messages to make them secure and immune to attacks. Cryptography is the art of achieving security by encoding messages to make them non readable.[1] Cryptography is associated with the process of converting ordinary plain text into unintelligible text and vice-versa. It is a method of storing and transmitting data in a particular form so that only those for whom it is intended can read and process it. Cryptography not only protects data from theft or alteration, but can also be used for user authentication.

The word cryptography has Greek origin it is combination of two,"Kryptos" which means hidden and "logos" which means word and graph, means secret and writing. Cryptography is a science of converting a stream of text into coded form in such a way that only the sender and receiver of the coded text can decode the text. Cryptography plays a very important role in internet based commercial activities as many secret documents which include payment details, money transfer, contract documents, and business plans and other confidential information are to be transferred from one computer to another computer. Cryptography is a technique that allows a piece of information to be converted into cyptic form before being stored in a computer database or transmit over the secure channel. Encryption of message is done to provide extra protection in order to maintain confidentiality of documents. For example, if an unauthorized person succeeds in tapping the channel then information he has copied may not be of his use, if it is encrypted. Cryptography is primarily used to protect the confidentiality of information from intruders. There are two kinds of cryptography Asynchronous Key Cryptography Synchronous Key Cryptography In synchronous key cryptography one key is shared between sender and receiver. While in Asynchronous key cryptography two key is shared between sender and receiver. One is called public key which is publically available while another is called private key, which is kept secret. Steganography is the process of hiding data into a medium such that medium appears to be unsuspicious.

Combination between cryptography and Steganography is done by first encrypting data using encryption techniques and hiding it into transportation medium using an Steganography techniques (Atito et. al. 2012).

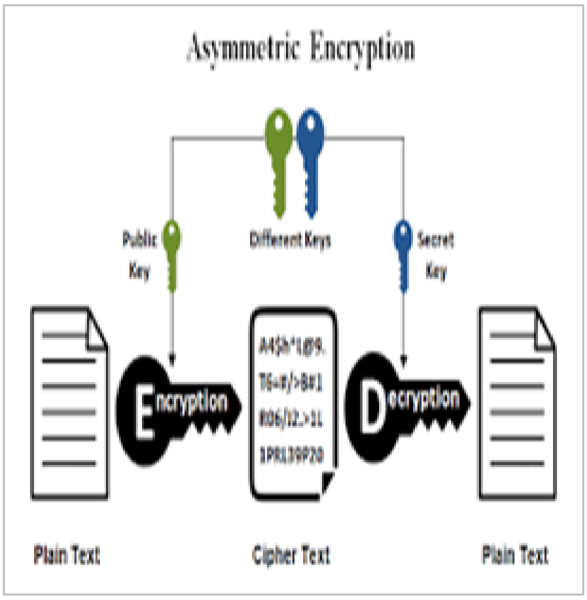


Figure 23-1 Cryptography concept

RELATED WORK

Rivest, Adi Shamir and Adelman has invented RSA algorithm which it is widely most used public key cryptosystem, this algorithm used to encrypt the data to provide security [3]. Vivek Choudhary and Mr. N. Praveen have proposed modification of RSA algorithm by the use of third prime number in their work, which increases security of RSA algorithm.[4]. Samiha Marwan, Ahmed Sawish, Khaled Nagaty developed DNA based cryptographic methods for data hiding in DNA Media. [5]. Alaa Hussein, Al-Hamami and Ibrahem Abdallah Aldariseh proposed enhancing the RSA algorithm; in this RSA algorithm they used additional third prime number in the composition of the private and public key. Because of additional prime number the factoring complexity of variable (n) is also increase. [6].

A. STEGANOGRAPHY

Steganography is a technique that facilitating of a message that is to kept secret inside other messages. This result is the concealment of the secret messages itself! Historically, the sender used methods such as invisible ink, tiny pin punctures on specific characters, minute variation between handwritten characters, pencil marks on handwritten characters etc.Of late, people hide secret message within graphic images. For instance, suppose that we have secret message to send. We can take another image file and we can replace the last two right most bits of each of that image with (the next) two bits of our secret message. The resulting image would not look too different, and yet carry a secret message inside! The receiver would perform the opposite trick. [1]

B. DIGITAL DESIGN

The term digital is derived from the way computer perform operations, by counting digits. For many Years applications of digital electronics were confined to computer systems. Today the digital technology is applied in a wide range of areas in addition to computers. Such application as television, Communication systems, radar, navigations and guidance systems, military systems, medical instrumentation, industrial process control and consumer electronics uses digital techniques. Digital technology has progressed from vacuum tube circuits to discrete transistors to complex integrated circuits, some of which contain millions of transistors. [2] Digital electronics is a field of electronics involving the study of digital signals and the engineering of devices that use or produce them.

Electronics is the science and technology concerned with the controlled flow of electrons and other carriers of electric charge. It covers theory, design, and construction of electronic devices, circuits, instruments, or systems. [7]In digital electronics digital outputs are generated from digital inputs. If the output of the logic circuit depends only on the present input values, we refer to the system as not having memory. Systems without memory are also known as combinatorial logic circuits because they combine inputs to produce the output. Combinatorial circuits can be constructed with gates alone. If, on the other hand, the output of the logic circuit depends on present as well as past input values, we then refer to such a circuit as having memory, because such circuits remember past input values. Systems with memory are also known as sequential logic circuits. Such circuits are more complicated and require some form of memory (flip-flops) and the presence of a clock signal to regulate the response of the circuit to new inputs, ensuring that the necessary operations occur in proper sequence–hence the name sequential logic circuit. We will first consider combinatorial circuits and then proceed to sequential ones.

Digital electronics is about designing and analyzing circuits and although this could be done using only the mathematical language of Boolean algebra introduced.

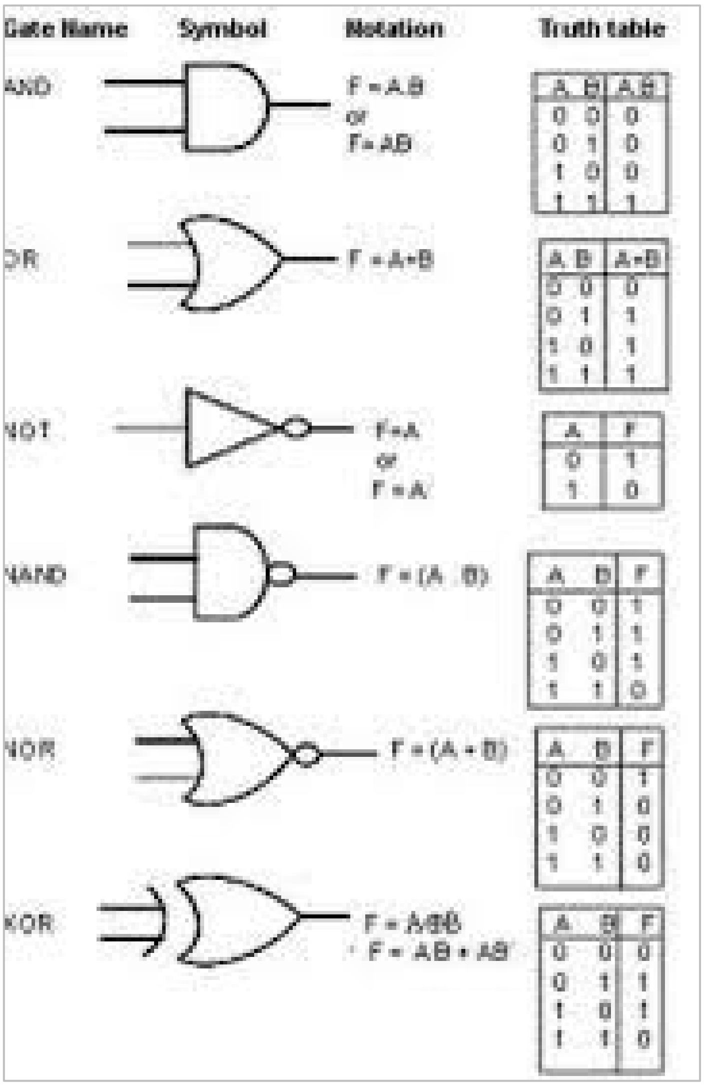


Figure 23-2 Full-Adder

C. HOW TO DESIGN

As we see the massages are sent in the form of bits, after going through digital circuit, it generates cipher text. In the receiver side by the reverse process of these digital circuits generates plain text to the receiver side. The cipher text can be hided by the technique of Steganography.

```
#include<stdio.h>
Int main()
{
Unsigned long long char b=0x32;
Unsigned long long int B;
Unsigned long long int  D;
//Encryption
B=b^0x0C;
printf (“\n%02x”,b);
D=B;
//Steganography
D=D<<2;
D=D>>2;
B=D;
//Decryption
B=B^0x0C
printf(“\n%02x”,b);
return 0;
}
```

As shown above we have initialize an unsigned integer b=0x32.It is exclusive ored with 0x0C, the result is stored at B.By two times left shift operation it is the case of Steganography. Now hidden data is sent to receiver. At the receiver side by the reverse process of Steganography technique, we are getting actual cipher text. In addition, by the process of decryption we are getting actual plaintext.

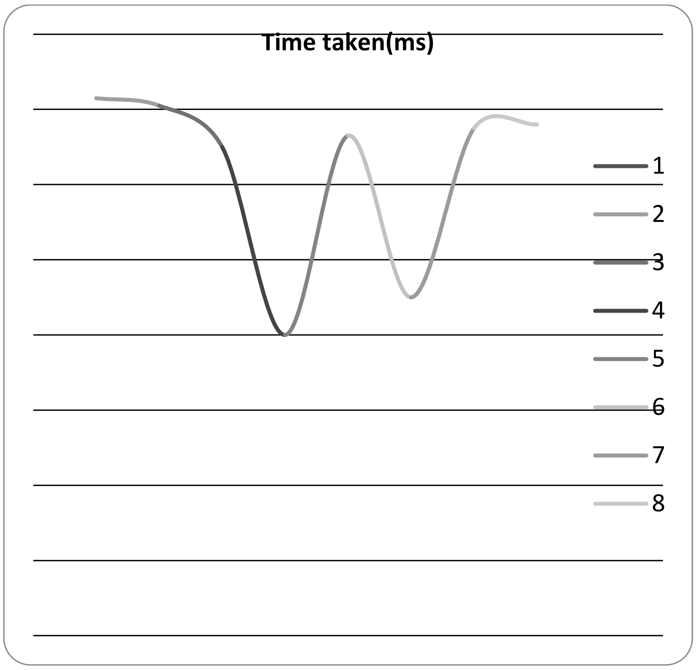


Figure 23-3 Obtained Result

CONCLUSION

Experimentally it is found that digital circuit design of plain text hides data efficiently in the form of cipher text, for hiding cipher text DNA steganography is used. So, it is very difficult for unauthorized parties to get a real plain text.

REFERENCES:

[1] Cryptography and Network security (Book), Atul Kahate, Cryptography Techniques, Introduction.

[2] Digital Fundamentals (Book), Floyd & Jain, Introductory Digital Concepts.

[3] R. L. Rivest, A. Shamir, L. Adelman, “On Digital Signatures and Public Key Cryptosystems,” MI Laboratory for Computer Science Technical Memorandum 82, April 1977.

[4] Vivek Choudhary1 and Mr. N. Praveen2 “Enhanced RSA Cryptosystem Based on Three Prime Numbers” 1 Post Graduate Scholar, Department of Computer Science & Engineering, SRM University, Chennai, Tamilnadu, India 2 Assistant Professor, Department of Computer Science & Engineering, SRM University, Chennai, Tamilnadu, India

[5] DNA based cryptographic technique for data hiding in DNA media Samiha Marwan, Ahmed Shawish, Khaled Nagaty.

[6] Al-Hamami, A. H., & Aldariseh, I. A. (2012, November). Enhanced Method for RSA Cryptosystem Algorithm. In Advanced Computer Science Applications and Technologies (ACSAT), 2012 International Conference on (pp. 402-408). IEEE

[7] The University of Waikato Electronics 2020

24. Online Calculator based on the Client Server Socket Programming

Harsh Sahay, Assistant Professor ,Department of Computer Science and Engineering

DAV Institute of Engineering and Technology,Betla Road Palamau,Daltonganj,

822126,India sahayharsh53@gmail.com

ABSTRACT

In client server computing, the clients request a resource and the server provides that resource. A server may serve multiple clients at the same time while a client is in contact with only one server. Both the client and server usually communicate via a computer network but sometimes they may reside in the same system. Here in this work, we have developed online calculator by socket programming. Basic requests those are sent by clients are serviced by remote server.

Keywords— *c,c++,tcp-ip,Linux.*

INTRODUCTION

Client–server model is a distributed application structure that partitions tasks or workloads between the providers of a resource or service, called servers, and service requesters, called clients. Client/Server is a term used to describe a computing model for the development of computerized systems. This model is based on the distribution of functions between two types of independent and autonomous processors: servers and clients. A client is any process that requests specific services from server processes. A server is a process that provides requested services for clients. Client and server processes can reside in the same computer or in different computers connected by a network.[1] According to MIS terminology, Client/Server computing is new technology that yields solutions to many data management problems faced by modern organizations. The term Client/Server is used to describe a computing model for the development of computerized systems. This model is based on distribution of functions between two types of independent and autonomous processes: Server and Client. The client/Server architecture is based on hardware and software components that interacts to form a system. This system includes three main components: Clients, Servers, Communication middleware [2]

The client is any computer process that requests services from the server. The client is also known as the front-end- application, reflecting the fact that the end user usually interacts with the client process. The server is any computer process providing services to the clients. The server is also known as the back-end application, reflecting the fact that the server process provides the background services for the client process.

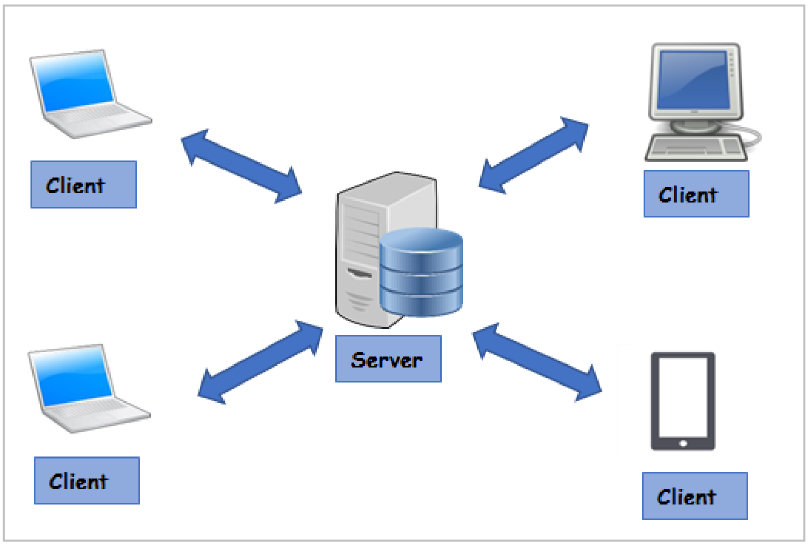
It is any computer process (es) through which clients and servers communicate. The communication middleware, also known as middleware or the communications layers, is made up of several layers of software that aid the transmission of data and control information between clients and servers.[2].

METHODOLOGY

In this methodology we have used programming languages such as c, c++, Tcp-ip, Linux Unix, socket programming. We have developed clients, also servers. The basic requests those are sent by clients such as addition, subtraction, multiplication, division etc. are responded by server to the client.

A. PROGRAMMING

As we see the massages are sent in the form of bits, after going through digital circuit, it generates cipher text. In the receiver side by the reverse process of these digital circuits generates plain text to the receiver side. The cipher text can be hided by the technique of Steganography.




```
#include<stdio.h>
#include<netinet/in.h>     // Internet address family
#include<sys/socket.h>     //Internet Protocol family
#include<fcntl.h>          //file control options
#include<sys/types.h>      //data types
#include<unistd.h>         //standard symbolic constants and types
int choice(int);
int main()
{
int sd,newsd;   // File Descriptor
//char wrbuf[100];
//char rdbuf[100];
struct sockaddr_in s_addr,c_addr;
sd=socket(PF_INET,SOCK_STREAM,0);
if(sd<0)
{
perror("socket");
}
s_addr.sin_family=PF_INET;
s_addr.sin_port=htons(2012);  s_addr.sin_addr.s_addr=inet_addr("0.0.0.0");

if(bind(sd,(struct sockaddr*)&s_addr,sizeof(s_addr))==0
printf("bind success\n");
else
{
perror("bind");
return;
}
listen(sd,1);
int len;
len=sizeof(c_addr);
printf("waiting for connectioni\n");
newsd=accept(sd,(struct sockaddr*)&c_addr,&len);
if(newsd==-1)
{
perror("accept");
    return;
    }
//if(fork())
//{
int wrbuf;
int rdbuf;
while(1)
{
bzero(rdbuf,100);
read(newsd,rdbuf,20);
write(newsd,wrbuf,20);
```

```
calculate(wrbuf);

//printf("read for data\n");
//printf("rdbuf=%s\n",rdbuf);
//printf("enter data\n");
//gets(wrbuf);
read(newsd,wrbuf,20);
}
return 0;
}

int calculate(int choice)
{
        clrscr();
        float a, b, res;
        char choice, ch;
        do
        {
                printf("1.Addition\n");
                printf("2.Subtraction\n");
                printf("3.Multiplication\n");
                printf("4.Division\n");
                printf("5.Exit\n\n");
                //printf("Enter Your Choice");
                //scanf("%d",&choice);
                switch(choice)
                {
                        case '1' : printf("Enter two number : ");
                                scanf("%f%f",&a,&b);
                                res=a+b;
                                //printf("Result = %f",res);
          return(res);
                                break;
                        case '2' : printf("Enter two number : ");
                                scanf("%f%f",&a,&b);
                                res=a-b;
                                //printf("Result = %f",res);
           return(res);
                                break;
                        case '3' : printf("Enter two number : ");
                                scanf("%f%f",&a,&b);
                                res=a*b;
                                //printf("Result = %f",res);
           return(res);
                                break;
       case '4' : printf("Enter two number : ");
                                scanf("%f%f",&a,&b);
                                res=a/b;
                                //printf("Result = %f",res);
          return(res);
                                break;
                        case '5' : exit(0);
                                break;
                        default : printf("Wrong Choice..!!");
                                break;
                }
                printf("\n------------------------------------\n");
        }while(choice!=5 && choice!=getchar());
        getch();
}
```

Bshop School near bahu bazar
sunday 11.00-1.00
Tuesday,Thirsday holiday
Rest of all 5.00-7.00

```
//client
#include<stdio.h>
#include<sys/socket.h>
#include<unistd.h>
main()
{
int sd,newsd,len;
//char wrbuf[128],rdbuf[128];
```

```
struct sockaddr_in s_addr,c_addr;
sd=socket(PF_INET,SOCK_STREAM,0);
if(sd<0)
{
perror("socket");
return;
    }
s_addr.sin_family=PF_INET;
s_addr.sin_port=htons(2012);
s_addr.sin_addr.s_addr=inet_addr("127.0.0.1");
connect(sd,(struct sockaddr*)&s_addr,sizeof(s_addr));
printf("connect success");
//if(fork())
//{
int choice;
int result;
while(1)
{
//bzero(wrbuf,128);
printf("enter choice\n");
gets(choice);
read(sd,choice,20);
//}
//}
//else
//{
//char rdbuf[128];
//while(1)
write(sd,result,20);
printf("%s\n",result);
}
}
```

CONCLUSION

It seems the excellent way to design client server architecture by socket programming. We can design it excellently by languages c, c + +.linux,unix,tcp-ip. Client–server model is a distributed application structure that partitions tasks or workloads between the providers of a resource or service, called servers, and service requesters, called clients. On line calculator is designed to the server side, and requests are sent by the clients to the remote server i.e. server side.

REFERENCES:

[1] Copyright @ www.bcanotes.com

[2] An introduction to client server computing subhash Chandra yadav,Sanjay kumar singh

25. Radio Frequency Identification (RFID): An Automatic Identification System

Harsh Sahay, Assistant Professor ,Department of Computer Science and Engineering

DAV Institute of Engineering and Technology,Betla Road Palamau,Daltonganj,

822126,India sahayharsh53@gmail.com

ABSTRACT

RFID Radio frequency identification is a form of wireless communication that uses radio wave to identify and track objects. Radio-frequency identification uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. [1] RFID (radio frequency identification) is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person.

Keywords— *Microcontroller 8051, Embedded C*

INTRODUCTION

The “Radio Frequency Identification (RFID) is an automatic identification system. RFID uses RF to identify “tagged” items .The tag items means identification of an object. This involves identification, location or specification about an object. Manual system to collect tall tax is time consuming. This reduces automatic fuel consumption. This technology ensures smooth flow of traffic in efficient and faster way by collecting the toll tax automatically. In this system drivers need not to take any cash is the one of the main benefit of electronic tolling system. The other benefits namely; less waiting time, reduction in vehicle emissions, increase in lane capacity etc, It will also help in controlling congestion level accurately.

Radio Frequency Identification (RFID) is a generic term for technologies that use radio waves to automatically identify people or objects from a distance of several inches to hundreds of feet. This ian Automatic identification (Auto-ID) technology [1] by which any object can be However, their possible area of use is much larger [4]. RFID terms as Radio frequency identification, It is wireless communication technology. Radio waves are used to automatically identify, track, and authenticate items or people by the RFID technology. RFID is an automatic identification like smart cards, bar codes, and voice recognition etc. used in machines to identify objects. [5] The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can be passed to computers to make use of it. [6]

Radio frequency identification (RFID) is a contactless form of automatic identification and data capture. Dating back to World War II, RFID transponders were used to identify friendly aircraft. The RFID system consists of a reader, transponder, and antenna utilizing several frequency ranges. Over 40 million RFID tags will be used in 1999 with sales projected to break the one billion-dollar mark before 2003 (Frost & Sullivan, 1997).Radio frequency identification is used in access control, asset control, and animal identification. The advantages of RFID are the capability for multiple reads, ability to be used in almost any environment, and the accuracy. The Automatic Identification Manufacturers, International Standards Organization, and the American National Standards Institute are currently developing standards. Barcodes have been developed in the railroad business to keep track of the various cars. Out of this system of identification grew the U.P.C. (Universal Product Code) which is now used in almost all manufactured goods. UPC is used to store the manufacturer code as well as the product code in a form that can be easily read by various scanners - even from a distance. But there are limits to the use of barcodes. There must be a direct line of sight between the reader and the code. The barcode can be obscured, for example by paint. One only has read-access to the data, i.e., one cannot add new data without adding another label. This is the point where a relatively new technology comes in: RFID (Radio Frequency

Identification). In RFID electronic chips are used to store data that can be broadcast via radio waves to the reader, eliminating the need for a direct line of sight and making it possible for "tags" to be placed anywhere on or in the product. One can even write to tags made of semiconductor chips, thus enabling updating of data. This write function introduces new capabilities, such as the updating of the manufacturing process of the attached item. RFID first appeared in tracking and access applications during the 1980s. These wireless AIDC systems allow for non-contact reading and are effective in manufacturing and other hostile environments where bar code labels could not survive. RFID has established itself in livestock identification and automated vehicle identification (AVI) systems because of its ability to track moving objects. To understand and appreciate the capabilities of RFID systems it is necessary to consider their constituent parts. It is also necessary to consider the data flow requirements that influence the choice of systems and the practicalities of communicating across the air interface. By considering the system components and their function within the data flow chain it is possible to grasp most of the important issues that influence the effective application of RFID. The RFID reader is designed for fast and easy system integration without losing performance, functionality or security. The RFID reader consists of a real time processor, operating system, virtual portable memory, and transmitter/receiver unit in one small self-contained module that is easily installed in the ceiling or in any other convenient location. [7].

RFID APPLICATIONS

Here are some RFID applications

- Credit card that you don’t need to swipe
- Inventory tracking
- Attendance tracking
- Control access to secure building
- Tracking library books
- Manufacturing and Processing
- Inventory and production process monitoring
- Supply Chain Management
- RetaiInventory control and customer insight
- Auto checkout with reverse logistics Security
- Access control
- Counterfeiting and Theft control/prevention
- Location Trackin
- Traffic movement control and parking management
- Wildlife/Livestock monitoring and tracking

PROPOSED SYSTEM

This system provides fast and efficient method for toll collection. The major function of this system includes vehicle theft detection, automatic tax collections, tracking speed of vehicle and avoidance of signal breaking. These mechanisms are done by single RFID toll gate control. If vehicle is stolen it can be tracked by RFID toll gate control. In the database information of tag is stored. Vehicle identification number matches with the information of tag. If match occurs stolen vehicles are identified and are caught by the police. Even speed of vehicle above 100% accuracy can be caught. These mechanisms are done using single RFID tag therefore saving the efforts of carrying money and records manually. As explained in the figure 1, the RFID readers which are mounted on the toll booth will notify the arrival of the vehicle. The prepaid RFID tags are fixed on vehicles checks for the unique ID. If the vehicle is not registered then the tax is paid manually. If the ID is registered, it gets the details from the database and checks the balance amount and automatically deducts the required amount. In case of insufficient balance it deducts the amount from the account holder and shows negative value. Once the transaction is completed the gate is opened.

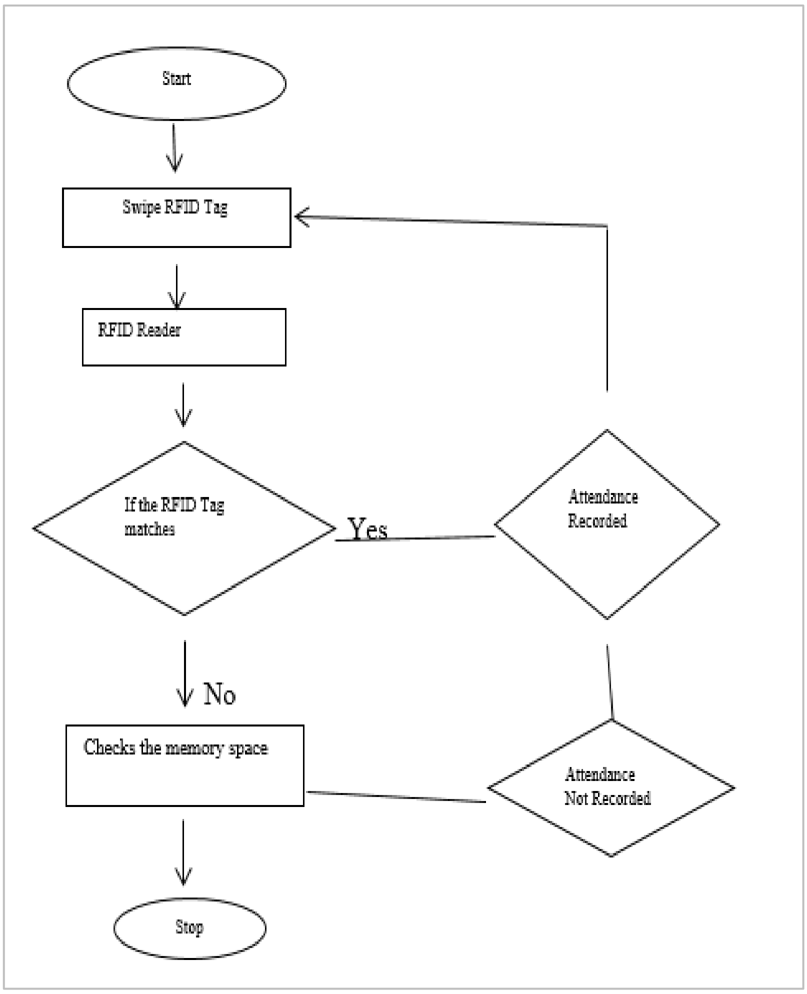


Figure 25-1 Proposed System

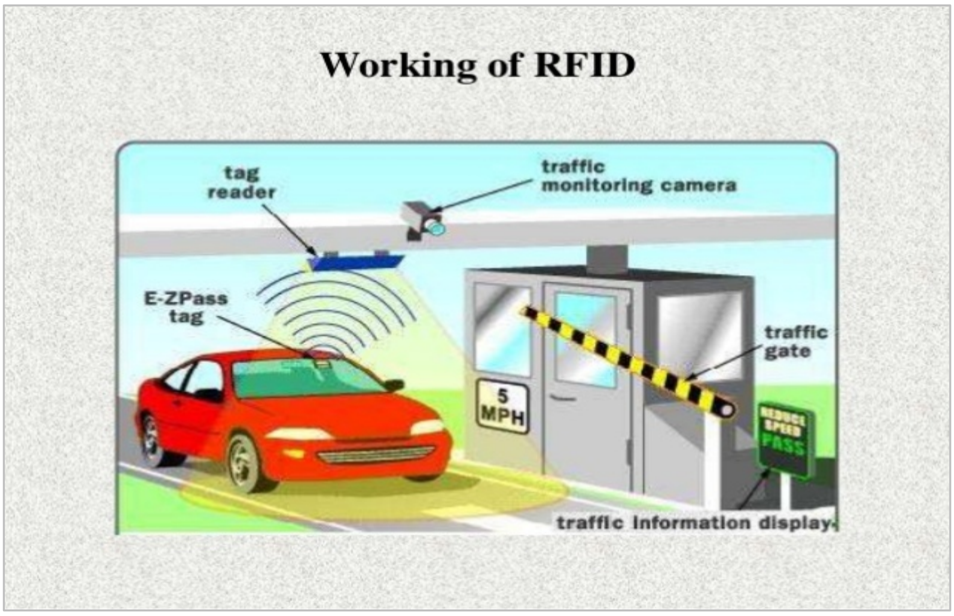


Figure 25-2 Working of RFID

PROGRAM

```
C51 COMPILER V7.08   RFID                                02/28/2004 08:31:41 PAGE 1
C51 COMPILER V7.08, COMPILATION OF MODULE RFID
OBJECT MODULE PLACED IN C:\ISP's\SP_ISP\bin\Debug\RFID.obj
COMPILER INVOKED BY: C:\Keil\C51\BIN\C51.EXE RFID.C BROWSE DEBUG OBJECTEXTEND OBJECT
(C:\ISP's\SP_ISP\bin\Debug\RFID.obj)

line level          source

        #include<reg51.h>
        #include<string.h>
        #include"lcd.h"
        #include"uart.h"
        char buf [20];
        int i=0,j=0;
        int count=0;

        main ()
          {
     1     char buf1 [20] ="4600D04632E2";
     1     lcd_init ();
     1     init_uart ();
     1     //IE=0x90;
     1     for (i=0;i<12;i++)
     1     {
     2     buf[i] =uart_rx();
     2     }
     1     if (strcmp (buf1, buf) ==0)
     1     lcd_string ("id matched");
     1     else
     1     lcd_string ("id not matched");
     1
     1     //uart_tx ('A');
     1     //void harsh (void) interrupt [1] using [3]
     1     /*lcd_cmd (0x80);

     1     lcd_data ('h');
     1     lcd_data ('a');
     1     lcd_data ('i');
     1     lcd_cmd (0x84);
     1     lcd_string ("your name is");
     1     lcd_cmd (0x01);
     1     lcd_string ("harsh sahay");*/
     1     while (1);
     1     }


MODULE INFORMATION: STATIC OVERLAYABLE
CODE SIZE        =    246    ----
CONSTANT SIZE    =     46    ----
XDATA SIZE       =   ----    ----
PDATA SIZE       =   ----    ----
DATA SIZE        =     26      23
IDATA SIZE       =   ----    ----
BIT SIZE         =   ----    ----
END OF MODULE INFORMATION.

C51 COMPILATION COMPLETE.0 WARNING(S), 0 ERRORS(S)
```

EXPERIMENT AND RESULT

The designed model of automatic tollgate system will automatically detects the identities of vehicles and performs the billing in accordance to the identity of each vehicle. Once all the rate. As all the test cases are passed system will automatically detect the vehicle. As the vehicles are identified doors are automatically closed or opened. RFID tag are read are RFID those are present in each toll gate. The information of vehicle such as owner detail, vehicle number, vehicle tags number and owner bank detail will be stored in database of microcontroller. If the vehicle number does not match with the detail of the microcontroller the process is terminated. If the vehicle in the toll gate matches with the record of database processes are further processed. Based on the kind of vehicle the tax amount is automatically deducted from the owner's bank account. The information are sent to the owner's mobile by GSM service and the status of vehicle are displayed to the LCD scrren.There is no network problem for this process, vehicle have no need to wait in a queue. Tax amount those are paid to the vehicle differs from vehicle to vehicle.

REFERENCES

[1] IMPINZ

[2] RFID: RFID Introduction, Present and Future applications and Security Implications RFID Introduction, Present and Future applicationsandSecurity Implications Nandita Srivastava MSEEStudent George Mason University Advisor: DrJens PeterKaps

[3] International journel of electronics, Communication ISSN 1434-8411

[4] A survey on radio frequency identification (Rfid) trends

[5] Survey paper on Rfid: radio frequency Identification Dalvinder kaur#1, jyotsna sengupta#2,#1 student Department of computer sciencePunjabiUniversityPatiala,India,#2ProfessorDepartment of Computer Science, Punjabi University, Patiala,

[6] Rfid Technology: an overview .Amit kumar pal1.AkanshaTripathi2,AnupamSaigal1ResearchScolar,BundelkhandUniversity,Jhansi,India#2,Library Assistantship Nadar University,Gr. Noida,India3 Librarian,Subharti Institute of TechnologyandEngineering,Meerut,IndiaInternational Journal of Research, Granthaalayah

[7] Huge List of Seminar Topics 2020 2019 Home Electronics Radio Frequency Identification Device (RFID) www.seminarsonly.com.

26. Monitoring air pollution Based on Internet of Things (IoT) and Interfacing of Microcontroller with VGA display

Shahir Uddin, Electronics & Communication Engg., Birla Institute of Technology, Patna Campus Patna, India shahir@bitmesra.ac.in
Kamal Kant, Electronics & Communication Engg., Birla Institute of Technology, Patna Campus Patna, India kamalkant2291@gmail.com
Vishal Kumar, Electronics & Communication Engg., Birla Institute of Technology, Patna Campus Patna, India vishal2400034@gmail.com
Dharmendra K. Singh, Electronics & Communication Engg., BIT Sindri, Dhanbad, India dksingh@nitp.ac.in
M. A. Hassan, Mechanical Engg. Department, NIT Jamshedpur, Jamshedpur, India hassan@bitmesra.ac.in

ABSTRACT

With the rapid advancement's of technology to fulfill the necessities of humans and overconsumptions of resources to drench their thirst of led to worsening the environmental condition. Various factors like industrialization, urbanization, deforestation etc. contributed to this adverse situation. The other most important factor behind this scenario is negligence or improper real time monitoring. Real time monitoring of the Air Pollutants with IoT based technology will provide ambient data with the cloud service will help in controlling this degrading Air Quality. This paper concern about providing an mobile and portable Air Pollution monitoring device to monitor the concentration of pollutant which would be powered with 3.3V only. The data monitored can be sent to the cloud which can be remotely accessed using android applications. This will facilitate the users to fetch the data of remote areas in the real time and also be displayed over the VGA display interfaced with microcontroller.

Index Terms— *Video Graphics Array; Particulate Matter2.5; Air Quality Monitoring; IoT.*

INTRODUCTION

In the present Era of development, environment is left with increased concentration of air pollutants. Air pollution is the main concern for all the developing as well as the developed countries. As per the studies after poverty Air pollution is the major problem faced by the world today. Humans are at the verge of treating development and advancements compromising with the life-threatening issues. The rapid increase in the concentration of various harmful gases in our atmosphere causes have adverse effects on humans and ecological community[1]. Air pollution may be linked with lung's impairments[2],[3], cardiovascular diseases[4], lung cancer, community acquired pneumonia.This paper deals with the monitoring of harmful pollutants and simultaneously displaying the sensors data over VGA display. Along with monitoring of gas pollutants, making people aware of the adverse effects of those is required by keeping regular track of these gases. Suspended particulate matter (SPM), carbon monoxide (CO), oxides of nitrogen (NO), oxides of sulfur (SO), lead aerosol, volatile organic compounds (VOC) are the main constituents of air pollutants [5][6].This will led them to take some precautionary measures and steps to fight or overcome these silent Killer pollutants [7].These not only making our live worse but also decreasing their average life expectancy by 1.8 years [8]. If people along with theinitiative taken by the government contribute to fight against this problem, the can be controlled and reduced up to some extent for the better future. The rise of population in the upcoming century, mainly in the developing countries there is a lack of capital for the major concern like air pollution control and it signifies that gradually the conditions will worsen in many more cities that will reach megacity status.[9]. As far as sustainability is concerned the ozone depletion, poverty and air pollution is the major problem faced by the world.[10] According to the data estimated by WHO 12.6 million of global deaths is due to environmental factors[11].

This paper presents real time wireless monitoring of the harmful pollutants and simultaneously displaying sensors data over VGA displays[12].The VGA(video graphic Array) standard display is able to both read and write hardware registers and offers increased 640×480 color resolution [13].So, we in way of providing a simplest and modular Air Quality Monitoring device which will send the sensor data over cloud and then it will be fetched using Mobile Applications.[14] It can be also displayed over VGA display panels mounted for forecasting the concentration of gases of different areas replacing those LED display panels. These displays will not give out the sensors data and also used for displaying precautionary measures in case of alarming increase of concentration of pollutants. These displays are less power intensive than the older one and provide good interface and performance. Along with sensing, making this device compatible to IoT (internet of things) will provide an easy access to the sensors data and make data acquisition lot easier [15]. This will provide a kind of real-time air pollution monitoring and forecasting system by sending the data over cloud platform and then fetching the data on mobile applications.

PROPOSED MODEL

To meet the requirements of the advancement in the field of electronics the need of decrease the device size in order to increase its compatibility and mobility is important. By using single chip microcontroller this model took a form of standalone device. Various Gas sensor, temperature and humidity sensor along with Wi-Fi enabled chip ESP8266 makes it easier for real time monitoring of gasconcentration of the atmosphere. The data fetched by the sensor also uploaded over cloud storage in real time so that it can also be remotely accessed.

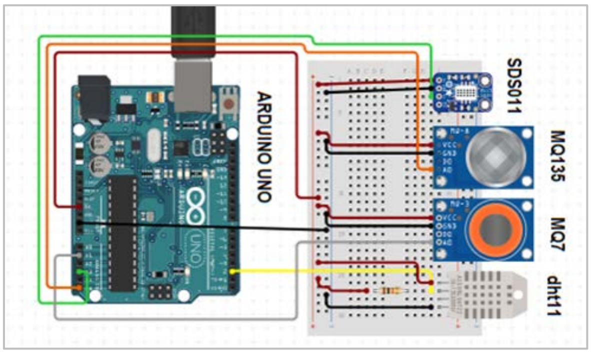


Figure 26-1 Circuit diagram of the model

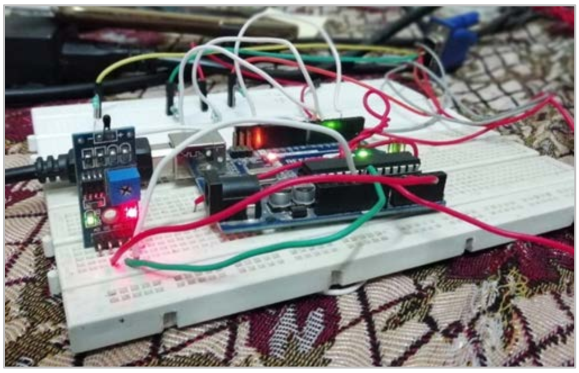


Figure 26-2 Hardware model

These circuit diagrams in fig.26-1 represent real time air pollution monitoring device. The data received from the device will be sent to cloud, stored and will also be displayed over VGA displays. The use of several semiconductor sensors has advantage of low cost, small size and high precision. This will provide a wireless real time air pollution monitoring system, designed using a microcontroller to measures the levels of various air pollutant's concentration.[16]Converting sensor acquired data from analog to digital value of air pollutant i.e. Co,NO2&SO2 etc. these are sent to the cloud using the Wi-Fi modem. Although the display board used so far for displaying air pollution monitoring is power intensive and bulky, so we use here is the VGA based display monitors. the microcontroller is been interfaced by the VGA monitor display for displaying the data of air pollution monitoring. the circuit connection of microcontroller is done with the help of resistance matrix and VGA cable. the resistance matrix connects the incoming output signal of microcontroller to the VGA connector cable to display the sensor data output in a required format. This will provide regular update of Air Quality Index(AQI) in the vicinity of the device. Based upon this AQI the quality it has been categorized in six levels namely Good, Moderate,Unhealthy, Very Unhealthy, Hazardous.[17]

The sensor data can also be displayed over VGA monitor such that it can provide these information over large displays. This can display the variation of sensor data due to changes in the concentration of gas in the surrounding. the signal generation of the VGA display can be done by obtaining the Arduino pin voltage to certain specific value in order to get different colours. This can be done by using resistances of different value to drop the pin voltage of Ofarduino to certain value. in order to get the balck color the voltage at the vga pin should be 5V and similarity based upon these resistance values colour signal will get generated.

The sensor output is fetched through the microcontroller and simultaneously displayed over the VGA display. This interfacing approach overcomes the scalability of size of displays used. The Video Graphic Array display provides color interface with the help of resistors of different values in order to regulate the voltage which corresponds to different color combinations.

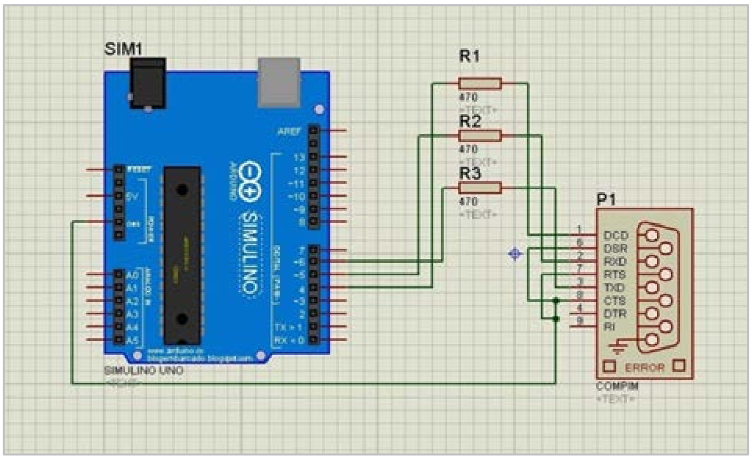


Figure 26-3 circuit Diagram of Arduino due to VGA port

This provides an easy access to get the desired data of whatever needed within short span of time.So, we are also working on the same. We are likely to provide these sensor data on Android Apps fetching the sensor data from cloud platform. The steps for initializing the uploading the sensors data over the cloud platform are to connect the microcontroller to Wi-Fi module with the specified pins mentioned in the data sheet. Then with the help of boot loader code has been uploaded to the board using specified burner software.

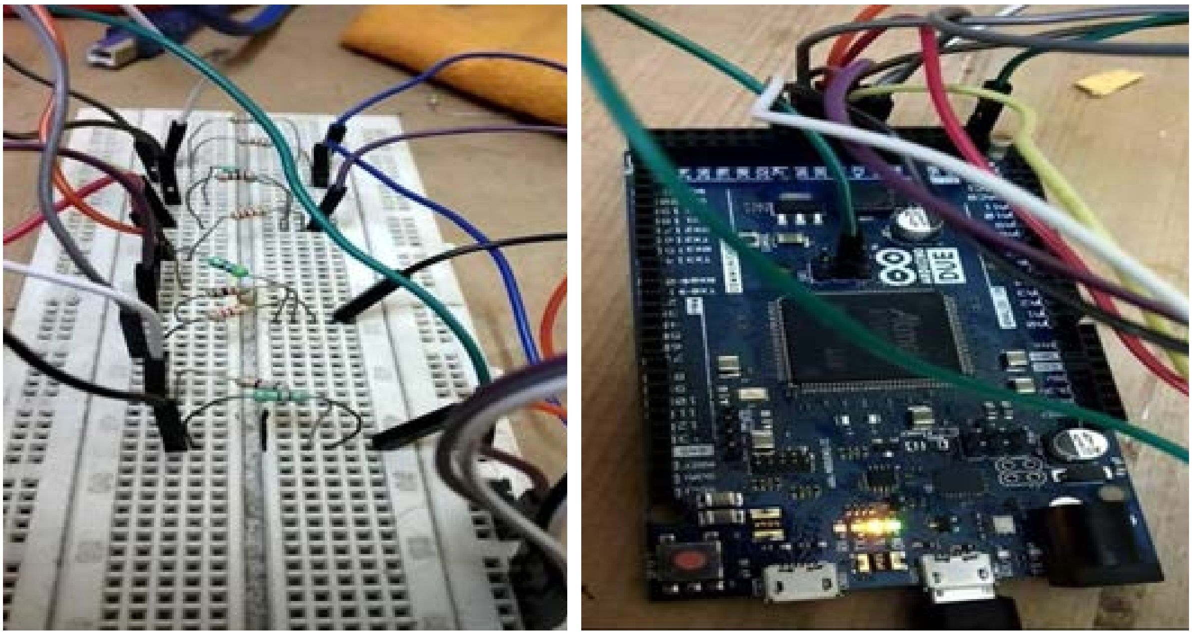


Figure 26-4 Circuit connection of VGA interfacing with Arduino Duo

Different Sensor for monitoring the air pollutant has been used which will provide the concentration of various gases. These consist of three air quality sensor, temperature and humidity sensor. The MQ series sensors used are resistance based whose conductivity increases with the rise in the concentration of gases in air. Along with this Particulate Matter sensor have been used to measure the concentration of PM2.5 & PM10 which is laser driven. These sensors are low cost and are accurate, precise, small in size and microcontroller compatible.[18]Sensor's specification used to measure the concentration of pollutants is shown in tabular form.

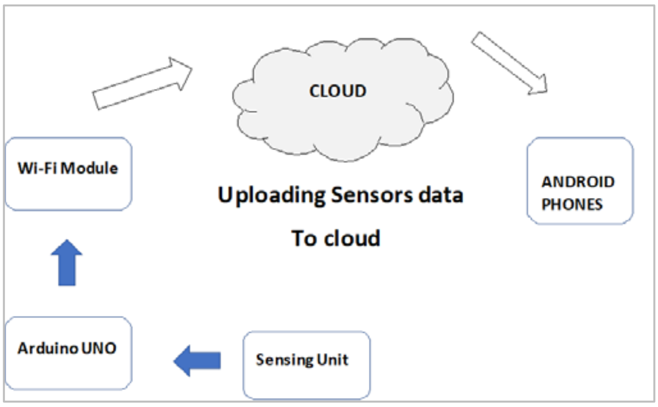


Figure 26-5 Block diagram of uploading data to cloud storage

Table 26-1 sensor's specification

Sensor	Sensing Gas	Operating Range
DHT22	Humidity & Temp	-40 - 125 C 0 - 100 %
SDS011	PM2.5 & PM10	0.0-999.9µg/m3
MQ7	CO	10 -10000ppm
MQ135	CO2, NH3, Benzene	10 – 1000 ppm

SDS011 is used to calculate the concentration of particulate matter in the atmosphere using a laser scattering technique. The low cost and precise size of this sensor made it suitable for use to sense air pollution by particulate matter emitted by traffic, building construction and industrial combustion.Concentration of PM gets influenced by several factors such as particle mass, chemical composition and shape as well. For the measurement stream of air is allowed to pass through the air channel to the measurement chamber. The light from laser diode get scattered and converted into electrical pulses, with the pulse area or height using transimpedance amplifier (TIA). After Analog to Digital conversion (ADC) through microcontroller embedded over it the pulse information is used to measure the PM values.

SOFTWARE ARCHITECTURE

Think Speak is an open source cloud platform provided for Internet of Things(IoT) by MATLAB analytics for uploading sensor data to the cloud in real time which means sensing and transmitting data at the same time. The provide features like storing, collecting, analyzing and visualizing sensor's data.

The result shows the monitored data of the different sensors after the final calibration of the sensors with microcontroller. mainly the air pollutants that are measured by the formed device are humidity, temperature, NH3, PM 2.5 and CO. The table below shows the monitored data of the specified pollutants by the microcontroller. The monitored data has also be shown on the VGA display that is connected to the microcontroller. The monitored data is displayed on the VGA display for broadcast purposes and also in colorful figures. Below are the results of monitored data.

Figure 26-6 The monitored data on VGA display by interfacing with the microcontroller

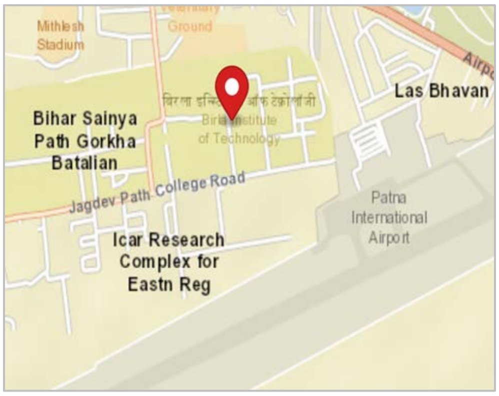


Figure 26-7 The figure shows the use of cloud to know the GPS location

Table 26-2 Sensor's Data

Date	Humidity (%)	Temperature (°C)	MQ135 (ppm)	PM2.5 ($\mu g/m^3$)	CO (ppm)
2019-07-27 20:15:57 IST	80	29	27	9	46.76141
2019-07-28 00:50:41 IST	78	28	27	9	46.55602
2019-07-28 00:52:46 IST	78	28	27	9	46.41908
2019-07-28 00:56:59 IST	78	29	28	9	43.95436
2019-07-28 00:59:05 IST	78	28	27	8	43.4751
2019-07-28 01:03:25 IST	79	28	27	2	43.4751
2019-07-28 01:05:31 IST	79	29	28	1	43.54357
2019-07-28 01:09:43 IST	79	29	27	10	43.74896
2019-07-28 01:11:49 IST	79	28	28	12	43.74896
2019-07-28 01:15:38 IST	77	29	28	12	41.3527
2019-07-28 01:16:41 IST	75	29	28	10	43.26971
2019-07-28 01:17:47 IST	76	28	27	12	42.58506
2019-07-28 01:18:50 IST	75	30	28	10	43.33817
2019-07-28 01:19:53 IST	74	30	28	12	43.33817
2019-07-28 01:20:57 IST	74	28	27	12	42.85892
2019-07-30 03:03:07 IST	65	29	28	12	42.65353

2019-07-30 03:04:13 IST	65	29	27	10	42.58506
2019-07-30 03:05:16 IST	65	29	28	12	41.83195
2019-07-30 03:06:20 IST	65	29	28	7	42.10581
2019-07-30 03:07:23 IST	65	29	27	13	41.21577
2019-07-30 03:08:26 IST	64	29	28	11	39.9834
2019-07-30 03:14:18 IST	66	30	27	13	41.3527
2019-07-30 03:15:22 IST	64	30	27	9	12.39212
2019-07-30 03:16:25 IST	63	30	27	11	44.98133

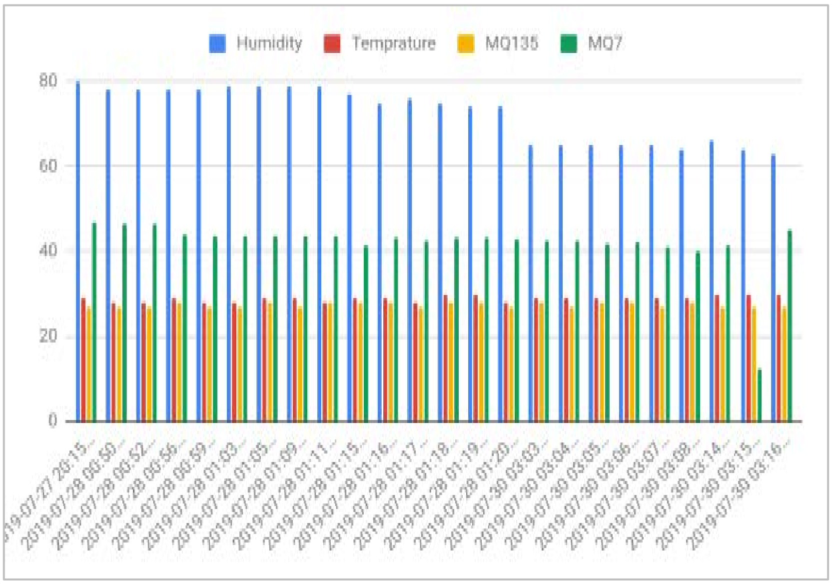


Figure 26-8 The graph shows the monitored data of air pollution monitoring device on the specified date and time in a graphical representation based on which Air Quality Index of the specific location can be calculated. The AQI can be displayed over the VGA display

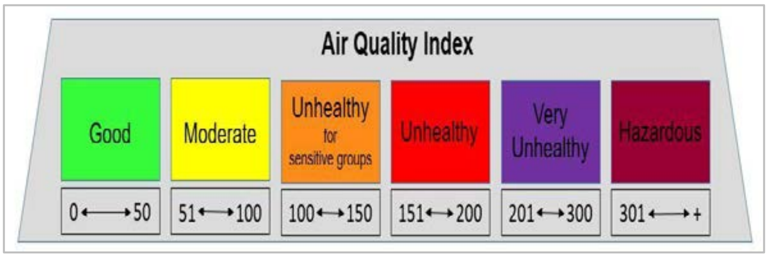


Figure 26-9 The below figure is the standard of Air Quality Index of the air. This shows the differentlevels of pollutants and their tolerance[17].

$$\text{Air Quality Index(AQI)} = \frac{\text{Pollution Level}}{\text{Pollution Standard}} * 100 \quad [20]$$

CONCLUSION

The device formed provides the monitored data of the air pollutants suspended in the atmosphere and sends the data over cloud in real-time for the user access. the device monitors the particulate matter, humidity, temperature and carbon monoxide suspended in the air. The results is been arranged in the tabular form. Based on the results it will be possible to get the information of change in the concentration of different air pollutants using the specified sensors. The sensor used in the prototype device is resistance and laser based sensors. A microcontroller computes the amount of air pollutants in the air and it is connected to the Wi-Fi module that sends the data to the server with the help of GSM module that provides the internet connectivity. The microcontroller used was NodeMCU. the microcontroller is connected to the VGA display that shows the data in representable and colorful format. Few sensors data cannot be displayed by the VGA displayed due to interfacing of the microcontroller through the resistance array. The users can easily check the real-time measurement via ThingView android application, along with the data of the past. The cloud platform also provides the graph of the monitored data for the visualization and interpretation of data.

REFERENCES

[1] Dhanashri Ajay konnur, Dr. L K Ragha, “Review Paper on Smart Sensor Network for Air Quality Monitoring”, International Journal of Innovative Research in Advanced Engineering, vol. 3, issue. 7, 2016.

[2] Professor Eddy Zeng, Professor Christian Sonne, “Environmental Pollution”, ELSEVIER.

[3] N. Paskin, “Toward unique identifiers”, IEEE explore, vol.87 , Issue. 7, 1999.

[4] Mutlu EA, Comba IY, Cho T, Engen PA, Yazıcı C, Soberanes S, Hamanaka RB, Niğdelioğlu R, Meliton AY, Ghio AJ, Budinger GRS, Mutlu GM, “Inhalational exposure to particulate matter air pollution alters the composition of the gut microbiome.”, Environmental Pollution, vol. 240, 2018.

[5] Swati Dhingra ; Rajasekhara BabuMadda; Amir H. Gandomi; Rizwan Patan; Mahmoud Daneshmand, “Internet of Things Mobile–Air Pollution Monitoring System (IoT-Mobair)”, IEEE Internet of Things Journal, vol. 6, issue. 3, 2019.

[6] Nihal Kularatna B. H. Sudantha, “An Environmental Air Pollution Monitoring System based on the IEEE 1451 Standard for Low Cost Requirements”, IEEE SENSORS JOURNAL, vol. 8, issue. 4, 2008..

[7] United Nations environment programme, “Air Pollution: Africa’s Invisible”, Silent Killer, 20 oct 2016.[online: https://www.unenvironment.org/pt-br/node/20803].

[8] N Künzli, R Kaiser, S Medina, M Studnicka, O Chanel, P Filliger, M Herry, F Horak Jr, V Puybonnieux-Texier, P Quénel, J Schneider, R Seethaler, J-C Vergnaud, H Sommer, H., “Public-health impact of outdoor and traffic-related air pollution: a European assessment”, The Lancet, vol. 356, pp. 795–801, 2000.

[9] Mage, D., Ozolins, G., Peterson, P., Webster, A., Orthofer, R., Vandeweerd, V., & Gwynne, M., “Urban air pollution in megacities of the world.”, AtmosphericEnvironment,vol. 30, pp. 681-686, 1996.

[10] Stuart L. Hart, “Beyond Greening: Strategies for a Sustainable World”, HARVARD BUSINESS REVIEW, 1997.

[11] WHO, “An estimated 12.6 million deaths each year are attributable to unhealthy environments”, WHO,2019.[online:https://www.who.int/news-room/detail/15-03-2016-an-estimated-12-6-million-deaths-each-year-are-attributable-to-unhealthy-environments.]

[12] A. R. Al-Ali ; Imran Zualkernan; FadiAloul, “A Mobile GPRS-Sensors Array for Air Pollution Monitoring” IEEE Sensors Journal, vol. 10, 2010.

[13] Wayne F. Berry, “VGA controller card”, US Patent 5 150 109, 1992.

[14] Benammar M, Abdaoui A, Ahmad SHM, Touati F, Kadri A, “A Modular IoT Platform for Real-Time Indoor Air Quality Monitoring.”,Sensors (Basel), vol. 14, 2019

[15] Borghi F, Spinazzè A, Rovelli S, Campagnolo D, Del Buono L, Cattaneo A, Cavallo DM, “Miniaturized Monitors for Assessment of Exposure to Air Pollutants: A Review”, International journal of environmental research and public health, vol.14, 2017.

[16] Jadhav D. A., Patane S. A., Nandarge S. S., Shimage V. V., Vanjari A.A, “Air Pollution Monitoring System Using Zigbee and GPS Module”, International Journal of Emerging Technology and Advanced Engineering, vol. 3, 2013.]

[17] The Minister for Environment, Forests & Climate Change Shri Prakash Javadekar launched The National Air Quality Index (AQI) in New Delhi under the Swachh Bharat Abhiyan, Oct 2014.[Online: www.cpcb.nic.in].

[18] Siby John , “Real Time Ambient Air Quality Monitoring System Using Sensor Technology, Jyoti Sharma”, Pec University Of Technology Chandigarh, 2018..

[19] Jadhav D. A., Patane S. A., Nandarge S. S., Shimage V. V., Vanjari A.A, “Air Pollution Monitoring System Using Zigbee and GPS Module”, International Journal of Emerging Technology and Advanced Engineering, vol. 3, 2013

[20] “Calculating a station air quality index”, EPA Victoria, 2015.[Online: https://www.epa.vic.gov.au]

[21] Rohizah Abd Rahman, Khairuddin Omar, Shahrul Azman Mohd Noah and Mohd Shahrul Nizam Mohd Danuri. A Survey on Mental Health Detection in Online Social Network, 2016.

[22] H. Appel, J. Crusius, and Alexander L. Gerla. Social comparison,envy, and depression on facebook: a study looking at the effectsof high comparison standards on depressed individuals. Journal of Social and Clinical Psychology, 2015.

27. Smart attendance Monitoring System with Computer Vision using IOT

Ashwin Raj, Electronics and Communication Engineering B.I.T. SINDRI DHANBAD, INDIA
rajashwin167@gmail.com
Aparna Raj, Electronics and Communication Engineering B.I.T. SINDRI) DHANBAD, INDIA
aparnaraj286@gmail.com
Imteyaz Ahmad, HOD,Electronics and Communication Engineering B.I.T. SINDRI DHANBAD INDIA iahmad@bitsindri.ac.in

ABSTRACT

The main aim of this project is to create a smart attendance monitoring system, which will use the concept of face recognition to identify students. Based on this a database will be created containing the information of attendance date wise. Apart from reducing time it will also help in replacing the laborious conventional method of using logbooks. The system also has the feature to send emails to the administrator about the student's attendance status at the time of recognition itself. At the time of closing of the camera, absentees' names will be called out.

Keywords— *Feature extraction, HOG algorithm, SQLite*

INTRODUCTION

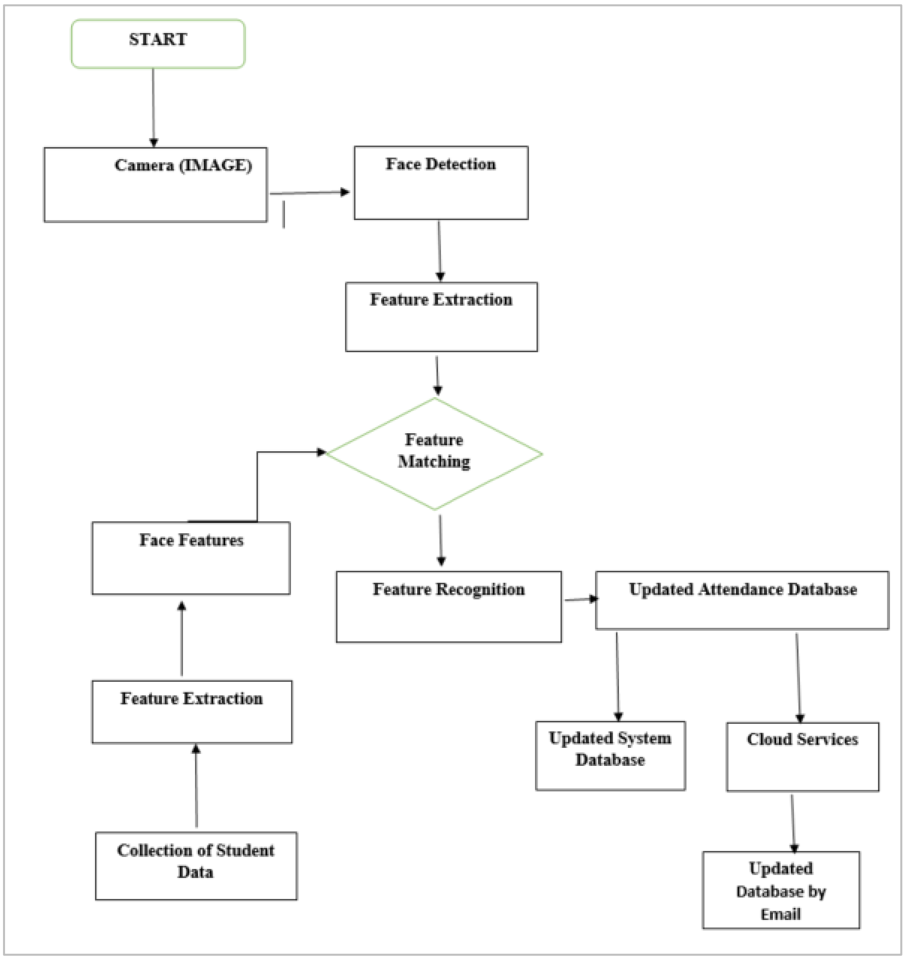
Attendances of every student are being maintained by every school, college and university. Empirical evidences have shown that there is a significant correlation between students who have poor attendances and their academic performances. There was also a claim stated that the students who have poor attendance records will generally link to poor retention. Therefore, faculty has to maintain proper record for the attendance. The conventional methods practiced in most of the institution includes manual entering of attendance in logbooks which is time consuming and can be easily manipulated. Calculating the average attendance of each student is also laborious. Bunking the classes or giving proxies for the absentees has also become quite flexible. Hence to solve all these problems we are introducing the idea of automated attendance monitoring system which works on the concept of face recognition.

The main motivation for the project was the slow and inefficient traditional manual attendance system. So, why not make if automated fast and much efficient. Also, such face detection techniques are in use by the department of a criminal investigation where the usage of CCTV footages and detecting the feces from the crime scene and comparing them with criminal database to recognize them. It is also becoming as a feature of daily life in China, where authorities are using it on the streets, in subway stations, and at airports.

METHODOLOGY

The concept is based on face recognition technique that requires the modules according our need. The system in which the software runs needs a web cam and internet connection. The camera starts to capture video and starts recognizing and marks the student's attendance. The attendance database is saved on the system and also send to the user via cloud services through email which can be accessed for later verification purpose.

A. FLOWCHART



B. CLOUD SERVICES (IFTTT):

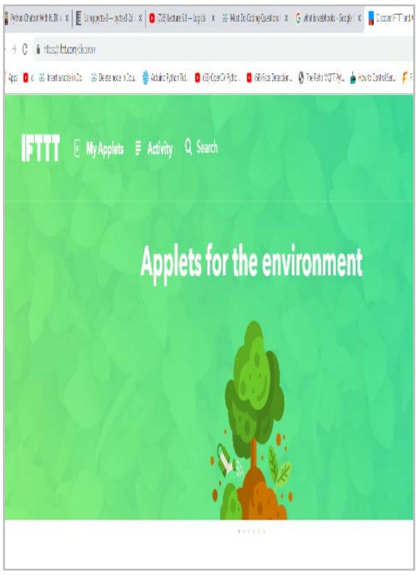


FigurE 27-1 IFTTT service

C. WORKING

The entire work is divided into two processes.

- Recognizing the person face.
- Storing and sending the data records.

RECOGNIZING THE PERSON FACE.

- Step 1: Finding all the Faces
  - Encode a picture using the HOG algorithm to create a simplified version of the image. Using this simplified image, find the part of the image that most looks like a generic HOG encoding of a face.
- Step 2: Posing and Projecting Faces
  - Figure out the pose of the face by finding the main landmarks in the face. Once we find those landmarks, use them to warp the image so that the eyes and mouth are centered.
- Step 3: Encoding faces
  - Pass the centered face image through a neural network that knows how to measure features of the face. Save those 128 measurements.
- Step 4: Finding the person's name from the encoding
  - Looking at all the faces we've measured in the past, see which person has the closest measurements to our face's measurements. That's our match!

STORING AND SENDING THE DATA RECORDS.

Here we are using ifttt to send a mail to user provided email id. Using the ifttt service. It works on the programing conditional statement If This Then That. The automations are accomplished via applets, which are sort of like macros that connect multiple apps to run automated tasks. An applet is created to link a triggering action (face recognition) to onset an event (sending an email).

Now for storing database on the system we have SQLite3. We use sql queries to create tables and feed information in it. Each time system runs the data get automatically uploaded in the database.

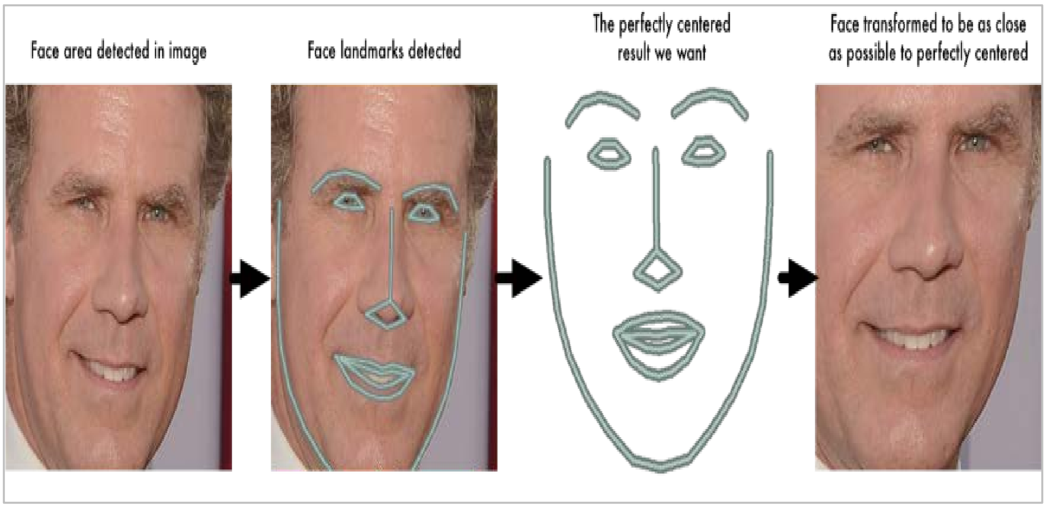


FigurE 27-2 Shows the use of landmarks and transforming the images to be close as possible for perfect centering.

D. VALIDATION OF RESULTS

- Face recognition by the system (Figure 27-3).
- Database on user system (Figure 27-4).
- Records on the email (Figure 27-5)

Figure 27-3 shows that the camera captures the video on live mode and extracts the face for recognition.

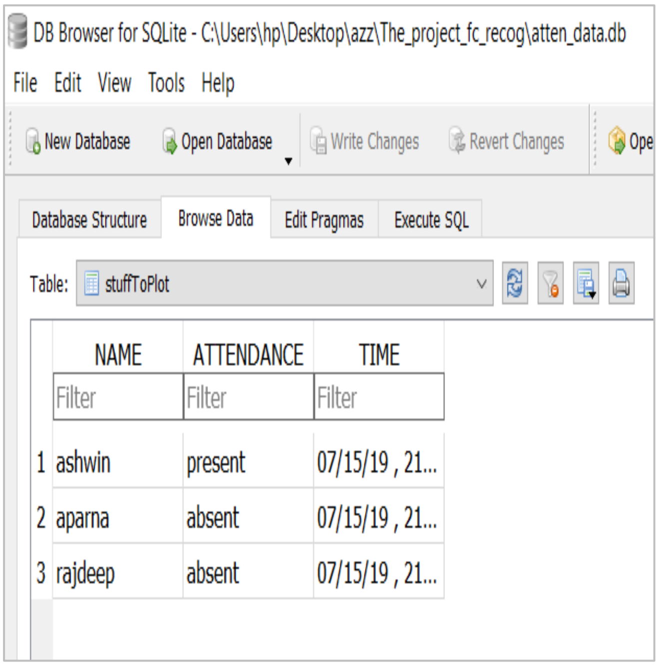


Figure 27-4 Shows the tabulated record of student's attendance. Here SQLite is used for database management.

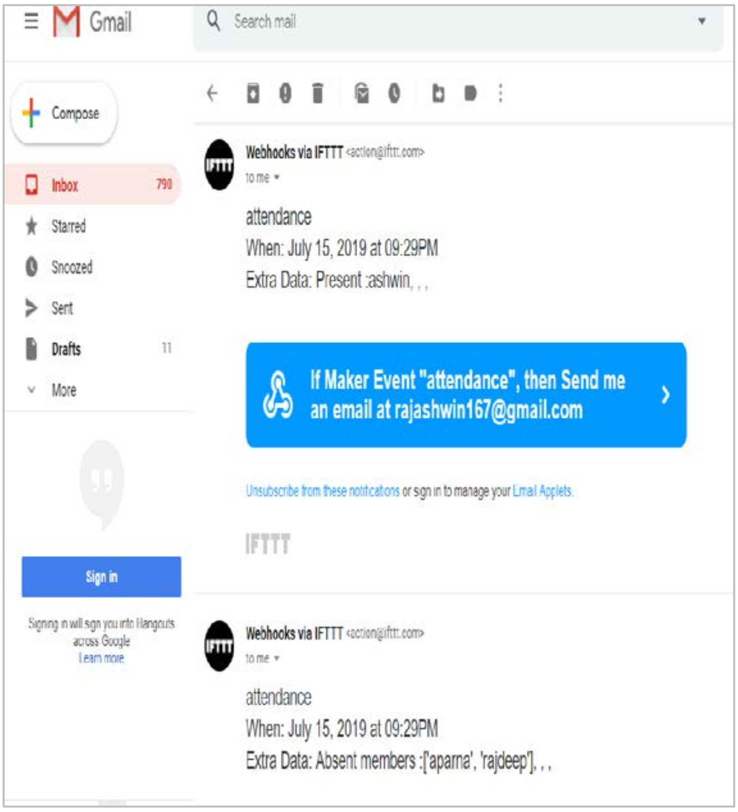


Figure 27-5 Shows attendance records send to the user email at the real time. Figure also shows the records are sent and updated to same email

COMPARATIVE STUDY

The study of this paper is compared to the research related on this topic. The study related to reference number-[5] uses the concept of taking multiple images of a person and storing it on a separate space. This method uses much space and consumes extra time for creating a training dataset whereas this method uses deep neural network concept which is smart and efficient enough to train itself by providing a single image of a person. So time will be reduced and storage dependency will also be sorted.

The study of reference number - [9] use the technique of storing records on the specific system where our model stores the records on the user system as well as send the real time attendance data to user's email using cloud system. So the data can be easily accessed from any place.

CONCLUSION

The system uses the camera of the computer to recognize the students by showing their name below their picture. As soon as it identifies the student an email is generated and sent to the address provided by user to notify about its attendance. After the identification of all students, the camera is closed and then name of the absent students are called out with the help of speech synthesizer. Then with the help of the Browser we can see the database which was created having the entry fields of name, attendance, date and time.

ACKNOWLEDGEMENT

I am thankful to Dr. Imteyaz Ahmad, HOD,Department of ECE BIT Sindri, I.P Sinha and Saurav kumar of Dthingz lab, Ranchi.

REFERENCES

[1] Alina L. Machidon, Octavian M. Machidon, Petre L. Ogrutan, "Face Recognition Using Eigenfaces Geometrical PCA Approximation and Neural Networks", Telecommunications and Signal Processing (TSP) 2019 42nd International Conference on, pp. 80-83, 2019.

[2] Nuruzzaman Faruqui, Mohammad Abu Yousuf, Md. Fazlul Karim Patwary, "Automatic Examinee Validation System using Eigenfaces", Advances in Science Engineering and Robotics Technology (ICASERT) 2019 1st International Conference on, pp. 1-7, 2019.

[3] Vegnish Rao Paramesura Rao, Chamode Anjana Hewawasam Puwakpitiyage, Dalia AbdulKareem Shafiq, Farhana Islam, Dini Oktarina Dwi Handayani, Hamwira Yacoob, Teddy Mantoro, "Design and Development of Facial Recognitionbased Library Management System (FRLMS)", Computing Engineering and Design (ICCED) 2018 International Conference on, pp. 119-124, 2018.

[4] Khem Puthea, Rudy Hartanto, Risanuri Hidayat, "A review paper on attendance marking system based on face recognition", Information Technology Information Systems and Electrical Engineering (ICITISEE) 2017 2nd International conferences on, pp. 304-309, 2017.

[5] Nabeelanaaz Suri, Maheshwari Marne, Mohini Ghotekar, Utkarsha Pacharaney, "Design of facial features based hospital admission using GSM", Inventive Computation Technologies (ICICT) International Conference on, vol. 1, pp. 1-6, 2016.

[6] Adam Geitgey-"Modern Face Recognition with deep Learning", 2016.

[7] Codacus – OpenCV face recognition, Nov 4 2016

[8] Open cv – "Face detection using haar cascades"

[9] M. Turk, A. Pentland, Eigenfaces for Recognition, Journal of Cognitive Neurosicence, Vol. 3, No. 1, Win. 1991, pp. 71-86

[10] Face Recognition: Robustness of the 'Eigenface' Approach Carmen Au1 , Jean-Sebastien Legare2 & Reehan Shaikh2 McGill

28. QCA Adder-Subtractor

[1]AMAR PRAKASH SINHA [2]S. METIA

[1]Associate Professor, BIT Sindri, Sindri, Dhanbad 828123

[2]Faculty of Engineering & IT, University of Technology, Sydney, Australia

Email: [1]amarpsinha@gmail.com, [2]metia.santanu@student.uts.edu.au

Contact: 19430935294, 2+61435186778.

ABSTRACT

Quantum-dot cellular automata (QCA) is one of the promising emerging technologies being investigated as an alternative to CMOS technology. This paper investigate the suitable design for optimized one-bit full adder (FA) for implementation in QCA. Also the fault tolerance of the proposed FA outputs due to the missing cell defects are analyzed, and the test vectors for detection of all expected faults are identified. QCADesigner software is used for design and simulation. The proposed designs are compared with previous works. In comparison with the compared previous design, the proposed FA has 25% and 26% improvement in cells count and area, respectively, and it is faster. For the proposed FA, the obtained results ascertain that these designs are more efficient in terms of area, cell count and delay. Therefore, the implementation of proposed designs may be used as a basic building block of a nanoprocessor.

Keywords— *Quantum-dot cellular automata, QCA, QCADesigner, majority gate, full adder.*

INTRODUCTION

Current CMOS technology has scaled down to few nanometer technologies. Present silicon CMOS technology is facing exigent problems, such as quantum mechanical effects, high power dissipation and profound problem in feature size reduction. We must go for altered structure of CMOS or alternate of CMOS, and nanotechnology is an answer to these problems. The international technology roadmap for semiconductors (ITRS) report [1] presents various possible technology solutions. Quantum-dot cellular automata (QCA) [2–5] is a nanotechnology that offers a promising method of computation, Signal processing and Signal transformation. Full adder (FA) Presents one of the most important building block of arithmetic and digital circuit. Designing a fast and smaller full adder is indispensable. Many researches has been targeted upon the implementation of adders with QCA technology [7–10]. Optimized design of one bit FA where carry is used as one of the input for implementation of sum is implementation in QCA has been presented here. Simulation of missing cell defects have been done and identification of test vectors for the detection of missing cell faults for the proposed one bit FA have been presented here. Comparison of the proposed FA with previous designs [7–10] have been done. Results ascertain that the proposed design is more efficient in terms of cell count and effective area in comparison with the other works referred. Further, reduction in number of clock phases, shows extremely low delay may be obtained using an optimized layout.

BASIC QCA CIRCUITS

Figure 28-1 gives schematic of the ideal QCA cell structures in ground state, which have four identical QDs represented as open circles, forming corners of a square. Two electrons are assumed, represented by solid dots, in each cell occupying the diagonal positions. The polarization is defined as given in figures 1(a) and (b), anticlockwise position to be -1 polarization (P = -1) and clockwise position to be +1 polarization (P = +1) respectively.

In a cell the electrons are allowed to jump between the individual QDs using quantum mechanical tunnelling. In an isolated cell the electron will occupy the diagonal dots at ground state due to the coulombic force possessing either of polarization. This gives a bistable latch like behaviour with only two stable states. The nearby cells have sufficient barrier in form of intercellular distance, to completely suppress the tunnelling to occur between adjacent cells. Coupling between two adjacent cells is governed by the coulombic interaction and clocking action. Figure 28-2 shows the coupling between the adjacent cells, which compels cell 2 to have the same polarization as cell 1.

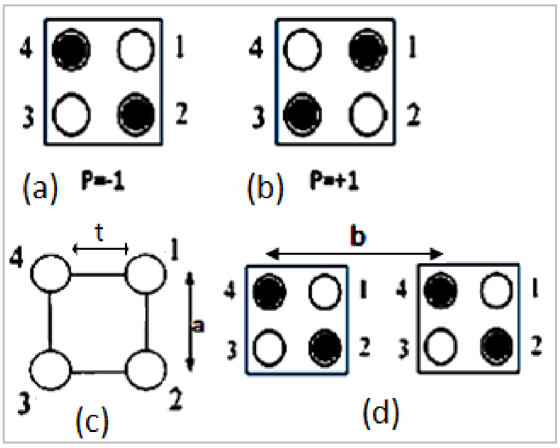


Figure 28-1 Ideal QCA cells, with (a) -1 polarization (b) +1 polarization, (c) dimensions of the cell (d) intercellular distance

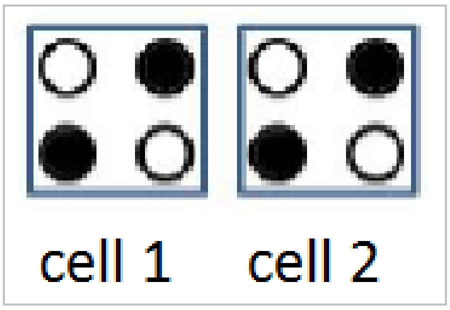
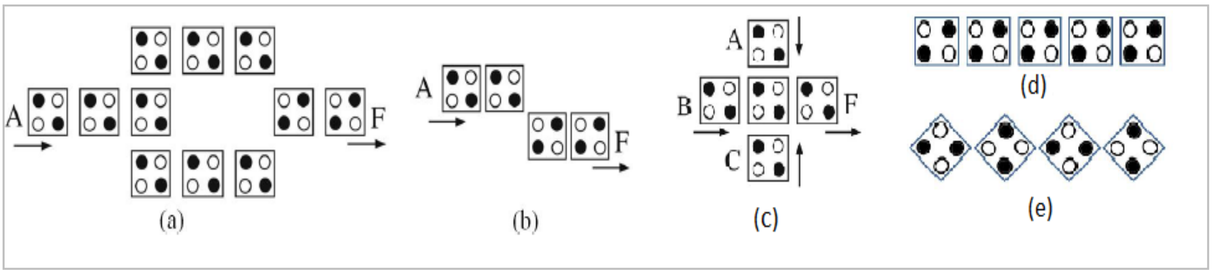


Figure 28-2 Cell 2 has the same polarization as cell 1 due to coulombic interaction.

The physical interaction between cells may be used to realize elementary Boolean functions. The basic logic gates using QCA structure are given in figure 28-3.



Figur 28-3 (a) Redundant inverter gate, (b) Inverter gate, (c) Majority logic gate, (d) Binary wire and (e) Inverter chain

Majority logic function given in figure 28-3(c) is the most important logic gate, with which we can implement OR gate when one input is permanently fixed to logic 1, and AND gate can be implemented fixing one input to logic 0. Clocking is very important aspect of QCA, which not only provides a mean for synchronizing information flow along the circuit, but also controls the direction of information flow in a QCA circuit. The QCA clock also provides the power required for the logic operations. Actually, the clock is used to control the tunnelling barrier height of QD in a QCA cell. Clocking scheme can be divided into four regions as given in figure 28-4(a). When clock gets low, the electron gets trapped in QD and cannot tunnel to other QD. This is the hold phase. When the clock signal is high, all QD's barrier gets lower and electrons are free to move. This may be called to be null polarization state or relax phase.

Figure 4(b) shows QCA clock, each cell in a particular clocking zone is connected to one of the four available phases of the QCA clock. Each cell in the particular clock zone is latched unlatched, and synchronized with the changing clock signal.

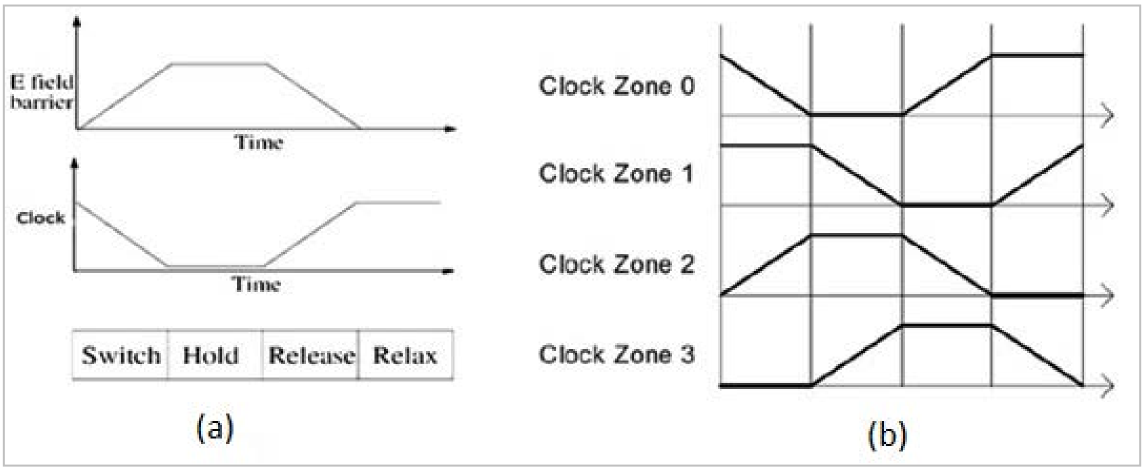


Figure 28-4 (a) Clocking scheme, clock regions and corresponding barrier potential, (b) QCA clock Zone

PROPOSED DESIGN

The equations for a FA realized with majority gates and inverters are given by:

$$S = a.b.cin + a.\bar{b}.\overline{c_{in}} + a.\bar{b}.\overline{c_{in}} + a.\bar{b}.\overline{c_{in}} = M(\bar{M}(a,b,c_{in}), M(a,b,\overline{c_{in}}), c_{in}) \text{ ....(1)}$$

And

$$c_{out} = M(a,b,c_{in}) \qquad \text{...(2)}$$

The schematic diagram of one-bit FA is presented in Figure 28-5. Main improvement lies in the use of carry output for implementation of sum. Design of logical structures using two inverters has been proposed. With the application of this method, the number of QCA cells has been reduced. Moreover designing two layers with a part of the calculation in layer 2 have been done in order to obtain the outputs, create the presented layout an effective design with the profound reduction in number of cells, with small size and minimum delay. Using this method the layout of the proposed single bit FA is obtained as given in figure 6. This design is designed with two layers. And multilayer wire crossing system for crossover wires have been done. The output signals can be used as the inputs of the other QCA circuits, as it is shown in Figure 28-6. Also as the output is not surrounded by the other cells therefore it can be accessed easily. Hence, this structure does not need wire crossover to transfer output signals.

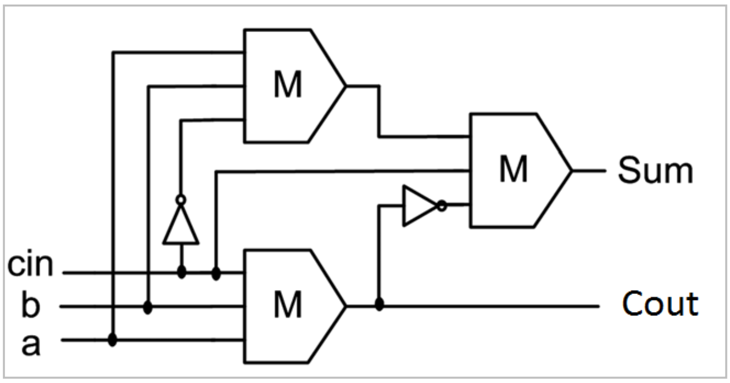


Figure 28-5 chematic diagram of the one-bit FA.

For the proposed circuit layout and functionality checking QCADesigner version 2.0.3 [6] is used. Following parameters for a coherence vector engine [6] is used: radius of effect 75 nm, relative permittivity 12.8, layer separation 11.4 nm, temperature 1° K, relaxation time 1.1 fs, time step 0.11 fs, total simulation time 72 ps, clock high 9.8 × 10^{-22} J, clock low 3.8 × 10^{-23} J, clock shift 0, clock amplitude factor 2. Also cells are assumed to have a width and height of 20 nm, and quantum dots have 5-nm diameter.

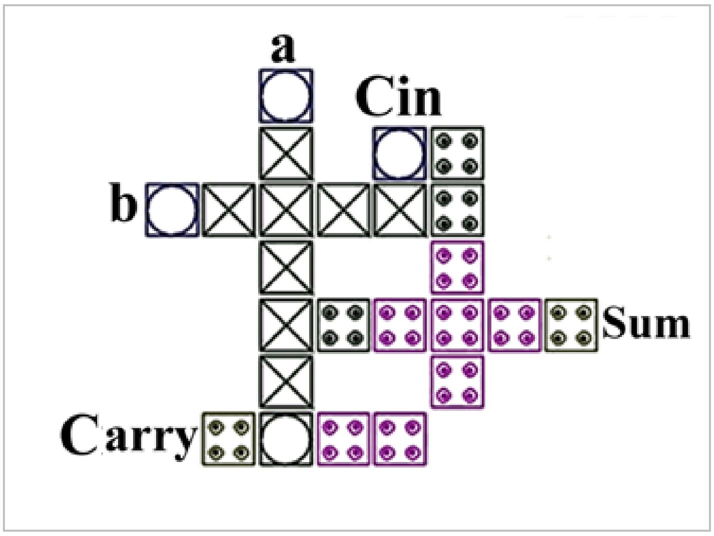


Figure 28-6 Layout of one-bit FA.

FAULT TOLERANCE IN THE PROPOSED FULL ADDER

Recently, fault-tolerant properties and characteristics of QCA for is the buzz word and have been reported by many researchers [7-9]. The cell misplacement, cell misalignment cell missing cell, misshapen cell, and additional cell defects are the identified defects as well as single electron fault, three electron fault etc as identified as faults in QCA circuits [11-13]. Here, simulation of missing cell defects and identification of the test vectors for detection of all faults for the proposed FA are provided. For all simulations, a particular cell labelled with the number i, shown in Figure 6, is deleted in the original (defect-free) configuration of the proposed FA. The new configuration has been simulated using QCADesigner with its coherence vector engine. The simulation results show that deleting the cells with the numbers 1 to 16 results desired output in output Carry; also deleting the cells with the numbers 5, 28, 30 and 31 results desired output in output Sum. In addition, for the input set {a b cin} = {000, 001, 010, 011, 100, 101, 110, 111} all distinct faulty outputs in the output Sum are obtained: {10101010, 01001101, 00010111, 01110001, 00001111, 11001100, 11010100, 01010101, 00101011, 00110011}; also, all distinct faulty outputs in output Carry are obtained: {00001111, 01001101, 11101000, 00110011, 10001110}. For detecting the effects of these defects, a test sequence can be utilized as: {a b cin} = {010, 011, 101, 110}. This test vector can detect any cell missing defects in the proposed FA layout.

RESULTS AND DISCUSSION

Waveforms of input and output signals, for the proposed one-bit FA have been shown in Figure 28-7. A detailed comparison between the proposed designs and previous works have been shown in Table 28-1, where BKA stand for Brent–Kung adder. As it is seen from Table I, in comparison with the best previous FA presented in [5,14], the important enhancements achieved for the proposed FA are 26% in the area, 25% in the cells count and 15% in the wasted area in cells, where the important improvement is obtained by the following equation:

Important improvement = (1-X/Y)*100......................(3)

where X is the cell count for our designs and Y is the cell count for previous designs. Also our FA is faster than the compared designs.

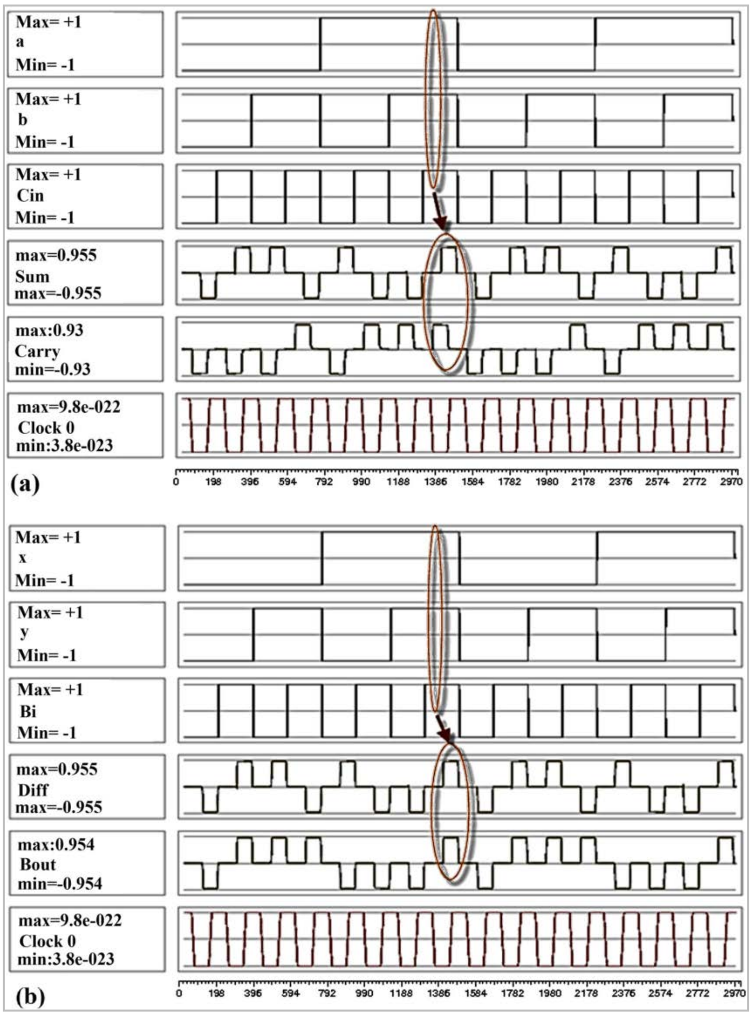


Figure 28-7 Simulation results for the proposed one-bit FA.

Table 28-1 Comparison with previous designs.

Reference	Approximate Area (μm^2)	Approximate wasted area in cells	Cell count	Delay (Clock Pulse)
Type 1[5]	0.05	84	79	5
Type 2[5]	0.03	42	51	3
Proposed FA	0.022	35	38	2

CONCLUSION

Optimized design of single bit full adder is presented in this paper. Also investigation of missing cell defect its characterization and finding the test vector to ascertain tolerant design of presented FA has been done. Minimum size, minimum cell count and faster design with minimum number of clock cycle is the main feature of the proposed design in comparison with other previous works. Hence, this structure can extensively be as the building block of QCA based circuits.

REFERENCES

[1] International Technology Roadmap for Semiconductors (ITRS), 2013. (Available from: http://www.itrs.net.),accessed date 2013.
[2] Lent CS, Tougaw P D. “A device architecture for computing with quantum dots”. Proceedings of the IEEE 1997; 85:541–557.

[3] B. Sen, et al., "Towards the Design of Hybrid QCA Tiles Targeting High Fault Tolerance," Journal of Computational Electronics, vol. 15, pp. 429-445, Jun. 2016.

[4] Mohsen Hayati and Abbas Rezaei, “Design of novel efficient adder and subtractor for quantum-dot cellular automata” International Journal of Circuit Theory and Applications, 43: 1446–1454. doi: 10.1002/cta.2019.

[5] Hashemi S, Tehrani M, Navi K. “An efficient quantum-dot cellular automata full-adder”. Scientific Research and Essays 2012; 7:177–189.

[6] QCADesigner, 2018. (Available from: https://waluslab.ece.ubc.ca/qcadesigner/qca-designer-downloads/).

[7] Tahoori MB, Momenzadeh M, Huang J, Lombardi F. “Testing of quantum cellular automata”. IEEE Transactions on Nanotechnology 2004; 3(4):432–442.

[8] Dysart TJ, Kogge PM, Lent CS, Liu M. “An analysis of missing cells defects in quantum-dot cellular automata”. IEEE International Workshop on Design and Test of Defect-Tolerant Nanoscale Architectures (NANOARCH ’05) in conjunction with the VLSI Test Symposium, Palm Springs, CA. May 1, 2005.

[9] Fijany A, Toomarian BN. “New design for quantum dots cellular automata to obtain fault tolerant logic gates”. Journal of Nanoparticle Research 2001; 3:27–37.

[10] Latha K, Maharshi MN. “Design of adders using qca”. International Journal of Advances in Engineering & Technology 2013; 6:1750–1759.

[11] B. Sen, M. Dutta, R. Mukherjee, R. K. Nath, A. P. Sinha and B. K. Sikdar, "Towards the design of hybrid QCA tiles targeting high fault tolerance," Journal of Computational Electronics, vol. 15, pp. 429-445, November 2015.

[12] M. Momenzadeh, M. B. Tahoori, J. Huang, and F. Lombardi, "Quantum Cellular Automata: New Defects and Faults for New Devices," in Proceedings of the 18th International Parallel and Distributed Processing Symposium, 2004, pp. 207-214.

[13] G. A. Anduwan, et al., "Fault-tolerance and Thermal Characteristics of Quantum-dot Cellular Automata Devices," Journal of Applied Physics, vol. 107, no. 11, pp. 1134061-10, 2010.

[14] M. A. Amiri, M. Mahdavi, and S. Mirzakuchaki, "QCA Implementation of a MUX-based FPGA CLB," in International Conference On Nanoscience and Nanotechnology, Australia, 2008, pp. 141-144.

29. IoT Based Maintenance for Mine Hydraulic Excavators

Dr. Prakash Kumar
Production Engineering Department, BIT Sindri, Sindri, Dhanbad 828123
prakashkr.prod@bitsindri.ac.in

ABSTRACT

Maintenance problems in mining equipment are considered as ill-structured problems for which effective algorithmic results are not possible due to lack of unknown nature of failures and mine conditions.

In general, maintenance methodologies focus on equipment failure in terms of breakdown. Majority of the maintenance optimization models are, in general, considers a fixed value of the cost of breakdown maintenance. But, the cost of breakdown maintenance not only includes down time losses and repair/replacement cost, but may also include various indirect cost. Prior detection of faults represents the most effective way to reduce the breakdown but the existing Indian scenario in terms of machine maintenance reveals the predominance of breakdown maintenance culture in the coal mining industries in particular and industries involving heavy duty earth moving machinery in general.

Various predictive maintenance systems have been used in coal mining industries to support engineering design and decision making. Its availability can be found in various mining parameters such as geological condition, mining condition, dig-ability assessment. Many researchers worked in the area of cost optimization in mining operation through IoT techniques. Advanced fault diagnosis methods have also been used in various research works such as model-based approaches, knowledge based approaches, qualitative simulation, neural network, genetic algorithm and classical multivariate statistical techniques.

But, very few models focus on the investigation of preventive replacement or a perfect planned maintenance policy or total productive maintenance policy that restores the equipment to an as-good-as-new state through IoT.

Keywords— *Mine Excavator, Failure & Maintenance optimization model, IoT.*

INTRODUCTION

A. DEVELOPMENT OF AN IOT SYSTEM

For efficacious detection of fault and trouble shooting in machines of mining industries, a relatively new programming approach in the form of Artificial intelligence (AI), in particular, knowledge-based systems (KBSs) is available which is being used in maintenance programs of mine equipments from common malfunctions to rarely emergency situations.

For effective maintenance methodologies, various fault detection techniques are used. For these techniques, systems are capable of utilizing human knowledge and tracing the complicated relations between different signals and possible results as experts do, so the same can be used in the mining industries too.

The software and database are used to overcome the difficulties of selecting the proper maintenance techniques. The precise diagnosis is carried out based on the different statistical analysis of the failure data. The relationship between the critical values of the component and various failures data are analyzed using expert knowledge. This knowledge is addressed by frames. By using this knowledge source, algorithm is developed for the process of inference.

The paper discusses an IoT framework for failure detection and predictive maintenance system being designed and developed. The proposed approach integrates conventional failure techniques with heuristic techniques derived from expert knowledge and different manuals to generate a prediction model of each component's failure. Detection of fault is performed by monitoring various parameters of excavators and assessing the measured and estimated data for abnormalities.

Categorization and location of the fault source is performed by the event and fault locator. If a component is the source of the fault, the predictive maintenance functionality is activated to assess the fault. The equipment is categorized in three categories based on the criticality, failure frequency and down time length. Assessment of the present conditions of equipment is performed using techniques which range from computer driven instrumentation (gauges, sensor etc) to human sensing to augur failure and to economically perform maintenance only when a potential failure is identified and at a time convenient to the production schedule.

The advantage of IoT include: reduction in machine down time, reduction in skill level for maintenance activities, ease of maintenance, speedy response and affordable cost. The reliability of diagnosis is highly dependent on the accurate information and past data. This study dealt with the design and development of a knowledge-based system for the evaluation of mining equipment in terms of fault diagnosis.

The method is more effective as it is designed to responds creatively like a human expert in unusual circumstances and can automatically modify its knowledge base as data is continuously and periodically monitored, and selected data is stored in the database. So, it can adjust existing rules or add new ones as the situation comes. It has extensions facility to provide interfaces to algorithmic programs.

The economic merit of particular IoT systems for condition based maintenance is obvious. It reduces frequency of breakdowns of critical components resulting in fewer work interruptions which has positive correlation with higher productivity in mines. The condition-based maintenance, if administered properly through AI, can prevent failures and also increases the availability of the equipment.

B. STAGES OF DEVELOPMENT

- Different techniques like Statistical Analysis, FMEA, FMECA, Fault Tree Analysis, Pareto Analysis and criticality analysis were used in order to develop this IoT system.
- Genetic Algorithm has also been used to make inferences, based on the acquired information (real time data) and the knowledge base, which further help to decide the suitable maintenance strategies in different situations.
- IoT system, based on wide range of fault diagnostics methodologies has been developed. While designing an IoT maintenance system, performance of these methodologies was verified using mining statistical data.
- For the development of this system, the standardization of the failure codes were classified. The critical components were identified and codes were given to the individual faults. Analyses were done through of the failure history analysis, maintenance manuals, and the expert knowledge. The rule base (algorithm) has been constructed and based on these algorithm program was written.
- For developing this particular Maintenance System, JAVA programming language has been used to make it "user friendly" and serves as a trouble-shooter.
- The similar methodology can also be used for different equipment

PARETO ANALYSIS

Pareto analysis can be applied by counting the number of defects for each of the different possible causes of poor quality in a product or services and then developing a frequency distribution from the data. The frequency distribution, referred to as a Pareto diagram, is an important visual assistance for attaining on major quality problems. Or in terms of maintenance management, a large majority of failures (80%) are produced by a very few reasons (20%).

A. USE OF PARETO CURVE IN RELIABILITY IMPROVEMENT

Pareto principle when applied to reliability, states that a majority of the failures may be diagnosed to only a small proportion of the many possible causes. These ‘vital few’ out of several causes are identified for tackling the problem to show significant result. ‘Pareto analysis’ indicates that factors leading to majority of the defects may be relatively few.

B. PARETO DIAGRAM

A Pareto diagram is a special type of histogram that helps us to distinguish and prioritize problematic areas. The Pareto diagram may involve data collected from data figures, maintenance and repair data, scrap rates of components or other sources. By identifying types of nonconformity from the relevant data sources, the Pareto diagram directs attention to most frequently occurring element. The diagram helps us to identify the root causes of the problems. Availability of relevant and reliable data determines the quality of the analysis.

Hence, the application of the Pareto analysis in maintenance management facilitates to focus on those failures which have the most impact on the maintenance strategies.

Tabel 29-1 Critical Components of Hydraulic Excavator EX 1200D (Troubleshooting A)

Sl. No.	Name of the component	Failure % age/ Year	Down Time/ Break down Hours	Mandatory Service	
				(1200 Hrs)	(2400 Hrs)
1	EC Sensor	3.9	04		Y
2	Boom Angle Sensor	3.1	06	Y	
3	Oil Temp Sensor	3.6	04		Y
4	Swing Parking Valve	0.4	03	Y	
5	Transmission Swing	2.8	08	Y	
6	Front Swing Pilot Valve	3.4	04	Y	
7	Travel Pilot Valve	0.9	02		Y
8	Roll In Pilot Pressure	3.2	04		Y
9	Pilot Shut Off Valve	0.7	04		Y
10	Intercooler	0.2	02		Y
11	Oil Cooler Fan Motor	1.9	12		Y
12	Front Idler	0.3	02		Y
13	Front Piping	0.8	04	Y	
14	Lubricating Piping	0.5	03	Y	
15	Pump Delivery Pressure	3.5	16		Y
16	Engine Control Dial Gauge	3.1	08		Y

Table 29-2 CRITICAL COMPONENTS OF HYDRAULIC EXCAVATOR EX 1200D (TROUBLESHOOTING B)

Sl. No.	Name of the component	Failure % age/ Year	Down Time/Break down Hours	Mandatory Service	
				1200 Hrs	2400 Hrs
1	Swing Motor	1.8	12		Y
2	Swing Bearing	3.1	09	Y	
3	Swing Control Valve	3.6	06		Y
4	Arm Assembly	1.6	12		Y
5	Boom Cylinder	2.4	16		Y
6	Main Control Valve	0.7	12		Y
7	Signal Control Valve	1.1	04	Y	
8	Front Attachment Pilot	0.4	04	Y	
9	Spool Valve	2.1	10		Y
10	Pump Control Valve	2.7	12		Y
11	Pump device Cylinder	0.8	08	Y	
12	Oil Cooler Unit	0.1	08		Y
13	Auto Lubrication Device	1.9	06	Y	
14	Track Adjuster	2.3	20	Y	
15	Upper Roller	3.2	08		Y
16	Lower Roller	3.9	12	Y	
17	Accumulator	0.5	08	Y	
18	Wiper Unit	3.3	02		Y
19	Actuator System	3.5	20		Y

Tabel 29-3 . CRITICAL COMPONENTS OF HYDRAULIC EXCAVATOR EX 1200D (TROUBLESHOOTING C)

Sl. No.	Name of the component	Failure % age/ Year	Down Time/Break down Hours	Mandatory Service	
				1200 Hrs	2400 Hrs
1	Monitor	3.4	06		Y
2	Air Conditioner Condenser	0.5	04		
3	Air Conditioner Control Panel	1.2	06		
4	Coolant Temp. Sensor	1.8	06	Y	
5	Coolant Level Indicator	3.1	08		Y
6	Coolant Temp. Gauge	3.7	08		Y
7	Overheat Indicator	3.6	04		Y
8	Preheat Indicator	3.2	04		Y
9	Engine Oil Pr. Indicator	3.3	01		Y
10	Engine Oil Level Indicator	3.7	01		Y
11	Air Filter Restriction Indicator	3.9	01	Y	
12	Exhaust Gas Temp Indicator	2.4	04		Y
13	Buzzer	3.9	01		
14	Buzzer Cancel Switch	1.1	02		
15	Transmission Oil Pr. Switch	3.4	01		
16	Pilot Pressure Sensor	2.1	04		
17	Hydraulic Oil Temp Sensor	3.1	04		Y
18	Battery	0.1	01		
19	Starter Relay Battery Relay	1.2	04		
20	DC-DC Converter	3.2	01		
21	Solenoids Valve Unit	1.7	06		
22	Solenoids Power Circuit	2.9	08		
23	Fuel Sensor	1.6	02		

C. TROUBLESHOOTING A

Troubleshooting A refer as a procedure in which any fault codes are displayed after diagnosing the Main Controller (MC) using the built-in diagnosing system or the service menu of monitor unit.

D. TROUBLESHOOTING B

Troubleshooting B refers as a procedure in which no fault code is displayed on the built-in diagnosing system although the machine's operation is abnormal. The troubleshooting B indicates the relationship between machine trouble symptoms and related parts which may cause such trouble if failed. Start the troubleshooting with more probable causes selected by referring to machine trouble symptoms and related parts failure.

In case any fault code has not been displayed in built in diagnostics system, we preferred to perform inspection of components in accordance with the Troubleshooting B procedures (for diagnosing the fault). When the fault code is displayed in built in diagnostics system, we referred to the troubleshooting A group and diagnose in accordance with that.

Relationship between machine trouble symptoms and related parts

The diagnostics system indicates the relationship between machine trouble symptoms and the potential problem parts/components, which may cause trouble if failed. So, analyses of these components are necessary.

The trouble symptoms in this diagnostics system are described provided that each trouble occurs independently. In case more than one trouble occurs at the same time, we can check all faulty components while diagnosing all suspected components in each trouble symptom.

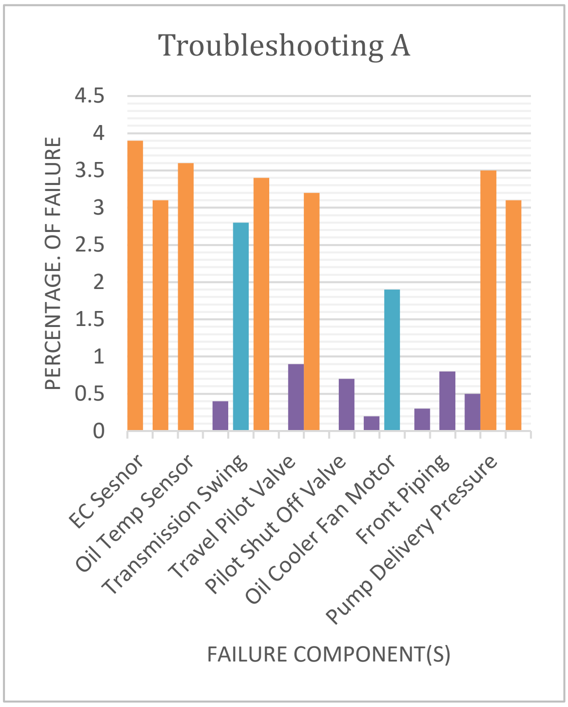


Figure 29-1 Troubleshooting A

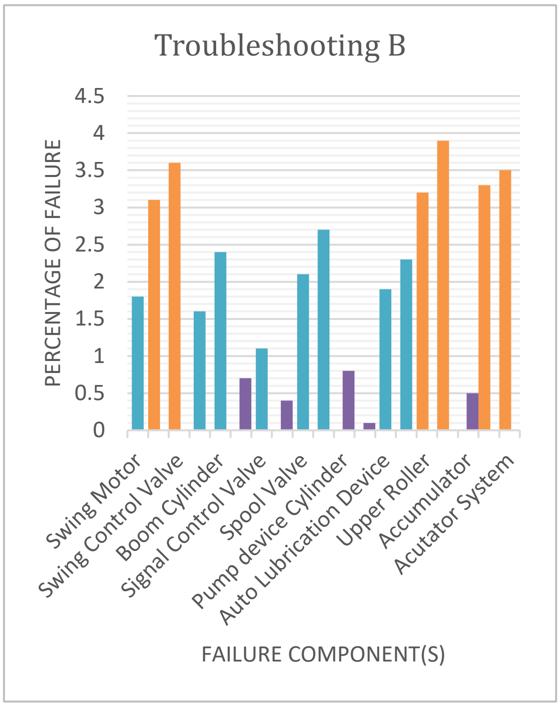


Figure 29-2 Troubleshooting B

E. TROUBLESHOOTING C

(Troubleshooting for monitor procedure)

Troubleshooting C refers as a procedure in which no fault code is displayed on the built-in diagnosing system although the machine's operation is abnormal. The troubleshooting C related to monitors, such as gauges or indicators malfunction. This includes malfunction of coolant temperature gauge, fuel gauge, indicator light check system, preheat indicator, engine oil level indicator, coolant level indicator, alternator indicator, engine oil pressure indicator, overheat indicator, air filter restriction indicator, buzzer, LCD, hour meter and hydraulic oil filter indicator.

Self-diagnosing service mode

Self-diagnostics service mode has three operating modes, learning value display, parameter change, and monitor display information setting referred as Troubleshooting A, B and C respectively. Learning value display includes abnormal EC sensors, engine control dial angle, boom angle sensor, pump delivery pressure, pump control pressure, swing pilot pressure and oil temperature etc. Parameter change includes engine speed, pump delivery flow rate, and solenoid valve output pressure, actuators, boom angle, swing speed etc.

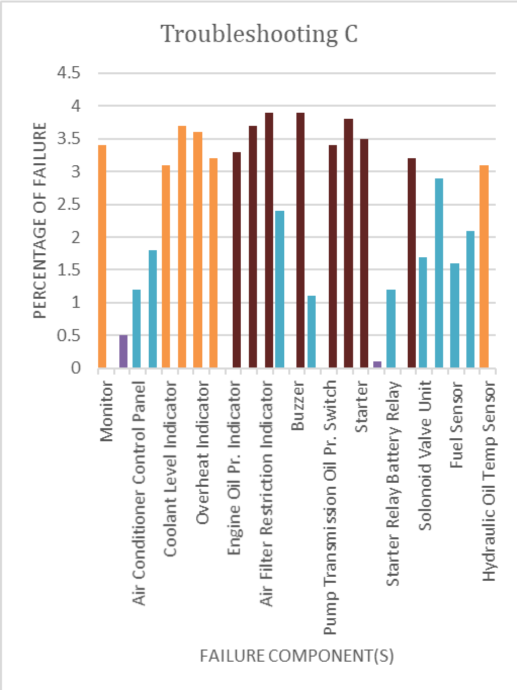


Figure 29-3 Troubleshooting C

Table 29-4 COLOUR VS REMARK OF THE TROUBLESHOOTING GRAPHS

Colour	Remark
Green	Failure Rate High / Down Time High or Medium
Yellow	Failure Rate Low / Down Time High
Brown	Failure Rate High/ Down Time Low
Blue	Failure Rate Low or Medium/ Down Time Low

COMPARISON OF RESULT

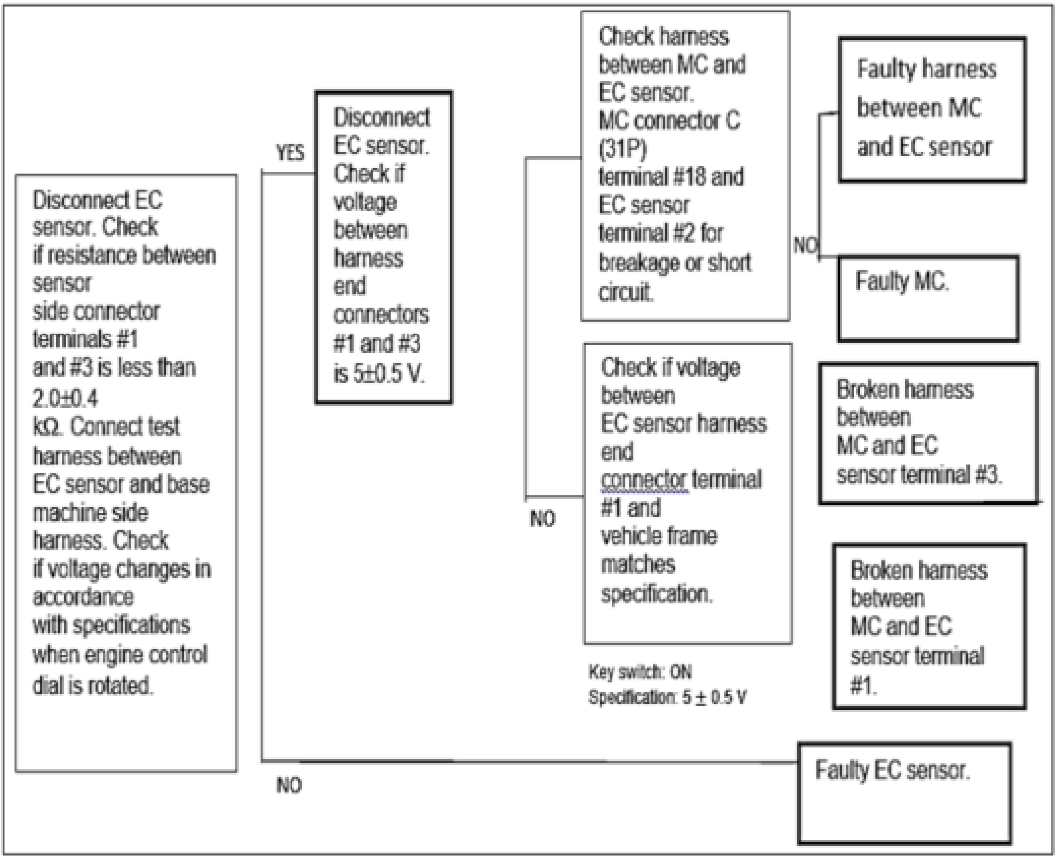
Research is still continuing, as it is the case in any area of knowledge, to understand machine performance and maintenance in greater details. However, such investigations have been found to readdress some specific areas of the whole problem, including performance, maintenance, reliability, utilization, machine-material interaction etc.

EXPERT SYSTEM DESIGN WITH THE HELP OF TROUBLESHOOTING SHEET

While designing the IoT maintenance system, performance of conventional methodologies was verified using mining statistical data. For the development of this System, the standardization of the failure codes was classified. The critical components were identified and codes were given to the individual faults. Coding process was streamlined through JAVA programming language. The JAVA programming language has an advantage over other programming language (LISP and PROLOG) is that: it has extensive data manipulation capability, incremental compilation facility, labelled memory architecture, efficient search and memory management procedure and also to optimize the system environment.

Analyses were done through the failure history analysis, maintenance manuals, and the expert knowledge. The rule base (algorithm) has been constructed in order to develop decision support system to operational maintainability. Based on these algorithm program was written. The goal of the system is to provide expertise to the non-experts in mining industries with a list of possible failure modes and decisions to be adopted.

The excavator's components were categorised as Troubleshooting A, B and C according to their function and fault classification. The rule/knowledge based (algorithm) system (fault diagnostics system) for various components of excavator has been constructed and explained in next section (Algorithm for Troubleshooting). Based on these algorithm program was written using JAVA programming language. ***The Program is appended in Annexure I.*** Example of Troubleshooting / Troubleshooting A Fault: Abnormal EC Sensor is illustrated by Figure 29-4.



EC Sensor	Specification:
Slow Idle	2.5V to 2.7V
High Idle (HP mode Switch: OFF)	3.3V to 3.7V
High Idle (HP mode Switch: ON)	Voltage at Fast Idle (HP Mode Switch: OFF) plus 0.2 V or more

Figure 29-4 Abnormal EC Sensor

Annexure I (PROGRAM FOR ABNORMAL EC SENSOR)

```
import java.util.*;
public class Troubleshooting_A
{
public static Scanner sc=null;
              public static void A6()
              {
              System.out.println("resistance between sensor side connector terminals #1 and #3 is less than 2.0±0.4kO.Enter y for yes and n for no");
              String a1=sc.next();
System.out.println("voltage changes in accordance with specifications when engine control dial is rotated.Enter y for yes and n for no");
              String a2=sc.next();

              if(a1.equalsIgnoreCase("y") && a2.equalsIgnoreCase("y") )
                                                        {
              System.out.println("voltage between harness end connectors #1 and #3 is 5±0.5 V.Enter y for yes and n for no");
String a3=sc.next();

        if(a3.equalsIgnoreCase("y"))
        {
                System.out.println("Check harness between MC connector C (31P) terminal #18 and EC sensor terminal #2 for breakage or short circuit.Enter y for yes and n for no");
                        String a4=sc.next();

                        if(a4.equalsIgnoreCase("y"))
                        {
                                        System.out.println("Faulty harness between MC and EC sensor");
                        }
                        else
                        {
                                System.out.println("Faulty MC.");
                        }
        }
        else
        {
                System.out.println("Check if voltage between EC sensor harness end connector terminal #1 and vehicle frame matches specification.Enter y for yes and n for no");
                        String a5=sc.next();

                        if(a5.equalsIgnoreCase("y"))
                        {
```

```
                                        System.out.println("Broken harness between MC and EC
sensor terminal #3.");
                        }
                        else
                        {
                                System.out.println("Broken harness between MC and EC sensor
terminal #1.");

                        }


        }


                                                        }
                                                        else
                                                        {

             System.out.println("Faulty EC sensor.");
```

CONCLUSION

The existing Indian scenario in terms of machine maintenance reveals the predominance of breakdown maintenance culture in the coal industries in particular and industries involving heavy earth moving machinery in general.

Considering the high capital cost and limited life of the main excavators, breakdown maintenance is not a right approach wherein a machine is attended for maintenance only after a component or a sub system breaks.

So, it is imperative to have some well researched diagnostic maintenance methodologies with efficient algorithmic solutions which will maintain the ill structured symptoms of failures through constant monitoring of the machines health and performance to keep it at the desired or standardized availability/ reliability level.

While designing the expert maintenance system, performance of these methodologies was verified using mining statistical data. For the development of this ES, the standardization of the failure codes were classified. The critical components were identified and codes were given to the individual faults. Analyses were done through of the failure history analysis, maintenance manuals, and the expert knowledge. The rule base (algorithm) has been constructed in order to develop decision support system to operational maintainability. Based on these algorithm program was written using JAVA programming language. The goal of the system is to provide expertise to the non-experts in mining industries with a list of possible failure modes and decisions to be adopted.

REFERENCES

[1] Adhammar Et.al, Preventive Management/Essential care Condition monitoring

[2] D.W.Rolston, Principles of Artificial Intelligence and Expert Systems Development, McGraw-Hill, 1988

[3] Jardine AKS, Maintenance, Replacement & Reliability, Pitman Publication

[4] Jim Parentzas, A Wab- Based controlled By a Hybrid expert System.

[5] Kumar Prakash, Srivastava.R.K (2012), "An expert System for Predictive Maintenance of Mining Excavators and Its Various Forms in Open Cast Mining" IEEE Xplore, pp.658-661.

[6] Kumar Prakash, Rajak A.K.,2014,Advanced Functional Maintenance Management for Mining Excavator, in an International journal of Mechanical Engineering & Technology (IJMET) Volume 5, Issue 4, April (2014), pp. 199-205.

[7] Kumar Prakash, Srivastava R.K., 2014, Development of Condition Based Maintenance Architecture for Optimal Maintainability of Mine Excavators" in an International Organization of Scientific Research- Journal of Mechanical and Civil Engineering (IOSR-JMCE).Volume 11, Issue 3 Ver. V PP 18-22. Private Limited New Delhi.

[8] Md. Ben-Daya, Salih O. Dufffuaa, Abdul Raouf Maintenance, Modeling& Optimization Probabilistic Risk Assessment and Management for Engineers & Scientists, IEEE Press (2nd Edition), 1996, EJ Henley & H. Kumamoto 1996.

[9] Reliability and Fault Tree analysis, Conference on Reliability and Fault tree analysis; UC Berkeley; SIAM Pub;

[10] Reliability and Risk Assessment, Longman Scientific & Technical 1993, J.D.Andrew1993.

[11] R.Keith Mobley, Lindley R. Higgins & Darrin J. Wikoff, 2008, Maintenance Engg. Handbook, 2nd edition

[12] Vasili Mehdi, Hong Tang Sai, Ismail Napsiah, Vasili Mohammadreza Maintenance optimization models: a review and analysis- (Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management Kuala Lumpur, Malaysia, January 22 – 24, 2011).

30. Classification Between Interictal and Ictal States of Epileptical Patients using Alpha Subband

[1]*Mustafa Sameer*, [2]*Dr. Bharat Gupta*, [3]*Rahul Priyadarshi*
Department of Electronics and Communication Engineering
National Institute of Technology Patna, Bihar, India
[1]mustafa.ec17@nitp.ac.in, [2]bharat@nitp.ac.in, [3]rahul.ec18@nitp.ac.in

ABSTRACT

In this study, alpha subband (8-12 Hz) is used for distinguishing between interictal and ictal states using Haralick features. Most of the previous methods is based on the whole frequency spectrum. This work use only alpha subband of electroencephalogram (EEG) for classification using image descriptors. To convert one dimensional EEG data into image Short Time Fourier Transform (STFT) has been used. Alpha subband is cut from the time frequency (t-f) plane and Haralick features is used as image descriptors to fed in the k-NN classifier. The results have been evaluated using accuracy metric and receiver operating characteristic (ROC) analysis. Maximum classification accuracy of 79% and maximum area under curve (AUC) of 0.84 is obtained to classify between interictal and ictal. Advantage of this work is rather using whole frequency band it utilizes only a particular band which reduces computational load.

Index Terms— *EEG, alpha subband, epilepsy, Haralick features, k-NN.*

INTRODUCTION

Epileptical seizures is one of the most severe neurological disease in the world. Electroencephalogram (EEG) which measures the electrical activity of the brain is generally used for the detection of seizures due to its low cost and high temporal resolution. It is recorded by placing electrodes on the scalp using international 10-20 system.

Seizures should be delimited in time, but the borders of ictal (during a seizure), interictal (between seizures) and postictal (after a seizure) in EEG often are indistinct [1]. Classification between different states i.e. interictal, ictal, pre-ictal [2] of epileptic patients is a complex task from EEG signal acquired from patients. In [3], authors reported nonlinear dynamic modelling approach of global principal dynamic modes for classification between interictal and ictal states of epilepsy.

To analyse the EEG pattern faithfully, it requires an expert neurologist still there is a high probability of misinterpretation. So there is a need to have an automated system which can assist the doctor. To make an automated system there are following steps: (1) preprocessing of EEG data i.e. removal of line noise and artifacts, (2) analyse the preprocessed data either in time, frequency, time-frequency (t-f), time-scale or any another domain, (3) extraction of appropriate features which characterise the data, (4) classification of data using machine learning techniques. This paper has used STFT, and extracted alpha subband (8-12 Hz) from the time-frequency plane. Haralick features are used to characterise the data and fed to the decision tree to distinguish between interictal and ictal classes.

DATASET USED

The publicly available University of Bonn, Germany EEG dataset has been used in this study [4]. It was collected with the use of 128 channels and includes five different classes of data, named as Z, N, O, F and S. Each class of the dataset consist 100 segments acquired from individual channel of duration 23.6 seconds and have the sampling frequency of 173.61 Hz, which is collected using 12 bit of resolution.

Table 30-1 represents the description of dataset. The classes N and F consists data of epileptic patients but during seizure free periods. These data have been taken from intracranial EEG signal, data of class N collected from hippocampal formation and F is acquired from the epileptogenic zone. Data of class S is recorded from epileptic patients during seizures. Fig 30-1. shows EEG segment of (a) N and (b) F class (c) S class.

Table 30-1 REPRESENTATION OF DIFFERENT CLASSES OF DATASET

SUBJECTS TO COLLECT EEG DATA	CLASS	NUMBERS OF SIGNAL	WAY OF DATA ACQUIRED
Epileptic Patients	N-(Seizure free)	100	EEG signal from the hippocampal formation
	F- (Seizure free)	100	EEG signal from epileptogenic Zone
	S-(Seizure)	100	EEG signal acquired during seizure period

METHODOLOGY

To detect epileptical seizures, this work has followed different steps presented in Fig.30-2. The available data is already pre-processed, hence without using any noise removal technique it has been used. Further, STFT has been applied on data.

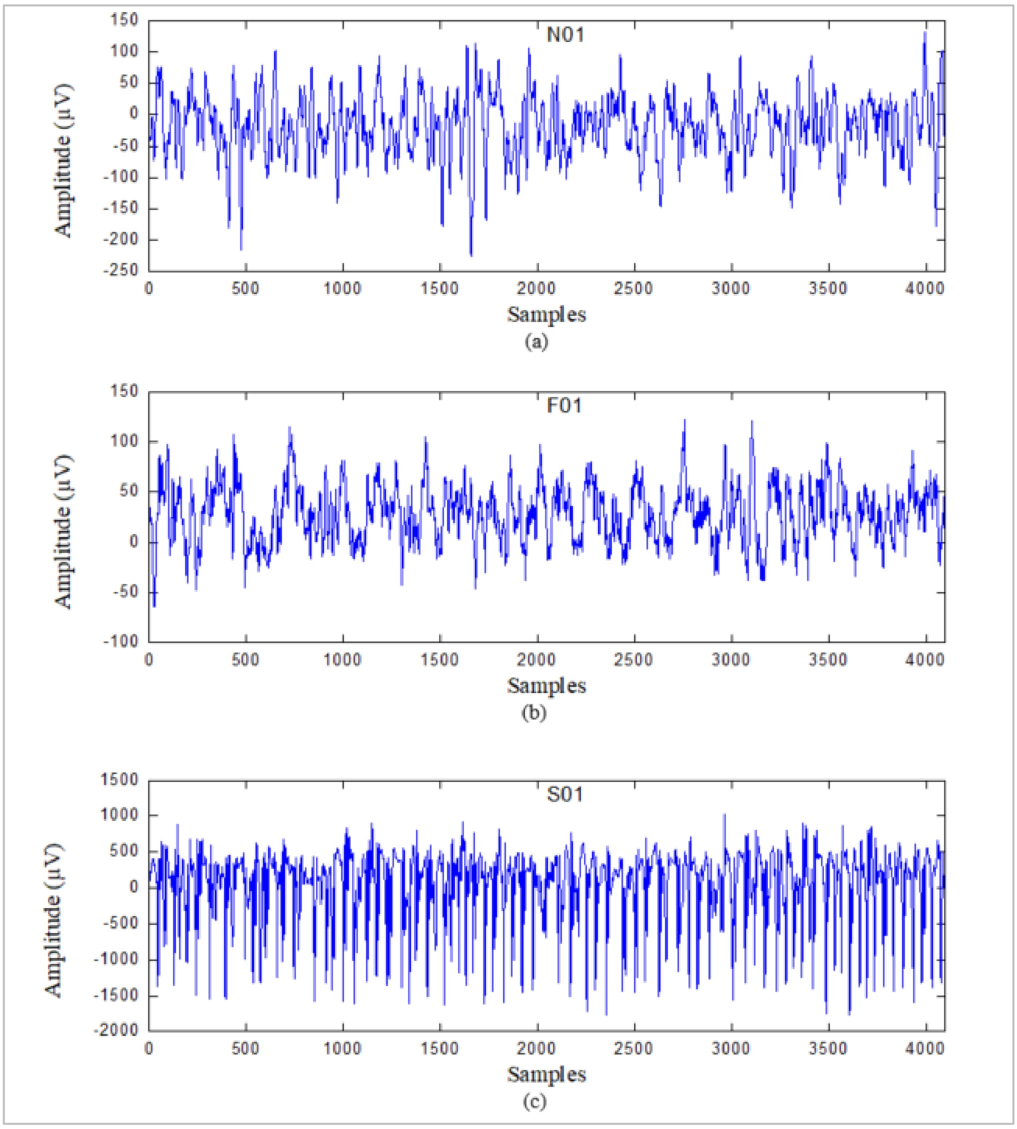


Figure 30-1 EEG segment of (a) N class (b) F class (c) S class

A. SHORT-TIME FOURIER TRANSFORM

There are various time-frequency methods available to perform analysis. For real time processing STFT is more preferable to wavelet transform methods [5] . In this paper, STFT has been used to perform time-frequency analysis of EEG data [6]. This method is useful for localization of frequency in time and vice versa. It transforms one dimensional (time domain) EEG data to two dimension (time-frequency). In this work hamming window of size odd (N/4), where, N is the number of data points, has been used. STFT of message (EEG) signal x (t) using short duration hamming window h (t) is given by the expression (1):

$$STFT(t,f) = \int_{-\infty}^{\infty} x(\tau)h(\tau - t)e^{-if\tau}\,d\tau \quad (1)$$

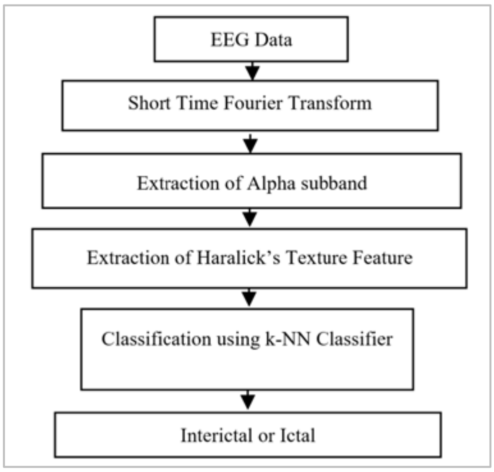


Figure 30-2 Steps performed in the work

B. FEATURE EXTRACTION

In this paper, Haralick's texture features [7] have been extracted, which is obtained from two dimensional time-frequency representation of EEG signals to detect any kind of seizure activity in it. Here, to extract Haralick's features, STFT has been performed over EEG data firstly to get an image data. Processing it as texture image helps to collect visually any information related to soaring amplitude, seizure activity or normal pattern on it. To evaluate all these selected features, gray-level co-occurrence matrix has been obtained from two dimensional EEG data, represented by P (having size S×S, where S is the number of gray levels in image data). This matrix can be generated by evaluating how often pairs of pixel corresponding to particular values occurs in an image. It can be formed by pixel pairs located at particular value of distance δ and angle θ. In this paper, angle θ has been selected as 0o, 45o, 90o and 135o.

C. K-NN CLASSIFIER

This classifier is comparatively simple, nonlinear, non-parametric and a form of instance based learning methodology can be applied for classification purpose even though dataset distribution in unknown. This method response quickly for limited set of data, whereas huge data size algorithm can be slow. That is all because of every calculations are postponed till completion of classification. This algorithm follows brute force approach, in which each data points are need to compared with target. The k-NN (nearest neighbor) classifier works on the principle of measurement of similarity. This classifier first helps to find the k samples, which are nearer to the unknown sample data. With the help of k nearest sample classifier will be able to find its average, to get similarity. Similarity can be measures in form of distance also termed as Euclidian distance (ED).

RESULTS AND DISCUSSION

In this research work, a total of 260 features of alpha subband has been extracted. Three experiments have been performed using three groups of EEG data (N, F and S). K-fold cross validation technique has been used for training and testing the data. Feature vector set has been partitioned into K parts of same size. One subset is used as testing set and left over sets are used as training set. This process is repeated K times. The average accuracy of all trials is taken into consideration. The results have been shown in Table II. Maximum AUC achieved between interictal and ictal classes is 0.84. For all three experiments the success rate is above 80%. In [8] maximum accuracy achieved is 79%. Fig. 30-3 shows the ROC curve for healthy and seizure patients [9].

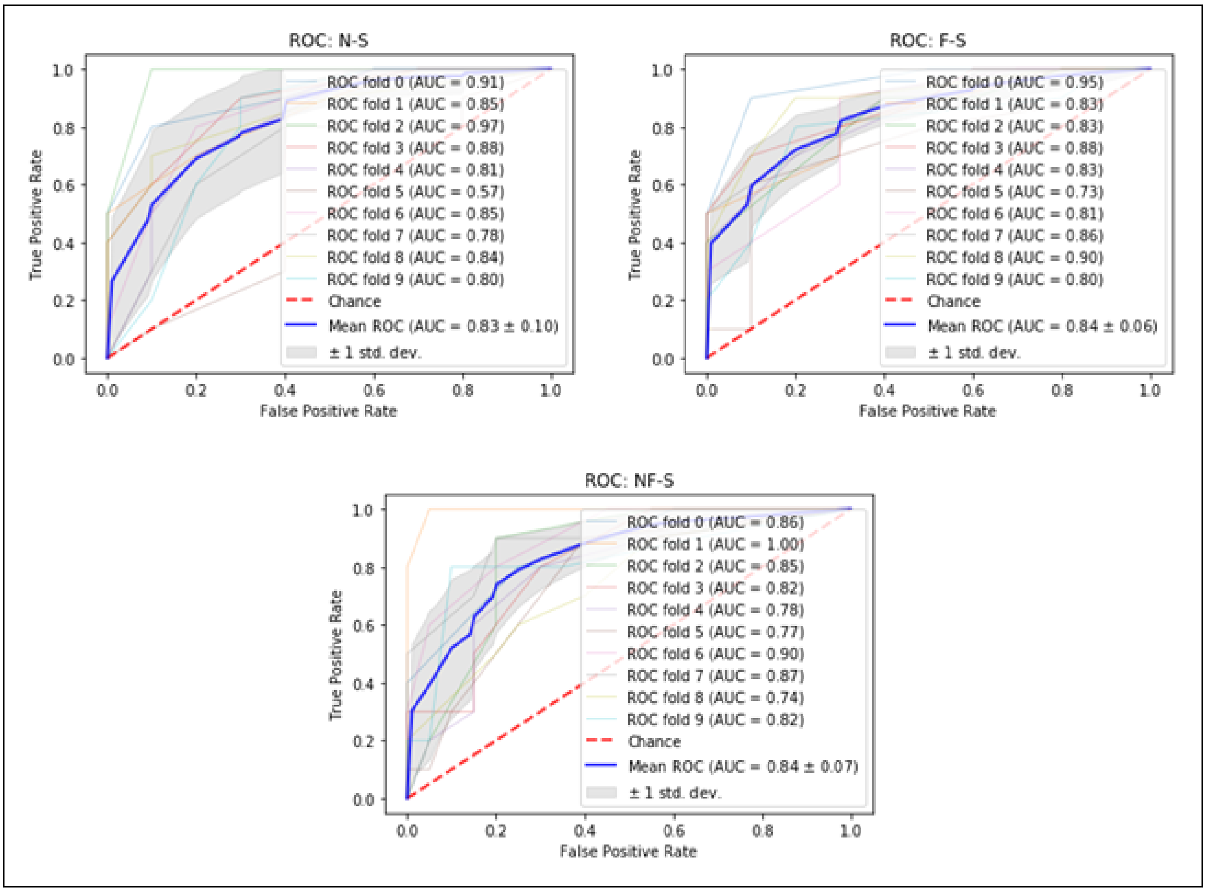


Figure 30-3 ROC to distinguish between interictal and ictal patients

CONCLUSION AND FUTURE WORK

In this paper, three experiments on epilepsy patient’s data of Bonn dataset using k-NN classifier has been presented. STFT has been used for conversion of one dimensional data to two dimension. Textural features of alpha subband have been used as feature in this work. F-S and |NF-S data clusters achieved best AUC value of 0.84. This study depicts without using full spectrum only alpha subband is able to differentiate between ictal and interictal groups. As a future work different classifiers with optimized parameters would be used to increase the accuracy.

REFERENCES

[1] R. S. Fisher, H. E. Scharfman, and M. DeCurtis, “How can we identify ictal and interictal abnormal activity?,” Adv. Exp. Med. Biol., 2014.

[2] B. K. Karumuri, I. Vlachos, R. Liu, J. A. Adkinson, and L. Iasemidis, “Classification of pre-ictal and interictal periods based on EEG frequency features in epilepsy,” in Proceedings - 32nd Southern Biomedical Engineering Conference, SBEC 2016, 2016.

[3] Z. Hameed, S. Saleem, J. Mirza, M. S. Mustafa, and Qamar-ul-Islam, “Characterisation of ictal and interictal states of epilepsy: A system dynamic approach of principal dynamic modes analysis,” PLoS One, 2018.

[4] R. G. Andrzejak, K. Lehnertz, F. Mormann, C. Rieke, P. David, and C. E. Elger, “Indications of nonlinear deterministic and finite-dimensional structures in time series of brain electrical activity: Dependence on recording region and brain state,” Phys. Rev. E - Stat. Physics, Plasmas, Fluids, Relat. Interdiscip. Top., 2001.

[5] M. K. Kiymik, I. Güler, A. Dizibüyük, and M. Akin, “Comparison of STFT and wavelet transform methods in determining epileptic seizure activity in EEG signals for real-time application,” Comput. Biol. Med., 2005.

[6] L. Cohen, “Time-frequency distributions-a review,” Proc. IEEE, vol. 77, no. 7, pp. 941–981, Jul. 1989.

[7] R. M. Haralick, I. Dinstein, and K. Shanmugam, “Textural Features for Image Classification,” IEEE Trans. Syst. Man Cybern., 1973.

[8] A. Gupta, P. Singh, and M. Karlekar, “A novel signal modeling approach for classification of seizure and seizure-free EEG signals,” IEEE Trans. Neural Syst. Rehabil. Eng., 2018.

[9] ANACONDA, “vers. 2-2.4.0, Anaconda Software Distribution. Computer software,” Anaconda Software Distribution. Computer software, 2016.

31. Investigations of Differential Group Delay Behavior in 3-Core Homogeneous Strongly Coupled Multicore Optical Fiber

*Umar Farooque[*1,2], Sandhir Kumar Singh[3], Dharmendra Kumar Singh[1], and Rakesh Ranjan[1]*
[1]*Optical Fiber Communication and Photonics Laboratory, Department of Electronics and Communication Engineering, National Institute of Technology, Patna, Bihar, 800005, India.*
[2]*Department of Electronics and Communication Engineering, Muzaffarpur Institute of Technology, Muzaffarpur, Bihar, 842003, India.*
[3]*Department of applied physics, Cambridge Institute of Technology, Ranchi, Jharkhand, 835103, India.*
**Corresponding Author: Contact:* +91-9905375210,
Email: ufarooque.mit@gmail.com, sandhir1975@yahoo.co.in, dksingh@nitp.ac.in, rr@nitp.ac.in.

ABSTRACT

In this paper, we have investigated the differential group delay (DGD) behavior between different supermodes in 3-core homogeneous strongly coupled multicore fibers (SC-MCFs) for different core refractive index profiles (step index and R.I. dip) and in different possible arrangements (triangular and linear layouts) of cores. Further, the impacts of core pitch (Λ), relative refractive index difference between core and cladding (Δ), and radius (α) on the differential group delay (DGD) between different supermodes have also been analyzed for all the considered configurations of SC-MCFs. The analysis presented has been done using FemSIM simulation platform and MATLAB. It is observed that core configurations and arrangements affect the DGD behavior between different supermodes of SC-MCF. Further, increase in core pitch and radius causes decrease in the DGD values while increase in relative refractive index difference (Δ) results in increase in DGD values. The DGD level is higher in linear layout compared to the triangular layout. However, there exists a particular core pitch below which and certain value of relative refractive index difference (Δ) above which, the DGD value in linear layout is lower than triangular layout. The above analysis will help in the design of MCFs with low value of DGD and its optimization by utilizing fiber design parameters and arrangements of cores.

Index Terms— *Multicore fiber; Homogeneous cores; Supermode; Differential group delay (DGD.*

INTRODUCTION

The existing transmission fiber, i.e., single mode single core fiber (SM-SCF) suffers with the capacity crunch for future ultra-high capacity demand. Therefore, in order to cope with the future capacity demand, space-division multiplexing (SDM) based multicore fiber (MCF) is anticipated to be a potential technology to realize a viable optical network which will be capable to accommodate the several data streams originating from, namely-future 5G communication, machine-to-machine networks, and the internet of things (IoTs) [1]. Further, MCF has been advocated for ultra-high capacity front-haul networks for 5G mobile networks which support several front-haul traffics and further enable the use of analog radio-over-fiber and optical beamforming technology [2].

In SM-SCF, there is only core parameters, i.e., radius and refractive index (R.I.) as a degree of freedom, while, there exists several degree of freedom in terms of core count, core arrangement/layout, core pitch (D) i.e., the separation between the centers of the two cores, cladding diameter (CD), and the outer cladding thickness (OCT) in MCFs. Further, depending upon the core pitch MCFs are of two types, namely-weakly-coupled MCF (WC-MCF) and strongly-coupled multicore fiber (SC-SMF). In WC-MCF, the core pitch is large enough which makes the individual core as a separate waveguide with adequately low mode coupling, mode density, and mode effective area (A_{eff}). Further, low mode effective area results in large nonlinearity and affects the transmission capacity of the fiber. In SC-MCF, cores are placed very close to each other, which causes strong core to core coupling and form supermodes, i.e., superposition of isolated core modes [3]. These supermodes are the eigenmodes of composite structures, i.e., coupled multicore structure [4]. The SC-MCF with n number of cores, exhibits n number of supermodes and among them the fundamental supermode has highest propagation constant (β). In addition to this, supermode structure supports extra degree of freedom especially in terms of core pitch to radius ratio (Λ/a), to manipulate the propagation characteristics and achieve better transmission performance [5]. Therefore, it is important to study the supermodes properties in coupled multicore fibers.

Recently, SC-MCFs with homogeneous cores have been studied to analyze the properties of supermodes using coupled mode theory for different core layouts such as linear array [6], circular [3,7-8] and hexagonal distribution [9-10] in one ring and multiple rings, honeycomb multi-ring arrangement [4], and homogeneous trench-assisted MCF (TA-MCF) in hexagonal one ring structure [11]. The major concern in the long distance transmission of optical signals with high transmission capacity in SC-MCF is the dispersion phenomenon among the different supermodes, i.e., differential group delay (DGD). In applications areas such as, signal processing in 5G (and beyond), fiber-wireless communications, radio-over-fiber transmission and microwave photonics (MWP) signal processing, where the time-delay control and synchronization play the vital role, require a detailed analysis of the group delay of the different cores of the fiber [12]. Several efforts have been made in the analysis of the dispersion properties in SC-MCFs [5, 11-16]. In [5], DGD variation with respect to refractive index difference between core and cladding (Δ), and the core pitch to radius ratio (Λ/a) have been investigated in 3-core strongly-coupled MCF in triangular layout. It is reported that for a particular value of V-number and at a particular wavelength, there exist a value of Λ/a, where the DGD vanishes.

Further, in [16], the variation in the zero DGD wavelength with the variation in separation between the cores in closely spaced two core fibers have been investigated; further, it is reported that by incorporating central refractive index dip in each core, this zero DGD wavelength can also be adjusted by variation in dip parameters. In [13], a compact three core fiber in triangular layout involving refractive index dip in each core have been proposed, and the impacts of R.I. dip parameters on the DGD value have been investigated. Further, it is reported that by proper control of the R.I. dip parameters result in ultra-low DGD over a wide range of wavelength. However, to the author's knowledge, the effect of core arrangements/layouts, core parameters such as radius (α), Δ, and Λ on the DGD among different supermodes in SC-MCFs with homogeneous cores have not been investigated in detailed.

In this paper, we have studied the effect of variations in α , Λ, and Δ on the DGD among different supermodes of 3-core SC-MCFs with homogeneous cores for different R.I. profiles (step index and R.I. dip) and in different possible arrangements (triangular and linear layouts). The rest part of the paper is organized as follows: Section 2 describes the design parameters, schematic designs, and the mode profiles of strongly coupled MCFs in different core layouts (linear and triangular) and R.I. configurations (step index and R.I. dip). The DGD behavior among different supermodes of SC-MCF configurations have been discussed in Section 3 and lastly Section 4 presents the conclusion of the present work.

DESIGN PARAMETERS, SCHEMATIC DESIGNS AND MODE PROFILES OF SC-MCFS

A. DESIGN PARAMETERS

Table 31-1 Design parameters of the 3-Core homogeneous SC-MCFs

Design Parameters	3-Core Homogeneous SC-MCFs				Unit
	Linear	Triangular	Linear R.I. Dip	Triangular R.I. Dip	
A	3.5	3.5	3.5	3.5	μm
n_0	1.444	1.444	1.444	1.444	-
n_1	1.45	1.45	1.45	1.45	-
Λ	$2a$	$2a$	$2a$	$2a$	μm

where, a, n_0, n_1, and Λ are the radius of the core, R.I. of the cladding, R.I. of the core, and core pitch, while, d, and n_d are the diameter of the R.I. dip structure within the core region, and the R.I. of the dip region, respectively.

The values of the fiber design parameters have been taken from [16]. Further, refractive index and the diameter of the R.I. dip region may be expressed as below [13].

$$n_d = \sqrt{pn_1^2 + (1-p)n_0^2} \qquad (1)$$

where, $p = 0.5$, and $d = 0.75a$

B. SCHEMATIC DESIGNS AND MODE PROFILES

The schematic designs and the mode profiles of different supermodes in different core layouts of the 3-core homogeneous SC-MCFs have been shown in Figs. (31-1)-(31-4).

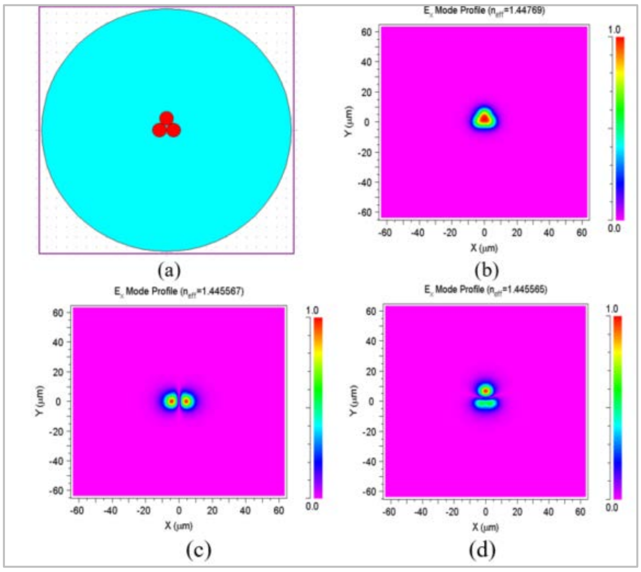


Figure 31-1 Core triangular homogeneous strongly coupled MCF (a) Schematic design, and mode profiles of (b) fundamental and (c), (d) higher order supermodes

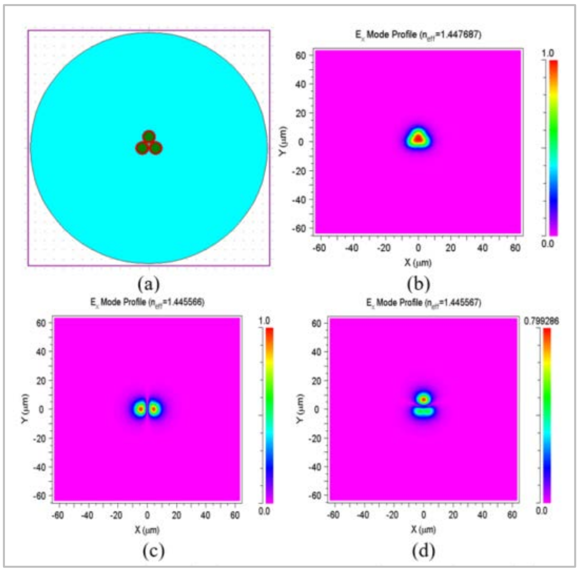


Figure 31-2 Core triangular homogeneous R.I. dip strongly coupled MCF (a) Schematic design, mode profiles of (b) fundamental and (c), (d) higher order supermodes

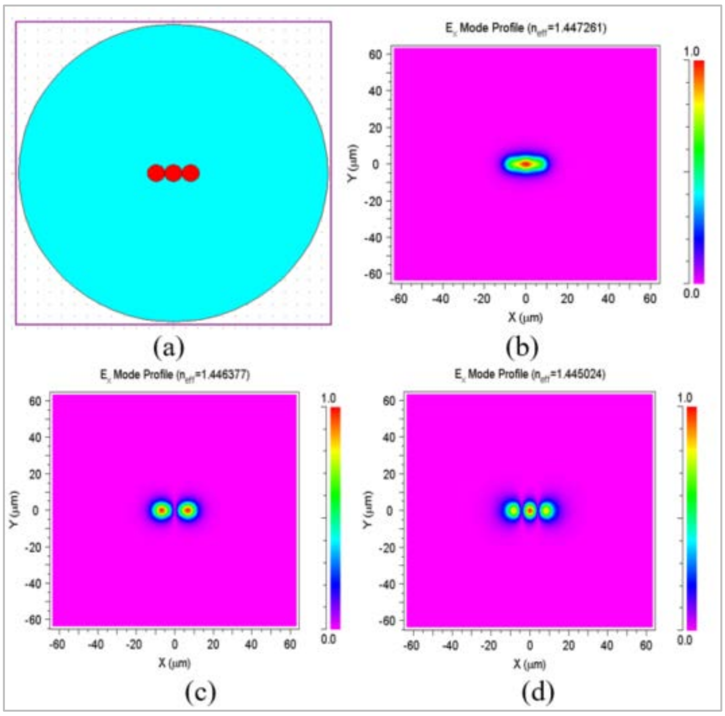


Figure 31-3 Core linear homogeneous strongly coupled MCF (a) Schematic design, mode profiles of (b) fundamental and (c), (d) higher order supermodes

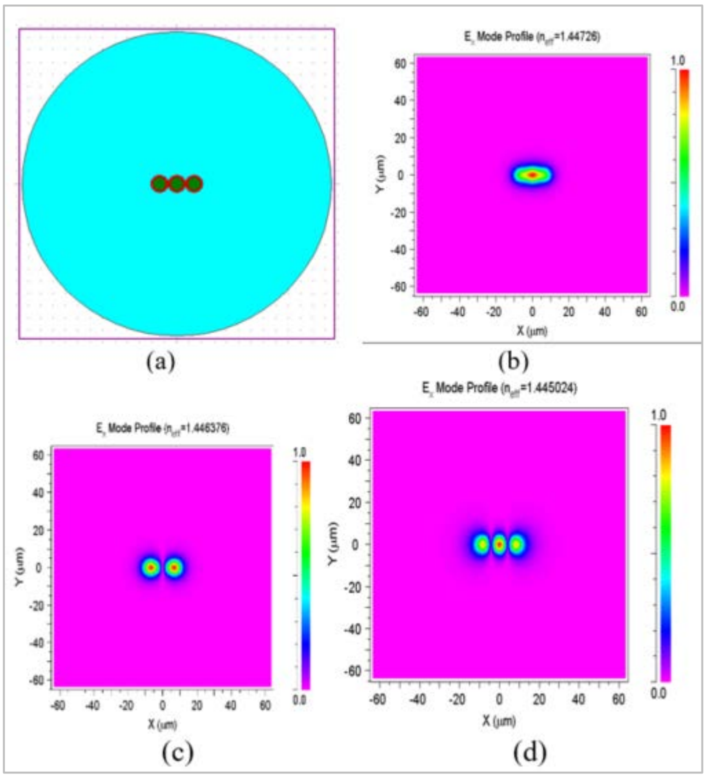


Figure 31-4 S-Core linear homogeneous R.I. dip strongly coupled MCF (a) Schematic design, mode profiles of (b) fundamental and (c), (d) higher order supermodes

RESULTS AND DISCUSSION

The differential group delay (*DGD*) between any two supermodes of coupled MCFs can be obtained by [13]

$$DGD = \frac{1}{c}\left[\Delta n_{eff} - \lambda \frac{d(\Delta n_{eff})}{d\lambda}\right] \quad (2)$$

where, *c* is the speed of light in vacuum and Δn_{eff} is the effective refractive index difference between any two supermodes. In the present analysis, we have calculated the values of *DGD* among different supermodes of various configurations of coupled MCFs using Eqn. (2) and plotted in the Figs. (31-5) - (31-8). The values of n_{eff} for different supermodes have been calculated using FemSIM simulation platform.

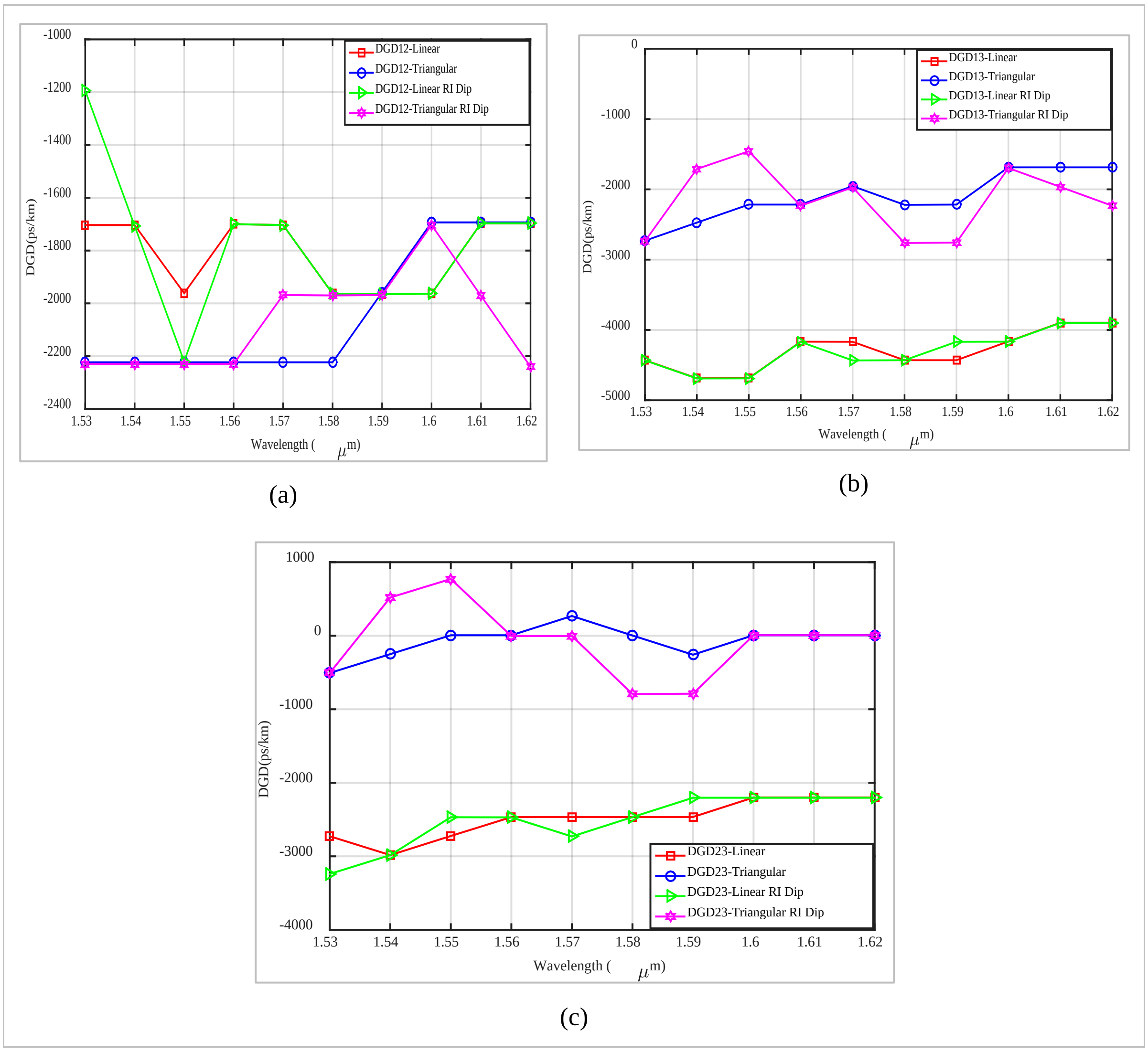


Figure 31-5 Wavelength dependent DGD variations in 3-core strongly coupled MCFs with homogeneous cores for different core layouts (a) DGD_{12} (b) DGD_{13} (c) DGD_{23}

Figures 31-5(a)-(c) show the wavelength dependent *DGD* variations among different supermodes of 3-core SC-MCFs. In 3-core SC-MCFs there are three supermodes, among them the supermode with highest propagation constant (β) is called as fundamental supermodes and the other supermodes are called as higher order supermodes. The supermode numbers (1, 2, and 3) have been assigned in decreasing order of their propagation constant. The different *DGDs* namely- DGD_{12},DGD_{13}, and DGD_{23} are the *DGDs* between supermodes 1 and 2, supermodes 1 and 3, and supermodes 2 and 3, respectively. The maximum value of the *DGD*, i.e.,$|DGD|_{max}$ over the considered wavelength range in linear and triangular layouts are 4690 ps/km and 2737 ps/km respectively. Therefore, the core layout has significant impact on the *DGD* levels. Further, incorporating R.I. dip structures in the core regions of linear and triangular layouts have significant impact on the *DGD* levels, and they exhibits relatively higher value of $|DGD|_{max}$ compared to their without R.I. dip structures over the considered wavelength region.

In Figs. (31-6)-(31-8), due to degeneracy in propagation constants (having similar propagation constant values) of higher order supermodes (supermodes 2 and 3) in triangular layout, *DGD* between supermodes 2 and 3 is nearly zero.

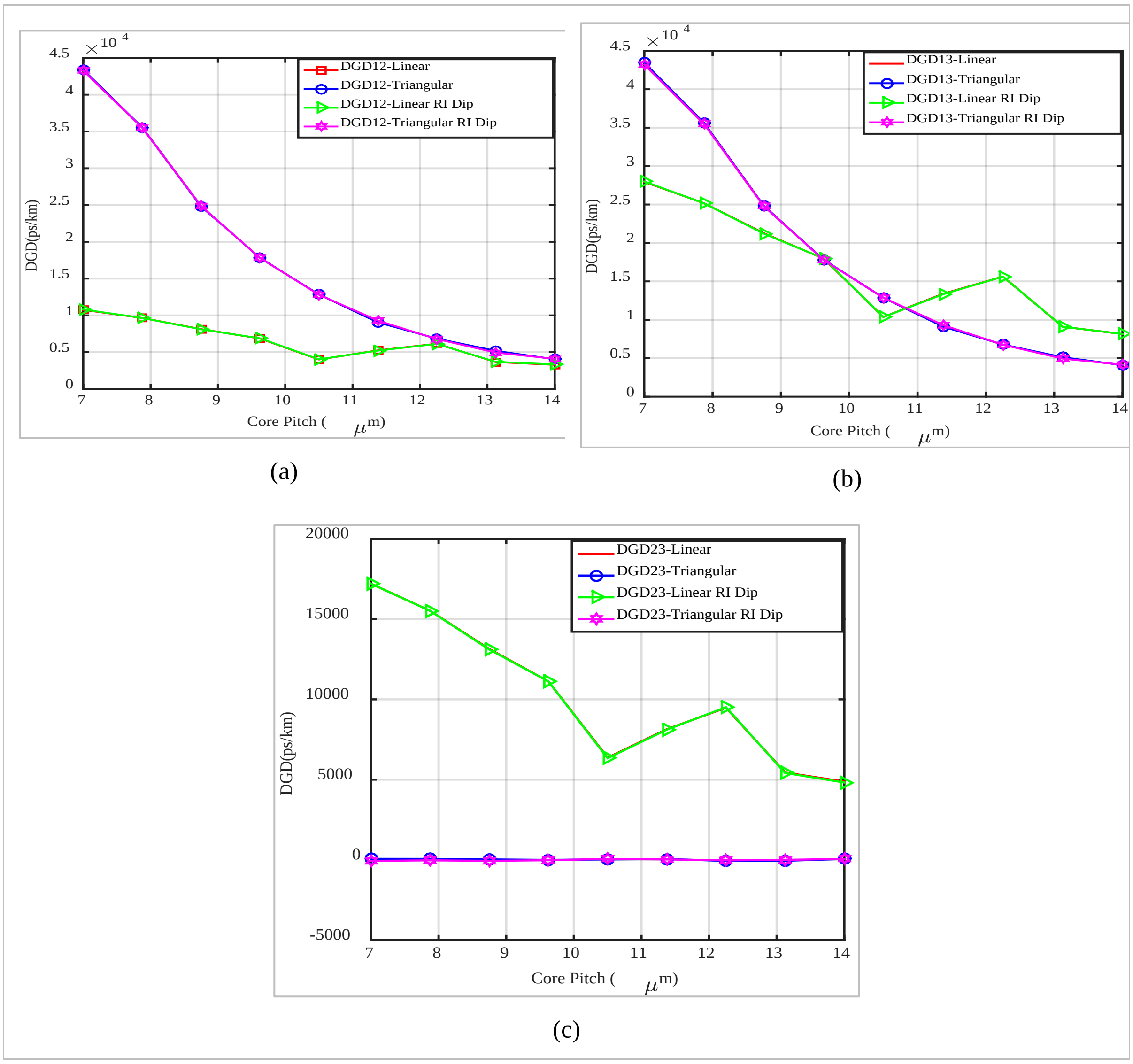


Figure 31-6 Core pitch dependent DGD variations in 3-core strongly coupled MCFs with homogeneous cores for different core layouts (a) DGD_{12} (b) DGD_{13} (c) DGD_{23}

While, linear layouts have different values of propagation constants for the different supermodes, therefore, they have different *DGD* values. This is mainly due to the symmetrical mode coupling in all cores of triangular layout, as each core in triangular layout has same number of surrounding cores; while in linear layout, the cores at the extreme end have only one neighboring core and intermediate cores have more than one neighboring cores.

In Fig. 31-6, core pitch has different impacts on the *DGD* levels in linear and triangular layouts due to the different arrangements of cores. Initially for smaller core pitch values, the *DGD* value is higher in triangular layout compared to linear layout. While, there exits certain core pitch after which *DGD* level in linear layout is higher compared to the triangular layout. However, the rate of decrease in *DGD* levels is higher in triangular layout compared to the linear layout. In Fig. 31-7, DGD values in all layouts decreases with the increase in core radius. Further, the value of *DGD* is higher in linear core layout compared to the triangular layout. The maximum value of the *DGD* i.e., $|DGD|_{max}$ in linear and triangular layouts are 13,720 ps/km and 12650 ps/km, respectively. From Fig. 31-8, it is observed that increase in relative refractive index difference (Δ) results in increase in *DGD* values for all configurations of SC-MCFs. Although, the value of $|DGD|_{max}$ occurs in linear layout, but after a certain value of Δ, $|DGD|_{max}$ value is lower in linear layout compared to triangular layout. Moreover, the rate of increase in $|DGD|_{max}$ levels is higher in linear layout compared to the triangular layout. On the other hand, incorporating R.I. dip structures in the two core layouts have no significant impact on the *DGD* levels compared to the without R.I. dip structures of respective layouts.

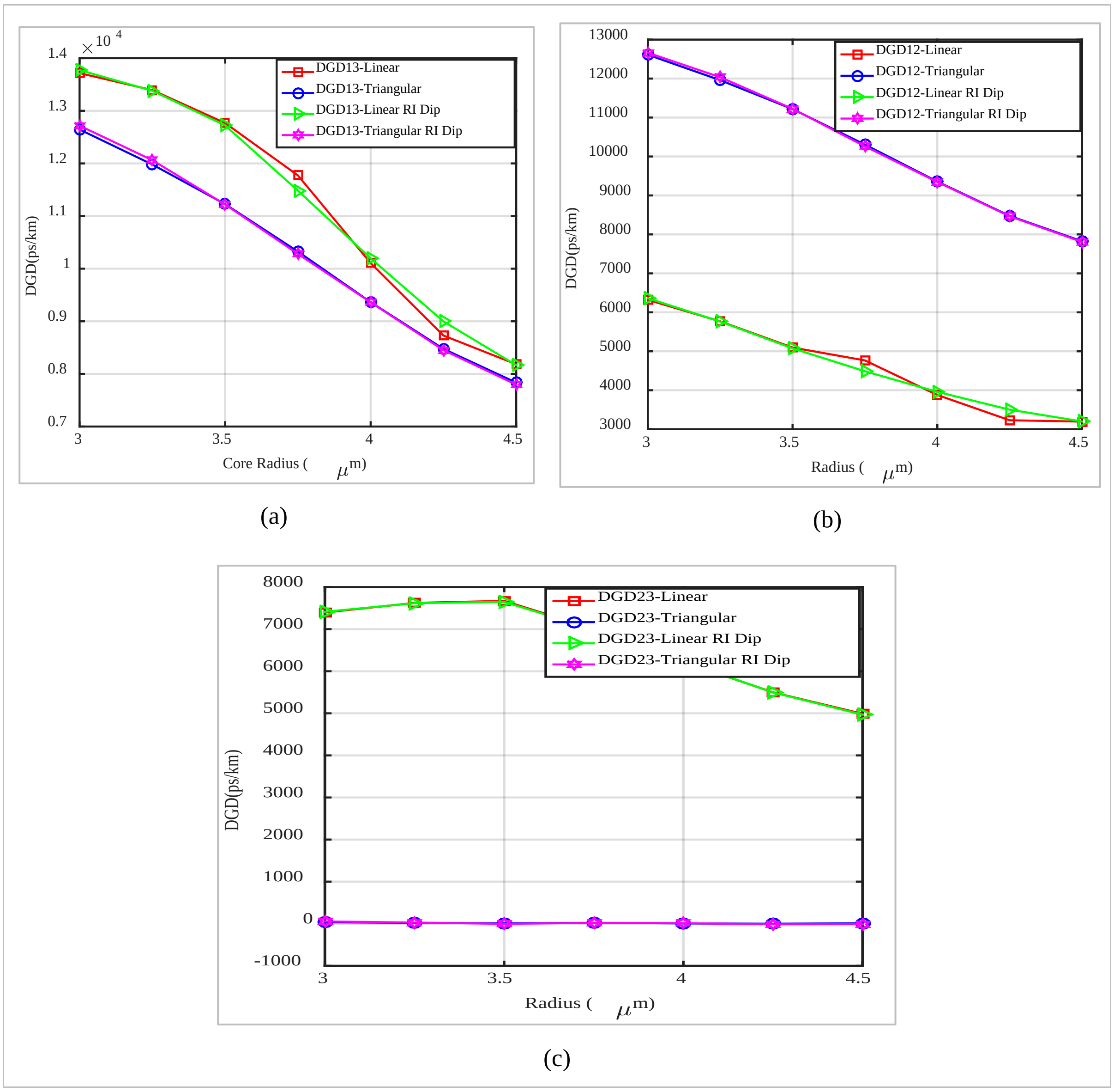


Figure 31-7 Core radius dependent DGD variations in 3-core strongly coupled MCFs with homogeneous cores for different core layouts (a) DGD_{12} (b) DGD_{13} (c) DGD_{23}.

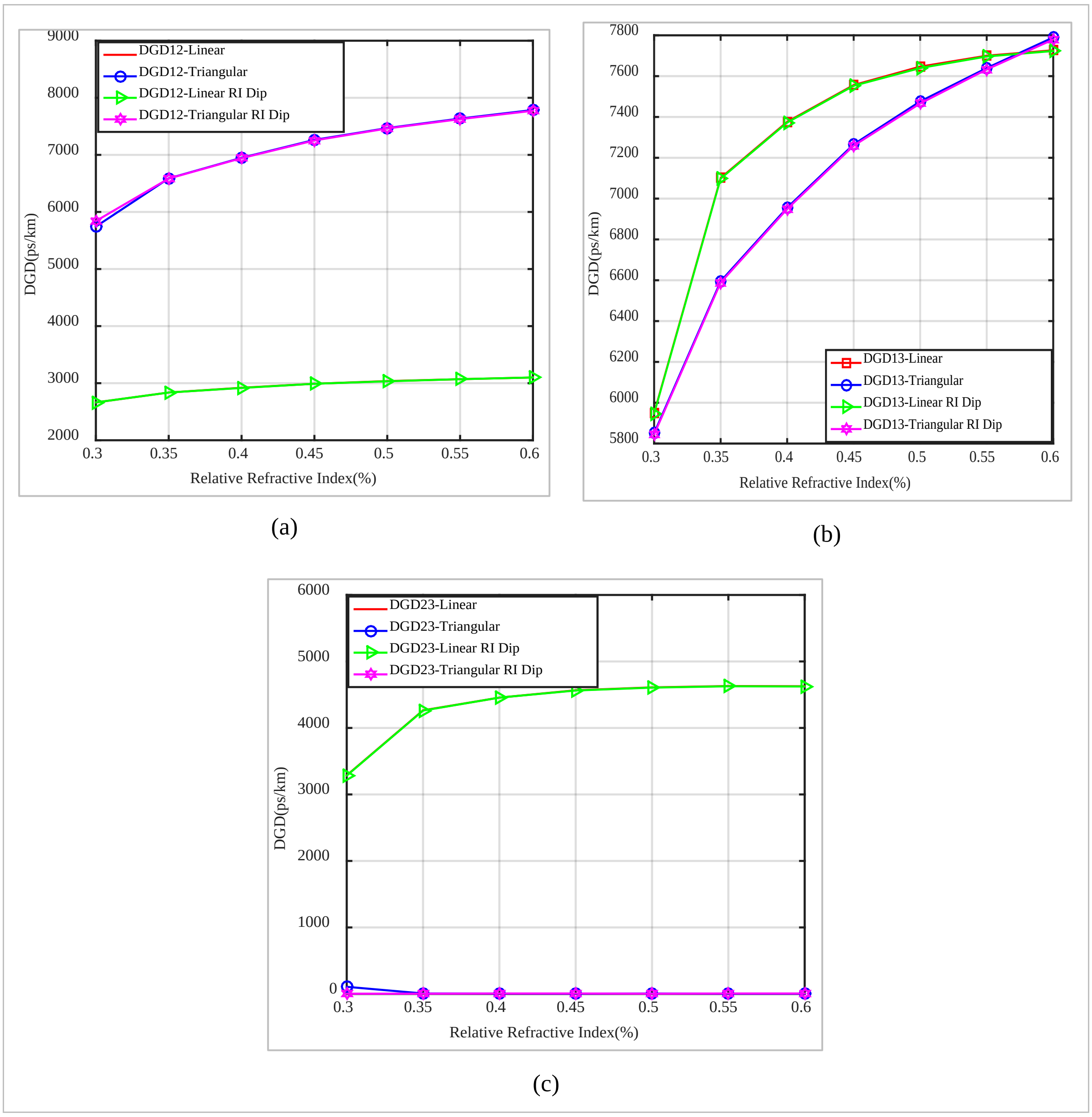


Figure 31-8 Relative refractive index difference dependent DGD variations in 3-core strongly coupled MCFs with homogeneous cores for different core layouts (a) DGD_{12} (b) DGD_{13} (c) DGD_{23}.

CONCLUSION

In the present analysis, impacts of core pitch (Λ), core radius (α), and relative refractive index difference between core and cladding (Δ) on the differential group delay (DGD) behavior among different supermodes of 3-core homogeneous SC-MCF layouts have done using FemSIM simulation platform and Matlab. The cores of MCFs under consideration have been arranged in linear and triangular layouts. It is observed that core configurations and arrangements affect DGD behavior between different supermodes of SC-MCF. Further, increase in core radius and pitch causes decrease in the DGD values while increase in relative refractive index difference (Δ) results in increase in DGD values. However, there exists a particular core pitch below which and certain value of relative refractive index difference (Δ) above which the DGD value in linear layout is lower than triangular layout. The above analysis will help in the design of MCFs with low value of DGD and its optimization by utilizing fiber design parameters and arrangements of cores.

ACKNOWLEDGMENT

This research work is a part of ECR award project (ECR/2017/000735) sponsored by Science and Engineering Research Board, Department of Science and Technology, GOI. We also thank to National Institute of Technology Patna, Bihar, India and Muzaffarpur Institute of Technology, Muzaffarpur, Bihar, India and Visvesvaraya PhD Scheme, MeitY, GOI for providing the immense support and encouragement.

REFERENCES

[1] K. Nakajima, T. Matsui, K. Saito, T. Sakamoto and N. Araki, "Multi-Core Fiber Technology: Next Generation Optical Communication Strategy," in IEEE Communications Standards Magazine, vol. 1, no. 3, pp. 38-45, Sept 2017.

[2] S. Rommel, D. Perez-Galacho, J. M. Fabrega, R. Muñoz, S. Sales and I. Tafur Monroy, "High-Capacity 5G Fronthaul Networks Based on Optical Space Division Multiplexing," in IEEE Transactions on Broadcasting, vol. 65, no. 2, pp. 434-443, June 2019.

[3] C. Xia, N. Bai, I. Ozdur, X. Zhou, and G. Li, “Supermodes for optical transmission,” Optics Express, vol. 19, no. 17, pp. 16653-16664, Aug 2011.

[4] C. Xia, M. A. Eftekhar, R. Amezcua-Correa, J. E. Antonio-Lopez, A. Schulzgen, D. Christodoulides, and G. Li, “Supermodes in coupled multicore waveguide structures,” IEEE Journal of Selected Topics in Quantum Electronics, vol. 22, no. 2, 4401212, March/April 2016.

[5] C. Xia, N. Bai, R. Amezcua-Correa, E. Antonio-Lopez, A. Schulzgen, M. Richardson, X. Zhou, and G. Li, “Supermodes in strongly coupled multicore fibers,” In: Optical Fiber Communication Conference and Exposition and the National Fiber Optic Engineers Conference (OFC/NFOEC), Anaheim, CA, pp. 1-3, 2013.

[6] C. Guan, L. Yuan, Q. Dai, and F. Tian, “Supermodes analysis for linear core array microstructured fiber,” Journal of Lightwave Technology, vol. 27, no.11, pp. 1741-1745, June 2009.

[7] J. Zhou, “Analytical formulation of super-modes inside multi-core fibers with circularly distributed cores,” Optics Express, vol. 22, no. 1, pp. 673- 688, Jan 2014.

[8] B. J. Ávila, J. N. Hernández, S. M. T. Rodriguez, and B. M. Rodriguez-Lara, “Symmetric supermodes in cyclic multicore fibers,” OSA Continuum, vol. 2, no. 3, pp. 515-522, March 2019.

[9] C. Jollivet, A. Mafi, D. Flamm, M. Duparre, K. Schuster, S. Grimm, and A. Schulzgen, “Mode-resolved gain analysis and lasing in multi-supermode multi-core fiber laser,” Optics Express, vol. 22, no. 24, pp. 30377-30386, Nov 2014.

[10] W. Ren, Z. Tan, and G. Ren, “Analytical formulation of supermodes in multicore fibers with hexagonally distributed cores,” IEEE Photonics Journal, vol. 7, no. 1, 7100311, Feb 2015.

[11] W. Wang, S. Qiu, H. Xu, T. Lin, F. Meng, Y. Han, Y. Qi, C. Wang, and L. Hou, “Trench-assisted multicore fiber with single supermode transmission and nearly zero flattened dispersion,” Applied Sciences, vol. 8, pp. 1-15, Dec 2018.

[12] S. García, M. Ureña, and I. Gasulla, “Bending and twisting effects on multicore fiber differential group delay”, Optics Express, vol. 27, no. 22, pp. 31290-31298, Oct 2019.

[13] Y. Wu and K. S. Chiang, “Compact three-core fibers with ultra-low differential group delays for broadband mode division multiplexing,” Optics Express, vol. 23, no. 16, pp. 20867- 20875, July 2015.

[14] M. Parto, M. A. Eftekhar, M.-A. Miri, R. A. Correa, G. Li, and D. N. Christodoulides, “A systematic approach for designing zero-DGD coupled multi-core optical fibers,” Optics Letters, vol. 41, no. 9, pp. 1917-1920, April 2016.

[15] J. Gao, X. Zhang, L. Shi, W. Shi, Y. Huang, and X. Ren, “Dispersion characteristics analysis of asymmetric multi-core fibers”, In: Passive Components and Fiber-Based Devices, B. Pal, ed., Vol. 8307 of Proceedings of SPIE (Optical Society of America, 2011), paper 83072O.

[16] K. S. Chiang, M. Liu, and Y. Qian, “Closely packed multicore fibers with zero differential group delay,” In: Procedding of 18th OptoElectronics and Communications Conference held jointly with International Conference on Photonics in Switching (OECC/PS), Kyoto, pp. 1-2, 2013.

32. Possibilities of 5G and its Application in Rural India: A Short Survey

[1]Navaneet Kumar Singh, [2]Nilabh Kumar, [3]Shashank Kumar Singh, [4]Amish Ranjan, [5]Prashant Kumar Singh
Dept. of ECE, University College of Engineering and Technology, VBU, Hazaribag, Jharkhand, India
[1]navaneetsingh0@gmail.com, [2]nilabhk5@gmail.com, [3]incredibleshashank@gmail.com,
[4]Amishranjan347@gmail.com, [5]Prashant10mar@gmail.com

ABSTRACT

Ultra-high-resolution 3D videos can be downloaded with 5G technology that is nearly 100 times faster than 4G technology. With this technology, high data can be handled as it has larger bandwidth. Internet of Things (IoT) is a physical network, which comprises namely, Bluetooth, Wi-Fi, and cellular on a single platform.The healthcare industry is transforming with the growth of the Internet of Things (IoT) and result inthe development of the Internet of medical things. IoMT for the healthcare industry requires big data, high speed, large bandwidth, and reliable connectivity, which will be fulfilled with 5G technology. In this paper, we present the current development and future perspective of Unmanned Ariel Vehicle (UAV) for providing 5G technology in rural India and the Internet of Medical Things (IoMT), as application of 5G. UAV based 5G architecture is explained along with its application in real-time. Real-time application of 5G can be applied asIoMT is also illustrated in this paper.

Index Terms— *Unmanned aerial vehicle, 5G, Internet of medical things, IoT, dedicated HardWare, commodity HardWare.*

INTRODUCTION

The crosstalk and poor connectivity were the common problems in the lower generation of technology but 5G technology will improve connectivity, cloud-based storage, and an array of connected devices and services. 5G technology enables us to download 3D ultra-high-resolution videos within a few seconds [9]. It can support data speeds of more than 100 Mbps, more bandwidth, and fewer delays due to built-in computing intelligence. Computing capability combined with virtual system architecture will open up a mobile internet of things (IoT). By 2020, the 5G network is expected to support 50 billion connected devices and 212 billion connected sensors as well as enable access to 44 zettabytes (ZB) of data. Fig. 32-1 shows the roadmap towards 5th generation (5G) wireless communication systems.

Nowadays, cellular networks are extensively deployed in urban areas, where the user's density is high. Thus, the forthcoming 5G technology is "urban" in nature. The key features of 5G are to provide multiple data transfer rate with very high speed to users, energy efficient and high security. On the other hand, more than one third of people in rural areas are still experiencing a lack of mobile broadband connectivity. One of the major challenges impairing the Sustainable Developing Goals is mobile broadband connectivity. In whole world, around 4.1 billion people are using the Internet in 2019, with a 5.3% increment compared with 2018. From 2005 to 2019, the number of Internet users increases by 10 percent every year. In India, 100-200 kbit/s per Internet user bandwidth usage [1].On the other hand, it is clear that traditional network operators are not keen to invest in such zones, which have of potentially low revenues. Clearly, the lack of 5G deployments in rural zones will inevitably increase the digital divide for the users living in such areas [2].In this situation, solutions regarding the mobile broadband connectivity in the rural areas are becoming of great importance. To cope with this situation, the Global Access to the Internet for All (GAIA) Research Group has been established by the Internet Research Task Force (IRTF) to design alternative networks for serving rural and/or low income zones [3]. 5G networks specifically to serve rural zones, is rapidly gaining attention by the research community [4], [5], [6]. With 5G technology, it is possible to study innovative solutions to go afar the unbending structure of previous known technologies, and to include the GAIA standard in design and management phases of 5G. In this scenario, numerous questions may come in our mind, such as: a) How to cover up rural areas with a network of UAV-based Base-Stations b) How energy consumption will be efficiently managed through the UAV-based BSs? c) How the available energy from the Solar Panels (SPs) and recharge sites will be managed at the ground? d) Is it feasible to provide a high level overview of a sustainable 5G cellular model to consider all the aforesaid aspects for rural areas? Is it economically feasible to provide 5G connectivity to rural areas user of India? What is the periodical subscription cost that should be charged to users of rural areas/ low income areas to compensate the installation and operational costs of the sustainable 5G network? One of the objectives of this paper is to identify the challenges and available facilities in rural India for launching 5G services at the earliest.

The Internet of things (IoT) is the physical networks in which different technologies combined together e.g Wi-Fi, Bluetooth and Cellular on a single platform [12-14]. The IoT for medical healthcare, which is IoMT requires high data, high speed and long battery life with reliable connectivity. The 5G fulfils these requirements with its superfast capabilities and supports IoMT for human health such as, diagnosis and treatment [16-18]. This paper also presents the detailed survey about how 5G has revolutionized the medical healthcare with the help of IoT for enhancing quality and efficiency of the wearable devices.

This paper is divided into 7 sections. Introduction is given in section 1. UAV based 5G structure and IoMT for future healthcare in rural areas are explained in section 2 and 3 respectively. Various applications of IoMT explained in section 4 and section 5 illustrates the benefits and challenges of Ultra Aerial Vehicle (UAV) and IoMT. Available solar power capacity in Indiaexplained in section 6 and summary of paper is illustrated in section 7.

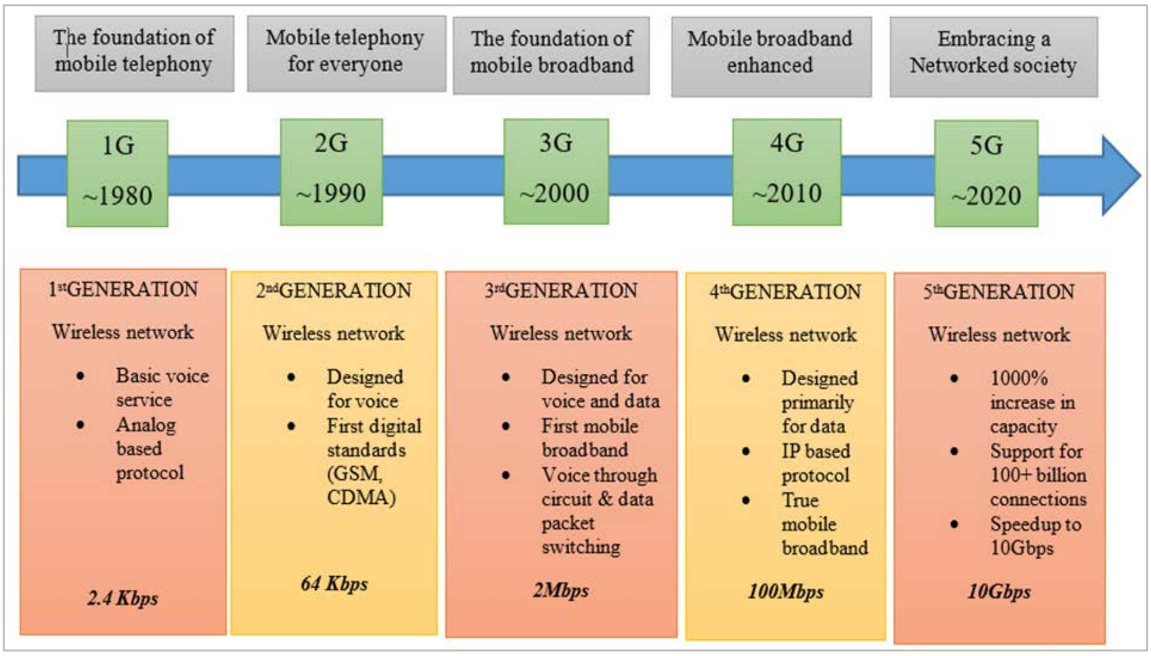


Figure 32-1 Time line towards 5G wireless communication [9]

5G ARCHITECTURE: UAV BASED

Researchers have laid out architecture for providing 5G services using UAV [7]. It mainly consists of dedicated HardWare (dHW) and commodity HardWare (cHW). dHW is planted over the UAV while cHW is installed at ground sites. dHW is responsible for low-level functionalities whereas cHW carries out high-level virtual functionalities. This decoupling reduces the weight that UAV have to carry for providing lag-free 5G network. UAV has constraint of power of supply. For this reason, UAVs have to be recharged time and again. UAV is responsible for covering the region of interest. The most important constraint for Quality of Service (QoS) is the movement to cover an area and recharge scheduling at site has to be planned efficiently. Fig 32-2 represents the working strategy of UAV for recharging, moving and covering action. Since, UAV is power supply constrained device, time and again recharging is necessary. While charging the UAV will not be able to cover area of interest, thus required amount of UAV is needed by dividing the time into slots and accordingly mapping the working and recharging schedule of each UAV. Fig 32-3 gives a view of dHW and cHW location. Radio link keeps the UAV connected with ground station.

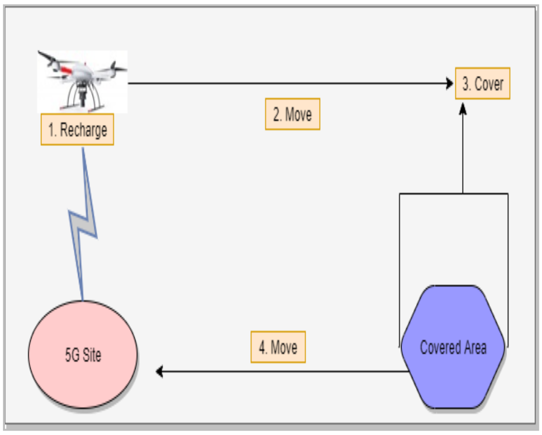


Figure 32-2 Recharging, moving and covering action.

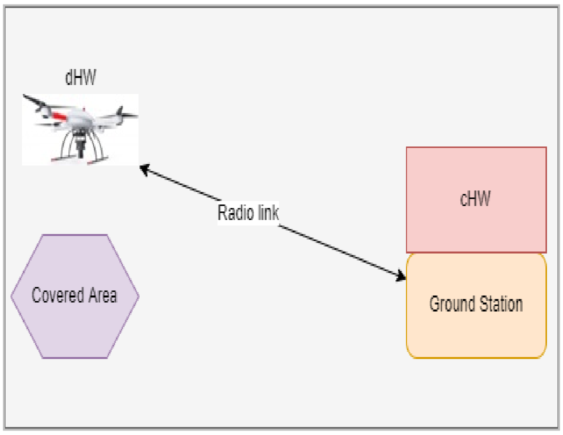


Figure 32-3 dHW and cHW decoupling

INTERNET OF MEDICAL THINGS (IOMT) OR HEALTHCARE IOT-THE FUTURE OF HEALTHCARE

Nowadays, to connect medical devices with networks and patients is of utmost importance in various research groups. As per experts forecast, by 2021 Internet of Medical Things (IoMT) market will surpass by $136.8 billion [10]. The IoMT will serve the sector by providing more accurate and quicker diagnoses, efficient healthcare services delivery, and reduced costs etc [11]. The IoMT deals with only medical devices with internet connectivity, however IoT includes all the ranges of web enabled devices from smart cars to smart kitchen. IoMT technology facilitates the medical device to process (collection, analysis and transmission) the healthcare data across the Web. In addition to the digital medical devices (like heart monitors), the non digital things like hospital beds and pills need to be connected over the internet. The basis of IoMT is machine-to-machine (M-M) communication, which is possible by Wi-Fi enabled medical devices [13]. To store and analyze the captured healthcare data, the IoMT devices link to cloud platforms like Amazon Web Services. The healthcare IoT is another term which is also used in place of IoMT [15]. Examples of IoMT include monitoring of remote patient with chronic conditions; medication orders and location tracking of patients; and mHealth wearable devices to communicate the data to caregivers [13]. Now many of the mobile devices come with Near Field Communication (NFC) radio frequency identification (RFID) tags, which allow the sharing of the healthcare data over IT systems. This gives way for more possible applications and developments of IoMT as IoT. The awareness of the available medical equipment and supplies among the hospital staffs can also be managed by deploying RFID tags on the healthcare items [11]. The telemedicine is the most common word used in connection with the remote monitoring of patient at home by the use of IoMT [10]. This technology helps the patient from unwanted travelling to the hospital and physician's door for their regular change in condition and the medical questions. It also helps the doctor to get the data of their patients anywhere. Primarily the protection to sensitive data of the patient is governed by Health Insurance Portability and Accountability Act. These days the protected data passes through the IoMT is of great concern among healthcare providers.

INNOVATIVE DEVELOPMENTS FOR THE INTERNET OF MEDICAL THINGS (IOMT)

The IoT in medical domain fast-growing area with several innovations being developed frequently [15]. Analysts showing main change in health care industry with IoT with the introduction of Machine Learning and artificial intelligence (AI). Deloitte consulting work suggests that the Internet of Medical Things (IoMT) market is set to reach $158.1 billion in 2022, owing to the rise in demand for better-quality medical technology [13]. Additionally, increased access to patient data is making it easier to incorporate IoMT devices seamlessly. For immobile patients it is essential to detect the slightest of movements on the body [11]. That is why smart monitors and sensors are placed on the clothing, bed, or skin of the patient to monitor their movements. This can also help with tracking involuntary movements to provide better insights into proper diagnosis management [10]. Apple launched its Movement Disorder API to help monitor patients with Parkinson's disease. The data captured is encrypted from end to end, giving greater privacy to patients. IoMT-based technologies also have the potential to locate patients, medical staff, and visitors that further enhances the concept of smart hospitals [13]. IoMT can improve healthcare quality while reducing cost. MRIs, X-ray machines, CT scanners, and other equipment can be remotely monitored for performance issues [15]. Long before hospital staff notices a problem; the manufacturer or service vendor can detect issues that need to be corrected. GE, Siemens, Philips, and other companies use IoMT for remote diagnostics, predictive maintenance, and performance upgrades to their imaging products [10-11].

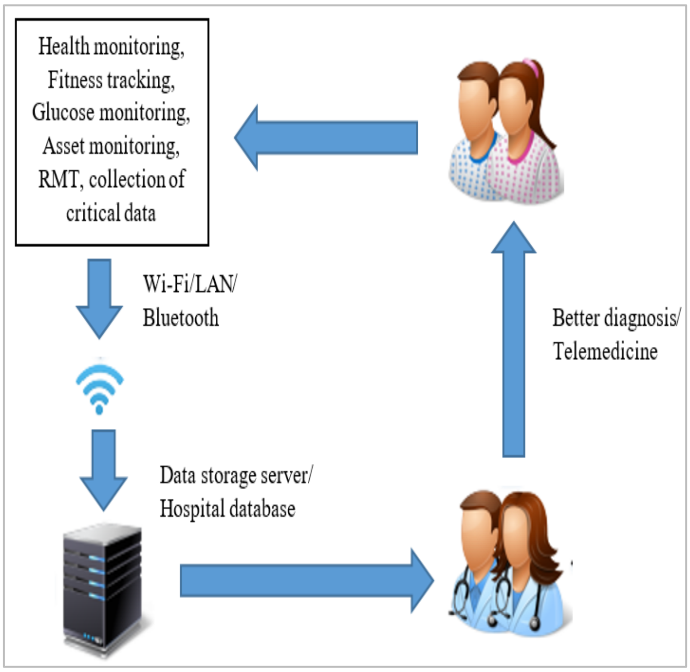


Figure 32-4 Healthcare Monitoring and diagnosis using Internet of medical things (IoMT)

A. REAL-TIME PATIENT HEALTH MONITORING

Due to advancements in biosensor technology there are many wearable smart devices are available which monitor the user's health [15]. These devices are fixed inside apparel, attached to the skin, or implanted; on-the-body IoMT sensors give patients freedom, and maintain close watch on their physical conditions. A critical feature of IoMT is to track the patient health across various parameters. Different sensors can help to track distinct areas of information such as heart rate, glucose level, respiration, etc. to provide a complete picture [13]. DocBox is a most important example of a patient monitoring platform that works with physical conditions directly [11]. The information is accepted directly through an API which is connected to a larger telehealth system.

B. FITNESS TRACKING AND DIAGNOSTICS

Now a day's fitness trackers are a specialized area which is in high demand [10]. This fitness tracker helps to diagnose primary conditions through a lifestyle analysis. Starts with sleeping quality to patient heart rate tracking, all the information's can be used by various insurance agencies and health care specialists [11]. This also helps to understand the patient conditions and also provide the status of progress report, especially in the case of rehabilitation and recovery.

C. SMART GLUCOSE MONITORING

Smart glucose monitors helps in providing information related to glucose fluctuations that will ultimately help to act accordingly in real time [10]. Combination of non-invasive glucose bio-sensors and wearable technology helps in tracking the insulin level effectively [13]. MINIMED 670G is one of the monitoring device that maintains the insulin in optimized way according to the core parameters.

D. ASSET MONITORING AND MAINTENANCE

The monitoring of health is important in the B2B side of health care systems. This includes the usual maintenance of machines, technology, and data systems where manufacturer of medical devices install IoMT devices to share asset data [15]. To ensure the functionality of machines, all assets can be tracked remotely and key trends can be mapped to enhance NPD and research.

E. VIRTUAL HOME SYSTEMS

Virtual home system is designed for getting the right treatment for seniors and homebound patients suffering from chronic illnesses. It introduces a interactive and a faultless mechanism to communicate with health care provider [13]. Lenovo Health and Orbita Health jointly developed a chronic and post-acute care system that worked fully on voice-inputs [11]. Smart sensors and AI technology solutions will provide greater connectivity at the patient's home.

F. REMOTE PATIENT MONITORING (RTM)

Medical connectivity technology is known as telemedicine which extends healthcare services instead of going the hospital [10]. Remote Patient Monitoring (RTM) avoid frequent visit to doctors, to patients suffering from chronic disease. Diabetics and heart patients can benefited from RTM technology. Patients' glucose level and activity of heartcan be monitored thought handy RTM devices and if any problems found it can automatically alert the doctor [13]. Virtual Home Assistants designed for many elderly patients, it can interact and remind with the patient for taking medications. It can also be accessed remotely by physicians and family.

G. COLLECTION AND INTEGRATION OF CLINICAL DATA

Many technologies are required for Collection and integration of clinical data. This procedure is becoming moreand more efficient and effective with IoHT. The generatedmedical data from the observations can be collected and communicated as not done before which savemoney and time by encouraging technology for the future. The use of IoT in healthcare is new technology as it developed with the development of healthcare software [12]. The demand of wearable devices is increasing day by day as it is programmed with such software, as use of mobile applications and healthcare solutions become easy to access to all [15]. The applications of IoT in the healthcare industry are bringing anexcess of applications for public healthcare.

BENEFITS AND CHALLENGES OF UAV AND IOT IN HEALTHCARE: INDIA'S RURAL PERSPECTIVE

Cost of UAV, recharging facility and solar power grid is one of the challenges, which will affect the acceptance of 5G network using UAV in rural areas. 25 UAVs are required [7] to provide 24 hrs 5G network. Since, UAV has limitation of altitude; buildings with more than 4 floors will create obstructions in network availability. Efficient scheduling of UAV for the purpose of recharging at site, moving from site to covering area and moving from covering area to site.

The applications of IoT in the healthcare industry are enormous with cheaper medical cost, improved patient experience, and better control over wastage in the healthcare sector, Dramatic reduction in errors, Better outcomes of medical treatments, Enhanced manageability of medical drugs and medicinal adherence. Although IoT is technology has proven its mark in the improvements pertaining to the field of medicines, it does not come without a downside. The primary challenges to patient privacy is serious concern, this can be resolve with the blockchain technology in the near future. Hacking of data and data corruption or manipulation also can be diminished with blockchain technology. Activity monitoring and management of IoT devices that consists of Electronic Medical Records (EMR) system is also a challenge for current medical infrastructures.The Fig. 32-5 has illustrate the increasing number of IoTs devices in the future years [10].

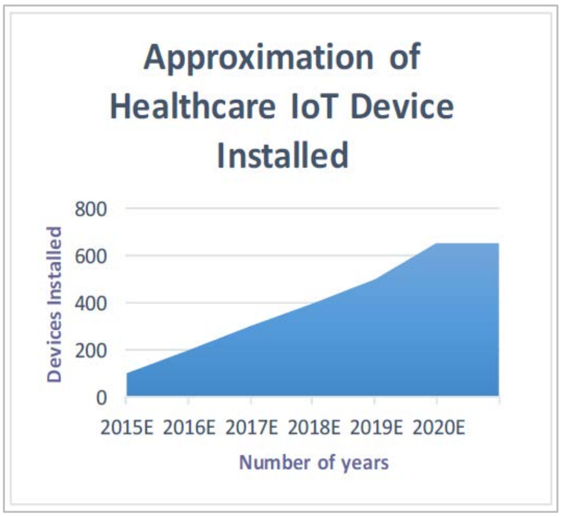


Figure 32-5 Growth in IoMT devices [10]

AVAILABLE FACILITIES FOR 5G IN INDIA

India has 28,181 MW solar power capacities as on 31st March 2019 [8]. Most of the solar power grids are located near rural areas. Fig 6 proposes that India's solar power capacity is increasing exponentially year by year. Thus, installing 5G network near available solar power grid will be easy and cost efficient. Indian rural areas rarely have 4-storey building or more than that. Therefore, the hindrance to UAV due to high rising buildings will not be experienced in rural areas. Thepopulation capacity of each village can be identified by the National Population Register. Accordingly, small cell 5G services and large cell 5G services can be provided for small area and large area respectively. Year wise growth of solar power has shown in fig.32-6

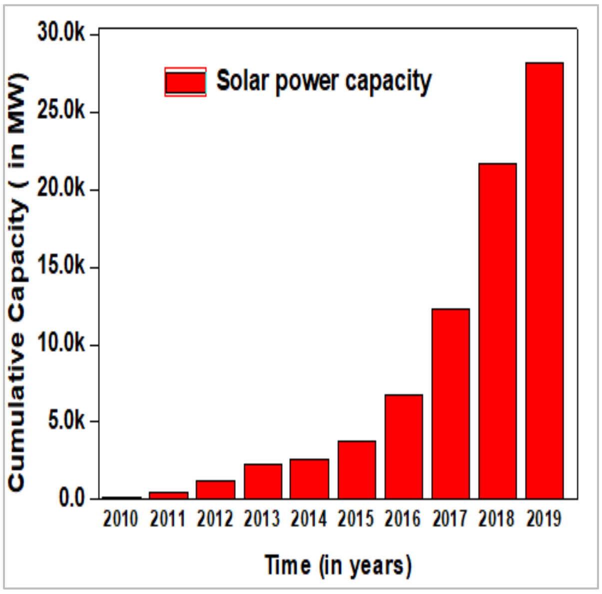


Figure 32-6 Solar Power Capacity in India year wise growth

CONCLUSION

With respect to India, it is observed that enough solar power facility is available for initiating 5G technology. Besides that, the need of the hour is scheduling the UAV according to rural area or low income zone(s) and population. In the context of 5G application, IoMT is one of the preferable and demanding areas. It reduces the physical presence of patient in the city hospitals. Real-time analysis of patients can be handled. Consequently, remote monitoring can be done due to the availability of ultra-high speed 5G network.

REFERENCES

[1] “International Telecommunications Union, ICT Facts and Figures 2019.” https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2019.pdf.

[2] J. Wu, S. Guo, H. Huang, W. Liu, and Y. Xiang, “Information and Communications Technologies for Sustainable Development Goals: State-of-the-Art, Needs and Perspectives,” IEEE Communications Surveys and Tutorials, vol. on press, 2018.

[3] J. Saldana, A. Arcia-Moret, A. Sathiaseelan, B. Braem, E. Pietrosemoli, M. Zennaro, J. Simo-Reigadas, I. Komnios, and C. Rey-Moreno, “Alternative networks: Toward a global access to the internet for all,” IEEE Communications Magazine, 2017.

[4] O. Onireti, J. Qadir, M. A. Imran, and A. Sathiaseelan, “Will 5G See its Blind Side? Evolving 5G for Universal Internet Access,” in Proceedings of the 2016 workshop on Global Access to the Internet for All, pp. 1–6, ACM, 2016.

[5] Chiaraviglio, N. Blefari-Melazzi, W. Liu, J. A. Gutierrez, J. van de Beek, R. Birke, L. Chen, F. Idzikowski, D. Kilper, P. Monti, and J. Wu, “5G in rural and low-income areas: Are we ready?,” in Proc. of ITU Kaleidoscope: ICTs for a Sustainable World, Bangkok, Thailand, pp. 1– 8, 2016.

[6] M. Khalil, J. Qadir, O. Onireti, M. A. Imran, and S. Younis, “Feasibility, architecture and cost considerations of using TVWS for rural Internet access in 5G,” in Innovations in Clouds, Internet and Networks (ICIN), 2017 20th Conference on, pp. 23–30, IEEE, 2017.

[7] L. Amorosi, L. Chiaraviglio, F. D'Andreagiovanni and N. Blefari-Melazzi, "Energy-efficient mission planning of UAVs for 5G coverage in rural zones," 2018 IEEE International Conference on Environmental Engineering (EE), Milan, 2018, pp. 1-9.

[8] http://www.cea.nic.in/reports/monthly/installedcapacity/2019/installed_capacity-03.pdf last Accessed on 08 January 2020.

[9] http://www.ericsson.com/res/docs/whitepapers/wp-5g.pdf

[10] HinaMagsi, etal, “Evolution of 5G in Internet of Medical Things” 2018 International Conference on Computing, Mathematics and Engineering Technologies – iCoMET 2018.

[11] Ali Hassan Sodhro, Madad Ali Shah, “Role of 5G in Medical Health”, IEEE International Conference on Innovations in Electrical Engineering and Computational Technologies (ICIEECT),Indus University, Karachi, Pakistan, 5-7 April, 2017.

[12] PallaviSethi ,Smruti R. Sarangi, “Internet of Things: Architectures, Protocols, and Applications”, Journal of Electrical and Computer Engineering, 26th January 2017.

[13] A. Darkins, P. Ryan, R. Kobb, L. Foster, E. Edmonson, B. Wakefield, and A. Lancaster, “Care Coordination/ Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic Condition,” Journal of Telemedicine Health, December, 2008.

[14] Samantha Rivers,” Enabling the Internet of Things with 5G Technology”, July 15, 2017.

[15] AnkurLimaye, “HERMIT: A Benchmark Suite for the Internet of Medical Things” IEEE journals, 2018, DOI 10.1109/JIOT.2018.2849859.

[16] L. Atzori, A. Iera, and G. Morabito, “The Internet of Things: A survey,” Computer Networks, vol. 54, no. 15, pp. 2787–2805, 2010.

[17] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, “Internet of Things (IoT): A vision, architectural elements, and future directions,” Future Generation Computer Systems, vol. 29, no. 7, pp. 1645–1660, 2013.

[18] M. Maksimovi´c, V. Vujovi´c, N. Davidovi´c, V. Miloˇsevi´c, and B. Periˇsi´c, “Raspberry Pi as Internet of things hardware: performances and constraints,” Design Issues, vol. 3, p. 8, 2014.

33. Measurement and analysis of nearness among different images using varied probe functions

Priyanka Srivastava, Department of Computer Science & IT, Jharkhand Rai University, Ranchi, India
priyanka12.1987@gmail.com

ABSTRACT

The focus of this paper is on a tolerance space-based approach to image analysis and correspondence for measuring the nearness among images. The basic problem considered is extracting perceptually relevant information from groups of objects based on their descriptions. Object descriptions are represented by feature vectors containing probe function. This article calculates the Hausdorff Distance (HD), Hamming Measure (HM), tolerance Nearness Measure (tNM) within few set of images of different categories and the result has been analyzed. All of them applies near set theory to images applying Content Based Image Retrieval (CBIR). The set of images are of bus, dinosaur. The motivation behind this work is the synthesizing of human perception of nearness for improvement of image processing systems. The desired output must be similar to the output of a human performing the same task..

Index Terms— *Hausdorff Distance (HD), Hamming Measure (HM), tolerance Nearness Measure (tNM), Content Based Image Retrieval (CBIR), probe functions.*

INTRODUCTION

This paper highlights on perceptual nearness and its applications. The observation of the perceptual nearness combines the basic understanding of perception in psychophysics with a view of perception found in Merleau-Ponty's work [1]. The sensor signals gathered by our senses helps in determining the nearness of objects of an image. The calculation includes the distance measurement among images for perceptual resemblance based on features of the image itself. The features are termed as probe function of the images. The analysis tries to correlate the results with those of human sensation where the values are integrated by the mind. A human sense shown as a probe, determines the physical characteristics of objects in our environment.

Image Resemblance is widely used various fields. Few of them includes query by image, management and search through digital archives of images and videos in personal, commercial and public domain image archives over the internet. Medical applications, its analysis, archive and searching within database uses the concept of image resemblance. Application in "image registration" problem where similarity between images used to determine similarity between an image and its transformation. Image quality assessment where the goal is to assess the similarity (or differences) within a well-positioned image and an inaccurate image. Classification and resemblance of pictures based on content based resemblance between pair of pictures.

The sensed physical characteristics of an object are identified with object features. It is our mind that identifies relationships between object feature values to form perceptions of sensed objects. It is conjectured that perception, i.e. human perception of nearness, can be quantified through the use of near sets by providing a framework for comparing objects based on object descriptions. Objects that have similar appearance (i.e., objects with similar descriptions) are considered perceptually near each other. Sets are considered near each other when they have "things" (perceived objects) in common. Specifically, near sets facilitate measurement of similarity between objects based on feature values (obtained by probe functions) that describe the objects. This approach is similar to the way humans perceive objects and as such facilitates the creation of perception-based systems.Three different distance has been measured among images which includes Hausdorff Distance (HD), Hamming Measure (HM), tolerance Nearness Measure (tNM).

HM calculates the distance between two metrics, the result is 0 if the corresponding bits are the same, otherwise, the result is 1. It is a metric which evaluates the number of bits that differ between two metrics. It is widely used in variety of applications to search images based on the content. Ex: Google, telecommunication to estimate the error by determining the overturned bits number within a fixed-length binary word.

METHODOLOGY

Hausdorff distance is used to measure the dissimilarity between two images on the basis of measuring the distance between sets in a metric space. It is a max-min distance between all possible relative positions. It is defined on any nonempty closed bounded subsets of any metric space [2, 3, 4]. It calculates the distance between two points as follows:

$$d_H(X, Y) = \max\{\sup_{x\in X} \inf_{y\in Y} d(x, y), \sup_{y\in Y} \inf_{x\in X} d(x, y)\} \quad (1)$$

Hausdorff distance metric is frequently used in CBIR. It is used to measure the distance (d) between two points A and B in a metric space E. A and B are two finite point sets such that A= $\{a_1, a_2, \ldots, a_p\}$ and B=$\{b_1, b_2, \ldots, b_q\}$ [3]. It is a measure of the maximum of the minimum distance between two sets of objects [5].

If the two images are same then the value of Hamming distance is zero. Hamming distance is given as:

$$d^{HAD}(i, j) = \sum_{k=0}^{n-1}[y_{i,k} \neq y_{j,k}] \quad (2)$$

d^{HAD} is the hamming distance among two objects *i* and *j*, k is the key of the respective variable which states y out of total variable n. It provides the amount of mismatches within the variable matching by k.

Tolerance classes is calculated using the Perceptual Tolerance i.e., for a given image X as

$$H_{\cong B,\epsilon} = \{(X,Y)\in O*O : \|\phi(X)-\phi(Y)\| \le \varepsilon\} \quad (3)$$

RESULTS AND DISCUSSION

We have calculated HM, HD, tNM using a database of 100 images of buses and a query image. The subimage size taken is 20, epsilon value is 0.01, probe functions (No. of features) is 1 and the probe function is Average Grey. Figure 33-1, 33-2, 33-3 reveals the graphical view of calculated HD, HM, tNM respectively of buses image.

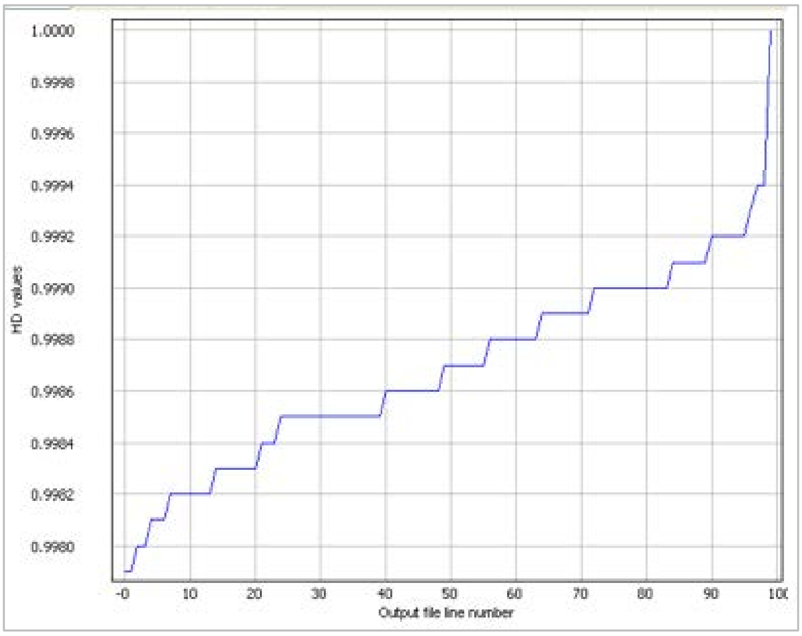


Figure 33-1 Graphical view of calculated HD of Buses image

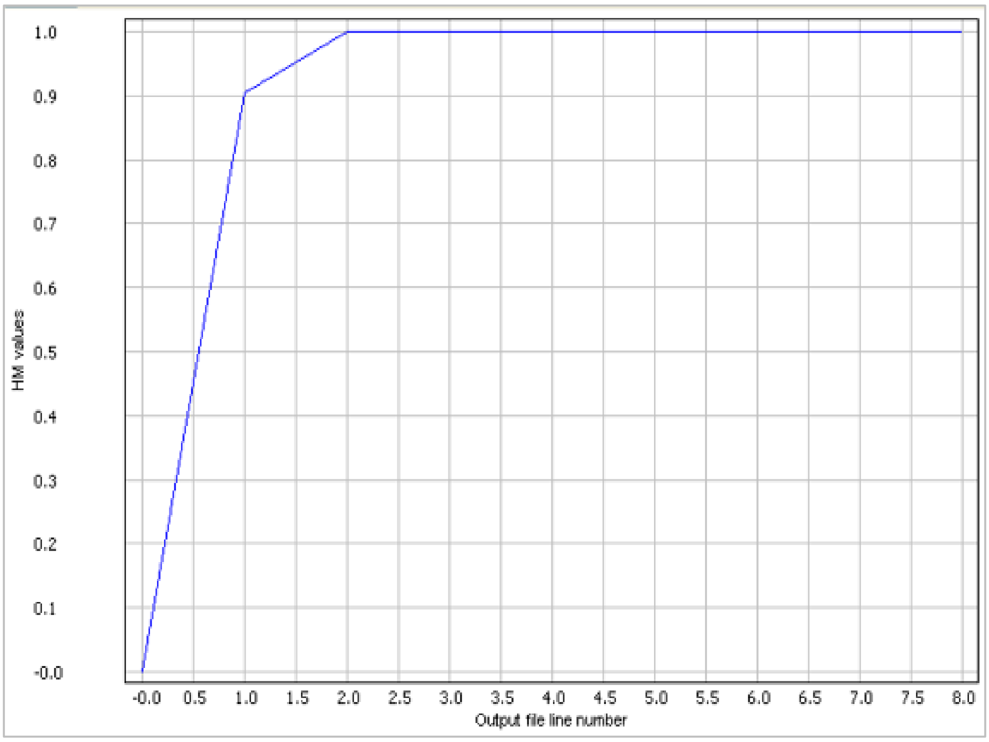


Figure 33-2 Graphical view of calculated HM of Buses image

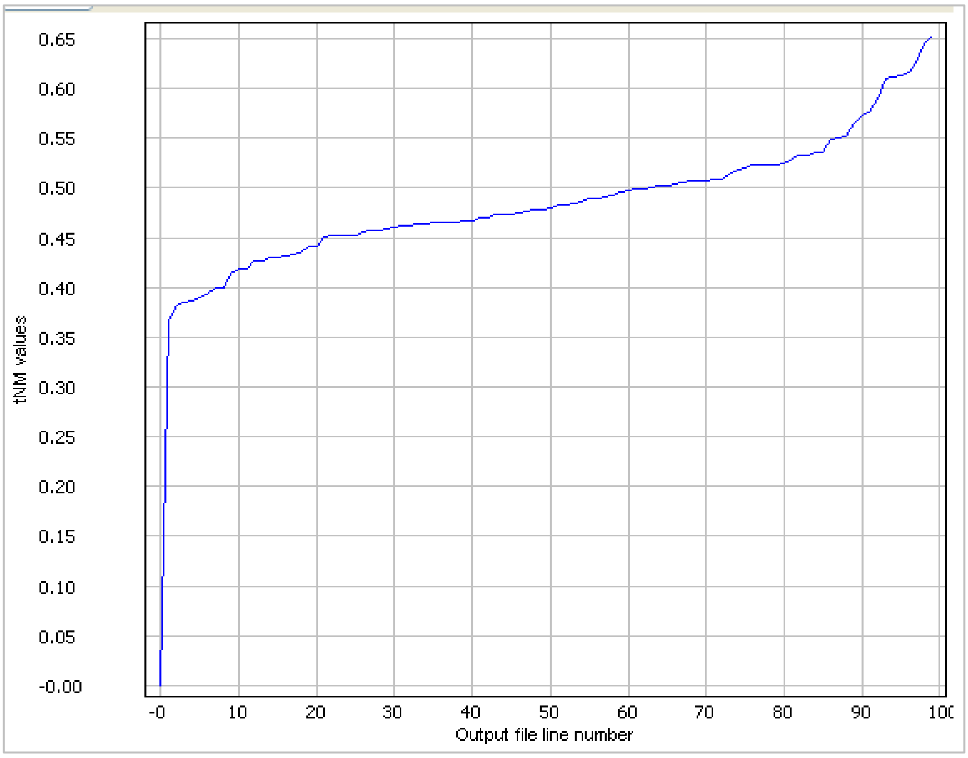


Figure 33-3 Graphical view of calculated tNM of Buses image

Similarly, the HM, HD, tNM of Dinosaur image have been calculated using a database of 100 varied images of dinosaur with a single query image. Here, the subimage size is 20, epsilon value is 0.01, probe functions (No. of features) is 1 and the probe function is Average Grey. Figure 33-4, 33-5, 33-6 reveals the graphical view of calculated HD, HM, tNM respectively of dinosaur image.

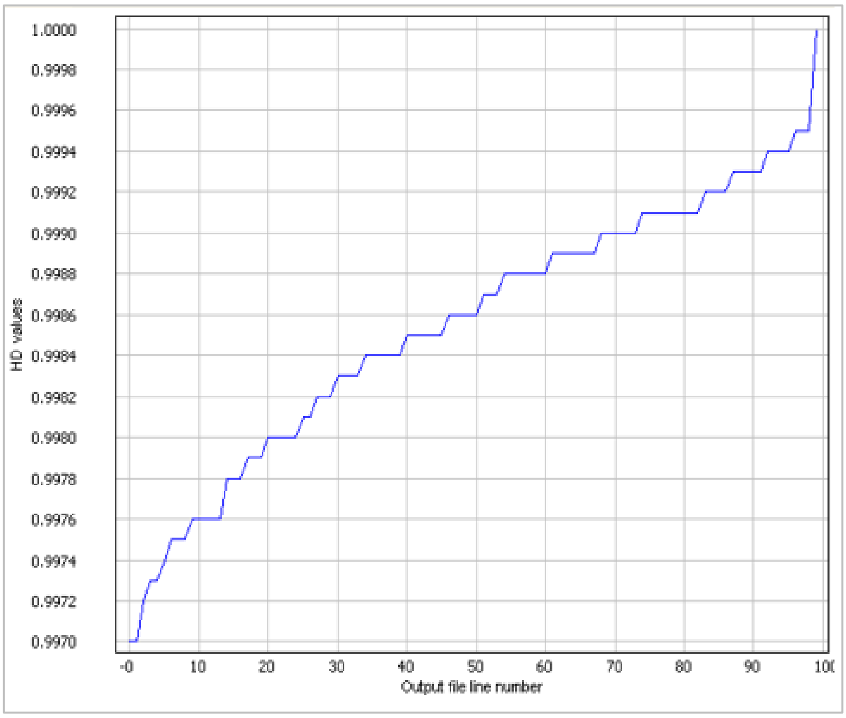


Figure 33-4 Graphical view of calculated HD of Dinosaur image

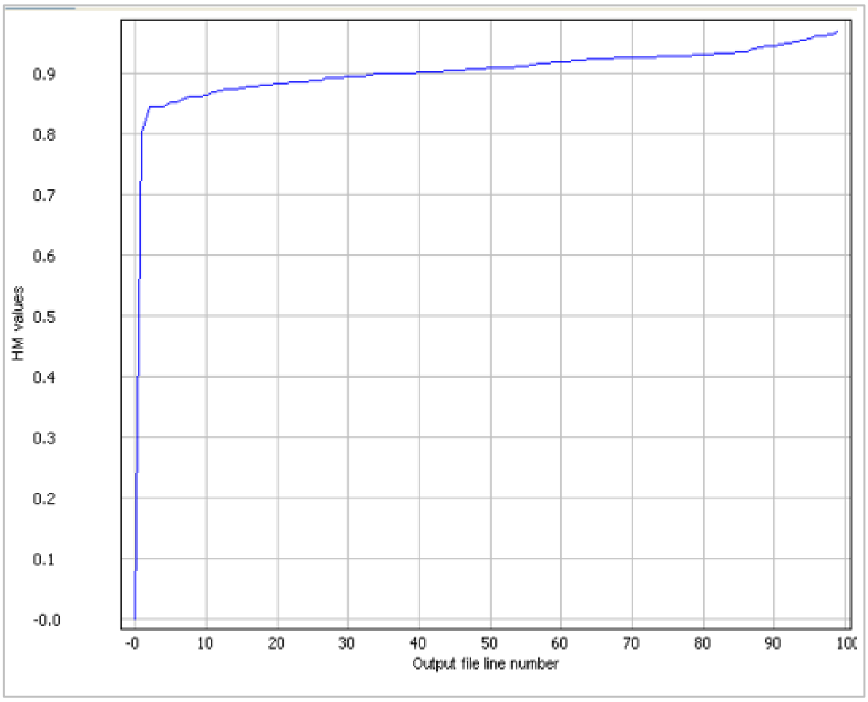


Figure 33-5 Graphical view of calculated HM of Dinosaur image

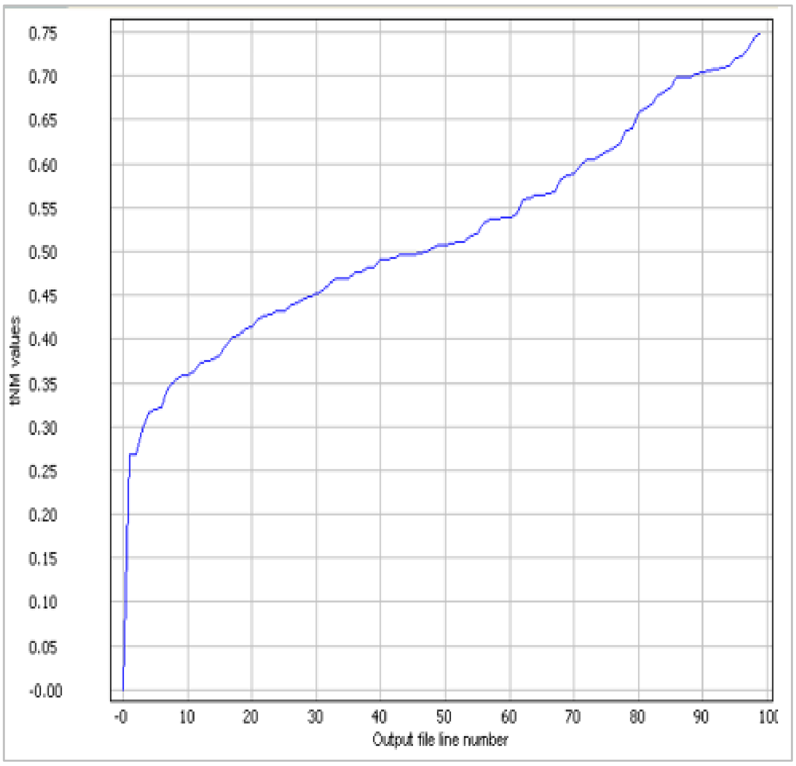


Figure 33-6 Graphical view of calculated tNM of Dinosaur image

After experiment, we concluded that we may fix the value of threshold ‘ε’, in tolerance relation. Further experiments can be made by considering different geometrical shapes as objects, with an intention of obtaining results which matches best with perceptual satisfaction of human beings.

REFERENCES

[1] Peters, J.F., 2017. Foundations of Computer Vision: Computational Geometry, Visual Image Structures and Object Shape Detection (Vol. 124). Springer.

[2] Yao, J.T., Ramanna, S., et. al., “Rough Sets and Knowledge Technology”, 6th International Conference, RSKT, October 2011.

[3] Skowron, Andrzej, and Zbigniew Suraj, eds. Rough Sets and Intelligent Systems-Professor Zdzisław Pawlak in Memoriam. Vol. 2. Springer Science & Business Media, 2012.

[4] Jothi, J.A.A. and Rajam, V.M.A., Effective segmentation and classification of thyroid histopathology images. Applied Soft Computing, 46, pp.652-664, 2016.

[5] Verma, Neha, Niti Verma, Rishika Bansal, Bhagyashree Kulkarni, A. B. Patki, and R. C. Meharde. "Software implementation issues in RFD analysis." In International Conference on Computer Information Systems and Industrial Management Applications (CISIM), pp. 508-513. IEEE, 2010..

34. A Hybrid Wide-slot Antenna with Elliptical and Staircase-shaped Wide-slots for Wideband Applications

Munish Kumar[1] and Vandana Nath[2], University School of Information, Communication and Technology
GGS Indraprastha University, New Delhi, India
[1]munishkm1989@gmail.com, [2]vandanausit@gmail.com

ABSTRACT

Miniaturized antennas having multiband or wideband capability are the need for modern wireless applications. In this paper, a microstrip-line-fed hybrid wide-slot (HWS) antenna of compact size is proposed for wideband applications. The main body of the proposed antenna includes an elliptical wide-slot (EWS) and staircase-shaped rectangular slots merged with each other. This HWS is excited using an open-ended microstrip line having a characteristic impedance of 50Ω. Great improvement in percentage impedance bandwidth (IBW) is noticed by using a HWS over the single EWS. The proposed antenna possesses an IBW of 109.52% (3.66–12.52 GHz) whereas the antenna structure having only the EWS shows an IBW of only 23.40% (10.30– 13.03 GHz). Merging of rectangular slots in a staircase fashion decreases the lower cutoff frequency from 10.30 to 3.66 GHz. Hence, miniaturization of 88.42% is achieved by using the HWS geometry. The gain of the proposed antenna varies from 1.65 to 5.8 dB along with average isolation of 26.72 dB in the entire operating frequency range. Compared to other reported wideband antennas, the proposed antenna achieves wide IBW, good gain within the operating frequency range with simple geometry and compact size of 22×24 mm2 only..

Index Terms— *Microstrip-line-fed; compact; wideband; hybrid wideslot; staircase; impedance bandwidth.*

INTRODUCTION

Nowadays, more focussed efforts are being devoted to developing those antenna structures that can support multiple wireless standards and having compact dimensions for short-range and high-speed wireless applications. Microstrip antennas due to their low profile and low fabrication cost are best suited for such scenarios. However, their performance is affected by narrow impedance bandwidth (IBW) and low gain values. To mitigate these problems, several broadbanding techniques such as co-planar waveguide (CPW) [1]-[3], fractals [5]-[8] and defected ground structures [9]-[13] or a combination of them have been proposed in the literature.

Coplanar waveguide (CPW) antenna structures are highly popular for their wideband response [1]-[3]. In [1], a simple CPW-fed rectangular microstrip patch antenna (MSPA) is proposed which shows a wideband response (2.7–11.7 GHz). But the overall size of the antenna is large, i.e., 40×52 mm2. A large octagonal CPW-fed patch antenna of size 47×47 mm2 discussed in [2] shows large operating bandwidth of 7.5 GHz (2.0-9.5 GHz). But the proposed antenna shows a negative gain up to 5 GHz. A more compact CPW-fed circular MSPA with multiple circular slots in a stacked manner is proposed in [3]. Using a shape blending algorithm, an IBW of 30.5–80.1% can be achieved successfully as discussed in [4]. But low gain and large size are still major issues in the CPW-fed antennas. The self-similar and space-filling properties of fractals help antenna researchers to fabricate the antenna structures within highly restricted space [5]. To solve the compactness problem in MSPAs, several wideband fractal antennas in the last decade have been proposed [6]-[8]. In [6], a CPW-fed flower shaped circular fractal antenna is proposed that shows wideband characteristics from 2.6 to 13.46 GHz. A CPW-fed rectangular MSPA with '+' shaped fractal slots (up to 3 iterations) is discussed in [7]. But an IBW of only 56% (4.56-7.92 GHz) is obtained. In [8], a wideband Fibonacci spiral MSPA based on Koch curve is proposed. But due to the high design complexity of fractals, their modelling and fabrication are quite difficult. Microstrip-line-fed wide-slot antenna structures have several advantages including high impedance bandwidth, high gain and low cross-polarization over CPW and fractal counterparts [9]. An EWS antenna in multilayer scenario with a rotated elliptical parasitic patch presented in [10] shows an IBW of 68.74%. Another similar structure but having an octagonal parasitic patch is proposed in [11] shows an IBW of 71.38%. A hexagonal wide-slot antenna having a circular slot at each corner is discussed in [12]. However, the proposed wide-slot structure shows the operating band from 2.16 to 3.43 GHz (45.19%) only. Recently, [13] came up with an idea of using multiple EWSs of different dimensions to produce a large IBW. Their proposed antenna shows the IBW ranging from 5.77-13.48 GHz.

This paper describes a compact and wideband microstripline-fed antenna by adding an elliptical wide-slot (EWS) and multiple rectangular slots in a staircase manner (named as hybrid wide-slot or simply HWS). Using the HWS, the proposed antenna shows the wideband behaviour ranging from 3.66 to 12.52 GHz. This paper is categorized as follows: Section-II presents various wideband antennas that are already published in the literature are discussed. In Section-III, the antenna design methodology using accurate design equations and steps to design the proposed antenna geometry are discussed. In Section-IV, both frequency and time-domain parameters are discussed. Finally, the applications of the proposed wideband antenna along with few concluding remarks are given in the conclusion section.

ANTENNA DESIGN AND PROPOSED METHODOLOGY

A. ANTENNA CONFIGURATION

The proposed wideband antenna consisting of EWS and four rectangular slots in staircase fashion is shown in Fig. 34-1. This HWS antenna is simulated using ANSYS Desktop ver. 17.0 on FR-4 material having dielectric constant (ε_r) 4.4, loss tangent ($\tan\delta$) 0.02, and thickness (h) 1.6 mm. It has HWS in the ground plane fed by an open-ended microstrip-line having a characteristic impedance of 50Ω.

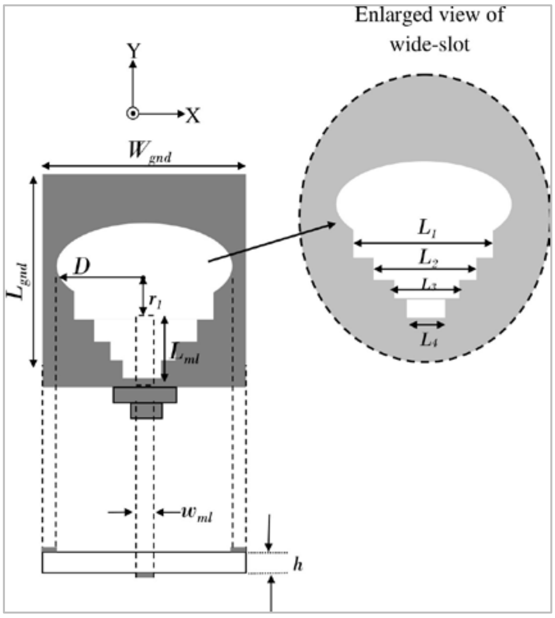


Figure 34-1 Schematic of the proposed hybrid wide-slot antenna fed by 50Ω microstrip line.

The distance between the open end of the microstrip-line and centre of the EWS is known as *feeding distance* (r_1). The relationship between the input impedance of an EWS and r_1 is given by [14]

$$R_{in}(r_1) = \frac{1}{G_{T,mn}} \frac{J_1^2(kr_1)}{J_1^2(kD)} \tag{1}$$

where *k* is the propagation constant, $\frac{1}{G_{T,nm}}$ is the input impedance of the TM_{mn} mode and depends on m^{th} zero of the Bessel function of order *n*. The parameter kD=1.84 refers to the fundamental mode. The value of $G_{T,mn}$ can be determined by [14]

$$G_{T,mn} = G_{ohmic} + G_{diel} + G_{rad} \quad (2)$$

where G_{ohmic}, G_{diel}, and G_{rad} are referred to as conductance due to ohmic, dielectric, and radiation loss respectively and are given in [14]. The value of r_1 is varied to obtain a good level of matching over a large frequency range as shown in Fig. 34-2.

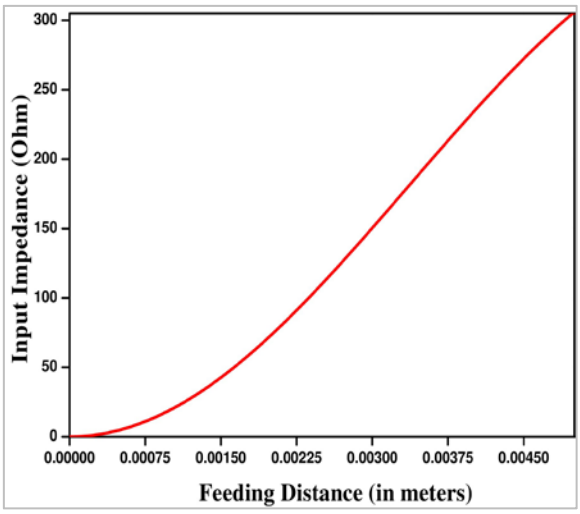


Figure 34-2 Input impedance $R_{in}(r_1)$ variation with feeding distance r_1.

The design evolution of the proposed HWS antenna starts with the designing of an elliptical slot excited by a microstripline of characteristic impedance 50Ω. The relationship between the size of an EWS and its frequency of operation for dominant mode TM_{11} is given by [15]

$$f_{11}^{e,o} = \frac{15}{\pi e.D}\sqrt{\frac{q_{11}^{e,o}}{\varepsilon_r}} \text{ GHz} \quad (3)$$

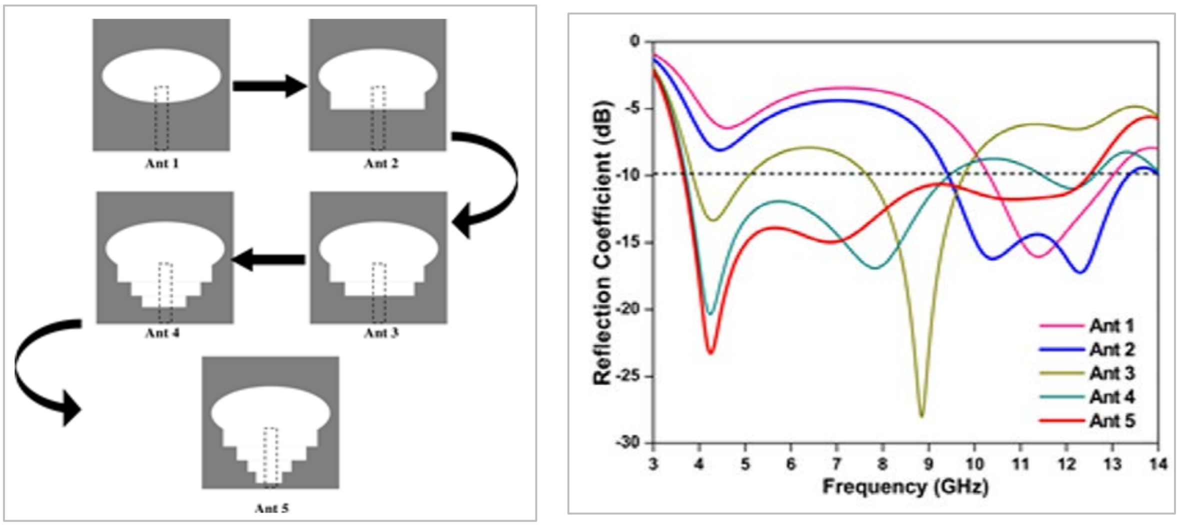
where *D* is the length of the semi-major axis of the EWS having eccentricity *e* and $q^{e,o}_{11}$ is an approximated Mathieu function for even q^{e}_{11} and odd mode q^{o}_{11} which is given by [15]

$$q_{11}^{e} = -0.0049e + 3.7888e^2 - 0.7228e^3 + 2.2314e^4 \quad (4a)$$

$$q_{11}^{o} = -0.0063e + 3.8316e^2 - 1.1351e^3 + 5.2229e^4 \quad (4b)$$

B. DESIGN STEPS

The evolution procedure of the proposed wideband antenna is illustrated in Fig. 34-3(a). Initially, an EWS is etched from the ground plane which is excited with the help of 50Ω microstrip-line [Ant 1]. The major constraint while designing a wide-slot antenna is that the overall size of the antenna is governed by the size of the wide-slot. To overcome this issue, an EWS of smaller dimension is etched and afterwards, multiple rectangular slots in staircase fashion are etched from the ground plane. The size of the EWS and feeding distance r1 are varied to obtain a good matching across the large frequency band. Ant 1 provides an IBW of 23.40% (10.3013.03 GHz) as shown in Fig. 34-3(b). To shift this frequency band towards the lower edge, multiple rectangular slots are etched in successive stages, i.e., up to Ant 5 which is the final proposed antenna geometry. The addition of rectangular slots decreases the lower cutoff frequency and creates a lower frequency band [Ant 3]. This lower-frequency merges with the upper-frequency band with successive addition of rectangular slots [Ant 4]. By using these slots, the lower cutoff frequency gets shifted from 10.30 to 3.66 GHz, i.e., miniaturization of 88.42% has been achieved.



(a) (b)

Figure 34-3 (a) Reflection coefficient and (b) impedance versus frequency for the proposed wideband antenna

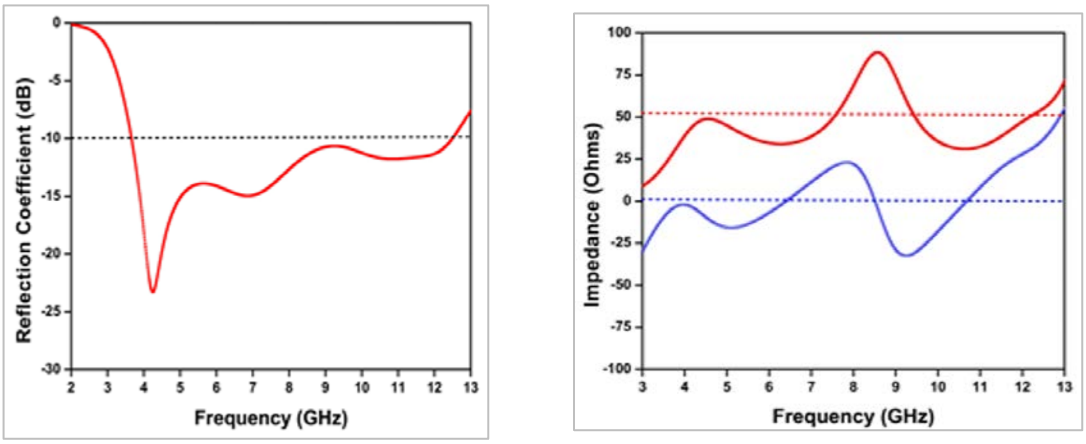
RESULTS AND DISCUSSION

The frequency domain parameters such as *S*-parameters, surface current distributions, impedance, gain, and radiation patterns are discussed in the following subsections. Time domain parameters including group delay and transfer function are also discussed.

A. FREQUENCY-DOMAIN PARAMETERS

REFLECTION COEFFICIENT AND IMPEDANCE VERSUS FREQUENCY:

The simulated reflection coefficient (S_{11}) of the proposed antenna is shown in Fig. 34-4(a) which is one of the key parameters for describing the operating bands. It is observed that the proposed antenna shows wideband behaviour ranging from 3.66–12.52 GHz which covers both *C* and *X*-bands, hence suitable for wireless applications that operate in this frequency range. Fig. 34-4(b) shows the real and imaginary parts of the impedance which should be ideally 50 and 0Ω, respectively. It is clear that both imaginary and real parts of the impedance oscillate around 0 and 50Ω within the operating frequency band, respectively.



(a) (b)

Figure 34-4 (a) Reflection coefficient and (b) impedance versus frequency for the proposed wideband antenna

SURFACE CURRENT DISTRIBUTION:

Fig. 34-5 shows the surface current distribution at different resonating frequencies. At lower frequency, i.e., 4.25 GHz (as shown in Fig. 34-5(a)), the surface current is mainly concentrated near the lowermost rectangular slot. At 6.86 GHz frequency, the surface current starts concentrating near the EWS periphery (shown in Fig. 5(b)). At higher frequencies, i.e., 10.85 GHz, the surface current is focussed near the EWS and staircase slots (shown in Fig. 34-5(c)).

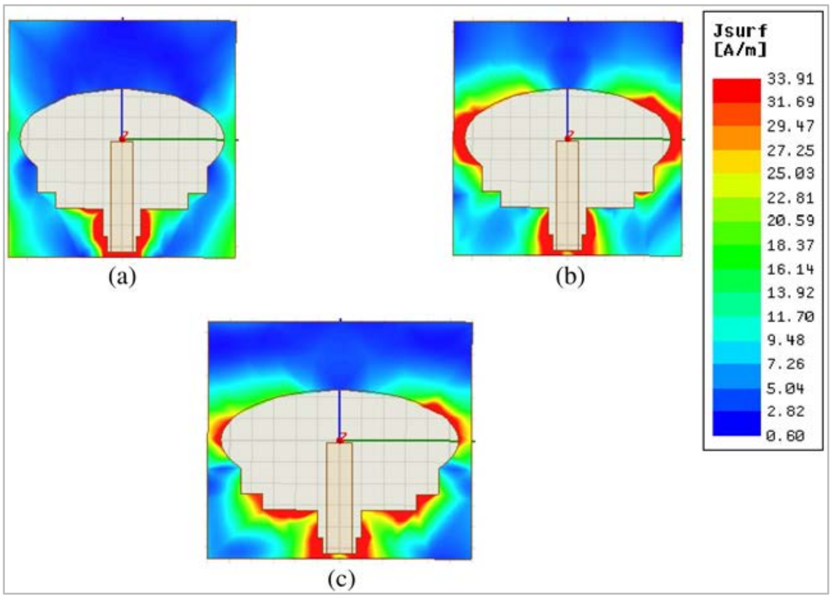


Figure 34-5 Surface current distribution at (a) 4.25, (b) 6.86 and (c) 10.85 GHz.

GAIN VERSUS FREQUENCY:

Fig. 34-6 shows the simulated gain curve for the proposed antenna within the operating frequency range. From Fig. 6, it can be studied that the co-polarization (CP) and cross-polarization (XP) gain of the antenna varies from 1.65 to 5.80 dB and from -36.75 to 8.20 dB, respectively. The average value for CP and XP gain is 3.63 and -23.09 dB, respectively. Hence, a good level of isolation ranging from 12.86 to 39.27 dB is reported for the proposed wideband antenna.

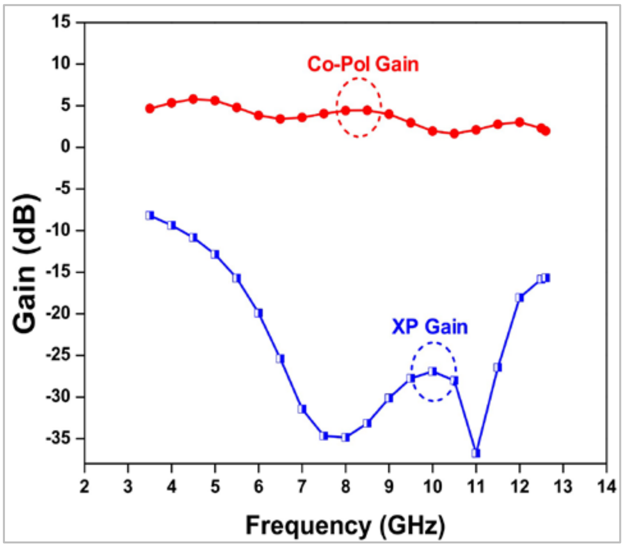


Figure 34-6 . Variaiton in co-polarized and cross-polarized (XP) gain with frequency

RADIATION PATTERN:

The radiation pattern of the proposed wideband antenna at 4.25, 6.86 and 10.85 GHz is depicted in Fig. 34-7(a), 34-7(b) and 34-7(c), respectively. An isolation of 15.67, 33.29 and 33.86 dB is obtained at 4.25, 6.86 and 10.85 GHz, respectively. The back radiation due to the presence of HWS leads to the near omnidirectional radiation pattern at a lower frequency. However, at a higher frequency, a little deviation can be observed which may be due to the excitation of high order resonating mode.

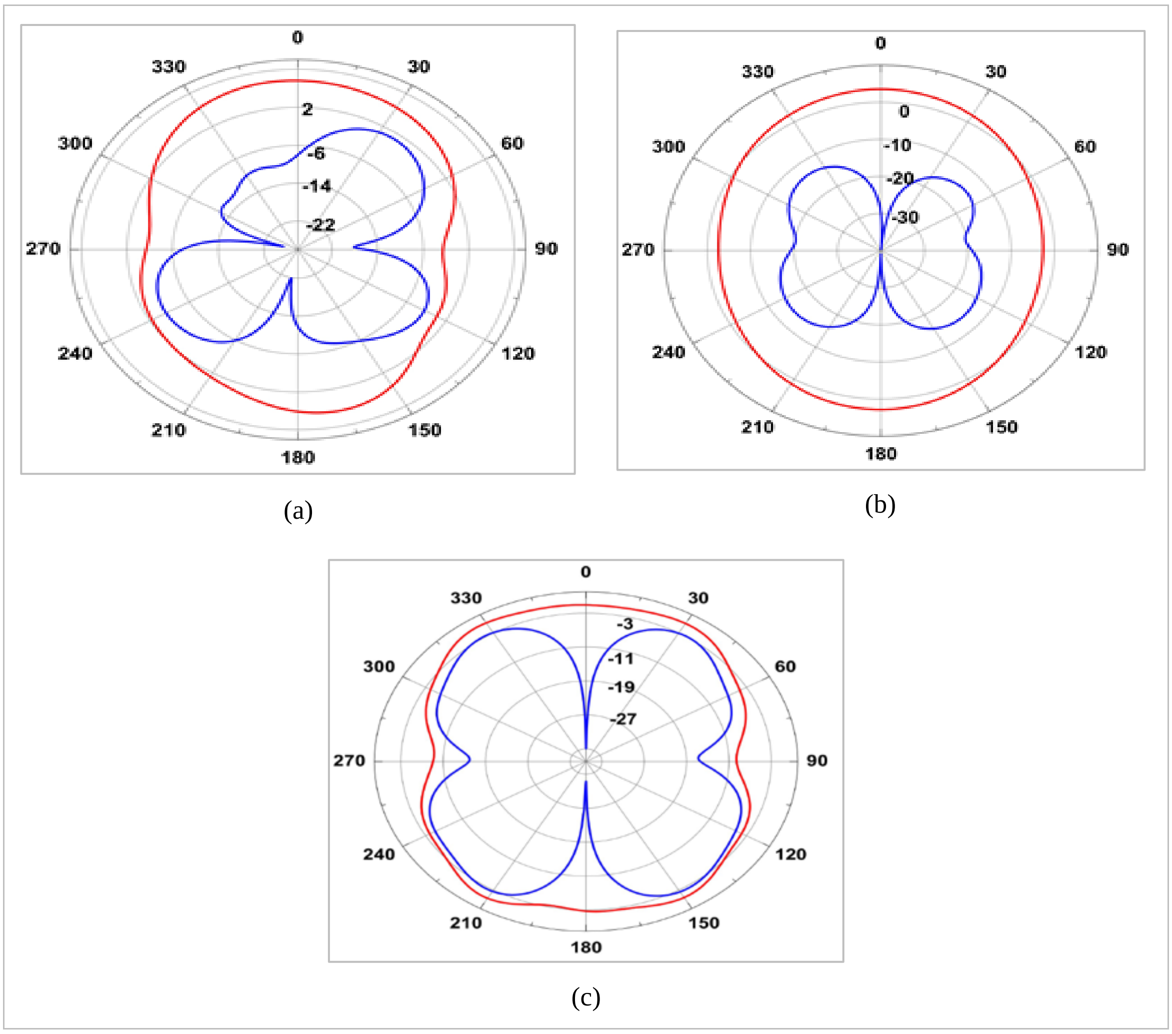


Figure 34-7 Simulated 2D radiation pattern at (a) 4.25 GHz, (b) 6.86 GHz and (c) 10.85 GHz. Solid red line: co-polarization and solid blue line: crosspolarization

B. TIME-DOMAIN PARAMETERS

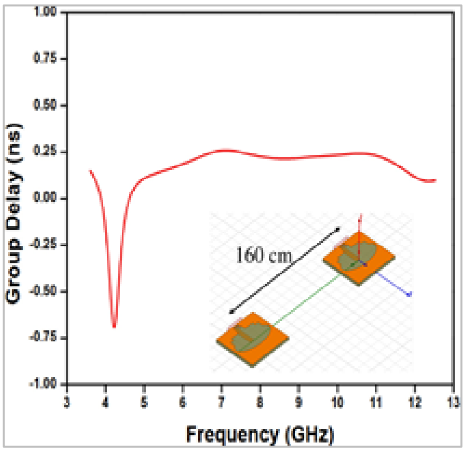
In the previous subsection, the performance of the proposed antenna in frequency-domain has been analyzed. The good performance in frequency-domain cannot guarantee that the given antenna will behave well in time-domain as well. For this, time-domain analysis using group delay parameter has been performed.

GROUP-DELAY:

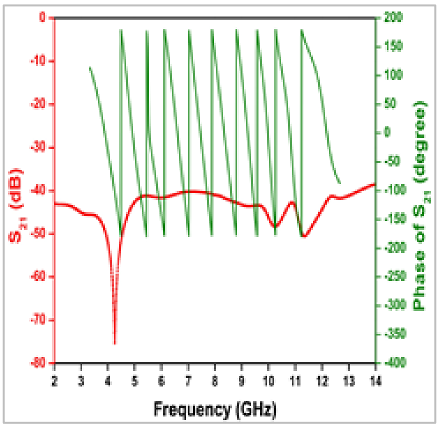
The group delay of the proposed antenna for side-by-side (SS) configuration is shown in Fig. 34-8(a). It is clear that the group delay for SS configuration is below 1 ns within the operating frequency range which is a prime requirement for the wideband applications.

TRANSFER CHARACTERISTICS:

The transfer function (S_{21}) and phase response (6 _S_{21}) of the proposed antenna are depicted in Fig. 34-8(b). For better time-domain response, the S_{21} should be below -20 dB and phase response should vary linearly. From Fig. 8(b) it is clear that both S_{21} and phase response are within their desired limits in the range where reflection coefficient is below -10 dB.



(a)



(b)

Figure 34-8. (a) Group delay and (b) S21

C. COMPARISON WITH EARLIER REPORTED ANTENNA STRUCTURES

Since the frequency of operation and size of the antennas discussed in this paper are different hence, a parameter known as bandwidth-dimension-ratio (BDR) is calculated and compared with the proposed antenna.

$$BDR = \frac{\%B.W.}{\lambda_W \times \lambda_L} (5)$$

where $\lambda_W \times \lambda_L$ is the electrical dimension of the antenna.

Table 34-1 shows the comparison of the proposed antenna with the antenna structures discussed in Section-I (”Introduction”). It is observed that the proposed wide-slot antenna has the highest BDR of about 1393 among all the reported antenna structures.

Table 34-1 COMPARISON OF PROPOSED HWS ANTENNA WITH EARLIER REPORTED WIDEBAND ANTENNAS

Ref./Year	**Physical size** ($W_{GND} \times L_{GND}$ mm2)	**Electrical Size** ($\lambda_W \times \lambda_L$)	**Frequency range** (GHz)	**Peak gain** (dB)	**BDR** $(= \frac{\%B.W.}{\lambda_W \times \lambda_L})$	**Technique used**
[1]/2018	40×52	0.36×0.47	2.7-11.7	-	741.93	CPW rectangular MSPA
[2]/2018	47×47	0.31×0.31	2.0-9.5	3.5	1328.56	CPW-fed octagonal ring MSPA
[3]/2018	36×45	0.38×0.48	3.2-13.9	<8	678.96	CPW-fed slotted circular MSPA
[6]/2013	43×51	0.35×0.42	2.46-13.46	7.1	937.16	Circular fractal MSPA
[7]/2017	30.6×30.6	0.47×0.47	4.56-7.92	-	248.9	’+’ shaped fractal
[8]/2018	18×35	0.39×0.48	2.34-11.5	-	713.35	Koch curve fractal
[10]/2017	25×24	0.32×0.30	3.8-7.78	11	714.05	EWS+multilayer
[11]/2018	25×24	0.33×0.32	4.0-8.44	10.3	669.21	EWS+multilayer
[12]/2018	40×40	0.29×0.29	2.16-3.43	2.6(avg.)	543.57	Hexagonal wide-slot
[13]/2019	22×24	0.42×0.46	5.77-13.48	8.66	410.12	Multiple asymmetric EWS
This work	22×24	0.26×0.29	3.66-12.52	5.8	1393.58	HWS antenna

CONCLUSION

An idea of merging different shapes for enhancing the impedance bandwidth is presented in this paper. Two different shapes, i.e., ellipse and rectangle in the form of staircase manner are merged with each other which give a wideband response ranging from 3.66 to 12.52 GHz (or 109.52%). The presence of rectangular slots in staircase fashion reduces the lower cutoff frequency from 10.30 to 3.66 GHz, thereby leading to miniaturization of 88.42%. A peak gain of 5.79 dB and a good level of isolation (below 15 dB) within the operating frequency band is obtained. A group delay of below 1 ns and linear phase response ensure the applicability of the proposed antenna for wideband wireless applications. The compact dimensions of 22×24 mm² (or $0.26\lambda_o \times 0.29\lambda_o$ where λ_o is the wavelength corresponding to lowest cutoff frequency, i.e., 3.66 GHz). All these features make the proposed HWS antenna a good candidate for modern wireless applications such as wireless LANs (upper band: 5.72–5.82 GHz), communication satellites (C-band) and military applications (X-band).

REFERENCES

[1] S. Peddakrishna and T. Khan, ”Design of UWB monopole antenna with dual notched band characteristics by using π-shaped slot and EBG resonator,” AEU-International Journal of Electronics and Communications, vol. 96, pp. 107-112, Nov. 2018.

[2] P. Khanna, A. Sharma, A. K. Singh, and A. Kumar, ”A CPW-fed octagonal ring shaped wide band antenna for wireless applications,” Advanced Electromagnetics, vol. 7, no. 3, Aug. 2018.

[3] K. Srivastava, A. Kumar, B. K. Kanaujia, and S. Dwari, ”Integrated amateur band and ultra-wide band monopole antenna with multiple bandnotched,” International Journal of Electronics, vol. 105, no. 5, pp. 741755, 2018.

[4] A. Wu, Z. Zhang and B. Guan, ”A shape blending based design of printed slot antennas for various wideband applications,” Microwave and Optical Technology Letters, vol. 61, pp. 374-380, 2019, DOI: 10.1002/mop.31572

[5] M. Kumar and V. Nath, ”Introducing multiband and wideband microstrip patch antennas using fractal geometries: Development in Last decade,” Wireless Personal Communications, vol. 98, no. 2, pp. 2079-2105, Jan. 2018, DOI: 10.1007/s11277-017-4965-x

[6] D. J. Kim, J. H. Choi and Y. S. Kim, ”CPW-fed ultrawideband flowershaped circular fractal antenna,” Microwave and Optical Technology Letters, vol. 55, no. 8, pp. 1792-1795, 2013.

[7] S. Kakkar and S. Rani, ”Implementation of fractal geometry to enhance the bandwidth of CPW fed printed monopole antenna,” IETE Journal of Research, vol. 63, no. 1, pp. 23-30, 2017.

[8] C. Sharma and D. K. Vishwakarma, ”Miniaturization of Spiral Antenna Based on Fibonacci Sequence Using Modified Koch Curve,” IEEE Antennas and Wireless Propagation Letters, vol. 16, pp. 932-935, 2017.

[9] M. Kumar and V. Nath, ”Microstrip-line-fed elliptical wide-slot antenna with similar parasitic patch for multiband applications,” IET Microwaves, Antennas & Propagation, vol. 12, no. 4, pp. 2172-2178, Nov. 2018, DOI: 10.1049/iet-map.2018.5377

[10] M. Kumar and V. Nath, ”Improved cross polarization and wideband multilayer wide-slot microstrip antenna with rotated parasitic patch,” 2017 IEEE Asia Pacific Microwave Conference (APMC), Kuala Lumpar, pp. 964-967, 2017, DOI: 10.1109/APMC.2017.8251611

[11] M. Kumar and V. Nath, ”Dual-Band Dual-Polarized Stacked Octagonal Fractal Patch Antenna with Nonlinear Manipulation,” 2018 IEEE Radio and Antenna Days of the Indian Ocean (RADIO), Grand Port, 2018, pp. 1-4, DOI: 10.23919/RADIO.2018.8572374

[12] S. P. Gangwar, K. Gangwar and A. Kumar, ”A compact modified hexagonal slot antenna for wideband applications,” Electromagnetics, vol. 38, no. 6, pp. 339-351, 2018.

[13] M. Kumar and V. Nath, ”Open Ended Microstrip-line-fed Compact Wideband MIMO-Diversity Antenna with Multiple Asymmetric Elliptical Wide-Slots,” 2019 URSI Asia-Pacific Radio Science Conference (APRASC), New Delhi, India, pp. 1-4, 2019, DOI: 10.23919/URSIAPRASC.2019.8738508

[14] F. Abboud, J. P. Damiano and A. Papiernik, ”A new model for calculating the input impedance of coax-fed circular microstrip antennas with and without air gaps,” IEEE Trans. Ant. Propag., vol. 38, no. 11, pp. 1882-1885, 1990.

[15] J. G. Kretzschmar, ”Wave propagation in hollow conducting elliptical waveguides,” IEEE Trans. Microw. Th. Tech., vol. 18, no. 9, pp. 547-554, 1970.

35. Role of Digital Technology in Weather and Everyday Mobility

Ishita Sharma, Ambuj Kumar and Peter Lindgren
CGC - Aarhus University, Business Development and Technology, Denmark

INTRODUCTION

Weather and climate change have emerged as an important theme in the transport sector and researchers have demonstrated that human mobility can be strained by space, social relations and weather. The weather helps people to decide what to wear every day, but it also has an important factor in their daily life and mobility [1]. In general, good weather has a positive impact on mobility. As the process of urbanization continues, more and more people move to the city and according to the report by the UN, more than 6 billion people will be living in the cities. One problem of living in the cities is dealing with pollution and traffic congestion. These two areas have been a death within the long run, but one most important element of city-dwelling that has been left unattended is the mobility and how weather affects it in the cities.

Predicting human mobility patterns is not a major problem in geography or apical economics, but it has been applied in several areas such as urban planning, monitoring infectious diseases and epidemiology, and location-based service. Many models have been presented in 1930 to address the problem. The widely used method is a gravity model that relies on a specific parameter that has been fitted on systematic collection of data, the disadvantage of the method was that when any measurement required could be lacking, the model is entirely not applicable. The Empiric quantification of human mobility patterns is important in human planning and the social network structure especially in responding to disease threats in light of the rapid growth in globalization and urbanization. The research uses a Global Positioning System to data-log and tracks individuals depending on the prevailing weather conditions.

The topic has attracted researchers in the past decade, most researchers concur that human mobility is mainly affected by space, time and social contract, and the most important factor that affects human mobility is the weather which receives less attention and naturally ignored in various papers. Weather naturally affects mobility and when people check weather reports daily, they not only check where, to begin with, but they also consider where to visit, for example, people would like to walk in the amusement park ina cloudy weather. Understanding the relationship between weather and mobility is important in appreciating the technologies that can be applied in enhancing mobility through an understanding of weather patterns and the development of the spatial design.

RESEARCH QUESTION

Does the everyday mobility of an individual get affected in different weather conditions and how can the use of technology and tracking devices contribute to the betterment in spatial designing?

DATA COLLECTION

Before the commencement of data collections, there was a need for focus groups with the population representatives that represented the major centers of data to be collected. The study did not include children in the study as it had only two groups of individuals, the students and the working class of individuals. After the collection of data, the data was stored in an SQL format, the procedures for data collections and storage was approved by the institution that monitored the study. During data collection, a group of participants was selected and a total of 12 participants were used. In total there was a group of University students and working professionals [6]. The tracking device used in the research was the GPS Application. The two different groups of individuals were tracked for two days to monitor their choice of mobility under different weather conditions. Apart from observation, other types of data were collected from interviews, where four participants were interviewed on a set of questions attached (See Figure 35-1).

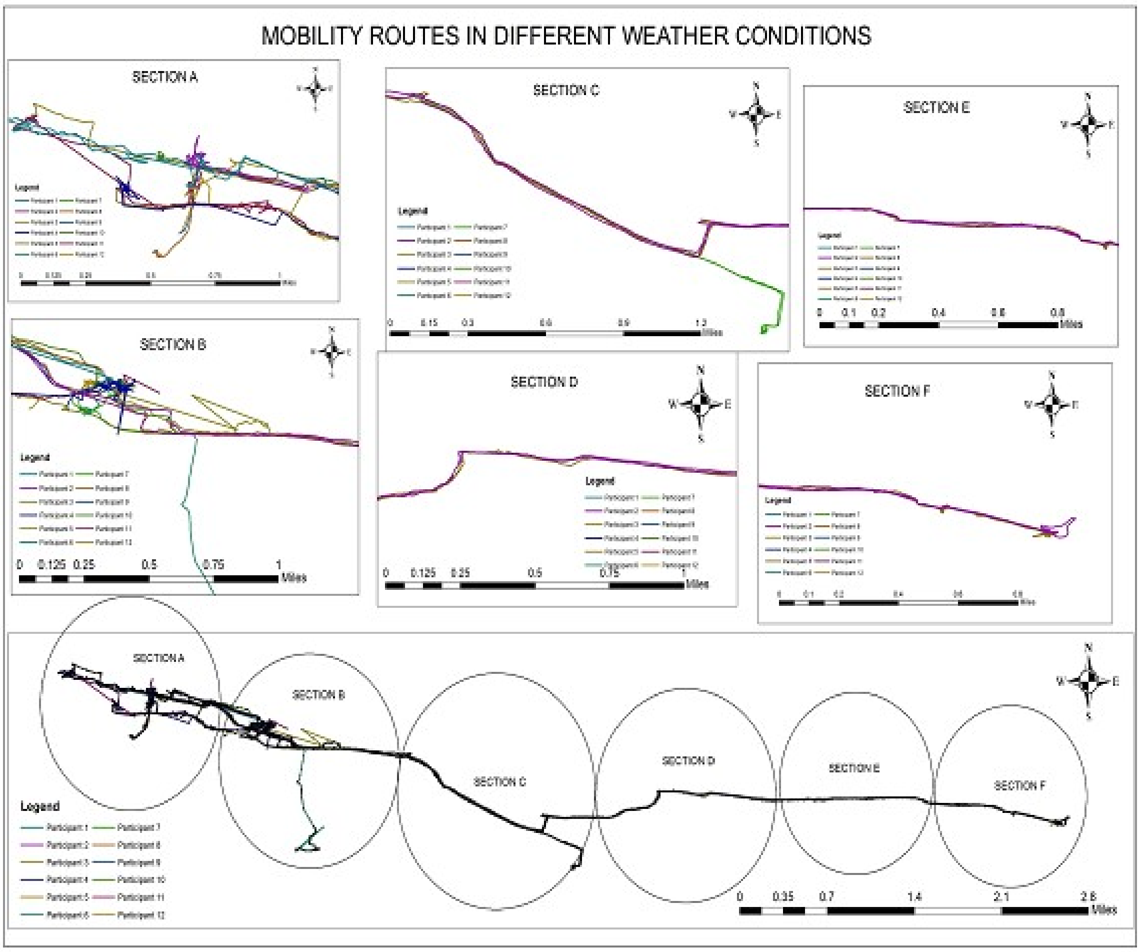


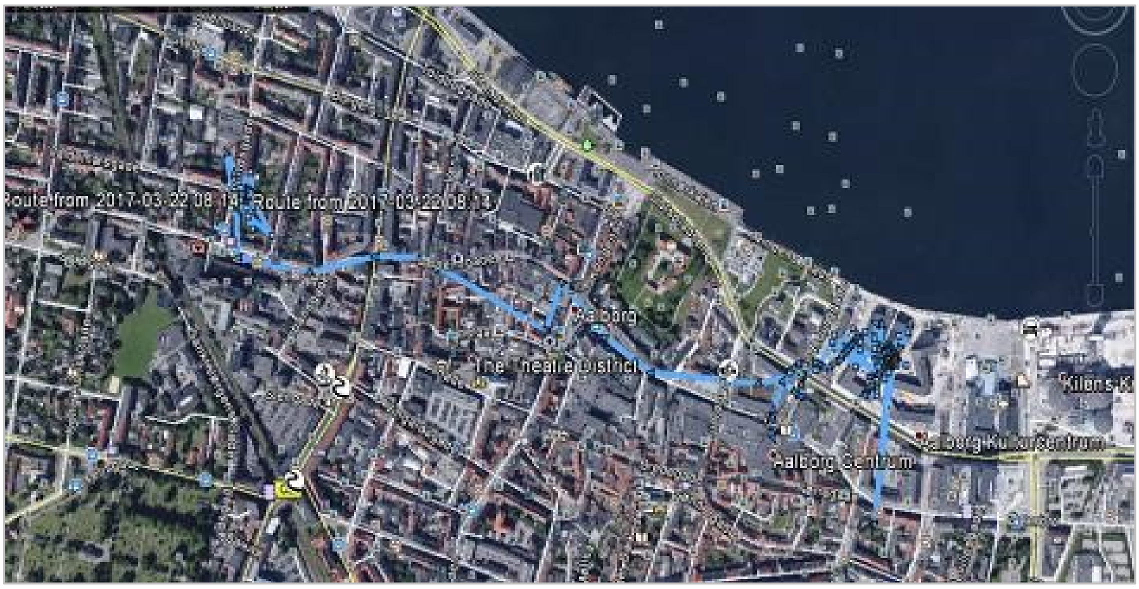
Figure 35-1 Mobility Patterns

TRACKING MOVEMENTS

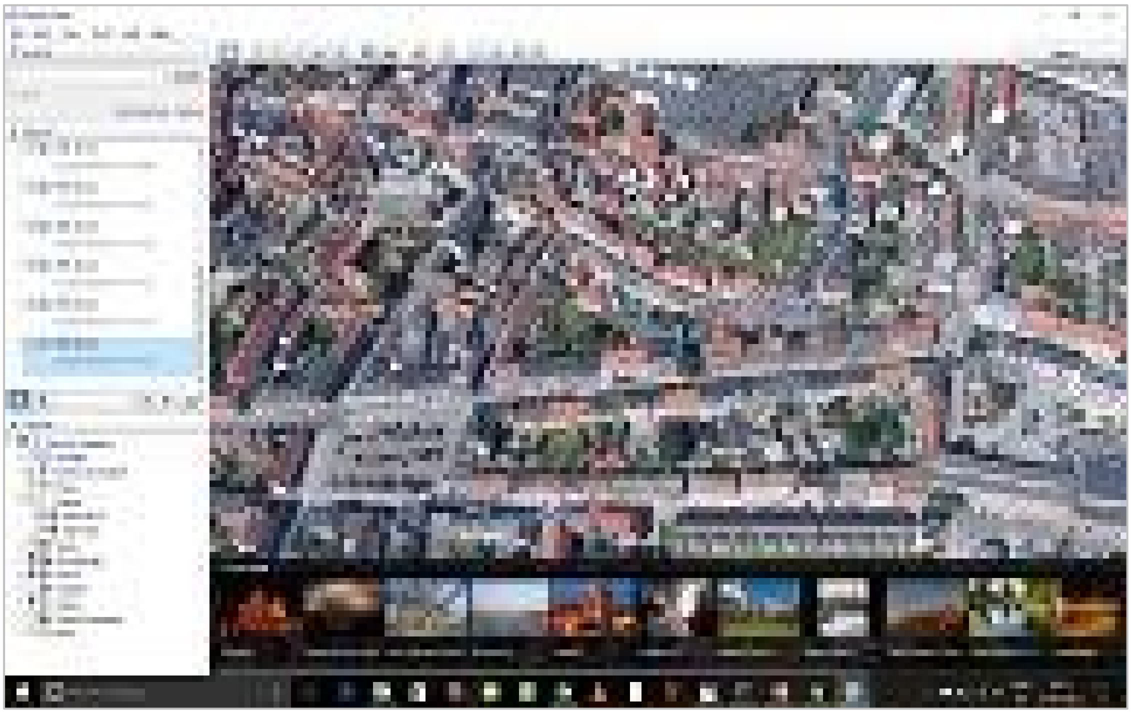
The GPS-data-loggers were continuously used in tracking the individual movements for the two days, the deployment of the device was agreed previously and the units were programmed to work in intervals of 3.5 minutes and they were set to turn off just after midnight. Since the sample population was few, the data log was easy to track. A data reduction algorithm that aggregated the consecutive GPS readings as located in the spatial windows became the sole source of information to identify the geographic positions and the locations of individuals within a given place [2]. As shown in the limitation part of the document, there were gaps in the data collected because there was data loss due to signal loss or incidents of individuals leaving a place and returning within very short notice. The Icluster algorithm that was used was given a threshold parameter time of 30 minutes that separated the gap types that showed that the individual visited the area after t minutes. Based on the errors that arose from using the data from the parameter time= 30, the time interval was reduced to t= 15. For each identified place, the total time of the visit was recorded on the GPS device, the data about the temporal patterns of visits was assessed by determining the times for a visit.

QUANTIFYING MOVEMENTS OF INDIVIDUALS

The data were quantified using the maximum likelihood methods that have been applied to the raw GPS data to fit various mathematical distributions such as linear decay, power-low and exponential decay. The movement kernels were applied to all individuals in the study for the same sex and also applied to different age groups. The ages were categorized in 10 year-bins because of the existence of the limited number of individuals which meant narrower groups. The difference in age categories was also applied in data and to determine the different parts of the city visited, a spatial angular direction was applied in a special wavelet analysis [4]. In this study, the French Top Hat algorithm was applied. The major metric that is derived from fitting the wavelength function to the data is using the wavelength position variance. The peaks that have been derived from the individual variance indicated directions from the homes where the most visited places were located. The Monte Carlo Simulations was applied in separating true patterns from random fluctuations.



(a)



(b)

Figure 35-2 Interviewer Movements

DATA ANALYSIS

For analyzing weather, there are two parameters used, one is temperature, pressure, and humidity. For mobility, two major aspects will be focused on this paper, the average number of check-ins and an average number of movements and movement distances under different weather conditions. When analyzing the movements, the user checks in at different locations at a given weather condition is recorded. On whether the different check-ins at different places during different weather conditions were analyzed. From the general observations, there is correlation between pressure and mobility, in areas like Barcelona, the correlation between pressure and mobility is negative, showing that there is no correlation between the two, another example observation is that the individuals who were in Boston and San Francisco have had more check-ins but shorter movements in high-pressure days. In a city like Boston, the high pressure does not affect the average check-ins, but it leads to longer movements.

Other aspects of weather such as wind speed also affect individuals' movement, for example from the observation, checking volumes in many cities received negative speeds. The relation between check-ins and wind speed is not linear though. For other cities, wind speed has similar effects as showers.

RESULTS

The participants were mostly mobile between 10 am and 3 pm. During the sunny days, the mobility was observed in the open and shared spaces. Based on the mobility patterns, it can be summarised that the weather did affect the individuals who use public transport or the individuals who own cars. The individuals who live and study close to the city take public transport during the rainy days. [2] There were also observed stops in coffee shops and restaurants during light showers. Of the total individuals studied, only 38% showed regular and predictable movement patterns that relate to weather. In the case study, the impact of spatiality and temporary structured routines on the dynamics of transitions. The findings were also important in appreciating how technology can be applied to understand the role of weather on different check-ins in the city. The research, therefore, gives careful considerations of the human and social interactions when under adverse weather conditions, particularly in the rich urban centers.

The movements were also rare in windy and cloudy weather, this accounted for only 14% of the locations. The low movement during this time can be attributed to the fact that people tend to stay indoors anticipating rainfall. In the clear mornings, the movements were further from the participant’s homes and most movements were only 1km from the city, which formed the kernel of the human movements. As the weather became more adverse, the mobility decreased, the movement of the University Students were less affected by the rainy weather as compared to the Lecturer. The movement for males and females varied significantly but in cloudy conditions, more females, 67%, stayed indoors when compared to males at 34%. The special anisotropy decreased when only movements within the city were considered, the movement became non-significant at < 10 km from the individual’s home during cloudy and light shower weather conditions. Over the two days, there was a standard deviation of 3.6 and the probability of the individual's movements analyzed using Weibull distribution. In hot sun and cloudy weather, the amusement parks enjoyed most visits, while the majority of the students visited stadiums.

A. EFFECTS OF WEATHER

The weather impacted directly the movement in different areas, from professionals to food places. Temperature affected most movements, with most movements occurring in moderate temperatures when compared to under diverse temperatures. When the temperature was under 24oC, there was more movement than when the temperature was 32oC. Another factor that affected movement was the humidity, the movement was diverse under moderate humidity than the uncomfortable humidity. During the favorable humidity, the movements were outward from the participant's home during the adverse humidity where most movements end up indoors. [2]

B. RELATED WORKS

The work presents the first work on the use of technology to track human movement based on weather. Most studies on human mobility are based on the weather and transport[6]. The study had the advantage of applying technology to make people's mobility better compared to most of the researches that focus on the impact of weather on public transport. The research also focuses on the mobility of the users without physical constraints that makes the analysis more general and suitable for public consumption. The data set is global and since the individual used in the study are global samples, the data fairly represents the population with various tastes and preferences.

LIMITATIONS

The research had a limited number of participants. The devices used in tracking also did not give a fair location since some participants forgot to track themselves. Some of the participants were more mobile than others and therefore were unable to track themselves. A sample of the people studied were internationals hence their locations could not be studied. The rates of data loss and mismatch resulted from the data collected due to the participants dropping or not wearing the device, dead batteries or participants misusing the devices, to minimize the data loss, the raw data were individually explored such as eliminating the sites not visited by the participants. The data was also aggregated to avoid potential bias that may emerge from the description of movement behaviors.

Other limitations of the research include the errors that result from poor satellite geometry or multipath signal errors, other factors such as data collections within the buildings being poor due to satellite geometry, the transient of the visited locations can also be heavily affected by the frequency of data collections. Therefore, despite the reliability of the GPS systems, the information gathered might have also suffered from the limited data giving the full repertoire of the movements that have occurred and the data also affected by the scales and the data analysis methods used. The small number of the tracked individuals could not have enough information to be used the assessment of the temporal variation in patterns during and after a given change in weather conditions. The research, therefore, suffered from common limitations when covering mobility at spatial scales. Since the study was carried in two days, the chances of forgetting the GPS devices were low, however, the compliance rates could not surplus a 78% rate [3]. The project, however, was boosted by the social behavior of the participants who successfully cooperated with the scientists through focus groups, identified the concerns that individuals had especially on the use of GPS units.

CONCLUSION

For Denmark residentials, the rain shelters need to be put on sidewalks for sudden showers while keeping in mind the swinging showers, here are also need for rain sheds. From the study, it is evident that nice weather that is characterized by moderate temperature, slow wind, suitable humidity, and high pressure had a positive effect on the user's mobility. The mobility of the sample was less influenced in some categories when compared to other categories of travel such as professional obligations and entertainment.

REFERENCES

[1] Gonzalez, M., Hidalgo, C., Barabasi, A.L.: Understanding individual human mobility patterns. Nature453(7196) (2008) 779–7822.

[2] Cho, E., Myers, S.A., Leskovec, J.: Friendship and mobility: user movement in location-based social networks. In: Proc. 17th ACM Conference on Knowledge Discovery and Data Mining(KDD), ACM (2011) 1082–10903.

[3] Noulas, A., Shaw, B., Lambiotte, R., Mascolo, C.: Topological properties and temporal dynamics of place networks in urban environments. In: Proc. 24th International Conference on World Wide Web (WWW Companion), ACM (2015) 431–4414.

[4] B¨ocker, L., Digest, M., Prillwitz, J.: Impact of everyday weather on individual daily travel behavior in perspective: a literature review. Transport Reviews33(1) (2013) 71– 915.

[5] Hanson, S., Hanson, P.: Evaluating the Impact of Weather on Bicycle Use. Committee on Bicycle and Bicycle Facilities (1977)

[6] Nankervis, M.: The effect of weather and climate on bicycle commuting. TransportationResearch Part A: Policy and Practice33(6) (1999) 417–431.

36. Design of Dual-Band and Low-Profile SIW CavityBacked Slot Antenna for 5G Applications

Amit Kumar[1], Azharuddin Khan, Amit Kumar Singh, and A.K.Singh[2]
Department of Electronics Engineering
Indian Institute of Technology (BHU), Varanasi, India
[1]amitk.rs.ece17@iitbhu.ac.in, [2]aksingh.ece@iitbhu.ac.in

ABSTRACT

In this paper, the design of dual-band and lowprofile SIW cavity-backed slot antenna operating at K-band and Ka-band has been proposed. The dual-band antenna consists of the SIW cavity with two parallel slots which are etched on the ground plane of the conductor. In order to obtain dual-band, higher-order hybrid modes are tuned and combined to form the second band of the proposed antenna with a wider bandwidth. For dual-band antenna, fractional bandwidth of 5.26% and 6.15% are achieved with the maximum gain of 5.45 dBi and 6.15 dBi at 24.7 GHz and 27.8 GHz, respectively. In terms of antenna performances including reflection coefficient, bandwidth, gain, and radiation pattern, a cavity-backed antenna using via-hole along with the slot has been proposed. Via-hole establishes a connection between the top and bottom surfaces of the cavity creating a new path for the current to flow by shortening the effective length of the slot. The results show that the bandwidth of 4.2 GHz (15.32%) ranging from 25.3 GHz – 29.5 GHz, a gain of 7.8 dBi and 9.2 dBi have been achieved at 25.9 GHz and 28.8 GHz respectively. The overall volumetric dimension of both the proposed design including feedline is 20 mm x 14 mm x 0.508 mm.

Index Terms— *cavity-backed, substrate integrated waveguide (SIW), slot antenna, dual-band, 5G.*

INTRODUCTION

In recent years, 5G technology has been under the spotlight and researched extensively. Sub-6GHz 5G communication systems have been come into commercial use recently [1]. Meanwhile, the demand for higher data rates and broader communication bandwidth stimulates the exploitation of new spectral resources for 5G communication [1]-[2]. Millimeter-wave (mm-wave) bands have received much attention in recent years for high-speed communications resulted from abundant spectrum resources. Particularly, frequency in the range of 24 - 30 GHz has been selected as the 5G mm-wave communication band by many countries (e.g., China, USA, Korea and so on).

Dual-band slot antennas have been proposed for their characteristics such as their applicability to planar surfaces. They are easy to synthesize into planar circuits and realize high isolation between feeding elements. Microstrip antennas with two radiating slots have low radiation gain because of their bi-directional radiation patterns [3]. Substrate integrated waveguide (SIW) cavity-backed antennas are proposed, to overcome the limitations (in terms of bi-directional radiation patterns, gain, and bandwidth) as a solution [4]. SIW technique has been investigated because of the demand to achieve low-cost waveguide components with low temperatures and the conventional printed circuit board [5]. SIW technology can give effectively the conventional nonplanar waveguide to a planar substrate by using metallic via holes [5]. SIW cavities make the design of cavity-backed slot antennas more flexible and less expensive to fabricate. Several techniques have been investigated to enhance the bandwidth of the SIW-based cavity-backed antenna [6]-[8]. In [6], it has been reported a slot antenna with a cavity using a substrate removal, in which a partially higher bandwidth is obtained by removing the substrate lying beneath the resonating slot; in spite of the fact that removing substrate isn't a simple task—it makes the structure unpredictable and costly. The bandwidth of the proposed antenna has been increased to 2.16%. A compact cavity antenna with onesided ramp-shaped grooves has also been designed in [7] to force the structure to work in the first negative-order resonance. The other solutions to improve antenna's bandwidth are to merge multiple resonant modes in an exceedingly single passband [8].

This paper presents, the design of dual-band and lowprofile SIW cavity-backed slot antenna supported for the fifth-generation (5G) wireless system for Europe, China (24.25 – 27.5 GHz), Korea (26.5 – 29.5 GHz), and USA region (27.5 – 28.35 GHz) [2]. Two parallel slots are utilized to obtain dual-band of the SIW cavity-backed antenna. To achieve wider bandwidth and high gain, a cavity-backed antenna using via-hole along with the slot has been also designed. The proposed antenna has a via-hole along with the slot to create a dual resonance.

ANTENNA DESIGN

A. DUAL-BAND SIW CAVITY-BACKED ANTENNA WITH PARALLEL SLOTS

The proposed slot antenna has been designed at 24-29 GHz on Rogers RT/Duriod 5880 copper laminated substrate with a substrate height of 0.508 mm, a dielectric constant of 2.2 and loss tangent (tanδ) of 0.0009. The proposed antenna configuration is illustrated in Fig.36-1. The geometrical parameters of the proposed structure are shown in Table 36-1. By using the resonant frequency equation, the primary dimensions of the cavity can be calculated.

$$a \approx \frac{580.95}{\sqrt{\varepsilon_r}} \sqrt{\frac{1}{4f_H{}^2 - f_L{}^2}} \qquad (1)$$

$$b \approx \frac{580.95}{\sqrt{\varepsilon_r}} \sqrt{\frac{1}{4f_L{}^2 - f_H{}^2}} \qquad (2)$$

Where a and b represents the length and width of the cavity, respectively (in mm), ε_r stands for the relative permittivity of the substrate, and f_L , f_H are the resonance frequencies (both are in GHz). These two equations are derived from the resonant frequency equation of the rectangular cavity [9]. Its rectangular backed cavity is realized by metalized vias arrays. The requisite conditions to make the SIW cavity identical to conventional metallic cavity are $d/s \geq 0.5$ and $d/\lambda_o \leq 0.1$. In order to avoid the bandgap effect, $d < s \leq 2d$ must be satisfied.

To provide the mechanical stability s/λ_o must be greater than 0.05. Two parallel slots are etched on the ground plane of the conductor. In order to obtain dual-band, an additional slot is introduced at the bottom plane of the cavity. It is observed that the Q factors of the two original modes are considerably reduced and also a new mode is excited in the SIW cavity. The strong capacitive load effect introduced by the slot changes the mode of the cavity to a lower frequency range and the first antenna band is generated at 24.7 GHz. By optimizing the positions, length and width of the slots, higher-order hybrid modes are tuned and combined to form the second band of the proposed dual-band antenna with a wider bandwidth.

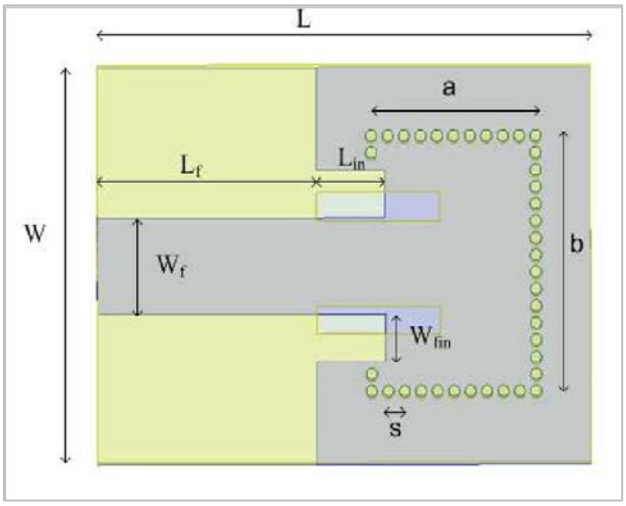


Figure 36-1 The geometrical configuration of the dual-band SIW cavity-backed antenna with parallel slots

Table 36-1 GEOMETRICAL PARAMETERS OF THE PROPOSED ANTENNA

Parameter	Value (mm)	Parameter	Value (mm)
L	18	a	6
W	14	b	9
W_f	3.37	S_L	4.5
L_f	8	S_W	1
L_{in}	2.5	d	0.4
W_{fin}	1.68	s	0.6
d1	3		

All the simulations are performed using a high-frequency structure simulator (HFSS) Ansys version 18.0, based on the finite element method (FEM) technique. The corresponding reflection coefficient is shown in Fig. 36-2. All material losses are taken into account when simulating the results. The simulated resonant frequencies are obtained at 24.7 GHz and 27.8 GHz. The simulated -10 dB operating bands are obtained in the range from 24.1 GHz to 25.4 GHz and from 26.8 GHz to 28.5 GHz with a fractional bandwidth of 5.26% and 6.15% respectively. Within the operating frequency band, the radiation diagrams in plane E and plane H are illustrated in Fig. 36-3 and Fig. 36-4. The level of cross-polarization in both planes is less than -35 dB with respect to copolarization in the direction of maximum radiation at 24.7 GHz and 27.8 GHz. The achieved simulated gain value is about 5.45 dBi and 6.15 dBi at 24.7 GHz and 27.8 GHz, respectively. To enhance the bandwidth and achieve high gain, siw based cavity-backed antenna via-hole along with the slot is designed.

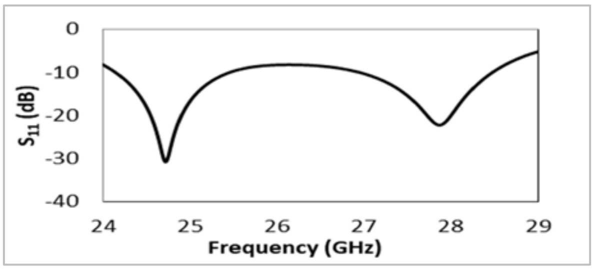


Figure 36-2 Simulated reflection coefficient (S11) of the dual-band SIW cavitybacked antenna with parallel slots.

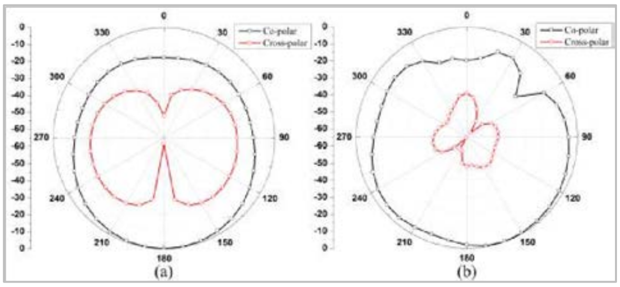


Figure 36-3 The radiation patterns of the proposed antenna at 24.7 GHz.

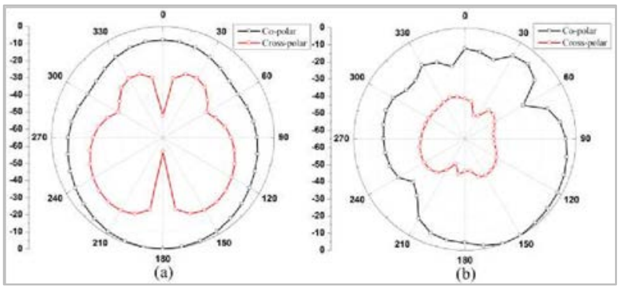


Figure 36-4 The radiation patterns of the proposed antenna at 27.8 GHz.

B. CAVITY-BACKED ANTENNA USING VIA-HOLE ALONG WITH THE SLOT

To enhance the bandwidth, a cavity-backed antenna using via-hole along with the slot has been proposed. All the design parameters are the same as discussed for dual-band siw cavity-backed antenna with Parallel slots. The proposed antenna configuration is illustrated in Fig.36-5. The occurrence of resonance is observed in a conventional cavity-backed slot antenna when the slot has a half wavelength at the operating frequency. The cavity size and slot length are two fundamental factors determining the frequency of this resonance. The current distribution during the first resonance comprises minimum current flowing to the center and a maximum current flows to the edges of the slot in the same direction. Via-hole establishes a connection between the top and bottom surface of the cavity creating a new path for the current to flow. At the time of second resonance, minimum current flows to the opposite side of via-hole and maximum current flow to the left edge of the slot. The effective length of the slot is shortened at a higher resonance frequency. By moving the position of via-hole, the second resonance frequency can be shifted to a higher or lower frequency without any significant effect on the first resonance frequency.

The Return loss i.e (S_{11}) of the antenna was obtained from the simulation in order to formalize the design of the antenna is shown in Fig. 36-6. The frequency range used in the simulation is 24 to 29 GHz with a 10 dB return loss bandwidth of 4.2 GHz. From the figure, it is observed that two resonances can be merged to ensure wideband matching. The fractional bandwidth obtained for S_{11} < - 10 dB is 15.32% (25.3 GHz – 29.5 GHz). This result gives higher fractional BW much higher than the regular SIW slot antenna.

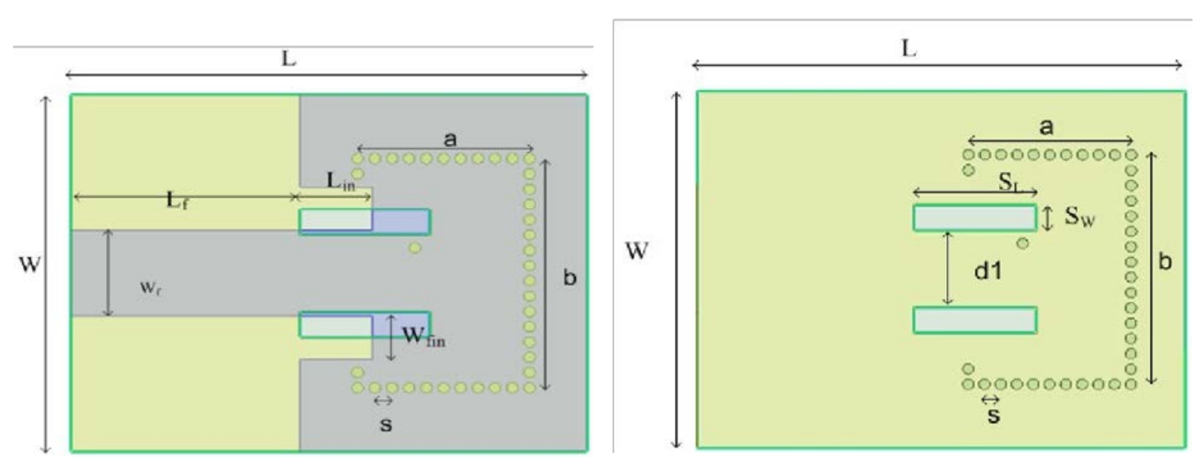


Figure 36-5 The geometrical configuration of the cavity-backed antenna using via-hole along with the slot.

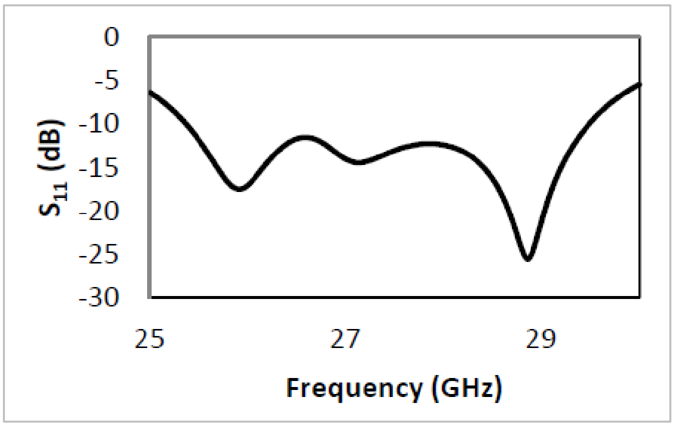


Figure 36-6 Simulated reflection coefficient (S11) of the cavity-backed antenna using via-hole along with the slot.

The radiation patterns in the plane E and plane H are illustrated in Fig. 36-7 and Fig. 36-8 at 25.9 GHz and 28.8 GHz respectively. The level of cross-polarization in E-plane is below -28 dB and H–plane is below -35.4 dB at 25.9 GHz resonance with respect to co-polarization. The level of crosspolarization in E-plane is below -25 dB and H–plane is below -38 dB at 28.8 GHz resonance with respect to copolarization. The simulated gain value is 7.8 dBi and 9.2 dBi is achieved at 25.9 GHz and 28.8 GHz respectively. This high gain and enhanced bandwidth acquired because of viahole along with the slot in the proposed structure. In addition, the planned antenna has an easy structure, lightweight, and planer configurations.

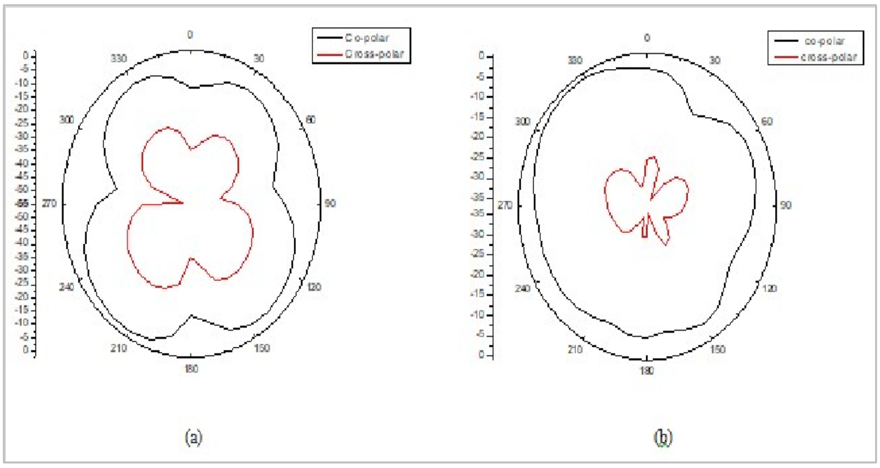


Figure 36-7 The radiation patterns of the proposed antenna at 25.9 GHz.

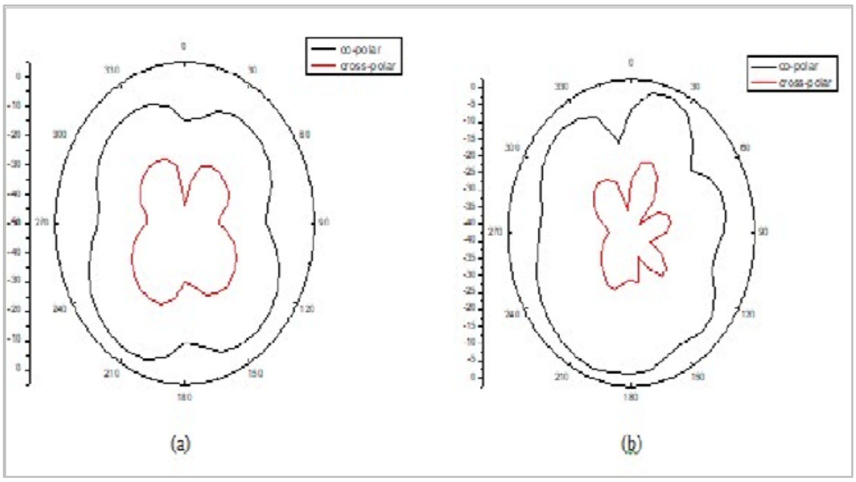


Figure 36-8 . The radiation patterns of the proposed antenna at 28.8 GHz.

CONCLUSION

The design of dual-band and low-profile SIW cavitybacked slot antenna for 5G applications has been presented. The design provides sufficient bandwidth at all frequencies (24.7 GHz, 27.8 GHz, 27.9 GHz, and 30.8 GHz) for the 5G applications. The radiation performance of the proposed antenna system is also acceptable. For the dual-resonance antenna, a wide bandwidth is achieved by shortening the effective length of the slot at the higher frequency using a single via-hole along with the slot. It has been shown that the antenna using via-hole along with the slot can achieve high gain and broader bandwidth performance when compared to dual-band antenna with parallel slots. It has been shown that the designed antenna system has a miniaturized size and simpler topology when compared with similar antennas [10][12], which is an ideal candidate for 5G communications. The simulated results show that the proposed antenna system is a good candidate for 5G applications in both the USA and Europe regions.

REFERENCES

[1] E. Dahlman et. al, “5G wireless access: Requirements and realization,” IEEE Commun. Mag., vol. 52, no. 12, pp. 42–47, December 2014.

[2] T. S. Rappaport et. al, “Millimeter-wave mobile communications for 5G cellular: It will work!” IEEE Access, vol. 1, pp. 335–349, May 2013.

[3] A. A. Omar, M. C. Scardelletti, Z. M. Hejazi, and N. Dib, “Design and measurement of self-matched dual-frequency coplanar waveguide fed slot antennas,” IEEE Trans. Antennas Propag., vol. 55, no. 1, pp. 223–226, Jan. 2007.

[4] M. P. Mohan, A. Alphones, and F. Karim “Triple Band SIW Cavity Backed Slot Antenna,” Proceeding of 2017 Asia Pacific Microwave Conference, 13–16 Nov. 2017.

[5] D. Deslandes and K. Wu, “Single-substrate integration technique of planar circuits and waveguide components,” IEEE Trans. Microwave Theory Tech., vol. 51, issue 2, pp. 593–596, Feb. 2003.

[6] S. Yun, D. Y. Kim, and S. Nam, “Bandwidth and efficiency enhancement of cavity-backed slot antenna using a substrate removal,” IEEE Antennas Wireless Propag. Lett., vol. 11, pp.1458– 1461, Dec. 2012.

[7] A. P. Saghati, and K. Entesari, “An ultra-miniature SIW cavity- backed slot antenna,” IEEE Antennas Wireless Propag. Lett., vol. 16, pp. 313–316, 2017.

[8] G. Q. Luo, Z. F. Hu, W. J. Li, X. H. Zhang, L. L. Sun, and J. F. Zheng, “Bandwidth-enhanced low-profile cavity-backed slot antenna by using hybrid SIW cavity modes,” IEEE Trans. Antennas Propag., vol. 60, no. 4, pp. 1698–1704, Apr. 2012.

[9] D. M. Pozar, Microwave Engineering, 3rd ed. Hoboken, NJ, USA: Wiley, 2009, pp. 278–279.

[10] Q. Wu, H. Wang, C. Yu, and W.Hong, “Low-Profile Circularly Polarized Cavity-Backed Antennas Using SIW Techniques,” IEEE Transactions on Antennas and Propagation, vol. 64, no.7, pp. 2832– 2839, 2016.

[11] I M. Asaadi, and A. Sebak, “High-Gain Low-Profile Circularly Polarized Slotted SIW Cavity Antenna for MMW Applications,” IEEE Antennas and Wireless Propag. Lett., vol. 16, pp. 752–755, 2017

[12] A. Ghalib, M. S. Sharawi, H. Attia, and R. Mittra, “ Broadband Substrate Integrated Waveguide Slotted Array Antenna at mm-Wave Bands,” IEEE MTT-S International Microwave Workshop Series on 5G Hardware and System Technologies, IMWS-5G, 2018.

37. Analysis of Coherent Microwave Photonic Filter for Digital Modulation Scheme

Tanooja Mishra[(1)] , Abhinav Gautam[(1)] , Amitesh Kumar[(1)]
[(1)] Department of Electronics Engineering, Indian Institute of Technology (ISM), Dhanbad.
**Corresponding author's e-mail address: sci.tanoojamishra018@gmail.com*

ABSTRACT

Coherent Microwave Photonic Filters (MPFs) are widely discovered for their ability to filter-out high-frequency microwave signals. In this paper, the analysis of a coherent MPF has been carried out for digital data communication using the OptiSystem simulation software. Eye-diagram, constellation diagram, and Probability of Error (PoE) have been investigated for the characterization of MPF using 8-DPSK and 64-QAM digital modulation schemes. The PoE in received signal is calculated for various optical fiber lengths at digital data rate 3 Gbps. Therefore, this analysis would be useful for next generation 5G communication by choosing the appropriate modulation scheme and observing various parameters such as Eye-diagram, constellation diagram, and PoE.

Index Terms— *Digital modulation Schemes (8-DPSK and 64QAM); Microwave photonic filter; Probability of Error; Eyediagram; Constellation diagram.*

INTRODUCTION

In the recent decade, the multidisciplinary area Microwave Photonics (MWPs) is a prominent area of research which offers the simultaneous study of optical and microwave signal in the same platform. Because of its unique characteristics, such as realization of delay lines for signal processing [1], ability to handling of phase and amplitude of a signal independently [2], center frequency tunability, etc., MWP has opened door for [wide range of applications. These applications are in the field of defense, RADAR, optical communication, photonic sensing, MWP filters, Fiber-to-Home or radio over fiber, etc.

In fact, new interdisciplinary technology has been adopted for the interface between microwave engineering and photonics in the optical domain to filter out high-frequency microwave signal, which is commonly known as Microwave Photonic Filters (MPFs). It facilitates the opting of desired frequency from the microwave signals through the processing of optical signals and therefore, paid significant contribution in the radar monitoring, prediction of unknown frequency, defense and military. At high-frequency microwave signals, these filters eliminate the difficulty of higher heat generation and other frequency-dependent losses with conventional electrical microwave filters and work efficiently [3], [4], [5]. Incoherent MPF is implemented using delay lines under FIR or IIR configuration. The incoherent light source is used for suppressing optical interference while using the incoherent MPFs, whereas coherent MPF is realized by using a single wavelength light source without any delay line configurations.

Also, there is no such issue of optical interference in the coherent MPF [6]. It possesses its application in nextgeneration 5G communication. Now a days, the demand for high data rates, service quality, and high bandwidth of transmission media has been increased due to increasing number of users in wireless network [7]. This next generation 5G communication works in millimeter-wave frequency range from 30 GHz to 300 GHz. It offers high bandwidth, high speed transmission of multi Gbps data, and also provides space for wireless monitoring through sensing network and smart city initiatives [8], [9]. Also, huge wireless transportation is possible in 5G communication. For this purpose, high-frequency RF signals are utilized for high speed data transmission. However, there is a problem to filter out these high-frequency RF signals using conventional electrical filters. Therefore MPFs are considered. In this manuscript, a simple, coherent MPF based on an optical Fabry Perot Filter (FPF) is proposed. Also, the analysis of MPF is done for different digital modulation schemes.

Digital modulation schemes offer higher security of data, extra information capacity, and obtainability of high speed system with excessive-quality of communication. Also, digital modulation schemes transfer higher amounts of data in compare to analog modulation schemes. Therefore, in communication systems, digital modulation schemes are most commonly used. Where, high-frequency carrier signal will get modulated through binary digital data that is imposed through varying amplitude, varying phase, and frequency of carrier signal. Now a days, Different types of modulations such as Binary Phase Shift Keying (BPSK), Quadrature Amplitude Modulation (QAM), M-ary Differential Phase Shift Keying (M-DPSK), Mary, PSK (M-PSK), and Quadrature Phase Shift Keying (QPSK), etc. are used. M-DPSK is an effective bandwidth digital modulation scheme and broadly used in mobile radio where the partial radio bandwidth is available [10]. Whereas, for high-capacity of transmission links, M-QAM having high spectral efficiency of optical signals can be generally deployed [11]. As the order of modulation schemes increases, the number of bits per symbol are also increasing, and bandwidth has been effectively utilized. Here, 8-DPSK (3 bit per symbol) and 64QAM (6 bit per symbol) modulation schemes are used.

In this manuscript, section 2 gives the brief overview of block diagram of proposed MPF. Section 3 provides a detailed analysis of proposed coherent MPF where the quality of demodulated data is examined on the basis of constellation diagram, eye-diagram, and PoE.

THEORY

Thes chematic block diagram of the proposed coherent MPF has been shown in Fig.37-1. This proposed MPF consists of a Mach-Zehnder Modulator (MZM) as a Phase Modulator (PM), an optical source, a Photo Detector (PD), and a bandpass filter using an optical Fabry Perot Filter (FPF). Here, an optical FPF is an essential element of coherent MPF. A laser source is used to generate a high-frequency optical carrier signal. An optical carrier signal is incident to MZM, which modulates it by a Radio Frequency (RF) signal that carries digital data. A Pseudo Random Bit Sequence (PRBS) is taken as digital data at rate of 3 Gbps for different digital modulation schemes.

In this analysis, 8-DPSK and 64-QAM digital modulation schemes are used to analyse the performance of coherent MPF. At the output of MZM, an intensity modulated signal is obtained, which consists of optical carrier, upper and lower sidebands. The intensity modulated signal is passed through the FPF to filter out undesired sidebands by selecting a particular Free Spectral Range (FSR). At the output of FPF, an optical carrier signal and first-order upper sideband are obtained. This optical carrier signal and first-order upper sideband beat upon PD. An RF signal is generated at the output of PD. An electrical amplifier is used to amplify RF signal. After amplification process, an RF signal is demodulated using 8-DPSK and 64QAM digital demodulation schemes. Thus, A digital data is successfully recovered. Further, the received digital data is analysed on the basis of probability of error, eye diagram, and constellation diagram.

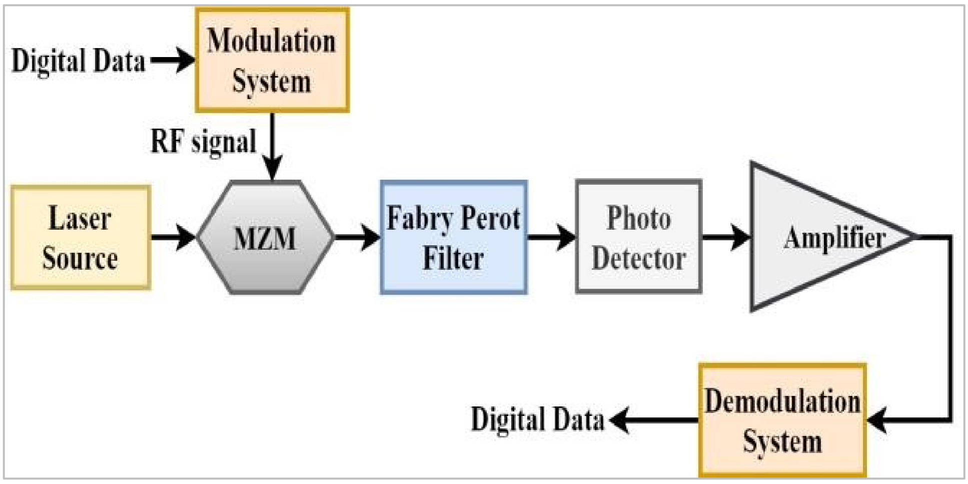


Figure 37-1 Block diagram of coherent microwave photonic filter

SIMULATION EXPERIMENT AND RESULTS

The experimental setup is conducted and simulated on the commercial OptiSystem simulation software platform. The filter response of proposed coherent MPF based on FPF is analysed. Fig.37-2 shows the filter response for sweeping range of frequency from 0 to 60 GHz of proposed coherent MPF. In this figure, it can be observed that the filter gives high-frequency response at only 30 GHz frequency apart from this frequency; the power will be degraded. The bandwidth of FPF is 0.1 GHz, and FSR is 30 GHz. The proposed coherent MPF filter is tuned at 30 GHz frequency. It works as bandpass filter.

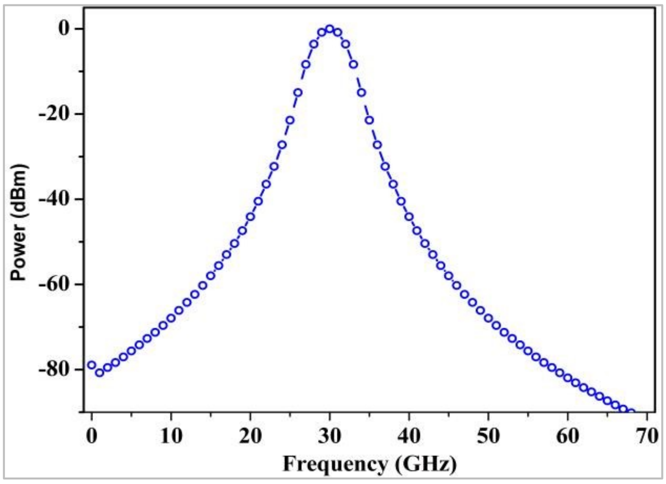


Figure 37-2 Filter Response of Fabry Perot Filter.

Fig.37-3 shows the schematic diagram of modulation system. Where, initially, a PRBS is generated at data rate 3 Gbps by using a periodic pseudo random sequence generator and converted into two bit sequences, i.e., in-phase (I) and quadrature-phase (Q) sequence using 8-DPSK and 64-QAM sequence generator. Further, I and Q bit sequences are applied to two different M-ary pulse generator and converted into two

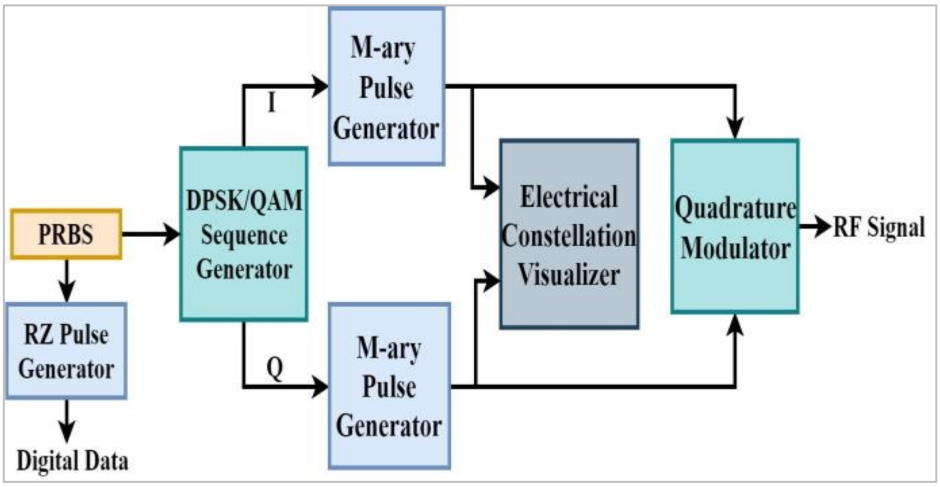


Figure 37-3 Schematic diagram of modulation system.

M-ary pulse form. A constellation diagram which shows digital modulated signal for 8-DPSK and 64-QAM digital modulation scheme, as shown in Fig. 37-4, is obtained using an electrical constellation visualizer that is connected between two M-ary pulse generator.

I and Q M-ary pulse waveforms are transferred and get modulated at high frequency 30 GHz using quadrature modulator. A RF signal is generated at 30 GHz and transmitted through wireless media. At receiver end, the RF signal is received at antenna and used as a modulating signal that modulates an optical carrier signal at frequency 193.1 THz using MZM. An intensity modulated signal is obtained at the output terminal of MZM, which is shown in Fig.37-4.

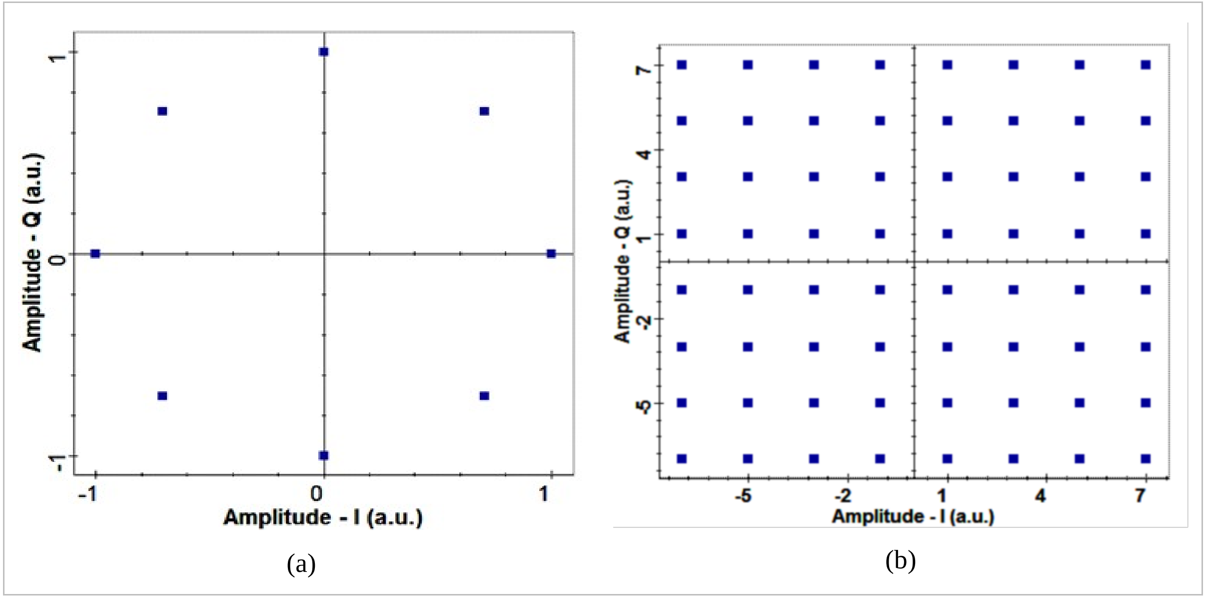


Figure 37-4 Ideal constellation diagram at input for (a) 8-DPSK and (b) 64QAM

Fig. 37-5 depicts an optical carrier signal, upper and lower sidebands. The optical carrier signal at frequency 193.1 THz and upper sideband at frequency 193.13 THz or adjacent sidebands are separated by 30 GHz frequency same as an RF signal frequency. Therefore, an intensity modulated signal is passed through an FPF that is tuned at 193.1 with Free Spectral Range (FSR) of 30 GHz frequency. An optical carrier and upper sideband are beaten upon a PD, and an electrical RF signal at 30 GHz frequency is observed. The received RF signal gets amplified by an electrical amplifier.

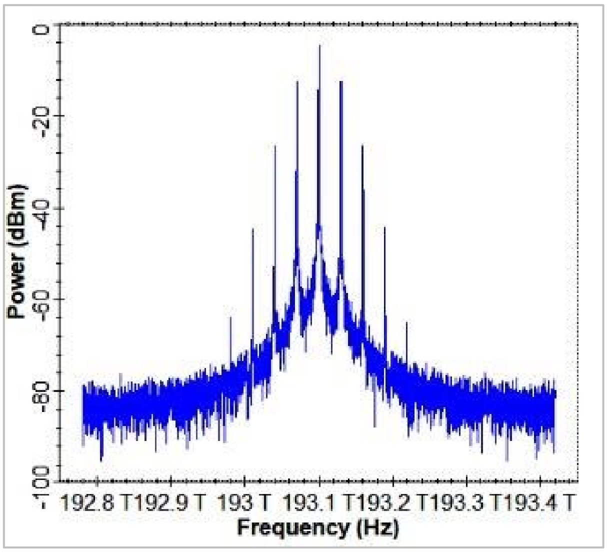


Figure 37-5 An intensity modulated signal at MZM output.

Fig. 37-6 shows schematic diagram of demodulation system. Further, a received RF signal is demodulated and converted into I and Q electrical signal using quadrature demodulator. Furthermore, I and Q waveform are applied to different M-ary threshold detector that approximates signal to desired threshold level. An electrical constellation visualizer is connected between different M-ary threshold detector to observe the constellation diagrams of received signal using 8-DPSK and 64-QAM digital modulation scheme, as shown in Fig. 37-7.

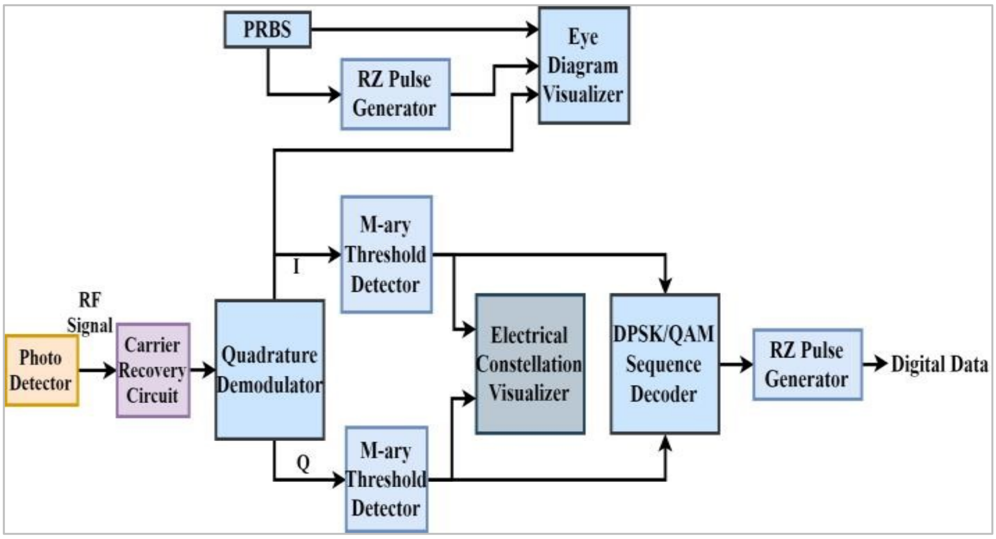


Figure 37-6 Schematic diagram of demodulation system.

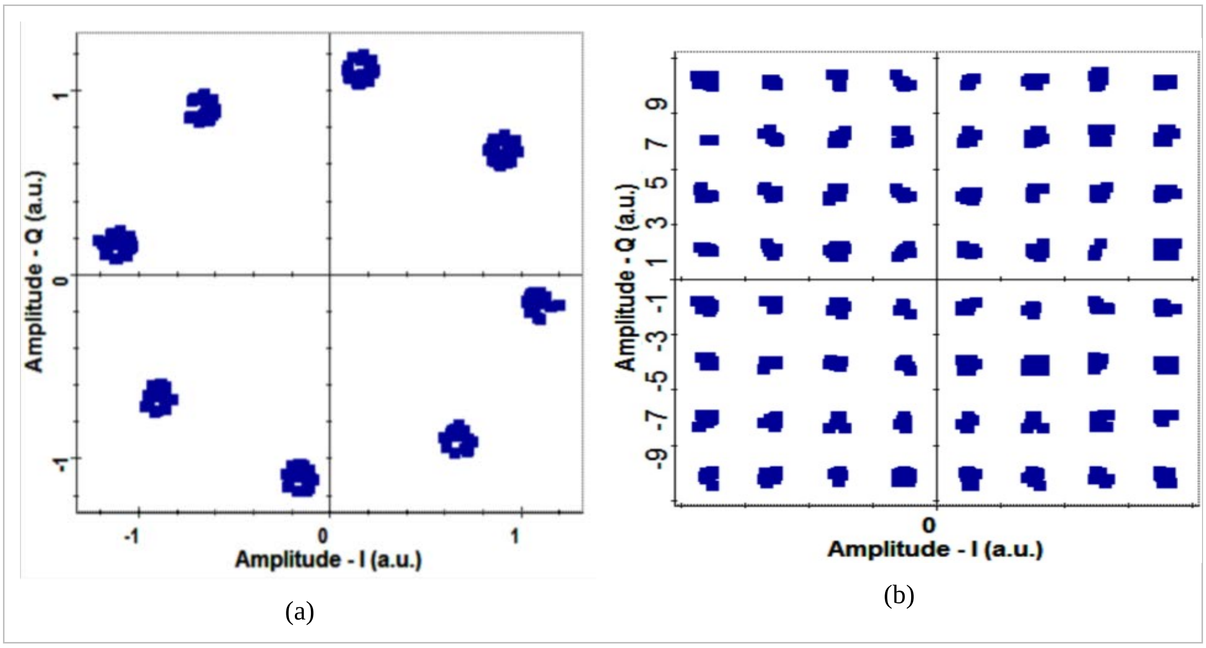


Figure 37-7 Constellation diagram at output for (a) 8-DPSK and (b) 64-QAM

Because of noise added in received signal, the symbol points have been shifted from their ideal coded value. After detecting an RF electrical signal, a channel recovery circuit is required for minimizing error at receiver end for demodulating of digital data. Due to large carrier-frequency offsets and optical noise, large phase errors are introduced in received signal, that can also be tolerated [12]. Carrier recovery circuit estimates and compensates the phase offset of the signal, and the frequency offset between the Local Oscillator (LO) and the signal [13].

However, some noise factors are remaining present in demodulated signal, which cannot be removed using carrier recovery circuit. Therefore, an ideal constellation diagram could not be recovered at receiver end. 8-DPSK has less symbol errors in compare to 64-QAM because of larger distance between adjacent symbol points in I and Q plane. Moreover, the outputs of different M-ary threshold detector are decoded using 8-DPSK and 64-QAM sequence decoder. After decoding of signal, a RZ pulse generator is used to convert decoded data into electrical pulse form. A digital input data is effectively recovered at 3 Gbps data rate.

The performance of the system is evaluated by measuring an essential factor known as eye-diagram. At the output of quadrature modulator, an eye-diagram of received in-phase Mary signal for 8-DPSK and 64-QAM is obtained by using an eye-diagram visualizer tool, which is shown in Fig. 37-8. By observing eye-diagram, the presence of Inter-Symbol Interference (ISI) which limits signal to noise ratio, and quality of recovered digital data can be determined in high speed digital transmission.

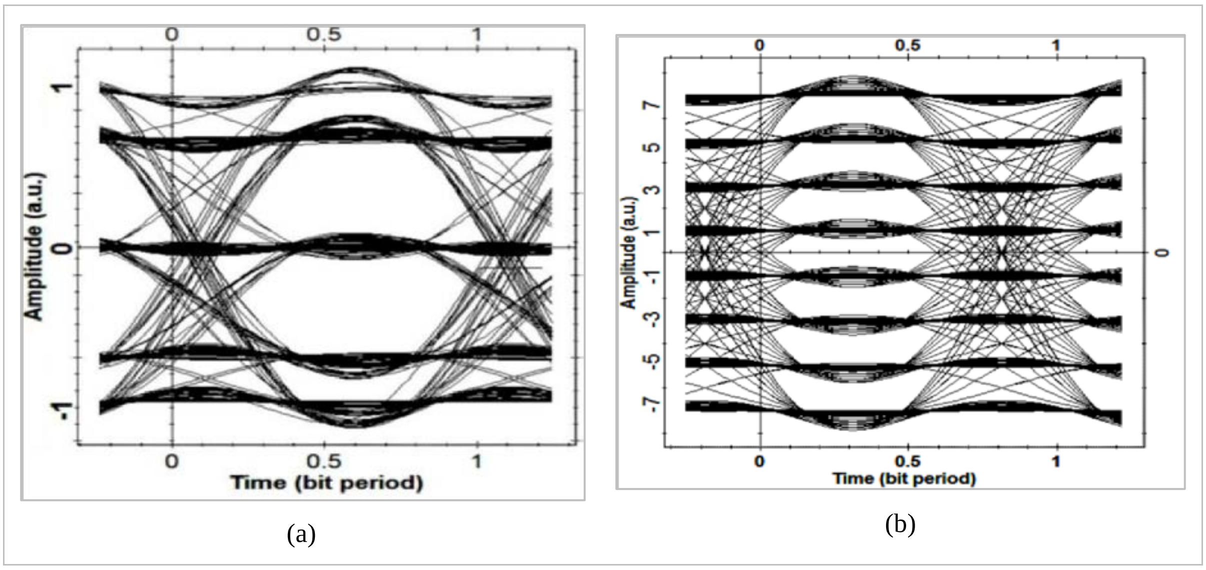


Figure 37-8 Eye diagram of received signal for (a) 8-DPSK and (b) 64-QAM

The eye opening for 8-DPSK signal is larger than 64-QAM because of more ISI existing in 64-QAM signal. But, whenever the data rate starts to increase, the opening of eye-diagram for 8-DPSK tends to decrease and become lesser than 64-QAM, which will still remain the same. Therefore, 64-QAM performs better and gives better results than 8-DPSK for higher data rate [14][15].

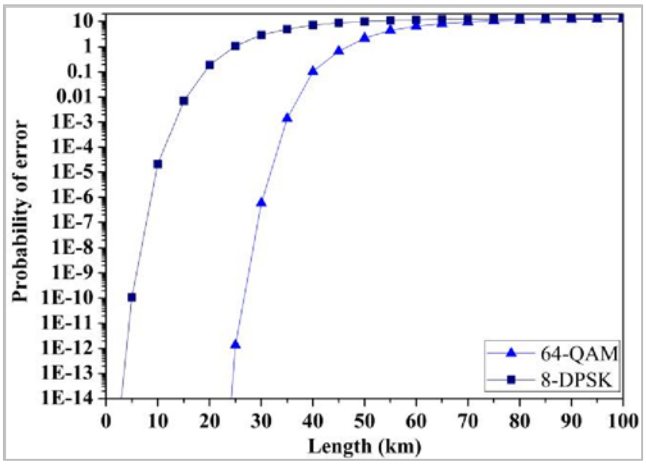


Figure 37-9 Probability of error vs. received power

Another important parameter, i.e., Probability of Error (PoE) of demodulated digital data, is investigated to characterize the performance of digital communication system. In this manuscript, the performance of coherent MPF has been examined for various optical fiber lengths. The Fig. 37-9 shows that the PoE is continuously changing as the optical fiber length is varying from 0 to 100 Km for both modulation scheme 8DPSK and 64-

QAM. PoE should be as low as possible so that the performance of system will be better. Hence, from this graph, it can be depicted that for 64-QAM, the PoE starts to increase from 10^{-9} after 29 Km length of optical fiber. However, for 8-DPSK, the PoE starts to increase from 10^{-9} after 8 Km length of optical fiber. Generally, the acceptable PoE is in the range of 10^{-9} or lower than this value. It is considered as optimum PoE in digital communication system. For larger distance and higher data rate, 64-QAM is preferred. This simulation experiment of coherent MPF is analyzed and justified for digital communication. This examination of analysis of coherent MPF will be useful in next generation 5G communication setup.

CONCLUSION

The simulation analysis of coherent microwave photonic filter has been analysed for different digital modulation scheme through the OptiSystem simulation software. Furthermore, 8-DPSK and 64-QAM digital modulation and demodulation schemes has been investigated in which it has been found that 64-QAM offers better performance than 8-DPSK scheme. Also, different parameters such as constellation diagram, eyediagram, and probability of error has been investigated, which indicated that the 64-QAM would be more suitable for the optical communication, like, 5G optical communication than 8DPSK.

REFERENCES

[1] R. A. Minasian, "Photonic signal processing of microwave signals," IEEE Transactions on Microwave Theory and Techniques, vol. 54, no. 2, pp. 832–846, Feb. 2006.

[2] J. Yao, "Microwave Photonics," Journal of Lightwave Technology, vol. 27, no. 3, pp. 314–335, Feb. 2009.

[3] R. J. Cameron, C. M. Kudsia, and R. R. Mansour, Microwave filters for communication systems: Fundamentals, design, and applications. 2018.

[4] J. Capmany, B. Ortega, and D. Pastor, "A tutorial on microwave photonic filters," Journal of Lightwave Technology, 2006.

[5] J. Capmany, B. Ortega, D. Pastor, and S. Sales, "Discrete-time optical processing of microwave signals," Journal of Lightwave Technology, 2005.

[6] J. Yao, "Photonics to the Rescue: A Fresh Look at Microwave Photonic Filters," IEEE Microwave Magazine, 2015.

[7] R. M. Aly, A. Zaki, W. K. Badawi, and M. H. Aly, "Time coding OTDM MIMO system based on singular value decomposition for 5G applications," Applied Sciences (Switzerland), vol. 9, no. 13, 2019.

[8] S. E. Alavi et al., "Towards 5G: A Photonic Based Millimeter Wave Signal Generation for Applying in 5G Access Fronthaul OPEN," Nature Publishing Group, 2015.

[9] X. Ge, H. Cheng, M. Guizani, and T. Han, "5G Wireless Backhaul Networks: Challenges and Research Advances," 2014.

[10] F. Adachi, S. Member, and M. Sawahashi, "Decision Feedback Differential Phase Detection of W a r y DPSK Signals," vol. 4, no. 2, pp. 203–210, 1995.

[11] A. Kanno et al., "16-QAM radio-over-fiber signal generation and its wireless transmission," Optics Express, vol. 19, no. 26, pp. 56–63, 2012.

[12] T. Inoue and S. Namiki, "Carrier recovery for M-QAM signals based on a block estimation process with Kalman filter," Optics Express, vol. 22, no. 13, p. 15376, 2014.

[13] X. Zhou, "Efficient clock and carrier recovery algorithms for singlecarrier coherent optical systems: A systematic review on challenges and recent progress," IEEE Signal Processing Magazine, vol. 31, no. 2, pp. 35–45, 2014.

[14] A. Note, "Understanding Data Eye Diagram Methodology for Analyzing High Speed Digital Signals," pp. 1–7, 2012.

[15] M. Gambhir and N. Shenvi, "Comparitive-Analysis-of-8-DPSK-and-16-QAM-Digital-Modulation-using-RoF-for-Hybrid-WDM-TDMPON.docx," vol. 6, no. 6, pp. 189–193, 2015.

38. Hybrid Mode Analysis of Hybrid Dielectric Loaded Plasmonic Waveguide

[1]Pintu Kumar, [2]Dharmendra K. Singh, [3]Rakesh Ranjan
Electronics & Communication Engineering, NIT Patna, India
[1]pintu.ec15@nitp.ac.in, [2]dksingh@nitp.ac,.in [3]rr@nitp.ac.in

ABSTRACT

In order to analyze the optical properties of the hybrid mode, such as propagation loss, as well as the modal index of the hybrid dielectric loaded plasmonic waveguide (HDLPW), the waveguide width and thickness of dielectric regions have been varied at the working wavelength of 1550 nm under the restraint of optical power in the low-index region. The hybrid mode investigation for the propagation of hybrid fundamental and higher order modes have been done in the present work to find out the optimum dimension of the HDLPW. For applications of the sensor, multimode propagation has a vital role. Propagation length about 443 µm and confinement of light in the spacer region approximate 31 % have been achieved with the optimal waveguide dimension of 200 nm × 50 nm (width × thickness) of the spacer region of the HDLPW. Nano-scale optical devices are beneficial for development of the advanced optical communication devices that can support the efficient implementation of 5G communications and networks.

Index Terms— *Hybrid Plasmonic waveguide, Surface Plasmon polariton, Hybrid Mode, Advanced optical communication.*

INTRODUCTION

In the present scenario, technology requires the high bandwidth communication services, such as high quality-videos/images transfer, cloud computing and data collection systems. Now days, over the internet in every minute, decades of video are being viewed and uploaded [1, 2]. To handle very huge number of data or user, there is a requirement of larger bandwidth, which can be provided by the optical communication systems and networks. For the optical communications, optical waveguides, optical logic gates, optical multiplexer, optical filter, optical switch, etc. are the basic devices. In order to achieve the high optical integrations, these basic optical devices have to be improved with minimum size and smaller losses. The minimum size of optical devices can be realized through both the dielectric and plasmonic waveguides. However, the power loss in dielectric waveguides is significantly lower as compared to plasmonic waveguides, but the dielectric waveguides are suffering from diffraction limit [3, 4]. The diffraction limit of the dielectric waveguide is the major issue for the minimization of the size of the waveguides and devices. Moreover, the diffraction limit problem can be solved by using plasmonic mechanism. In the plasmonic waveguide, the structure is consists of dielectric material and metal, which is helpful to propagate the light through true nano-scale size (< 100 nm) due to surface Plasmon polaritons (SPPs). At the optical wavelength range, the metal has complex permittivity which causes more power loss. Therefore, the problem arises from both dielectric and plasmonic mechanisms can be resolved using the concept of hybrid plasmonic waveguide, which is basically the combination of these two mechanisms [5-16]. The devices based on hybrid plasmonic waveguide are very helpful to connect optics with electronics. In the hybrid plasmonic waveguide, lower refractive index material must be interfaced with metal to achieve the low propagation loss. Usually, the hybrid mode is transverse magnetic (TM) nature because plasmonic mode has only TM nature [5]. Different arrangement of the waveguide based on the hybrid plasmonic mechanism has been explained such as, hybrid metalinsulator-metal [5-11], hybrid insulator-metal-insulator [7], hybrid dielectric loaded plasmonic waveguide [12-14], hybrid plasmonic using metal cap [6, 15-17] and hybrid metal insulator [17]. Fundamental mode propagation has less propagation loss, which is beneficial for the requirement of the optical device based on large propagation length. Multimode propagation is applicable for bio-sensing applications [18-20]. For the understanding of the monolithic integration of passive optical devices, silicon-on-insulator based hybrid plasmonic waveguide is a benefit. CMOS technology is adaptable with this technology and has the potential of monolithic integration with electronic devices. PTFE-based hybrid dielectric loaded plasmonic waveguide (HDLPW) can be useful for the realization of monolithic integration with active optical devices.

In this paper, the hybrid mode investigation of the HDLPW has been done in terms of propagation loss and modal index, at the operating wavelength (λ) of 1550 nm by changing the waveguide width and thickness of low-index and high-index regions. Further, to analysis, optical properties (in terms of confinement factor and loss propagation) of fundamental hybrid mode of the HDLPW by varying in thickness of dielectric regions (both low- and high- index).

This work is organized as follows. Section II demonstrates the three dimensional view of HDLPW structure and the properties of materials. In section III, the method of numerical analysis, i.e., the finite element method has been described briefly. Section IV examines the variations of modal index and propagation loss with varying of HDLPW dimensions. The conclusion of this work has been provided in section V.

DESCRIPTION OF STRUCTURE

Figure 38-1 shows the three dimensional view of the structure of HDLPW. In the z-direction, the light is propagating and optical power is confined in the x-y plane. The HDLPW structure consists of a spacer/low-index dielectric region, sandwiched between high-index dielectric region and metal layer and dielectric is loaded with metal that means the width of the metal region is greater than the width of the dielectric region. Here, t_s is the thickness of low-index/spacer region and t_h represents high-index region thickness. The width of the hybrid dielectric loaded plasmonic waveguide is considered as W. Indium gallium arsenide phosphide (InGaAsP) is used as high refractive-index material, which has a relative permittivity of 11.32 [18], and polytetrafluoroethylene (PTFE) is used as a low refractive - index/spacer region, with relative permittivity of 1.7 [4, 10]. PTFE is useful for nonlinear applications and is of low cost. InGaAsP has nonlinear material properties with low nonlinear loss. The permittivity of silver (Ag) is calculated by Drude model, which defines the permittivity as [10],

$$\varepsilon = \varepsilon_\infty - \frac{w_p{}^2}{w^2 + jw\delta} \tag{1}$$

where, $\varepsilon_\infty = 1$, which represents the dielectric constant at infinite angular frequency, bulk plasma frequency and damping frequency for silver are denoted as w_p $(= 1.39 \times 10^6\ rad/sec)$and δ $(= 3.08 \times 10^{13}$ per sec) respectively. Hence, at working wavelength of 1550 nm, the permittivity of silver can be obtained -129 + 3.3i. Here, the substrate material is PTFE, and air is a cladding material. All the analysis of the optical properties of the hybrid mode of the HDLPW has been done at 1550 nm..

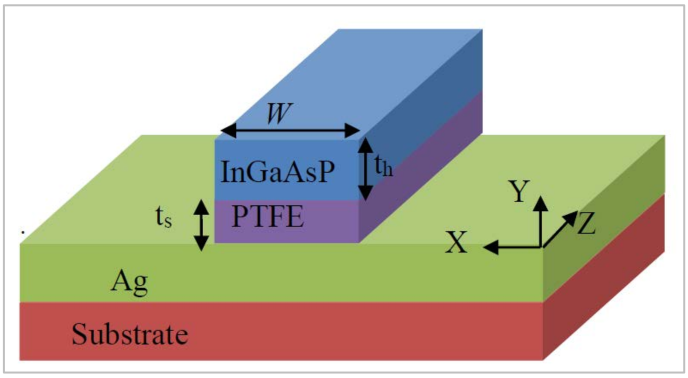


Figure 38-1 Three-dimensional view of HDLPW

METHOD OF MODE ANALYSIS

To investigate the hybrid mode characteristic of the hybrid plasmonic waveguide, different numerical methods such as, finite difference frequency domain (FDFD) method [19], finite element method (FEM) [5, 6, 8, 11] and finite difference time domain (FDTD) method [13] have been reported in literature.

In this paper, to analyze the hybrid mode characteristics of the HDLPW, COMSOL Multiphysics simulator has been used, which is basically based on FEM. In the 2-D FEM, all boundaries considered as perfect electric conductor with extra fine mesh size. The thickness of the silver layer is considered as 100 nm, to abolish the effect of metal (Ag) layer on the hybrid mode within the spacer region, whereas, the plasmonic skin depth of silver assumed constant about 20 nm at the near-infrared wavelengths. For the investigation of multimode, firstly the height (thicknesses) of spacer/low- and high-index regions are fixed along the y-axis at 50 nm and 150 nm, respectively. If the width of the waveguide is increased, then the number of propagating modes also increases. Figure 38-2 shows the mode profile of the various modes of HDLPW, where it has been observed that the optical power is restricted in the low-index region. Different possible hybrid modes for this particular dielectric loaded waveguide structure are fundamental hybrid mode(TM_{00}), first hybrid mode (TM_{01}) and second hybrid mode (TM_{02}). The hybrid mode profile analysis has also been performed by varying the thickness of the dielectric regions.

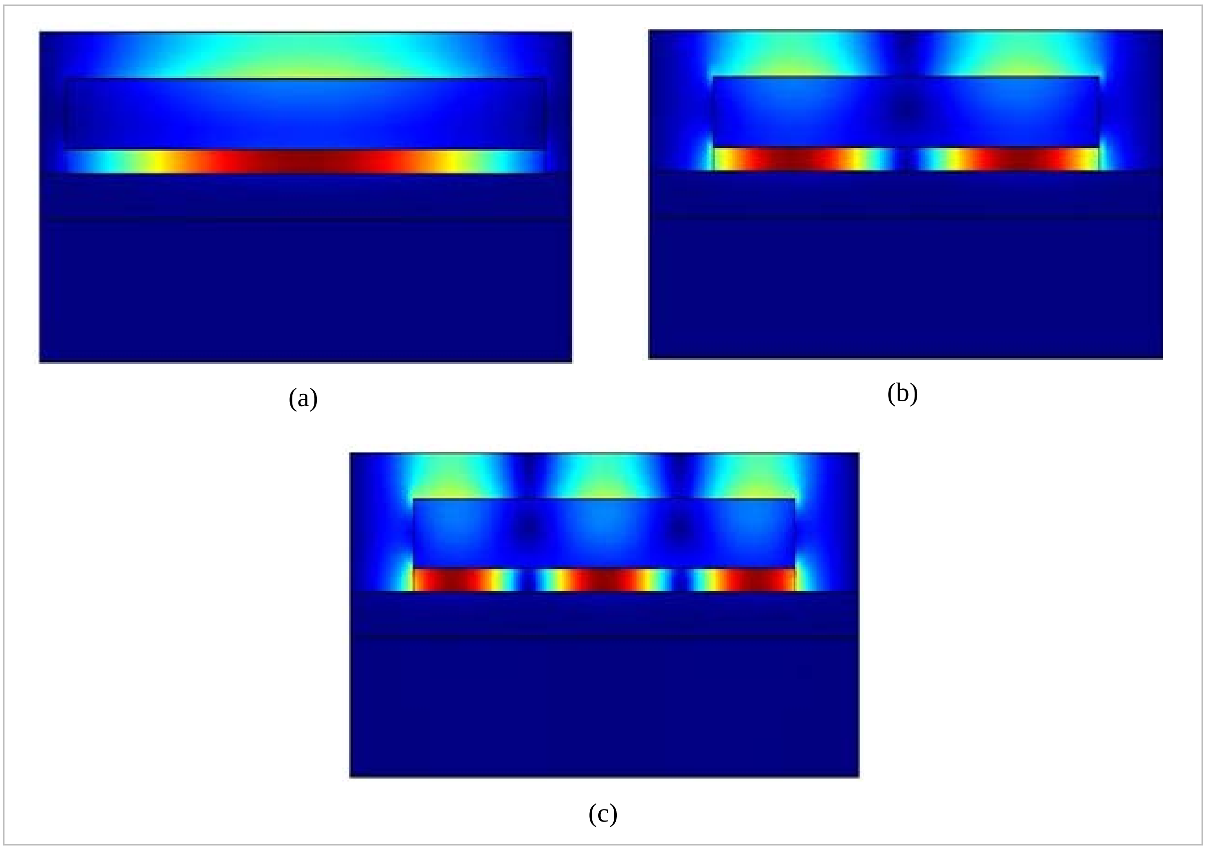


Figure 38-2 Mode profile of TM modes (a) TM00 (fundamental mode) (b) TM01 (first mode) (c) TM02 (second mode) of the HDLPW

NUMERICAL RESULTS AND DISCUSSION

Modal index and propagation length of the hybrid mode is carry out from real and imaginary part of effective index, respectively. The real part of effective index has been calculated as, $Re(N_{eff}) = \beta/k$, where β is the propagation constant and k is the wave number for the free space medium. Propagation length (p_l) of a hybrid mode is a distance at which the optical power is decreased to 36.7 % of the initial optical power and it can be measured as [8],

$$p_l = \frac{\lambda}{4\pi\, Im(n_{eff})} \quad (1)$$

where, $Im(n_{eff})$ represents an effective index of imaginary part and λ is the working wavelength.

A. EFFECT OF WIDTH OF THE HDLPW ON HYBRID MODE PROFILE

In this part, thickness of the dielectric region is fixed as $t_s = 50\ nm$, $t_h = 150$ nm and only the waveguide width of the HDLPW is varying from 100 nm to 1800 nm. The purpose of analysis of the hybrid mode to achieved smaller size of the optical devices and low propagation loss. Hybrid mode is only those modes whose optical power is mostly confined in the low - index region. However, the propagation of the higher order hybrid model has been useful for sensing applications. When the width of the waveguide is increases, it causes the propagation of higher order hybrid modes in the hybrid plasmonic waveguide. Figure 38-3 shows the real part of the effective index of the hybrid modes at 1550 nm for the HDLPW. The figure clearly indicates that, the number of hybrid modes increases with the increase in the waveguide width. At minimum width of the waveguide, where the light is propagating through the spacer/low-index region is known as cutoff width of the hybrid mode. Here, TM_{00} (fundamental mode) does not show cutoff width, but the cutoff widths for TM_{01} and TM_{02} are 700 nm and 1200 nm, respectively for the current hybrid plasmonic waveguide structures.

The propagation length of all three hybrid modes of the hybrid plasmonic waveguide is almost constant after a certain increase in waveguide width, which is illustrated in Fig. 38-4. The figure shows that TM_{00}, TM_{01} and TM_{02} have a uniform propagation length after 500 nm, 1400 nm and 1600 nm, respectively. Moreover, the propagation loss is increasing with the higher order modes of the waveguide. So, propagation length is greater in the fundamental mode in comparison to higher mode.

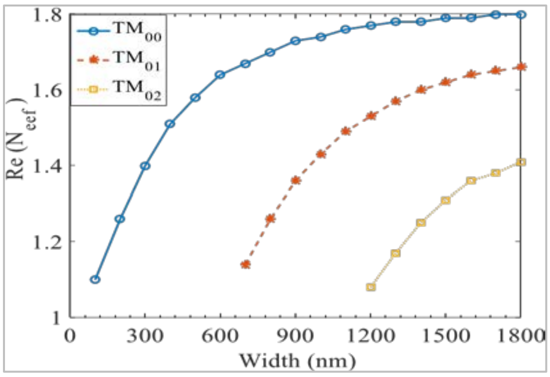


Figure 38-3 Effective index for fundamental (TM00), first (TM01) and second (TM02) hybrid modes with waveguide width of the HDLPW.

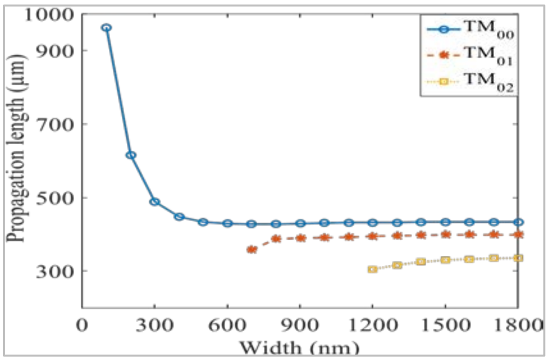


Figure 38-4 Propagation length for fundamental (TM00), first (TM01) and second (TM02) modes with waveguide width of the HDLPW

B. EFFECT OF THICKNESS OF HIGH-INDEX REGION

In this section, the waveguide width of HDLPW is fixed to 1500 nm to investigate the higher order hybrid mode profiles. The thickness of the low-index region is considered as 50 nm. To observe the variations in the hybrid mode profile of the HDLPW with the variations of thickness of the high - index region, Fig. 38-5 illustrates the relation between the thickness of the high - index region and real part of the effective index. The figure clearly indicates that the real part of the effective index increases with increasing thickness of the high - index region, which shows that for the significantly larger thickness of the high - index region, the hybrid mode of the hybrid plasmonic waveguide turns toward the dielectric waveguide. The fundamental mode propagates for all the assumed values of thickness of the high - index region, whereas, the first and second modes are propagating in the waveguide, if $t_h \geq 75$ nm and 100 nm, respectively. Figure 5 shows that the effective index of the fundament hybrid mode is more than other higher order modes, which indicates the strength of the electric field, along the y-axis is more, so it is confined large power in the low-index region. The cutoff thickness of the high - index region is defined as the minimum thickness of the waveguide from which optical power starts to propagate in the spacer region. Here, fundamental hybrid mode is no cutoff thickness, while for the first and second hybrid modes it is around 75 nm and 100 nm, respectively. Figure 38-6. shows that propagation length variations by changing of the thickness of the high-index region. The propagation length of the fundamental hybrid mode is firstly decreases, after certain value its get saturated and then increases with thickness of the high - index region, but the higher order hybrid mode is only saturated and increases with the thickness of InGaAsP. The figure shows that the propagation length of the fundamental mode is quite larger than higher order mode.

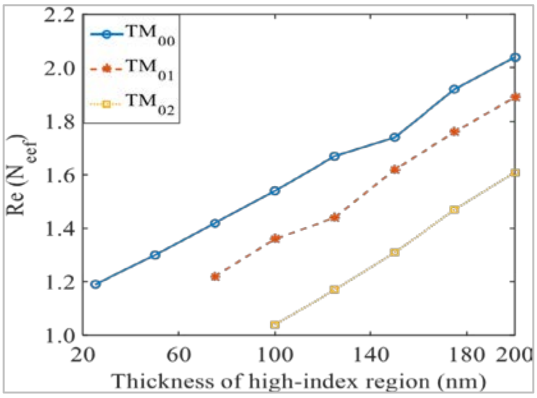


Figure 38-5 Effective index for fundamental (TM00) and first (TM01) modes with the thickness of InGaAsP of the HDLPW

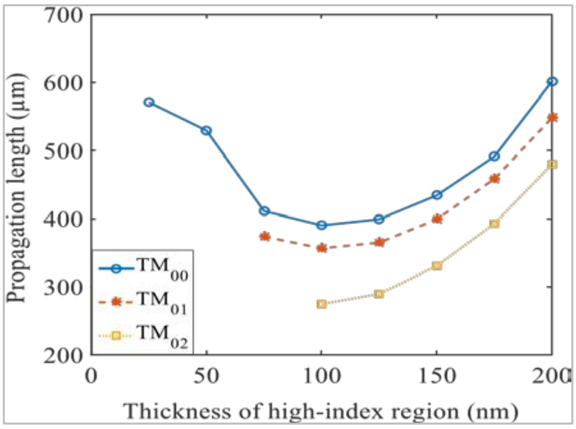


Figure 38-6 Propagation length for fundamental (TM00) and first (TM01), modes with thickness of InGaAsP of the HDLPW

C. EFFECT OF THICKNESS OF LOW-INDEX REGION

In this section, the waveguide width of the HDLPW is fixed at 1500 nm for the analysis of hybrid mode profiles of fundamental and higher order modes. The thickness of highindex region (t_h) is assumed as 150 nm. The investigation of the hybrid mode profile has been observed by varying the thickness of the low - index region of the hybrid plasmonic waveguide. Figure 38-7. indicates that modal index decreases with increasing value of the thickness of the low-index region. With the significant increase in the thickness of spacer region, the nature of hybrid mode turns towards the plasmonic mode. Fig. 38-8 illustrate that the thickness of the spacer region is increasing, propagation length increases. Figure clearly shows that fundamental mode is low propagation loss as compared to higher order mode.

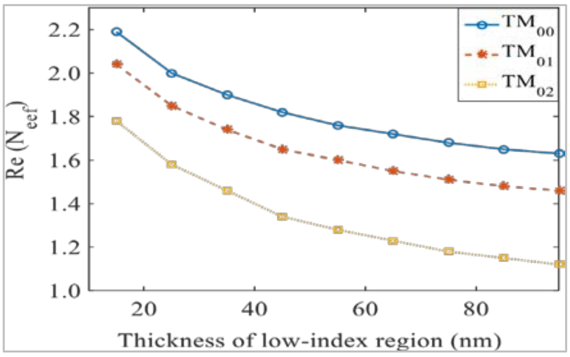


Figure 38-7 Effective index for fundamental (TM00) and first (TM01) modes with the thickness of PTFE of the HDLPW

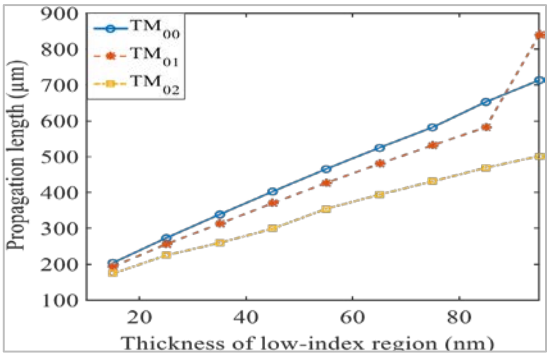


Figure 38-8 Propagation length for fundamental (TM00) and first (TM01), modes with thickness of PTFE of the HDLPW

D. EFFECT OF THICKNESS DIELECTRIC REGION OF FUNDAMENTAL MODE OF THE HDLPW

In this section, To investigate the optical properties of the fundamental hybrid mode of the HDLPW, the width of the waveguide is fixed at 200 nm. From the above section analysis, conclude that fundamental mode is less propagation loss. Figure 38-9(a). indicates that real part of the effective index is decreasing as thickness of low-index increases and highindex decreases. Which indicates that smaller values of the high - index region is plasmonic nature and also higher value of the low - index region is plasmonic nature. If increasing the value of thickness in spacer region is plasmonic because hybrid mode turns toward pure plasmonic as Ag-PTFE. At a constant spacer thickness, if thickness of the high - index region is increasing then hybrid modes again turn toward plasmonic nature but due to Ag-InGaAsP. For the hybrid mode, choose between them according to the requirement of propagation length and confinement of light. Figure 38-9(b). illustrated that propagation length is increasing as increases thickness of low-index region.

To optimize the dimension of the hybrid plasmonic waveguide by using of the confinement factor of light. However, confinement factor is associated with the power (energy) confined in the low-index region of the hybrid mode in the hybrid plasmonic waveguides. It is defined as the ratio of the optical power propagating through spacer region (P_{spacer}) to the total optical power (P_{total}) propagating through the hybrid plasmonic waveguide and in percent, it is expressed as [21],

$$CF(\%) = \frac{\iint |\langle P_{zi}(x,y)dxdy\rangle|}{\iint_{-\infty}^{\infty} |\langle P_z(x,y)dxdy\rangle|} \times 100 \qquad (2)$$

Here, the optical power of time-averaged Pointing vector along the z-axis in the spacer region represents as $P_{zi}(x, y)$ and $P_z(x, y)$ indicates the total optical power of the timeaveraged Pointing vector along the z-axis of the whole waveguide structure. confinement factor in the terms of percentage is shown in fig. 38-9(c). figure clearly indicate that confinement of light is firstly increases, then saturated with the thickness of the dielectric region. If $t_h > 170\ nm$ and $t_s > 40\ nm$, confinement of light, almost maximum at lower dimension. So optimal dimension for HDLPW are W = 200 nm, $t_h = 170\ nm$ and $t_s = 40\ nm$, at which propagation length and confinement factor 443μm and 0.3 respectively.

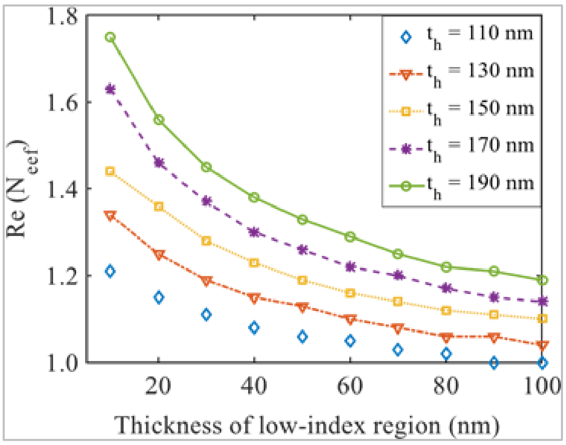


Figure 38-9(a) Effective index for fundamental mode with thickness of dielectric region of the HDLPW

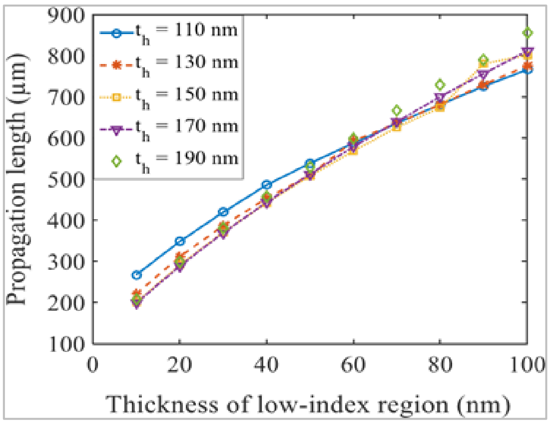


Figure 38-9 (b) Propagation length for fundamental mode with thickness of dielectric region of the HDLPW

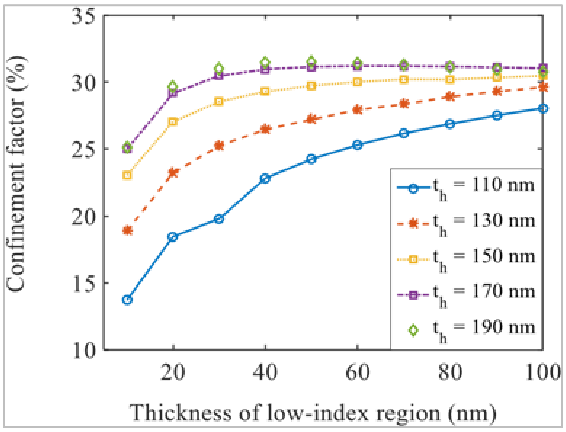


Figure 38-9 (c) confinement factor for fundamental mode with thickness of dielectric region of the HDLPW

CONCLUSION

In the current work, the optical properties of the hybrid modes have been investigated for the hybrid dielectric loaded plasmonic waveguide. The analysis of the modal index and propagation loss of HDLPW structure has been done by changing the waveguide dimensions. The hybrid mode investigation has been achieved for both fundamental and higher order hybrid modes. The propagation of multimode is a key factor for the bio-sensor devices. For the multimode propagations, propagation length of the hybrid mode is better than higher order modes. Further, we investigated the optical properties (such as propagation loss and confinement factor) of the hybrid fundamental mode of the HDLPW by variants of the thickness of dielectric region (both low- and high-index regions). Propagation length about 443 μm and confinement of light in the spacer region approximate 31 % have been achieved with the optimal waveguide dimension of 200 nm × 50 nm (width × thickness) of the spacer region of the HDLPW. This analysis is beneficial for the nano-scale optical devices such as power splitter, sensors, directional coupler, all-logic gates, etc. based on hybrid plasmonic mechanism. For future purposes, optical devices are solving the problem of interconnecting between electronics and optics technology. Nano-scale optical devices are beneficial for development of the advanced optical communication devices that can support the efficient implementation of 5G communications and networks.

REFERENCES

[1] A. E . Willner, S. Khaleghi, M.R. Chitgarha, and O. F. Yilmaz, “Alloptical signal processing,” Journal of Lightwave Technology, vol. 32, pp. 660-680, February, 2014.

[2] X. Wang, D. Chen, H. Li, G. Feng, and J. Yang, “In-line Mach-zehnder interferometric sensor based on a seven-core optical fiber,” IEEE Sensors Journa, vol. 17, pp. 100-104, January, 2017.

[3] Q. Li, and M. Qiu, “ Structurally-tolerant vertical directional coupling between metal-insulator-metal Plasmonic waveguide and silicon dielectric waveguide,” Optics Express, vol. 18, pp.15531-15543, July, 2010.

[4] A. V. Krasavin, and A. v. Zayats, ”Silicon-based Plasmonic waveguides,” Optics Express, vol. 18, pp. 11791-11799, May, 2010.

[5] M. Z. Alam, J. A. Stewart, and M. Mojahedi,‘Theoretical analysis of hybrid Plasmonic waveguide,” IEEE Journal of Selected Topics in Quantum Electronics, vol. 19, p. 4602008, June, 2013.

[6] M.Z. Alam, J.A. Stewart, and M. Mojahedi, “A marriage of convenience: hybridization of surface Plasmon and dielectric waveguide modes,” Laser Photonics Reviews, vol. 8, pp. 394–408, 2014

[7] M. T. Noghani, H. Mohammad, and V. Samiei, “Analysis and optimum design of hybrid Plasmonic slab waveguides,” Plasmonics, vol. 8, pp. 1155–1168, March, 2013.

[8] Y. Bian, and Q. Gong, “Optical performance of one-dimensional hybrid metal-insulator-metal structures at telecom wavelength,” Optics Communications, vol. 308, pp. 30-35, June, 2013.

[9] P. sharma and V. D. Kumar, “Investigation of multilayer planer hybrid Plasmonic waveguide and bends,’ IET Electronics Letters, vol. 52, pp. 732-734, April, 2016.

[10] P. Sharma and V. D. Kumar,”Hybrid Insulator Metal Insulator Planar Plasmonic Waveguide-Based Components” IEEE Photonics Technology Lettters, vol. 29, pp. 1360-1363, August, 2017.

[11] J. Tian, R. Yang, L. Song and W. Xue, ”Optical Properties of a YSplitter Based on Hybrid Multilayer Plasmonic waveguide” IEEE Journal of Quantum Electronics, vol. 50, pp. 898-903, November, 2014.

[12] T. Holmgaard,and I. Bozhevolnyi, “Theoretical analysis of dielectric-loaded surface Plasmon-Polariton waveguides,” Physical Review, vol. 75, pp. 245405-1- 245405-12, 2007.

[13] H. S. Chu, E. P. Li, P. Bai, and R. Hegde, “Optical performance of single-mode hybrid dielectric-loaded Plasmonic waveguidebased components,” Applied Physics Letters, vol. 96, p. 221103, June, 2010.

[14] J. Grandidier, S. Massenot, G.C.D. Francs, A. Bouhelier,J.C. Weeber, L. Markey and A. Dereux,” Dielectric-loaded surface plasmon polariton waveguides: Figures of merit and mode characterization by image and fourier plane leakage microscopy,” Physical Review, vol. 78, p. 245419, 2008.

[15] D. Dai, and S. He, “A silicon-based hybrid Plasmonic waveguide with a metal cap for a nano-scale light confinement,” Optics Express, vol. 19, pp.16646-16653, September, 2009.

[16] J. Wang, X. Guan, Y. He, Y. Shi, Z. Wang, S. He, P. Holmstrom, L. Wosinski, L. Thylen and D. Dai,”Sub-μm2 power splitters by usingsilicon hybrid Plasmonic waveguides,” Optics Express, vol. 19, pp. 838-847, January, 2011.

[17] M. Z. Alam, J. S. Aitchison and M. Mojahedi, “Propagation characteristics of hybrid modes supported by metal-low-high index waveguides and bends,” Optics Express, vol. 18, pp. 12971-1279, June, 2010.

[18] M. Nikoufard, M. Alamoun and S. Pourgholi, “Multimode Interference Power-Splitter Using InP-Based Deeply Etched Hybrid Plasmonic Waveguide,” IEEE Transaction on Nanotechnology, vol. 16, pp. 477483, May, 2017.

[19] N. Eti and H. Kuri, “Model Analysis of Ridge and Rib Types of Silicon Waveguides With Void Compositions,” IEEE Journal of Quantum Electronics, vol. 52, p. 8400207, October, 2016.

[20] G. Veronis and S. Fan, “Modes of Subwavelength Plasmonic Slot Waveguides” Journal of Lightwave Technology, vol. 25, pp.25112521, September, 2007.

[21] X. Sun, M. Z. Alam, M. Mojahedi, and J. S. Aitchison, "Confinement and Integration Density of Plasmonic Waveguides," IEEE JournaL of Selected Topics in Quantum Electronics, vol. 21, p. 4600308, July/August, 2015.

39. A Method of Fault Tolerance and Mitigation in Wireless Sensor Networks

[1]Dr. Arun Kumar Marandi, [12]Sweta Kumari Barnwal, [3]Dr. S. N. Singh
[1]Dept. of computer Science & IT ARKA JAIN University, India Jamshedpur-831014,
[3]NIT Jamshedpur NIT Jamshedpur, India Jamshedpur-831014, India
[1]dr.arun@arkajainuniversity.ac.in , [2]kumar.sweta85@gmail.com, [3]snsingh.ece@nitjsr.ac.in

ABSTRACT

For a system fault tolerance is the ability to do the work without any interference. In present era wireless sensor network has wide role or a variety of applications with unlimited future scopes. In Wireless Sensor Networks there are several types of failures just because of various environmental hazards, such as interference, internal factures(battery failure, hardware failure, link errors, DoS attack, processor failure, transceiver failure etc., which affects the whole transmission and therefore the deployment of Wireless Sensor Network is not effective. In this manner fault tolerance is most critical issue in Wireless Sensor Networks. This paper presents, how the faulty nodes of mobile communication can be detect and mitigate. It is very tough to monitor the WSNs continuously by manual operator, so there is a requirement of a system which is in capable of overcoming the failures and can send the data in proper manner. The WSN should be designed in such a way that it should be able to find out the faulty nodes, try to resolve and then transmit the sensed data if any fault occurs and make the fault free network by improving fault tolerance capability. In this paper we have proposed an algorithm for fault detection, which will rectify the fault and make the network fault free, ultimately maximizes the efficiency of the cluster and improves the network performance.

Index Terms— *fault detection, wireless sensor networks (WSNs), fault tolerance, mobile node management.*

INTRODUCTION

Wireless Sensor Networks (WSNs) have received significant attention in recent years due to their potential application in military sensing, wildlife tracking, traffic surveillance, health care, environment monitoring, building structures monitoring, etc. WSNs can be treated as a special family of wireless ad hoc network [1]. Each sensor node is equipped with a sensing unit, which is used to capture events of interest, and a wireless transceiver, which is used to transform the captured events back to the base station called sink node .Sensor nodes collaborate with each other to perform tasks of data sensing, data communication, and data processing [2]. Nodes in WSNs are prone to failure due to energy depletion, hardware failure, communication link errors, malicious attack, and soon. Unlike the cellular networks and ad hoc networks where energy has no limits in base stations or batteries can be replaced as needed, nodes in sensor networks have very limited energy and their batteries cannot usually be recharged or replaced due to hostile or hazardous environments. So, one important characteristic of sensor networks is the stringent power budget of wireless sensor nodes. Two components of a sensor node, sensing unit and wireless transceiver, usually directly interact with the environment, which is subject to Variety of physical, chemical, and biological factors. Fault tolerant computing can be defined as "The ability to execute specified algorithms correctly regardless of hardware failure and software errors" [2-3]. Five level of fault tolerance are physical layer, hardware layer, system software layer, middleware layer and application layer. Basically the technology of fault tolerant computing encompasses theory and techniques of fault and error detection and correction, modelling, analysis, synthesis, and architecture of fault- tolerant system and their evaluation. The complexity of this subject area can be viewed in a different way. It need computer that would sustain essential operation even under multiple hardware failures and software errors [4]. This implies the requirement of "self-repairing" and highly reconfigurable computer. Moreover we address five categories of applications: node placement, topology control, target and event detection, data gathering and aggregation, and sensor surveillance.

FAULT TOLERANCE AT DIFFERENT LEVELS

On the basis of study it classify fault tolerance in WSNs into four levels i.e. hardware layer, software layer, network communication layer, and application layer [3-4].

A. LAYER OF HARDWARE

Faults here can be caused by malfunction of any hardware component of a sensor node, such as memory, battery, and microprocessor. Three main reasons causing hardware failure are: sensor node will not always use the highest quality components, strict energy constraints restrict long and reliable performance of sensor nodes, sensor networks are often deployed in harsh and hazardous environment which affect normal operation of sensor nodes [2].

B. LAYER OF SOFTWARE

This consist of two components system software (such as operating system) and middleware (such as communication, routing).Software bugs are a common source of error in WSNs. Since it is difficult to provide fault tolerance in economic way in hardware level of sensor node, it is expected at the middleware level [1-3].

C. LAYER FOR NETWORK COMMUNICATION

Faults in this layer are the faults on wireless communication links which can be caused by radio interference of sensor nodes[11]. The standard way to enhance the performance of wireless communication is to use aggressive error correction schemes and retransmission. These two methods may cause promote delay of operation [2-3].

D. APPLICATION LAYER

Fault tolerance can be addressed also at the application layer. An approach for fault tolerance cannot be directly applied to other applications. It requires proper addressing of fault tolerance in different applications, on a case by case basis. A WSN is a self-organised network that consists of a large number of low- costs and low –powered sensor devices, called sensor nodes .which can be deployed on the ground, in the air, in vehicles, on bodies, under water, and inside buildings.

FAULT DETECTION AND RECOVERY

To tackle faults in a WSN, the system should fellow two main steps. The first step is fault detection. It is to detect that a specific functionality is faculty, and to predict it will continue to function properly in the near future [5]. After the system detects a fault, fault recovery is the second step to enable the system to recover from the faults. Basically, there are two types of detection techniques: self –diagnosis and cooperative diagnosis [6].Some fault that can be determined by a sensor node itself can adopt self diagnosis detection.

For example, a sensor node itself can detect fault caused by depletion of battery. The remaining battery of the sensor node can be predicted by measuring current battery voltage. Another example is the detection of failure links. A sensor node may detect that some link to one of its neighbours is faulty if the node does not receive any message from the neighbour within a predetermined interval. However, there are some kinds of fault that require cooperative diagnosis among a set of sensor nodes [5-6]. Recovery is defined as the continuation of system functions after the incidence of an error with data integrity. In a total system environment it is a problem requiring both hardware and software aids. An essential requirement is that error propagation must be minimized and any damaged data must be reconstructed before restarting. The most common used technique for fault recovery is replication or redundancy of components that are prone to be failure [4].

For example, WSNs are usually used to periodically monitor a region and forward sensed data to a base station. When some nodes fail to provide data, the base station still gets sufficient data if redundant sensor nodes are deployed in the region. Multiple path routing is another example. In the case of providing single route, a requested call cannot be set up or be maintained if some nodes/links along the route fail. Keeping a set of candidate routes provides high reliability of the routes for routing. It requires K-connectivity of the network if it is able to tolerate failure of K-1 nodes.

NODE PLACEMENTS IN TWO-TIERED WIRELESS SENSOR NETWORK

Sensor nodes are prone to failure, one approach to improving reliability and prolonging lifetime of WSNs is the introduction of two-tiered network architecture [7]. The architecture employs some powerful relay nodes whose main function is to gather information from sensor nodes and relay the information to the sink. Relay nodes serve as a backbone of the network. They are more powerful than sensor nodes in terms of energy storage, computing, and communication capabilities. The network is partitioned into a set of clusters and the relay nodes act as cluster heads and they are connected with each other to perform the data forwarding task [5-6]. Each cluster has only one cluster head and each sensor belongs to at least one cluster, such that sensor nodes can switch to backup cluster heads when current cluster head is not available [7]. In each cluster, sensor nodes collect raw data and report to the cluster head. The cluster head analyzes the raw data, extracts useful information, and then generates outgoing packets with much smaller size to the sink via multichip paths. A fault in transmitter can cause the relay nodes to stop transmitting tasks to the sensors as well as relaying the data to the sink. Data sent by the sensors will be lost if the receiver of a relay node fails. So, a communication link fault on a sensor requires the sensor to be reallocated to other cluster heads within communication range [4-5-7]. If faults occur in inter-cluster heads, another multichip path should reconnect the two corresponding cluster heads. Thus to handle general communication faults, there should be at least two node-disjoint paths between each pair of relay nodes in the network [4].

An intuitive objective of relay node placement in two-tiered WSNs is to place the minimum number of relay nodes so that some degree of fault tolerance can be achieved. A lot of work has been done on the minimum placement of relay nodes for fault tolerance in two-tiered WSNs. It does not employ relay nodes and two-tiered architecture but it can be reduced to the same placement problem in two-tiered architecture by setting uniform communication ranges for both sensor nodes and relay nodes [8]. So in this paper we focus on relay node placement problem in two-tiered networks in this section. There are variant dentitions on the problem of minimum placement of relay nodes. The problem can be described as follows. If given a set of sensor nodes that are randomly distributed in a region and their location, some relay nodes are needed to be placed on the region for forwarding data to the sink, such that each sensor node is covered by at least one relay node. The objective is to minimize the number of relay nodes that make the network k-connected. It is assumed that the original sensor network is 2-connected and sensor nodes also participate in forwarding of the data. The objective is to guarantee that at least two relay nodes cover each sensor node and the network of relay nodes is 2-connect. Since sensor nodes usually have limited computing and communication capability, and especially very limited energy resource, it restricts application of the algorithm.

A. FORMAL DESCRIPTION OF THE PROBLEM IS AS FOLLOWS

Given,

- A set of sensor nodes S in a region
- A uniform communication radius d
- The problem is to place a set of relay nodes R, such that
  - The whole network G is connected
  - G is 2-connected.

The objective of the problem is to minimize |R| where |R| denotes the number of relay nodes in R.The authors proposed a (6 C ")-approximation solution for the case 1 of the minimum relay node placement problem (MRP-1 for short), and then proposed a (24C")-approximation solution for case 2 (MRP-2 for short), where " is an arbitrary positive number and running time is polynomial when " is fixed. The solutions were further extended to the scenario where communication radii of sensor nodes and relay nodes are different. The basic idea of the solutions is to partition the problem into two phases. The 1st phase is to place some relay nodes to cover all sensor nodes [3-5]. The second phase is to add more relay nodes to make the whole network connected=2-connected.The solution is based on two fundamental works. The first is the covering with disks problem. Given a set of points in the plane, the problem is to identify the mini- mum set of disks with prescribed radius to cover all the points. In a polynomial time approximation scheme (PTAS) for this problem was proposed. That is, for any given error, the ratio of the solution found by the scheme to the optimal solution is not larger than. The running time is polynomial when € is fixed. The scheme was called min-disk-cover scheme. The other fundamental work is the Steiner tree problem with minimum number of Steiner points. Given a set of terminals in the Euclidean plane, the problem is to find a Steiner tree such that each edge in the tree has length at most d and the number of Steiner points is minimized. Du et al. proposed a 2.5-approximation algorithm for the STP-MSP. The algorithm was called STP-MSP algorithm. Note that sensor nodes do not participate in data forwarding. STP-MSP algorithm cannot be directly applied to the problem. Based on earlier foundational works, the (6 + €) approximation algorithm for MRP-1 is as follows.

B. ALGORITHM FOR THE SOLUTION

Step 1: To search the relay nodes R

- Input: S, a set of sensor nodes with locations. €, any given error that is larger than 0. d , the communication radius of sensor nodes and relay nodes.
- Output: G, a connected network including sensor nodes and relay nodes.
- Use the min-disk-cover scheme to place a set of relay nodes R_1, such that for8s 2 S; 9r 2 R_1, and recovers.
- Use R_1 as an input of the STP-MSP algorithm to place additional relay nodes R_2, such that G is connected.
- Output G and the position of each relay node.

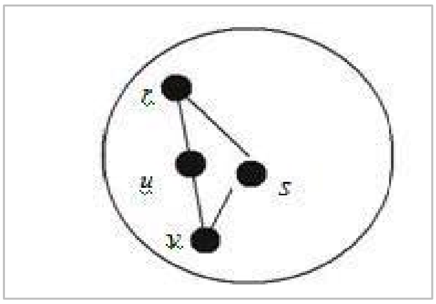


Figure 39-1 Communication circle of sensor

Step 2:

- Input: S , a set of sensor nodes with locations.€ any given error that is larger than 0. d , the communication radius of sensor nodes and relay nodes.
- Output: G, a 2-connected network including sensor nodes and relay nodes.
- Run algorithm 1 to get a set of relay nodes R, such that S C R is connected.
- Add three backup nodes in the communication circle of each r 2 R. The set of all backup nodes in this step is denoted by R^0
- Output G and positions of relay nodes in R C R^0

Step 3:

- Input: R _ r > 0, "> 0, and set of sensor nodes X D fx_1; : : :; x_n g.
- Output: Set of relay nodes Y D fy_1; y_l g.
- Apply 5-approximation algorithm in [23] to place set of relay nodes
- Z D fz_1 ; : : :; z_k g, such that the resulting network is connected.
- Duplicate each of the relay nodes in Z to obtain Y

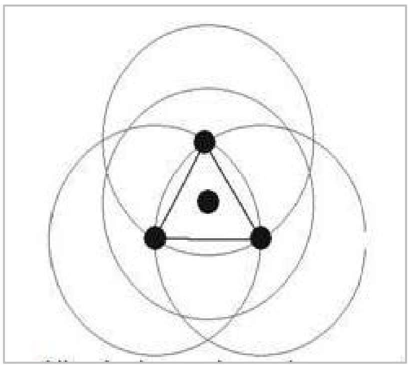


Figure 39-2 Adding backup nodes to the communication circle of r

ANOTHER APPROACH (TOPOLOGY CONTROL)

Although node placement provides a method to achieving fault tolerance in a WSN, the property of fault tolerance may be not valid due to movements and energy depletion of nodes. Therefore, topology control is required to construct and maintain the property of fault tolerance in WSNs [9]. A faulttolerant topology control protocol was proposed it first constructs a Connected Dominating Set (CDS) as a backbone of the network. For each node in the CDS, it adds necessary neighbours of the node to the backbone, such that it meets the required vertex connectivity degree. The power on/off model is adopted to turn on the nodes in the backbone to meet connectivity requirement, and other unnecessary nodes are off. Period rotation is used to keep the fairness among nodes.

There are several selection metrics. One is powerbase selection: the node in CDS selects nodes with more power one by one till the resulting graph is local k vertex connected [10]. Another metric is connection degree. The nodes with higher connection degree are first selected. It is because that the nodes with higher connection degree are supposed to have shorter delay. Simulation results show the improvement of network lifetime with a desired vertex connectivity degree.

The problem is to adjust each sensor's transmission range, such that there exist k-vertex disjoint communication paths from each sensor to the set of super nodes. The objective is to minimize the total power consumed by sensors. Three solutions were proposed. The first k-approximation algorithm consists of two steps. In the first step, a given graph is reduced to a direct graph where super nodes are merged as a root. In the second step, existing optimal solution for the Min-Weight k-Out Connectivity problem is adopted to compute the minimal transmission range of each sensor. The two steps are briefly introduced one by one.

The given graph is denoted by G (v, E, c), where V is the set of nodes, E is the set of edges, and c is the set of weight of the edge (indicating the power consumed in the edge). The reduced graph is constructed as follows. All super nodes in V are merged into one node called the *root*. Edges between sensors remain the same, and an edge between a sensor and a super node is replaced with an edge between the sensor and the root. The weight of the edge remains the same. It should be pointed out that if a sensor is connected to more than one super node, only the edge to the closest super node is kept. After that, every undirected edge between two sensors is replaced with two directed arcs that point to each of them. An undirected edge between a sensor and the root is replaced with one directed arc from the sensor to the root. The process of the step is illustrated in Figure below. The algorithm in the second step is based on the reduced graph from the first step. It applies existing optimal solution for the Min-Weight k-Out Connectivity problem in the reduced graph. The final transmission range of each node is the transmission range used to meet the longest edge in final result. Detail of the algorithm is as follows.

Algorithm

- Construct the reduced graph of G.
- Reverse the direction of each arc in the reduced graph and keep the weight of the arc the same.
- Apply the optimal solution for the Min-Weight k -Out Connectivity problem.

- Reverse back the direction of each arc. **for** each sensor **d**
- Adjust transmission range to meet the longest arc in the graph.
- **end for.**

A. PICTORIAL CONCEPT

Fault-tolerant algorithms for collaborative target detection in sensor networks in which sensor nodes can either fail due to harsh environmental conditions or maliciously. Both algorithms are based on sensor nodes sharing information to reach consensus.

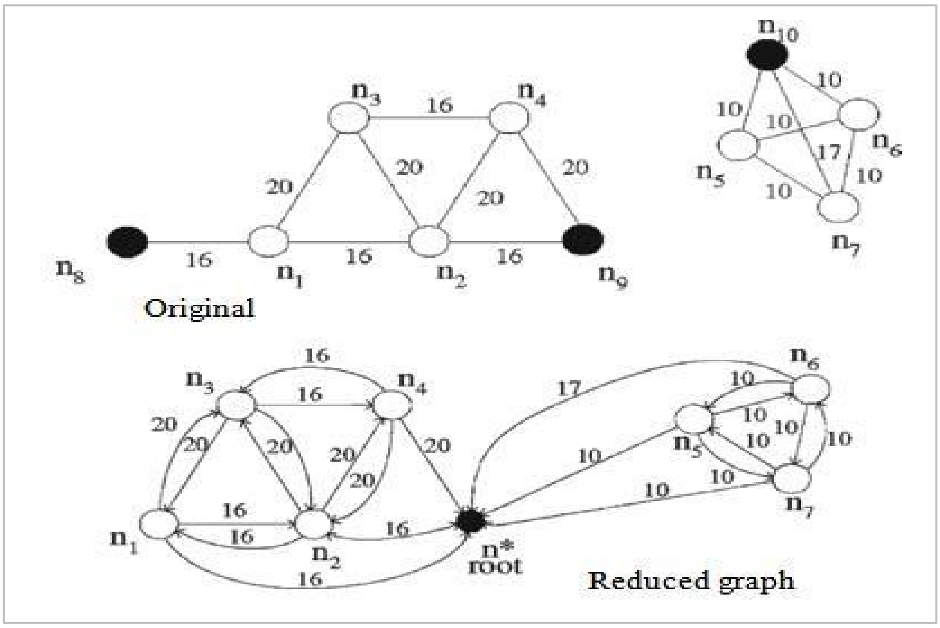


Figure 39-3 Original graph and reduced graph

Fault-tolerant algorithms for collaborative target detection in sensor networks in which sensor nodes can either fail due to harsh environmental conditions or maliciously. Both algorithms are based on sensor nodes sharing information to reach consensus.

The first algorithm, called *value fusion*, works as follows. Each node obtains raw energy measurements from every node, computes an average by removing the largest n and smallest n values, and compares this average to a threshold for final decision for a given n. The second algorithm, called *decision fusion*, does not work on raw measurement but rather on local decision of each sensor node. It works in the same way as the value fusion algorithm. The authors mention that there is no need for dropping the data when all nodes are known to be fault-free.

Algorithm for target detection

- Each sensor in a given neighbourhood obtains its signal measurements.
- Each sensor computes its median.
- If the median exceeds a threshold the sensor becomes an event sensor.

Algorithm for target localization

- Obtain the estimated signal strength from all event sensors in a given neighbourhood.
- Compute the local event sensor that has the maximum signal strength in a given neighbourhood and label them root sensors.
- For each root sensor compute the location of a target based on the geometric centre of a subset of event sensors.

Algorithm for target identification

- For each epoch, apply above Target Detection and Target Location algorithm.
- After collecting raw data for T epochs, the base station applies a clustering algorithm to group the estimates into a final target position computation. Each group is one target.
- If the size of a group is less than half the number of epochs (i.e., T =2), then with high probability this group is a false alarm; otherwise, report a target and obtain the estimate of the position of the target using the geometric centre of all raw data within the group.

B. BY INCREASING CAPACITY OF A CELLULAR NETWORK

As the demand for wireless service increases, the number of channels assigned to a cell ultimately becomes inadequate to support the essential number of users. At this point, cellular design techniques are needed to provide more channels per unit coverage area. Techniques such as cell splitting, sectoring, and coverage zone approaches are used to expand the capacity of cellular systems and increases the fault tolerance ability. There are several methods for enhancing capacity of a Cellular network:

C. CELL SPLITTING

It is is the process of sub dividing a congested cell into smaller cells, each one having its own base station and analogous reduction in antenna height and transmitted power ultimately increases capacity of a cellular system. By keeping D/R ratio constant entire system is rescaled.

D. CELL SECTORING

In Wireless network, a single unidirectional antenna at base station can be replaced by multiple directional antennas covering a particular sector for signal radiation and power is transmitted in single desired direction by decreasing number of interfering co-channel cells and co-channel interference, ultimately increases S/I ratio which turns to enhance the system performance. On the amount of sectoring used, the cochannel interference is reduced.

E. MICROCELL ZONE CONCEPT

On increased number of hand off, load on the switching and control link increases because of sectoring. By microcell zone concept, this problem can be resolve.

F. IMPROVISED TECHNIQUE USING KRUSHKAL'S ALGORITHM

FGSS: Fault-tolerant Global Spanning Sub graph

It present a centralized greedy algorithm, FGSSk that builds kconnected spanning sub graphs. Kristal's algorithm is wellknown algorithm to construct the minimum spanning tree (1connected spanning sub graph) of a given graph. FGSS is a generalized version of Kruskal's algorithm for k2The algorithm is given in Algorithm 1.

$FGSS_k$

INPUT: G ($V; E$), ak-connected simple graph;

OUTPUT: G_k($V_k; E_k$), ak-connected spanning sub-graph of G; V_k:= V , E_k:= ;;

sort all edges in E in an ascending order of weight (as defined

in *Definition 2*); **for** each edge($u_0; v_0$)in the order **do** **if** $u_0$is not$k$-connected to$v_0$inG_k **then** E_k:= E_k [f($u_0; v_0$)g;

else if all nodes are in the same$k$-connectedcomponent **then** exit;

end if ;

end for ;

By using network flow techniques, a query on whether two vertices are k-connected can be answered in $O(n+m)$ time for any fixed k, where n is the number of vertices and m is the number of edges in the graph. For k 3, there also exists O (1) time algorithms. Therefore, the time complexity of $FGSS_k$ is $O(m(n + m))$, and can be improved to $O(m)$for k 3.

CONCLUSIONS

The goal of the paper is to investigate current research work on fault tolerance in WSNs. it studied how fault-tolerant techniques were addressed in node placement, topology control, target and event detection, data gathering and aggregation, and sensor surveillance. The paper focused on the application layer and introduced representative works in each application. Actually, there are other applications where fault tolerance attracts attention, such as clustering, time synchronization, gateway assignment, etc.Although extensive works have been done on fault tolerance in each layer of the WSN system, cross-layer solutions are expected in future. Use of the resource could be more efficient if resource can be properly integrated and scheduled in different layers. Therefore, cross-layer solutions are expected to have better performance than current solutions.A new trend of WSNs is to cooperate or integrate with other wireless de-vice/systems, such as actuator networks and RFID system. For example, there are an increasing number of applications that require the network system to interact with the physical system or environment via actuators. That is, it requires the use of sensor networks along with actuators to build wireless sensor and actuator net-works (WSANs). Although fault tolerance techniques for WSNs could be reused in WSANs, there are new challenges that require new solutions. The sensors Network, report their data to the actuator may either switch to another actuator or directly pass the data to the sink.

REFERENCES

[1] V. Dhiman and T.P. Sharma," Optimal Node Deployment for Fault Tolerant Wireless Sensor Networks: A Survey", International Journal of Advanced Research in Computer Engineering & Technology.,Vol. 4 Issue 5, May 2015.

[2] F. Hussen, K. Elleithy and A. Razaque.," Implementation of Fault Tolerance Algorithm to Restore Affected Nodes in Scheduling Clusters", International Journal of Computer Networks & Communications., Vol.4, No.1, January 2012.

[3] D. K. Baruah and L.P. Saikia.," A Review on Fault Tolerance Techniques and Algorithms in Cloud Computing Environment", International Journal of Advanced Research in Computer Science and Software Engineering. Vol. 5, Issue 5, May 2015.

[4] P.D. Kale and R.M. Tugnayat.," A Survey of Fault Detection and Management Techniques in Wireless Sensor Networks", International Journal of Engineering and Technical Research, Vol.2, Issue-6, June 2014

[5] Bhuiyan, M.Z.A.; Wang, G.; Cao, J.; Wu, J. Deploying wireless sensor networks with fault-tolerance for structural health monitoring. IEEE Trans. Comput. 2015, 64, 382–395.

[6] Zhu, Y.H.; Qiu, S.; Chi, K.; Fang, Y. Latency aware IPv6 packet delivery scheme over IEEE 802.15.4 based battery-free wireless sensor networks. IEEE Trans. Mob. Comput. 2016.

[7] A.K. Marandi and D.A. Khan.,"Statistical analysis of defect removal effectiveness to improve the software quality and reducing the estimated cost", IEEE Xplore. 04 May 2015.

[8] F. Araujo,´ and L. Rodrigues. "On the Monitoring Period for Fault-Tolerant Sensor Networks," LADC 2005, LNCS 3747, Sao˜ Salvador da Bahia, Brazil, October 2005.

[9] J.L. Brediny, E.D. Demainez, M.T. Hajiaghayiz, and D. Rus, "Deploying Sensor Networks with Guaranteed Capacity and Fault Tolerance," MobiHoc 2005, urbana-champaign, IL, 2005.

[10] M. Cardei, S.Yang, and J.Wu, "Algorithms for Fault-Tolerant Topology in Heterogeneous Wireless Sensor Networks," IEEE Transactions on Parallel and Distributed Systems, vol. 19, no. 4, pp. 545–558, 2008.

[11] Samira Choukhi, et. al.; "A Survey on Fault Tolerance in Small and Large Scale Wireless Sensor Networks" , Computer Communication 2015.

40. Investigations on CRLH-TL based Multiband Conformal Antennas for Curved Surfaces

Mohammad Ameen, and Raghvendra Kumar Chaudhary

Department of Electronics Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad, India

mohammadmn61@gmail.com, and raghvendra.chaudhary@gmail.com

ABSTRACT

This paper discusses the design of a low profile and compact triple-band conformal antenna based on composite right/left-handed (CRLH) transmission line (TL). The intended antenna provides an electrically smaller size with ka = 0.84 due to its ZOR behaviour with complete electrical size of 0.17 λ0 × 0.20 λ0 × 0.004 λ0 at 2.27 GHz. The antenna provides a overall physical dimension of 23 × 27 × 0.6 mm3. The intended antenna provides three frequency bands ranging from (2.25–2.29 GHz), (3.39–3.95 GHz), and (4.80–6.12 GHz) with impedance bandwidths (IBWs) of 1.98%, 15.62%, and 24.95% for the three consecutive bands. The proposed CRLH-TL antenna exhibits a maximum gain of 0.76 dBi, 1.45 dBi, and 3.22 dBi for the three frequency bands respectively. The intended provides similar results for bending angle $\theta = 0^0$ *to* $\theta = 240^0$*. Hence the intended conformal antenna is well suitable for working in various curved surfaces.*

Index Terms— *composite right/left-handed, conformal antenna, triple band, low profile, transmission line.*

INTRODUCTION

Due to the emerging technologies and their corresponding applications, devices with lesser size and more number of functionalities are necessary for the upcoming and modern wireless application systems. Older antenna designs are based on microstrip planar structures, which faces the problem of smaller gain, higher cross-polar radiation, narrow impedance IBW, poor radiation efficiency with higher antenna dimensions. After the introduction of the metamaterials (MTMs), progressively technologies are showing drastic improvement in terms of antenna size and their performances. MTMs antennas are based on artificially engineered designs, which have both negative permeability ($\mu < 0$) and negative permittivity ($\varepsilon < 0$). These properties are shown by the LH structures with different features that are not achievable by existing RH structures [1]– [2].

MTMs can provide device miniaturization with good antenna performances, what the current technologies needed. MTM based antennas can be realized either by CTLH-TL based structures [1–10] or resonant approach [11–12] by the placement of split-ring resonator (SRR), complementary SRR, and so on. The inherent features of MTM are the generation of negative order mode, ZOR modes and first-order mode which are being exploited for device miniaturization with multiple numbers of operating frequency bands [1]. Different types of MTM based antenna configurations are highlighted with wideband and multiband performances are explained in [2–15], where it mainly uses CRLH-TL based wideband antenna by merging different modes [3–5], epsilon negative -TL based narrowband CP antenna [6], ENG-TL with square-shaped crossed slots [7], CRLH-TL based wideband antennas [8], loading of two simplified MTM transmission lines [9], loading of multiple CRLH-unit cells [10], complementary capacitive loops [11], MTM inspired antenna using SRR [12], patch loaded with electromagnetic bandgap conductor [13], and ENG-TL based MTM inspired antenna [14]. Besides the advantage of compactness and wider bandwidth, these antennas facing the problem of lesser gain [8], [10], [14]. and lower radiation efficiency [10] with a larger antenna profile [5], [14].

Recently, the use of conformal antennas are also getting more interest towards the antenna designers and researchers due to the reason of easily mountable to any curved surfaces and it provides design flexibility by changing the bending angle (θ). Various number of conformal antennas based on MTM [15], as well as microstrip technology [16–19] are explained in the literature. Antennas based on epsilon negative zero and munegative zero explained [15], conformal array [16], flexible antenna with reconfigurability [17], loading MTM structures [18] and multiple-input-multiple-output antenna based on conformality [19]. These antennas provide better results at the expense of larger size and volume. Hence it is difficult to arrange properly on the newer application systems. Even though these antennas facilitate moderate IBW, but they do not provides compactness and required gain for the contemporary technology needs. The current antenna designs are targeted towards compactness and lesser space utilization. Hence it is necessary to design a flexible antenna with better performance that is useful for the modern wireless application systems.

In this work, a CRLH-TL based low-profile antenna is motivated from [2] is made into a conformal antenna for tripleband applications is investigated. The antenna compactness is achieved due to the CRLH-TL property. The newly designed MTM antenna can be used in various curved surfaces by changing the $\theta = 0^0$ to $\theta = 240^0$. The intended antenna without bending can covers almost similar response when compared with conformal for various bending angles.

ANTENNA GEOMETRY AND DESIGN

The simplified view of the designed triple band CRLH-TL loaded antenna with dimensions are marked as depicted in Fig. 40-1. The intended CRLH-TL antenna geometry is designed on the antenna fabrication is not complex. The intended CRLH-TL antenna mainly exists of an upturned 'L' shaped feed line of length (Lf1 + Lf2 + G2) and width (Wf). A trimmed step-shaped slot of width G2 is placed inside the main feed line, which gives the CRLH-TL series capacitance (CL) [1]. A chamfered meander line is added for achieving the shunt elements LL and CR. The edge chamfered meander line is connected with a corner blended triangular-shaped stub for providing the virtual ground to CRLH-TL. Fig. 40-2 demonstrates the 3D view of the actual antenna (θ = 2100) designed for different faces of the front view. The final dimensions of the CRLH-TL antenna with θ = 00 are 23 × 27 × 0.6 mm3 with electrical size of 0.17 λ0 × 0.20 λ0 × 0.004 λ0 at 2.27 GHz. The optimized dimensions at θ = 00 are L = 23, L1 = 6, L2 = 0.35, LV = 6.92, Lf1 = 8.5, Lf2 = 18.20, Lg = 5, W = 27, W1 = 1.8, W2 = 9, Wg = 17.7, Wf = 5, G1 = G2 = 0.3, and G3 = 0.5 (All dimensions are in mm).

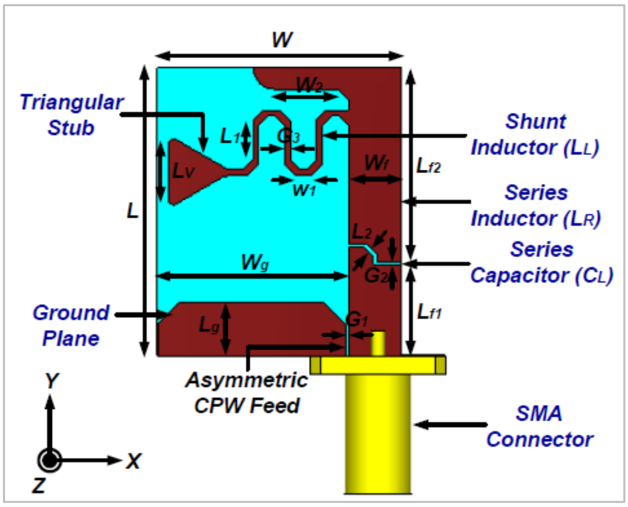


Figure 40-1 The schematic view of the proposed tri-band antenna modified from [2].

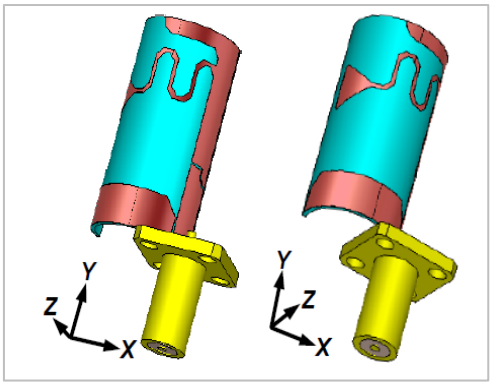
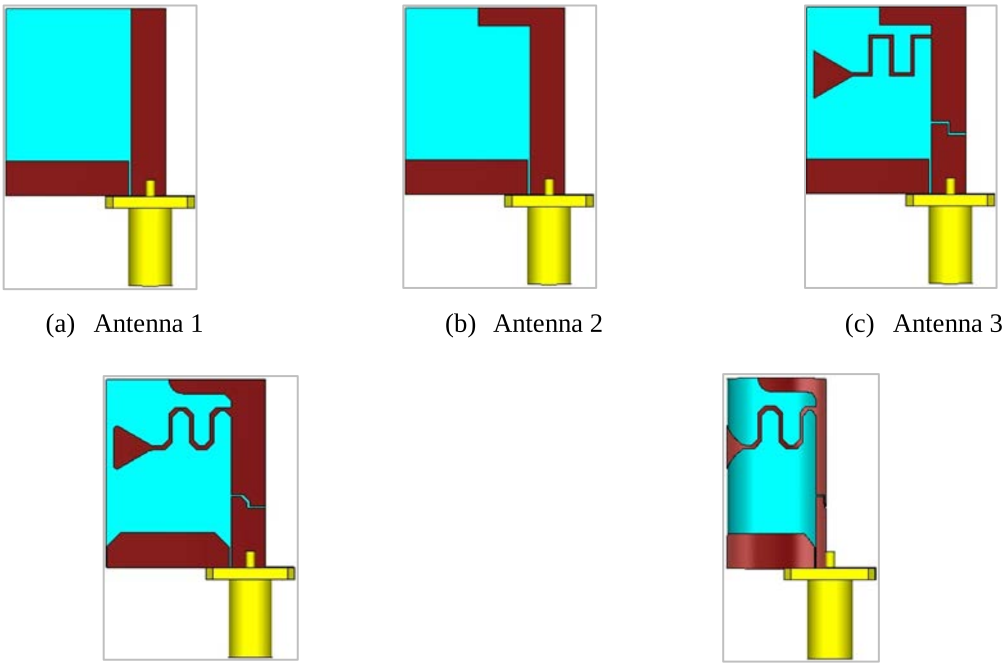


Figure 40-2 The 3D view of the conformal antenna for different angles of front view

A. DESIGN STAGES OF THE PROPOSED ANTENNA

Fig. 40-3 and 40-4 displays the design evolution stages of the intended CRLH-TL antenna and its input reflection coefficient responses (S_{11}). Firstly, a microstrip line and ground plane uses asymmetric CPW feeding which is represented as Antenna 1. The continuation of the microstrip feed line to an upturned '*L*' shape feed denoted as Antenna 2 in Fig. 40-3(b). The addition of step-type capacitor, meander lines, and triangular strip results in the generation of CRLH-TL antenna-3 in Fig. 40-3(c). In the next stage, modifying the trimmed shape meander lines and step-type capacitor results in antenna-4 is plotted in Fig. 40-3(d). In the last stage, changing the bending angle $\theta = 0^0$ to $\theta = 210^0$ results in Antenna-5 depicted in Fig. 40-3(e).



(a) Antenna 1 (b) Antenna 2 (c) Antenna 3

(d) Antenna 4 (e) Antenna 5

Figure 40-3 The conformal antenna design evolution from Antenna-1 to Antenna-5.

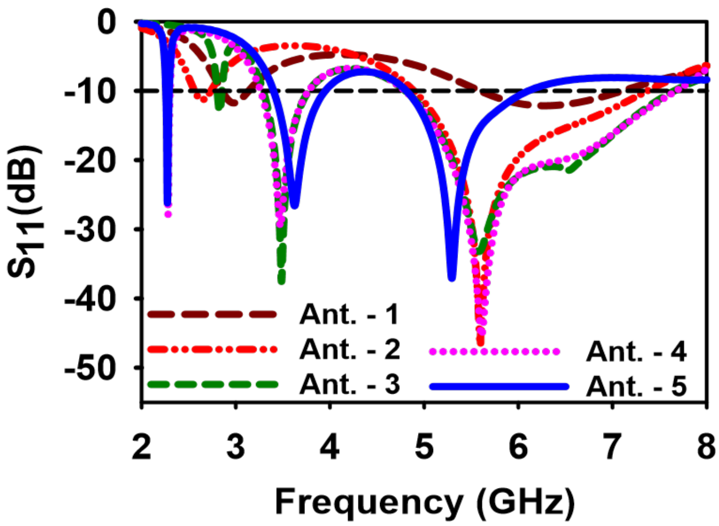


Figure 40-4 S_{11} responses of the antenna design stages described in Fig.40-3.

B. EQUIVALENT CIRCUIT MODELLING OF THE CRLH-TL ANTENNA-5

The proposed triple-band CRLH-TL loaded antenna pictured in Fig. 40-3(e) is based on open-ended boundary condition TL. The circuit model of the CRLH-TL antenna is pictured in Fig. 40-5. In the circuit diagram, the series arm mainly exists of a series inductor (L1) which is accounted due to the feedline part (Lf1 × Wf). The shunt capacitor C1 is represented by the asymmetric gap between the microstrip feed and AGP. Further CRLH-TL is loaded and which consists of a series capacitor represented by CL is formed due to the trimmed steptype slot of gap G2. The series inductance (LR) is obtained due to Lf2 × Wf part which constitutes the series arm of CRLH-TL. For realizing shunt arm, chamfering is done in the normal meander line and it is represented by LL. The shunt capacitance (CR) is provided due to the gap between the chamfered meander lines. The additional capacitor (CV) is generated due to the coupling between triangular-shaped patch with edges that are blended and the AGP. Here the edge-blended triangular stub works as the virtual ground for the CRLH-TL antenna. The resistor (R) and conductance (G) accounts for the losses in TL. The intended antenna-5 is based on open-ended boundary condition of TL and hence the resonant frequency is due to shunt elements LL, CR, and CV.

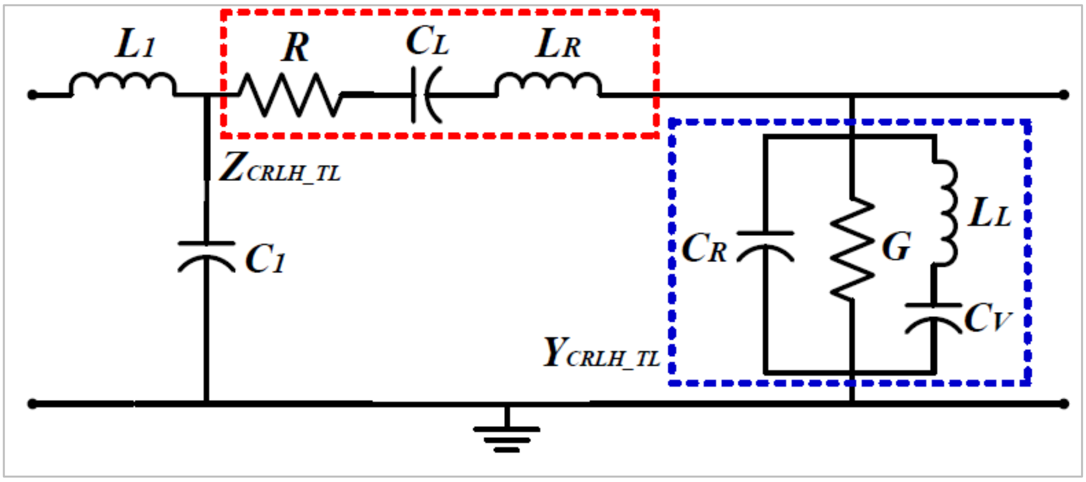


Figure 40-5 . Equivalent circuit diagram for the conformal CRLH-TL antenna-5

C. PARAMETRIC STUDIES OF THE INTENDED CRLH-TL ANTENNA

Fig. 40-6 shows the variation of the S11 responses by varying the series capacitor (CL) width represented by G2. It is noted that when the width G2 is varying from G2 = 0.1 mm to G2 = 0.9 mm and there is no variation in the ZOR. In Fig. 40-7, the variation of the shunt capacitor (CR) by changing the width W1 from W1 = 0.6 mm to W1 = 2.2 mm is depicted. It is clearly noted that the changes in the shunt element CR, the ZOR is shifting towards smaller frequency ranges and an optimized value of W1 = 1.8 mm is selected.

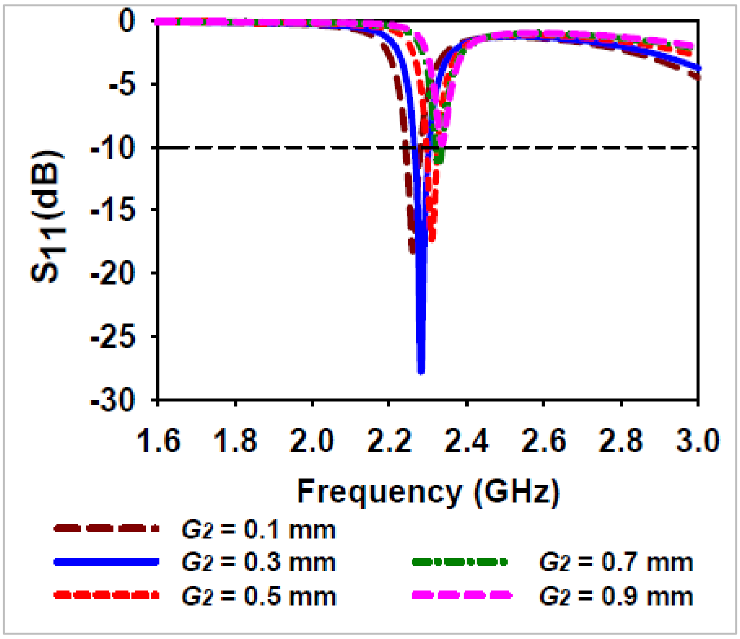


Figure 40-6 Simulated S_{11} of the Antenna-5 by varying G2 from 0.1 mm 0.9 mm.

Fig. 40-8 depicts the modification of shunt inductor (LL) values by varying the length L1 of the trimmed meander line. It is noted that by enlarging the length of the trimmed meander line from L1 = 4 mm to L1 = 8 mm. The resonance will shifts to a lower frequency range, signifies that increasing the shunt inductance (LL) shifts the resonance to smaller frequency and an optimized value of L1 = 6 mm is selected. So it is proved that changing the series and shunt parameters, the shift occurs in shunt elements and no shift is noticed by varying series elements.

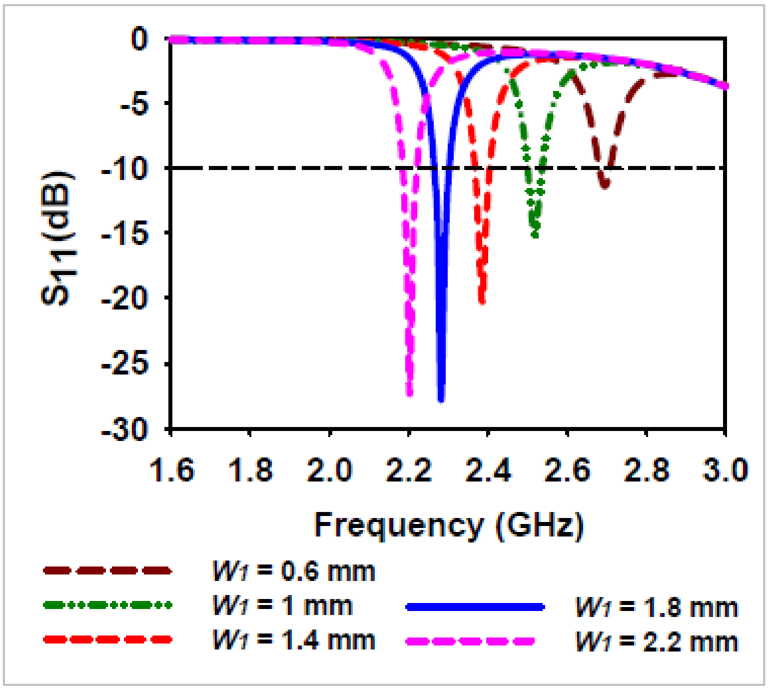


Figure 40-7 Simulated S_{11} of the Antenna-5 by varying W1 from 0.6 mm 2.2 mm.

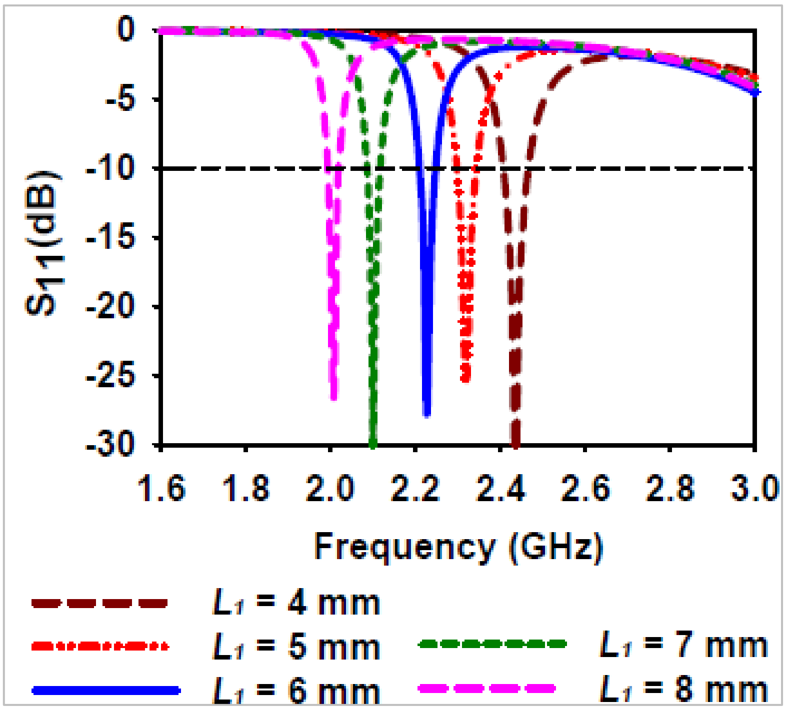


Figure 40-8 Simulated S_{11} of the Antenna-5 by varying L1 from 4 mm to 8 mm.

ANALYSIS OF CRLH-TL BASED CONFORMAL ANTENNA

The antenna-4 designed in the above stage can be made conformal by varying the θ as shown in Fig. 40-9 (antenna-5). By making conformal as depicted in Fig. 40-10 and 40-11, the antenna can be placed in any conformal surfaces with better space and volume utilization. Fig. 40-10(a) to 40-10(d) showing the antenna designs by changing the bending angle from $\theta = 30^0$ to $\theta = 120^0$. Also in Fig. 40-11(a) to 40-11(d) showing the antenna designs by changing the bending angle from $\theta = 150^0$ to $\theta = 240^0$. Fig. 40-12 and 40-13 depicts the variation of S_{11} characteristics from $\theta = 30^0$ to $\theta = 240^0$. It is to be noted that good S_{11} response are obtained at higher bending angle $\theta = 210^0$

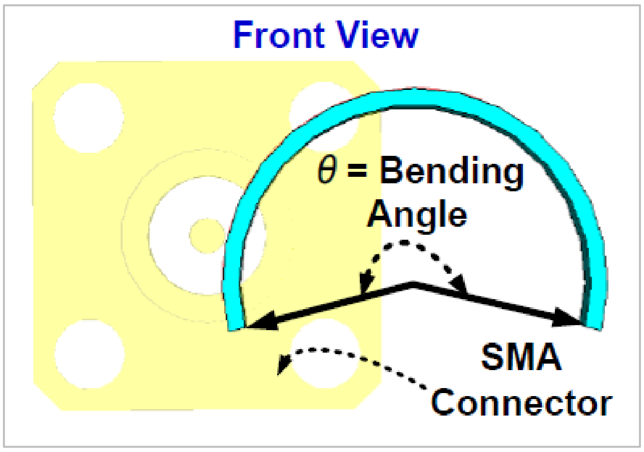


Figure 40-9 Proposed bending scheme with bending angle

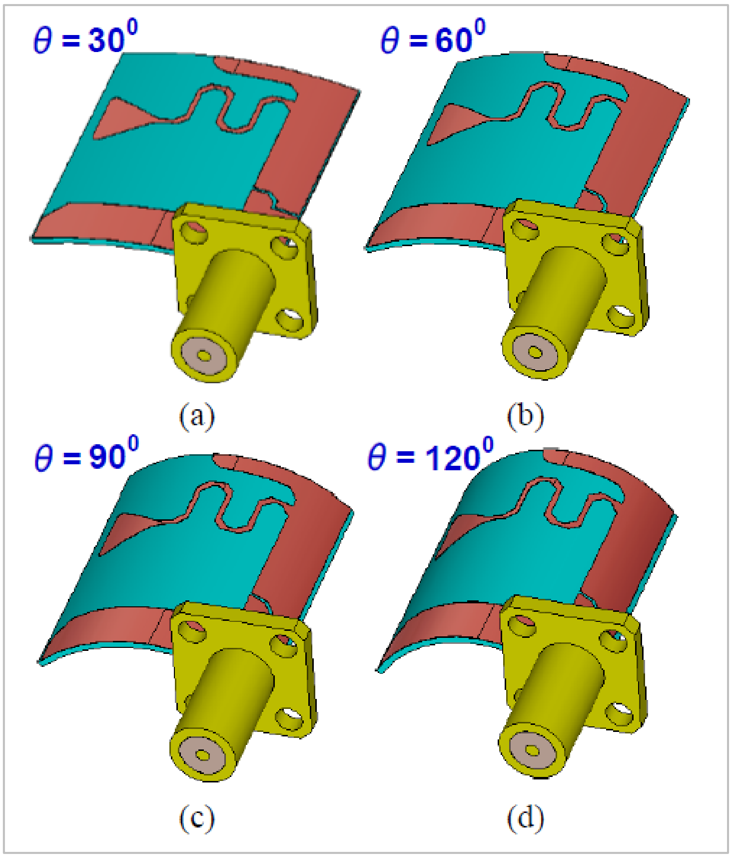


Figure 40-10 CRLH-TL based conformal antenna. (a) $\theta = 30^0$, (b) $\theta = 60^0$, (c) $\theta = 90^0$, and (d) $\theta = 120^0$

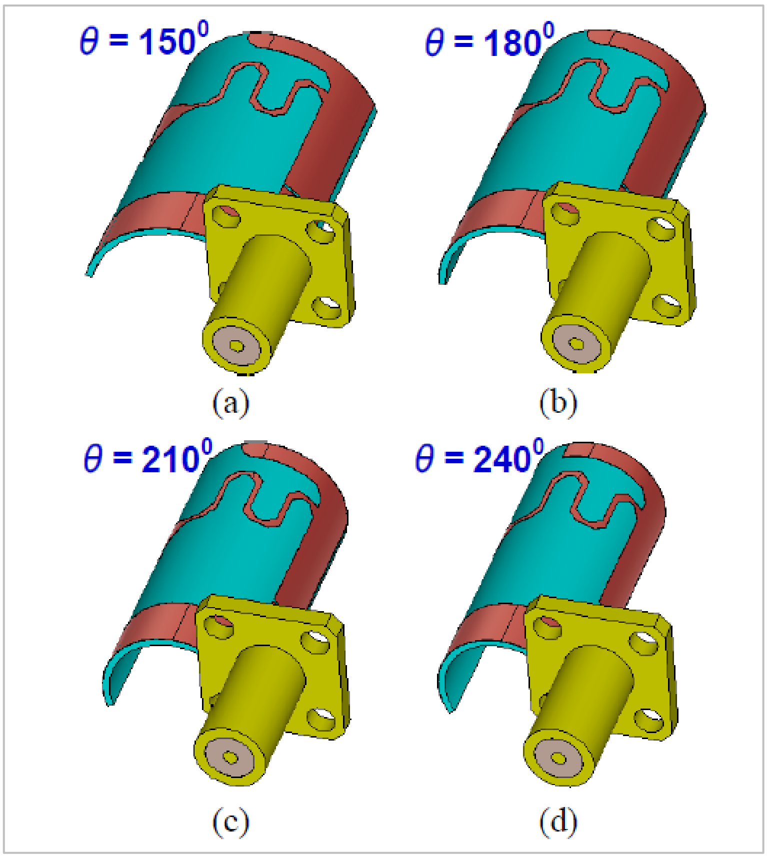


Figure 40-11 CRLH-TL based conformal antenna. (a) θ = 150⁰, (b) θ = 180⁰, (c) θ = 210⁰, and (d) θ = 240°

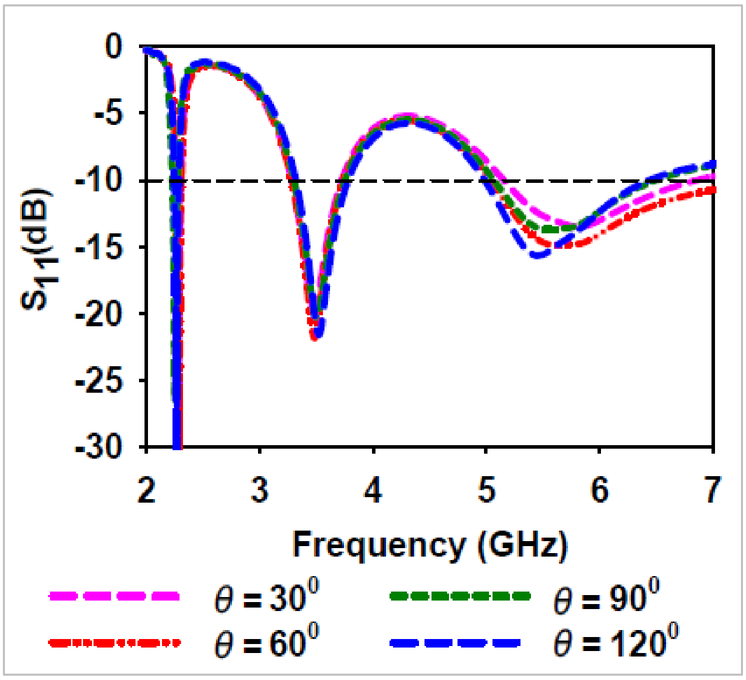


Figure 40-12 Simulated S_{11} results of the antenna-5 from $\theta = 30^0$ to $\theta = 120^0$

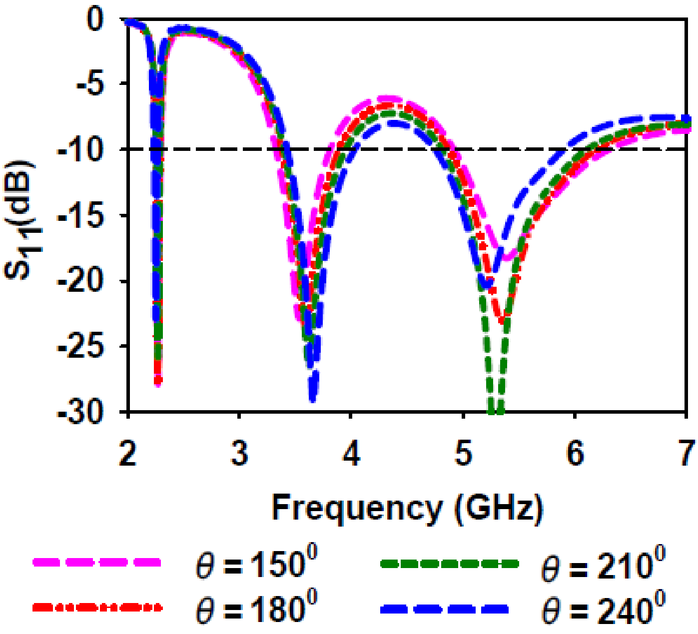


Figure 40-13 Simulated S_{11} results of the antenna-5 from $\theta = 150^0$ to $\theta = 240^0$

RESULTS AND DISCUSSIONS

The designed conformal antenna-5 is simulated using CST Microwave Studio. The 10-dB BW for the tri-band CRLH-TL antenna at $\theta = 210^0$ is 45 MHz (2.25–2.295 GHz), 564 MHz (3.39–3.954 GHz), and 1320 MHz (4.80–6.12 GHz) with an equivalent IBW of 1.98%, 15.62%, and 24.95% for the three consecutive bands at the mid frequencies of 2.27 GHz, 3.61 GHz, and 5.29 GHz as depicted in Fig. 40-14. Also, Fig. 40-15 demonstrates the radiation efficiency and gain of the intended antenna-5 at $\theta = 210^0$. The intended CRLH-TL conformal antenna exhibits a maximum gain of 0.76 dBi, 1.45 dBi and 3.22 dBi for the three consecutive bands. The simulated efficiency of 64.15%, 94.8%, and 97.02% is obtained for the working bands. The 2-D radiation pattern of the CRLH-TL antenna is also drawn. Fig. 40-16 depicts the simulated 2D patterns in *yz*– and *xz*–plane at the midpoints of each working band for 2.27 GHz, 3.61 GHz, and 5.29 GHz. For *xz*–plane at 2.27 GHz and 5.29 GHz, the antenna shows circular pattern and the bidirectional radiation behavior is noticed at 3.61 GHz. At *yz*– plane, bidirectional radiation behavior is noticed at 2.27 GHz and 5.29 GHz and circular pattern is observed at 3.61 GHz.

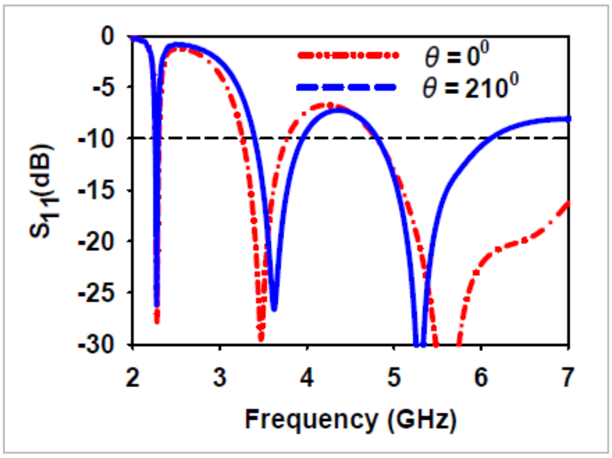


Figure 40-14 Simulated S_{11} response of the proposed tri-band CRLH-TL loaded antenna for $\theta = 0^0$ and $\theta = 210^0$

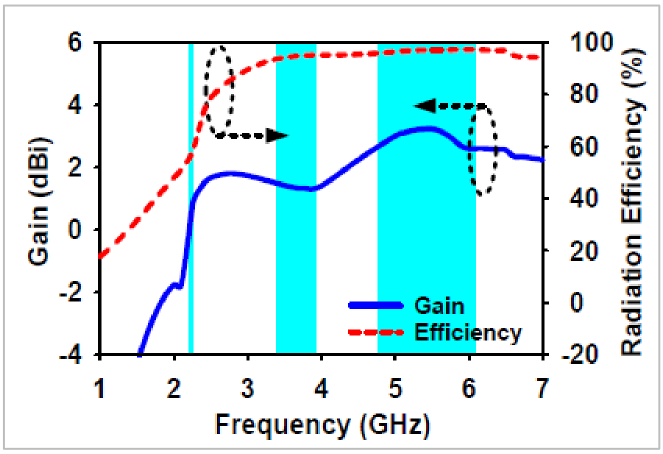


Figure 40-15 Gain and efficiency of the intended MTM antenna at θ =210º

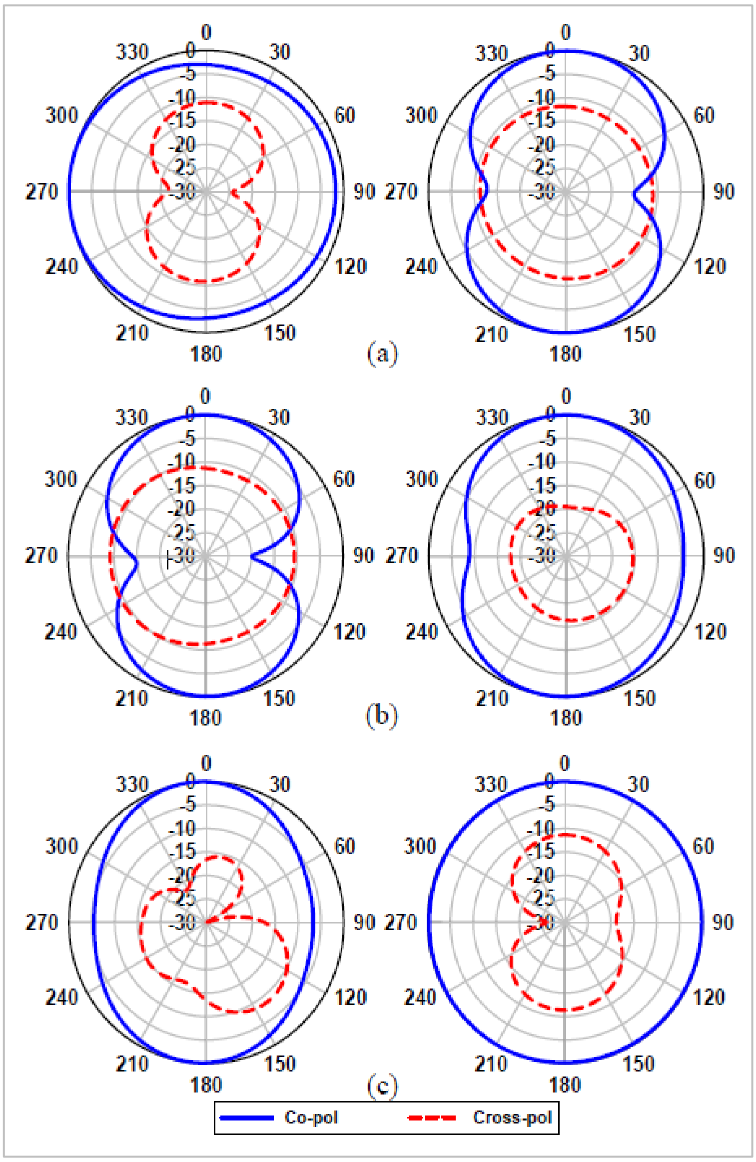


Figure 40-16 The radiation pattern of the conformal CRLH-TL antenna at θ = 210⁰.

CONCLUSIONS

A compact CRLH-TL based low profile and miniaturized tri-band conformal antenna is designed and studied in this paper. The intended antenna shows improved IBW of 1.98%, 15.62% and 24.95% for the three consecutive frequency bands. The equivalent circuit model is designed and parametric investigations are done for analyzing the ZOR performance of the antenna. The intended antenna provides a compact electrical size of 0.17 $\lambda_0 \times 0.20$ $\lambda_0 \times 0.004$ λ_0 with $ka = 0.84$. Triple band antenna responses are obtained by simply changing the bending angle of the CRLH-TL antenna from $\theta = 0^0$ to $\theta = 210^0$.

REFERENCES

[1] A. Lai, K. et. al.,, "Infinite wavelength resonant antennas with monopolar radiation Pattern Based on Periodic Structures," IEEE Trans. Antennas Propag., vol. 55, no. 13, pp. 868–876, Mar. 2007.

[2] M. Ameen, S. Kalraiya and R. K. Chaudhary, "A compact low profile modified ACS-fed triple band open-ended metamaterial antenna for UMTS, WLAN, and WiMAX applications," 2019 URSI Asia-Pacific Radio Science Conference (AP-RASC), India, 2019, pp. 1–4.

[3] M. Ameen and R. K. Chaudhary, "Metamaterial circularly polarized antennas: Integrating an epsilon negative transmission line and single split ring-type resonator," IEEE Antennas Propag. Mag., .doi: 10.1109/MAP. 2019.2950920.

[4] M. Ameen and R. K. Chaudhary, "Metamaterial-based wideband circularly polarized antenna with rotated V-shaped metasurface for small satellite applications," Electron. Lett., vol. 55, no. 7, pp. 365–366, Apr. 2019.

[5] P. W. Chen and F. C. Chen, "Asymmetric coplanar waveguide (ACPW) zeroth-order resonant (ZOR) antenna with high efficiency and bandwidth enhancement," IEEE Antennas Wireless Propag. Lett., vol. 11, pp. 527–530, 2012.

[6] M. Ameen, and R. K. Chaudhary, "Metamaterial-based circularly polarised antenna employing ENG-TL with enhanced bandwidth for WLAN applications," Electron. Lett., vol. 54, no. 20, pp. 1152–1154, Oct. 2018.

[7] L. Liu and B. Wang, "A broadband and electrically small planar monopole employing metamaterial transmission line," IEEE Antennas Wireless Propag. Lett., vol. 14, pp. 1018–1021, 2015.

[8] P. L. Chi and Y. Shih, "Compact and bandwidth-enhanced zeroth-order resonant antenna," IEEE Antennas Wireless Propag. Lett., vol. 14, pp. 285–288, 2015.

[9] C. Zhou, G. Wang, J. Liang, et. al., "Broadband antenna employing simplified MTLs for WLAN/WiMAX Applications," IEEE Antennas Wireless Propag. Lett., vol. 13, pp. 595–598, 2014.

[10] M. Palandoken, A. Grede and H. Henke, "Broadband microstrip antenna with left-handed metamaterials," IEEE Trans. Antennas Propag., vol. 57, no. 2, pp. 331–338, Feb. 2009.

[11] L. M. Si, Q. L. Zhang, W. D. Hu, et al., "A uniplanar triple-band dipole antenna using complementary capacitively loaded loop," IEEE Antennas Wireless Propag. Lett., vol. 14, pp. 743–746, March 2015.

[12] L. Si, W. Zhu and H. Sun, "A compact, planar, and CPW-fed metamaterial-inspired dual-band antenna," IEEE Antennas Wireless Propag. Lett., vol. 12, pp. 305–308, 2013.

[13] W. Cao, et. al., "Multi-frequency and dual mode patch antenna based on electromagnetic band-gap (EBG) structure," IEEE Trans. Antennas Propag., vol. 60, no. 12, pp. 6007–6012, Dec. 2012

[14] M. S. Majedi and A. R. Attari, "A compact and broadband metamaterial-inspired antenna," IEEE Antennas Wireless Propag. Lett., vol. 12, pp. 345–348, 2013.

[15] J. Xiong, X. Lin, Y. Yu, et. al., "Novel flexible dual-frequency broadside radiating rectangular patch antennas based on complementary planar ENZ or MNZ metamaterials," IEEE Trans. Antennas Propag., vol. 60, no. 8, pp. 3958–3961, Aug. 2012.

[16] A. T. Castro and S. K. Sharma, "Inkjet-printed wideband circularly polarized microstrip patch array antenna on a PET film flexible substrate material," IEEE Antennas Wireless Propag. Lett., vol. 17, no. 1, pp. 176–179, Jan. 2018.

[17] S. M. Saeed, et. al., "Wearable flexible reconfigurable antenna integrated with artificial magnetic conductor," IEEE Antennas Wireless Propag. Lett., vol. 16, pp. 2396–2399, 2017.

[18] M. Wang, et. al., "Investigation of SAR reduction using flexible antenna with metamaterial structure in wireless body area network," IEEE Trans. Antennas Propag., vol. 66, no. 6, pp. 3076–3086, Jun. 2018.

[19] W. Li, Y. Hei, P. M. Grubb, X. Shi and R. T. Chen, "Compact inkjetprinted flexible MIMO antenna for UWB applications," IEEE Access, vol. 6, pp. 50290–50298, 2018.

41. Area Coverage Optimization in WSN using Modified PSO

Amulya Anurag[1], Rahul Priyadarshi[2], Amit Goel[3], Bharat Gupta[4]

[1,2,3,4]Department of Electronics & Communication Engineering, National Institute of Technology Patna (Bihar), 800005, India

[1]amulya.ec18@nitp.ac.in, [2]rahul.ec18@nitp.ac.in, [3]amit1604086@nitp.ac.in, [4]bharat@nitp.ac.in

ABSTRACT

Wireless sensor network found immense uses in the daily life. Also, the random deployment of nodes is a preferable option in many applications such as earthquake observation, military applications, forest fire detection etc. It is expected that deployed nodes should be to able to monitor the field of interest (FoI) with the optimum capacity. In order to maximize the coverage of area, each node should be repositioned to an optimal position inside the FoI. A Modified Particle Swarm Optimization (PSO) algorithm has been proposed to achieve optimize coverage while keeping the number of nodes minimum. It introduces the concept of negative velocity in order to avoid premature convergence of the algorithm. The simulated results show a significant improvement in the performance with compared to the standard PSO.

Index Terms— *WSN, FoI, Particle swarm optimization, coverage, coverage rate.*

INTRODUCTION

The modern age requires a mixture of sophistication and simplicity in technology. Wireless sensor network (WSN) is a leading solution of modern age requirement[1]. WSN is a group of spatially distributed sensor nodes capable of sensing environment, processing information, transmission of gathered data[2]. The WSN consists of mainly four components viz: a group of spatially dispersed sensor nodes, an interconnection network between nodes, a central point of information gathering and a set of computing resources at the central point (or beyond) to handle data correlation, event trending, status querying, and data mining.

The coverage problem[3] in WSN can be stated as "how to deploy and relocate sensor nodes in order to maximally cover the field of interest (FoI) while keeping number of sensing nodes minimum". There are several categories of coverage techniques: Forced-based, grid-based, computational geometry based and metaheuristic based. Each category has its own prerequisites and constraints[4].

The concept of Particle Swarm Optimization (PSO) was first given by James Kennedy and Russell Eberhart in year 1995. It is a very efficient optimization technique inspired by the behavior of bird flocking. The particles involved in the swarm have very limited computational capability but working in a unison they provides a powerful optimization tool. The authors of [5] proposed an algorithm based on PSO and Voronoi diagram where PSO provides an optimal locations for sensor nodes and afterward Voronoi diagram checks the optimality of the solution. The authors of [6] has proposed an algorithm which optimize the coverage of a FoI in terms of energy and lifetime of the WSN in presence of obstacles. Another paper [7] uses PSO to optimize the information coverage rate using the minimum number of sensor nodes and using minimum energy[8].

Though PSO offers a great ease to optimize any multiobjective fitness function, its suffers from premature convergence[9]. Standard PSO can fall easily to a local maxima or minima rather than to a global solution. The presented algorithm introduces the concept of negative velocity and shows the improvement in the maximum coverage of the FoI in compared to standard PSO. It also shows faster convergence in compared to the standard PSO. The remaining paper has been organized in following manner: section II briefs the coverage mathematical models. Section III describe the standard PSO algorithm. Section IV elaborates the proposed algorithm. Section V simulation results are explored and finally in section VI the paper has been concluded.

WIRELESS SENSOR NETWORK COVERAGE MATHEMATICAL MODEL

A. PROBLEM DESCRIPTION

The field of interest is a restricted 2-dimensional plane, and a fixed number of sensor nodes are randomly deployed within the FoI. The objective is to attain the maximum coverage of the FoI using the deployed nodes. Some constraints and assumption has made:

- The sensing range of a node is in a form of disc centered at the nodes' position.
- The nodes are mobile in nature and they have enough energy to relocate to the final position from initial position.
- All the nodes are isomorphic with same sensing and communication radius.
- One node can know the location of every other node present in the FoI.
- There are no obstacles present inside the FoI.

B. COVERAGE MATHEMATICAL MODEL

Coverage ratio is the measure of what percentage of total area is being covered. Let the N be the total number of sensors dispersed in the FoI of area A and every node may sense an area A_s, thus the coverage ratio C_R can be given in (1) :

$$C_R = \left(\bigcup_{i=1,2,..N} A_{si} \right) /_A \qquad (1)$$

But the above expression of coverage ratio may become cumbersome and complicated for randomly dispersed nodes. A better option is provided by the authors of [10] for evaluating coverage ratio represented in (2).

$$C_R = \frac{m}{n} \qquad (2)$$

Where, *m* denotes the number of grid points covered by sensor nodes and *n* represent total number of grid points present in FoI. The value of m is defined by the coverage model being used. For binary sensing model as shown in (3):

$$m = cardinality\left(\bigcup_{i=1,2,..N} Q_i \right) \qquad (3)$$

Where, Q_i is the set of grid points lying inside the coverage range (r_s) of the sensor s_i. Whereas for probabilistic sensing model, the value of *m* is given by the number of grid points satisfying the following criteria described in (4):

$$C_{xy}(\rho, S_N) = 1 - \prod_{i=1}^{N}\left(1 - \left(C_{xy}(\rho, s_i)\right)\right) \geq C_{th} \qquad (4)$$

Here, $C_{xy}(\rho,S_N)$ is the joint coverage probability, C_{th} is a predetermined threshold and $C_{xy}(\rho,s_i)$ is the probability of detection the node s_i of a grid point $\rho(x,y)$ and given by the probabilistic sensing model as in (5):

$$C_{xy}(\rho, s_i) = \begin{cases} 1 & if \quad d(s_i, \rho) \leq r_s - r_e \\ e^{\left(\frac{-\alpha_1 \beta_1 \lambda_1}{\beta_2 \lambda_2 + \alpha_2}\right)} & if \quad r_s - r_e < d(s_i, \rho) < r_s + r_e \\ 0 & if \quad d(s_i, \rho) \leq r_s + r_e \end{cases} \qquad (5)$$

Where, r_e $(0 < r_e < r_s)$ is the uncertainty radius present in the sensing capability of the nodes and α_1, α_2, β_1, β_2 are constant related to nodes' characteristic, the value of λ_1, λ_2 are given in (6) and (7):

$$\lambda_1 = r_e - r + d(s_i + \rho) \qquad (6)$$

$$\lambda_2 = r_e + r + d(s_i + \rho) \qquad (7)$$

In all the above equation $d(s_i, \rho)$ represent the Euclidian separation amidst a sensor node s_i and point $\rho(x,y)$ given in (8):

$$d(s_i, \rho) = \sqrt{((x_i - x)^2 + (y_i - y)^2)} \qquad (8)$$

PARTICLE SWARM OPTIMIZATOIN

Particle swarm optimization[11] is a simple yet a very powerful optimizing tool. In PSO a total of N particle is dispersed randomly inside the search space. These swarm particle traverse through the search plane to give the local best solution and global best solution of the objective function. Let N be the total swarm size, x_i and p_i are the position and local best position of the sensor node s_i (where $1 \le i \le N$). Velocity of the particle is given by v_i. p_g denotes the global best particle and d is the dimension of the search space. Equation (9) and (10) describe the standard equations of the PSO.

$$v_{id}(t+1)= w*v_{id}(t)+c_1*r_1*(P_{id}-x_{id}(t)+c_2*r_2*(p_{gd}-x_{id}(t)) \qquad (9)$$

$$x_{id}(t+1) = x_{id}(t)+ v_{id}(t+1) \qquad (10)$$

In (9), the first part on the right hand side is *inertia part* and w denotes the inertia weight, the second part is the *cognitive part* with c_1 and r_1 being cognitive constant and random number ($0<r_1<1$). The third part is the *social part* with c_2 and r_2 being social constant and random number ($0<r_2<1$). Equation (10) updates the position of the node s_i. The velocity of any particle is governed by its own velocity, position of the best position achieved by it and the global best position.

PROPOSED ALGORITHM: MODIFIED PSO

A. OBJECTIVE FUNTION FOR THE COVERAGE PROBLEM

Suppose the WSN has the total N sensor nodes dispersed randomly over a square area. The aim of proposed work to enhance the coverage ratio by using a fixed amount of nodes and minimizing the movement of sensor nodes.

This optimization can be modeled as described in (11)

$$\text{Min}[F_1(x),F_2(x)] \qquad (11)$$

This is the multi-objective function where $F_1(x)$ and $F_2(x)$ are described in (12) and (13). Here, $x \epsilon$ *Search space*.

$$F_1(x) = \left(\frac{1}{N}\right) \sum_{i=1}^{N} \sqrt{(x_{i_{initial}} - x_{i_{new}})^2 + (y_{i_{initial}} - y_{i_{new}})^2} \qquad (12)$$

$$F_2(x)=1-C_R \qquad (13)$$

Where, $(x_{i\ initial}, y_{i\ initial})$ is the initial position of the nodes when they were deployed and $(x_{i\ new}, y_{i\ new})$ is the position of the node s_i after any iteration. To solve multi-objective function is to convert it into a weighted-sum problem as in (14).

$$min \sum_{i=1}^{2} \omega_i . F_i(x) \qquad (14)$$

In (14) ω_i is the weights associated with function F_i with two criteria viz: $\sum\omega_i = 1$ and $\omega_i > 0$ *for* $i=1,2$.

B. IMPROVED PARTICLE SWARM OPTIMIZATION

Assume that *N* have been deployed randomly in the area *A* and the search dimension is 2 *(d=2).* Let x_i and p_i are the position and local best position of the sensor node s_i (where $1 \leq i \leq N$). Velocity of the particle is given by v_i. p_g denotes the global best.

Step 1. *Initialization:* Deploy *N* number of sensor nodes to random positions in the area *A (d=2).* Assign zero initial velocity to every node. Assign the current position of nodes as the local best position.

Step 2. *Global best calculation:* Calculate the Euclidian Distance of each node's best position with respect to the origin of the area *i.e. (0,0).* The particle having largest value gives the global best position.

Step 3. *Position and Velocity updation:* The velocity and position one node (starting from 1st node) is to be updated using (15) and (16).

$$v_i(t+1)= w*v_i(t)+c_1*r_1*(P_i-x_i(t)+c_2*r_2*(p_g-x_i(t)) \qquad (15)$$

$$x_i(t+1) = x_i(t)- v_i(t+1) \qquad (10)$$

Step 4. *Local best calculation:* If the fitness value (using (14)) of the ith particle for current iteration is better than the previous iteration then, update the local best position for that particle with the current position otherwise no changes will be done in the local best position.

Step 5. Repeat step 3. and step 4. for every node in the swarm.

Step 6. If ending criteria is not met, traverse to step 2. Otherwise the present result is the optimized result. End of the algorithm.

The above steps describe the complete working of the proposed algorithm. Negative velocity of the particle ensures that algorithm will not converge prematurely.

SIMULATION RESULTS AND DISCUSSION

For observing the functioning of the presented algorithm, MATLAB 2019a software has been used.

A. SIMULATION PARAMETERS AND RESULTS

The parameters used for this simulation has been listed in table 41-1.

Table 41-1 Simulation Parameters

N	20
A	20×20 m^2
Max iteration	400
c_1	1.467
c_2	1.467
α_1	1
α_2	0
β_1	1
β_2	0.5
d (dimension of search space)	2
w	0.9 – (iteration / (2*Max iteration))

For simulation 20 sensor nodes has been deployed in 20×20 m^2 area in a random fashion The sensing radius is being varied for each simulation.

The optimization of coverage ratio of nodes having sensing radius r_s =*1.5m & r_e*= 0.25m has been shown in Fig. 41-1 and Fig. 41-2.

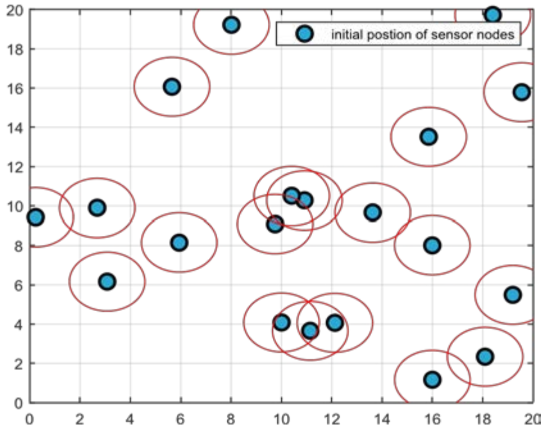


Figure 41-1 Initial placement of sensor nodes with r_s =1.5m & r_e= 0.25m

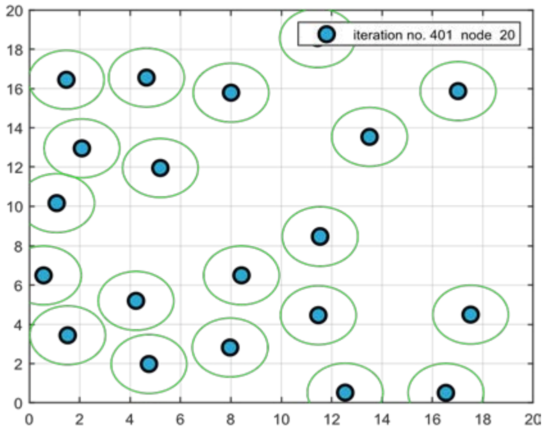


Figure 41-2 Optimised position of nodes(r_s =1.5m & r_e= 0.25m) after applying improved algorithm

The Fig. 41-2 shows the nodes acquire better position after algorithm. The initial coverage ratio was around 34.5% which becomes 45% after 270 iterations i.e.10.5% increase. The improvement in coverage ratio can be seen in Fig. 41-3.

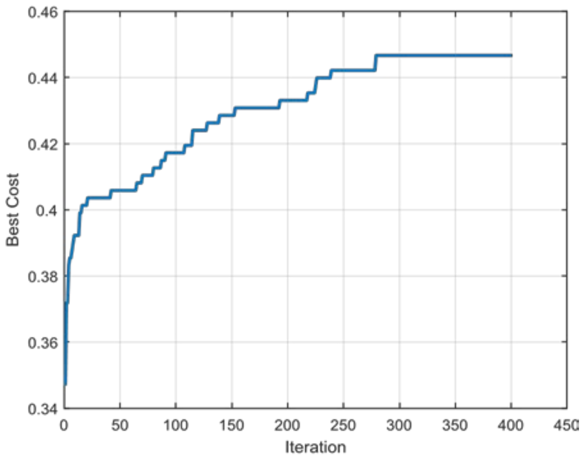


Figure 41-3 Coverage ratio vs. interation for r_s =1.5m & r_e= 0.25m

Similarly, simulation has been done a WSN with the nodes having r_s =*2m & r_e*= 0.5m and has been depicted in Fig. 41-4 and Fig. 41-5.

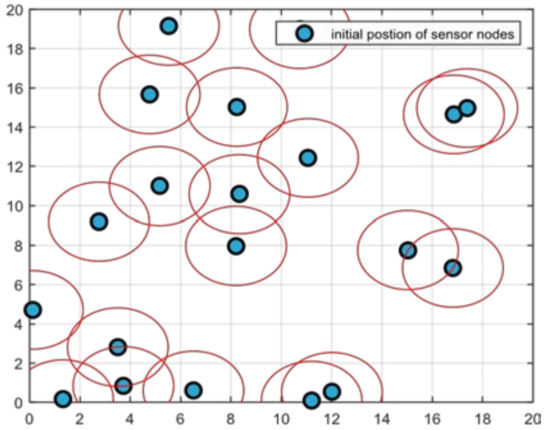


Figure 41-4 Initial placement of sensor nodes with r_s =2m & r_e= 0.5m

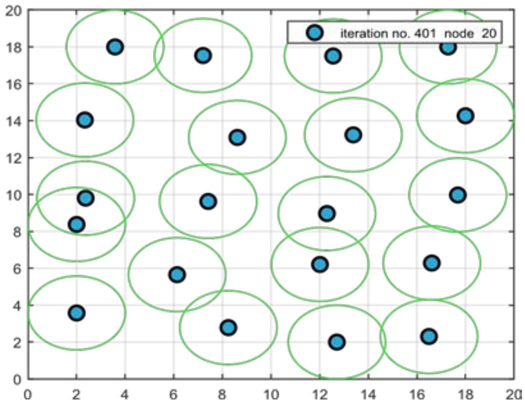


Figure 41-5 Optimised position of nodes(r_s =2m & r_e= 0.5m) after applying improved algorithm

The Fig. 41-5 gives a better proof that the nodes have better position after going through proposed algorithm. The initial coverage ratio was around 54% which becomes 73% after 240 iterations which is 20% increase. The improvement in coverage ratio can be seen in Fig. 41-6.

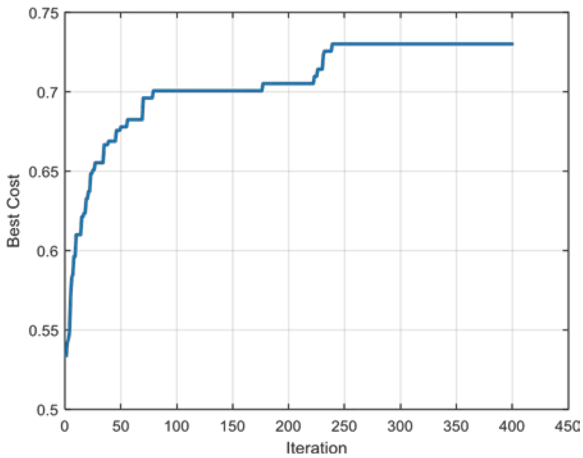


Figure 41-6 Coverage ratio vs. interation for r_s =2m & r_e= 0.5m

Another simulation has been done to a WSN with the nodes having r_s =3m & r_e= 1.25m and has been depicted in Fig. 41-7 and Fig. 41-8.

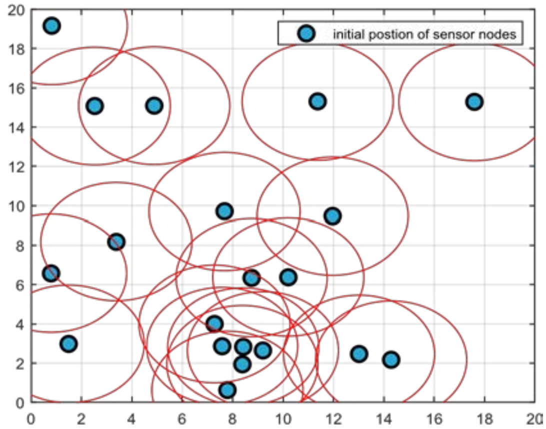


Figure 41-7 Initial placement of sensor nodes with r_s =3m & r_e= 1.25m

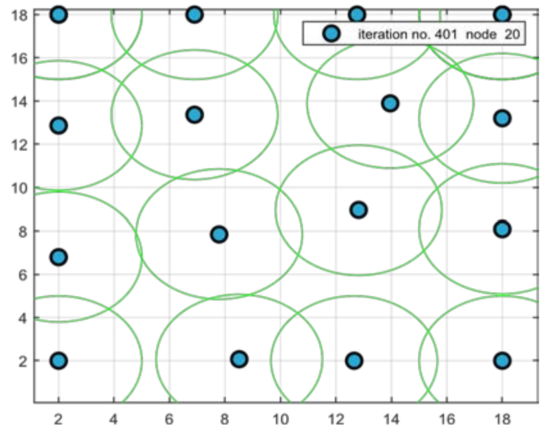


Figure 41-8 Optimised position of nodes(r_s =3m & r_e= 1.25m) after applying improved algorithm

The Fig. 41-8 shows that the nodes have a much better arrangement inside the FoI after the proposed algorithm. The initial coverage ratio was around 81% which becomes almost 100% after 50 iterations which is 19% increase. The improvement in coverage ratio can be seen in Fig. 41-9.

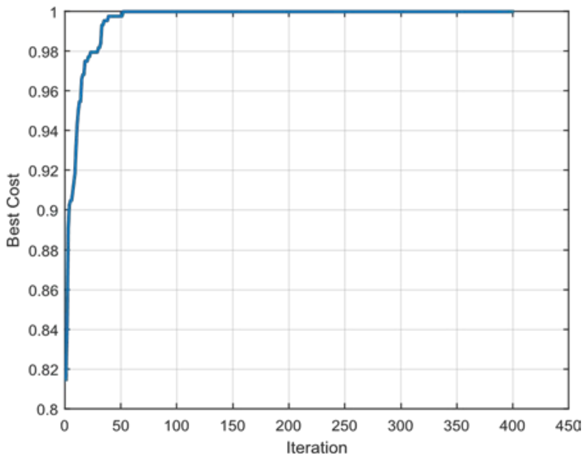


Figure 41-9 Coverage ratio vs. interation for r_s =3m & r_e= 1.25m

B. COMPARISION WITH STANDARD PSO

For a clear comparison of the proposed and standard PSO algorithm[12] Table 41-2. is to refer.

Table 41-2 COMPARISOIN BETWEEN STANDARD AND MODIFIED PSO

Radius (m)	Max Coverage Ratio		No. of iteration taken	
	Standard	***Modified***	***Standard***	***Modified***
1.5	23%	45%	240	270
2	40%	73%	180	240
3	75%	Almost 100%	250	55

Table 41-2. signifies that there is a significant improvement in the coverage ratio of the WSN in comparison to standard PSO. The percentage increase in the maximum coverage ratio in for r_s= *1.5m, 2m, 3m* is *95%, 82.5%, 33.3%* respectively, which shows a fair performance increase of this algorithm with respect to standard PSO. Also, the concept of negative velocity in the algorithm reduces the premature convergence of conventional PSO.

CONCLUSIONS

The presented paper aims to improve coverage of FoI using minimum number of sensors using a modified version of Particle swarm optimization. With the help of simulations for different scenario it can be seen that proposed algorithm shows a significant improvement in coverage of FoI. The obtained results have also been compared with that of standard PSO and the improvement in performance can be observed using the same number of nodes. The modified position updation in the algorithm makes it easier to search for global optimum rather than local optimum. The future goals of this work would be to optimize the coverage when obstacles are present inside the FoI and make it more energy efficient.

REFERENCES

[1] H. M. Ammari, “Coverage in Wireless Sensor Networks: A Survey,” Netw. Protoc. Algorithms, 2010.

[2] J. Yick, B. Mukherjee, and D. Ghosal, “Wireless sensor network survey,” Comput. Networks, 2008.

[3] R. Elhabyan, W. Shi, and M. St-Hilaire, “Coverage protocols for wireless sensor networks: Review and future directions,” J. Commun. Networks, vol. 21, no. 1, pp. 45–60, 2019.

[4] C.-F. Huang and Y.-C. Tseng, “The Coverage Problem in a Wireless Sensor Network,” in Proceedings of the 2Nd ACM International Conference on Wireless Sensor Networks and Applications, 2003, pp. 115–121.

[5] N. A. B. A. Aziz, A. W. Mohemmed, and M. Y. Alias, “A wireless sensor network coverage optimization algorithm based on particle swarm optimization and Voronoi diagram,” in 2009 International Conference on Networking, Sensing and Control, 2009, pp. 602–607.

[6] A. Metiaf and Q. Wu, “Particle Swarm Optimization Based Deployment for WSN with the Existence of Obstacles,” in 2019 5th International Conference on Control, Automation and Robotics, ICCAR 2019, 2019.

[7] M. Rout and R. Roy, “Optimal wireless sensor network information coverage using particle swarm optimisation method,” Int. J. Electron. Lett., vol. 5, no. 4, pp. 491–499, 2017.

[8] I. G. Siqueira, L. B. Ruiz, A. A. F. Loureiro, and J. M. Nogueira, “Coverage area management for wireless sensor networks,” Int. J. Netw. Manag., 2007.

[9] R. V. Kulkarni and G. K. Venayagamoorthy, “Particle swarm optimization in wireless-sensor networks: A brief survey,” IEEE Trans. Syst. Man Cybern. Part C Appl. Rev., 2011.

[10] Y. Zou and K. Chakrabarty, “Sensor deployment and target localization based on virtual forces,” in Proceedings - IEEE INFOCOM, 2003.

[11] R. Eberhart and J. Kennedy, “A new optimizer using particle swarm theory,” in MHS’95. Proceedings of the Sixth International Symposium on Micro Machine and Human Science, 1995, pp. 39–43.

[12] Z.Fan and W. Zhao, “Network Coverage Optimization Strategy in Wireless Sensor Networks Based on Particle Swarm Optimization.” 2011.

42. Analysis of Optical Parameters of Hexagonal Solid Core PCF with Methanol filled inner Cladding ring

Shahir Uddin[1], Tarannum Parveen[1], M A Hassan[2], Dharmendra K Singh[3]*
[1]Department of Electronics & Communication Engineering, BIT Patna (Bihar), India
[2]Mechanical Engg. Department, NIT Jamshedpur, Jamshedpur, India
[3]Department of Electronics & Communication Engineering, BIT Sindri (Dhanbad), India
[1]shahir@bitmesra.ac.in, [*]tarannumparveen09@gmail.com, [2]hassan@bitmesra.ac.in, [3]dksingh@nitp.ac.in

ABSTRACT

A unique hexagonal lattice structure of silica based solid core Photonic Crystal Fiber (PCF) has been designed which is surrounded by array of air holes filled with Methanol. Optical properties like birefringence, confinement loss and negative dispersion have been investigated. A five ring hexagonal solid core PCF with inner ring filled with Methanol and outer four rings constitute as air holes is proposed. A simple approach is used to attain high birefringence, low confinement loss and negative dispersion. The designed structure has been simulated using FEMSIM module of R-Soft software. The results depict at diameter d=1.5µm, 1.8µm and 2.1µm, the birefringence and confinement loss is endow as 0.000025, 0.000029, 0.000033 and 0.001, 0.001, 0.001 at 1.55µm.

Index Terms— *birefringence, confinement loss, dispersion, methanol, photonic crystal fiber.*

INTRODUCTION

Photonic Crystal Fiber (PCF) belongs to that class of fiber which has a number of microscopic air holes throughout its entire length. It makes the use of photonic crystals to form cladding around the core Due to its unique properties it can guide light in various mechanism like TIR(Total Internal Refection) and photonic band gap [1]In PCFs photonic band gap are set up to avert light propagation in certain direction with certain range of wavelengths.. On merging the properties of optical fiber and PCF a series of unique properties like exorbitant birefringence [2], l,ow confinement loss, negative dispersion. Innumerable single mode operation[3] is achieved which leads to reduction in cross talk that is unworkable with classical fibers. Further, these guiding properties [4] can be intensified by using different materials to the holes by filling the holes [5]. Also light propagation in PCFs is at higher level when it compared to standard fiber, which uses constant lower refractive index cladding.

Today PCF are being used in many important applications which includes spectroscopy [6], metrology, medicine, imaging, tele-transmission, industrial machining and military automation [7], Dual core PCF which is used as the sensing element of the hydrostatic pressure sensor A PCF with hexagonally latticed circular air holes [8] is designed to deliver single-polarization single-mode (SPSM) operation over a broad wavelength band. A unique hexagonal lattice structure of PCF filled with Methanol has been designed.

The structure's various parameter like birefringence, confinement loss and dispersion have been scrutinized. This has been done using the Finite Element Method (FEM).The numerical method used in this study is FEM which is adequate for the analysis of general dielectric waveguide geometries [9]. The fiber manifests immensive negative dispersion because of quick slant change of refractive indices at the coupling wavelength between the inner core and outer core The reciprocity of unalike geometric parameters like hole-to-hole spacing was scrutinized in detail. The dependence of different geometrical parameters, namely, hole-to-hole spacing and different air-hole diameter was investigated in detail. With these reported guiding properties, this fiber can be used for the application of residual dispersion compensation in high speed data transmission optical system. Proper arrangement and positioning of number of air holes some captivating properties like ultraflattened chromatic dispersion, very high nonlinearity, lofty sloping negative dispersion[10], slight confinement loss, small and huge effective mode area (A_{eff}), and high birefringence is achieved [11]. The propound PCF shows higher sensitivity for chemicals like Ethanol [12] and Methanol [13] whose refractive index are low. The scrutinization represents value of confinement loss that can have a great impact on various geometrical properties like inner and outer layer diameters and pitch values. These results from the propound PCF have been used for chemical sensors that has low refractive index. Hence the requisite optical properties have been found.

DESIGN AND ANALYSIS

In Fig. 42-1 hexagonal solid core PCF with inner ring filled with methanol is shown. The background material is chosen as silica having the refractive index of 1.45. The diameter of air holes is same throughout the structure for ease in fabrication. This inner ring is filled with the liquid methanol having refractive index of 1.317. The distance between two air holes, which is known as pitch (Λ) is considered same in proposed structure i.e. 3μm.

The proposed work consists of micro-structured fiber whose air holes are of the same size. Also, the diameter of air holes of cladding region to has been varied from 1.5μm to 2.1μm and keeping the pitch (Λ) constant at 3μm throughout to compare and analyzed the results of the effect of air holes size. The proposed work is stimulated using FEMSIM module of R-Soft software and further all the requisite optical parameters are calculated and performance analysis has been done.

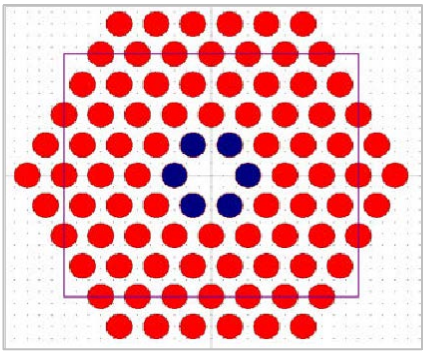


Figure 42-1 Cross-sectional view of proposed structure with inner ring filled with methanol

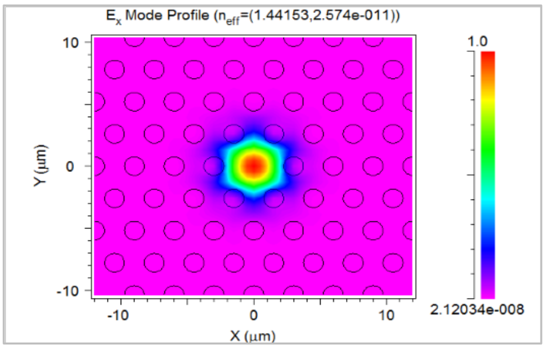


Figure 42-2 Light confinement in x polarization for hexagonal solid core PCF

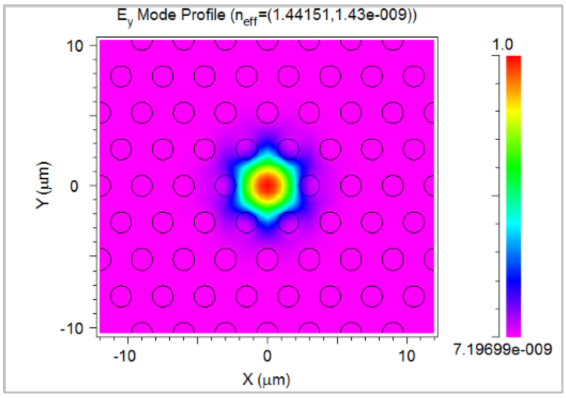


Figure 42-3 .Light confinement in y polarization for hexagonal solid core PCF

To be guided along solid core PCF, light must be confined to a central core by reflection from the cladding that surrounds it. The modes does increase with the increase in the wave number k rather they gets stabilized above kthreshold wavelength or remains constant below k-threshold wavelength. The guiding structures can be acquired for particular designs in which this constant number is just 1. In that “interminable” single-mode fiber is obtained [14] and [15]. The light confinement in PCF results in two values; the real value and the imaginary value which are used for finding dispersion and the losses of PCF respectively are shown in Fig. 42-2 and Fig. 42-3.

The birefringence, *B* is calculated as

$$B = Real|n_{effx} - n_{effy}| \qquad (1)$$

Where |neff - neff | are the effective index of X and Y polarization mode.

It can be seen that with increment in diameter for hexagonal solid core PCF with methanol filled inner cladding ring, value of birefringence increases for the same value of wavelength i.e., for λ=1.7μm and at d=1.5μm value of birefringence is 3×10^{-5}, at d=1.8μm it is 3.2×10^{-5} and for d=2.1μm it gives the highest value among three i.e., 3.8×10^{-5} shown in Fig. 42-4. Exploration reveals that fibers with [6] high birefringence leads to better polarization and propagation of light energy.

Confinement Loss can be calculated as:-

$$L_c = \text{Loss (dB)}/z = 8.686\ k_0 \text{Im}\ [n_{eff}] \qquad (2)$$

where *c* is the speed of light in vacuum and Im[n_{eff}] is the imaginary part of the effective refractive index

Fig. 42-5 depicts the confinement loss when the diameter d=1.5μm, lowest and highest value of confinement loss in Xpolarization are 0.01db/m and 0.09 db/m and in Ypolarization are 0.015db/m and 0.10db/m. When the diameter change from d=1.5μm to d=1.8μm the lowest and highest value of confinement loss in X-polarization are 0.015db/m and 0.09db/m and in Y-polarization is 0.015μm and 0.07μm. At last when diameter d=1.8μm lowest and highest value of confinement loss in X-polarization are 0.015db/m and 0.095db/m and in Y-polarization is 0.015μm and 0.08μm respectively between the wavelength 1.2μm to 1.7μm.

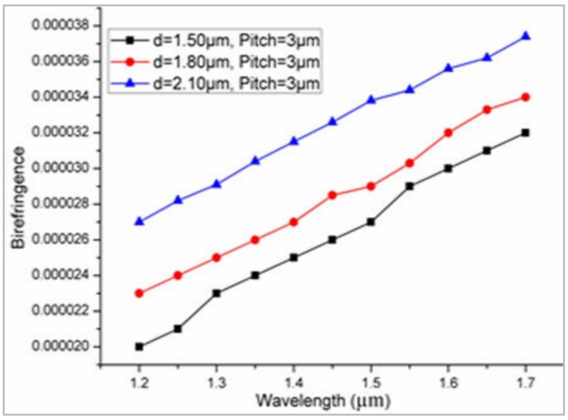


Figure 42-4 Birefringence curves of the proposed designed with methanol filled inner Cladding ring

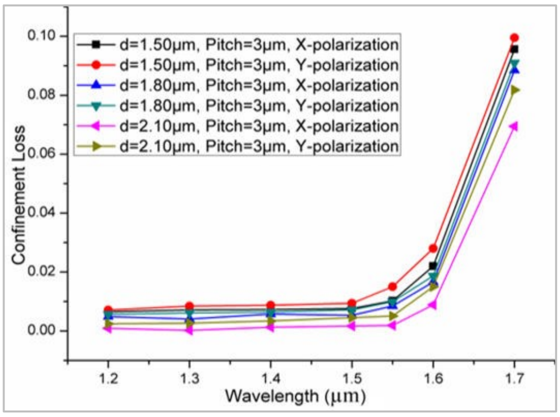


Figure 42-5 Wavelength versus confinement loss (dB/m) for hexagonal solid core PCF

The dispersion D can be calculated as:-

$$D(\lambda) = -\frac{\lambda}{c}\frac{d^2 Re(n_{eff})}{d\lambda^2} \qquad (3)$$

Where D is the dispersion, λ is the wavelength, n_{eff} is effective refractive index, c is the speed of light.

Fig. 42-6 depicts the dispersion curve when air hole diameter d=1.5 μm where positive dispersion occurred 0.7μm to 1.7μm wavelength. Fig. 42-7 shows the dispersion between 0.7μm to 1.8μm wavelength where the maximum negative dispersion -300 ps/km-nm is achieved when air hole diameter is 1.8μm. In Fig. 42-8 the diameter 2.1μm is consider achieving better results, shows the dispersion values are 0 ps/km-nm or negative over the entire proposed wavelength. It can be observed from the graph that increasing air holes diameter from d=1.5μm to 2.1μm we have more negative values for dispersion which reduces the crosstalk effect and attenuation for better and long distance communication. In each case the value of dispersion decreases with increase in wavelength.

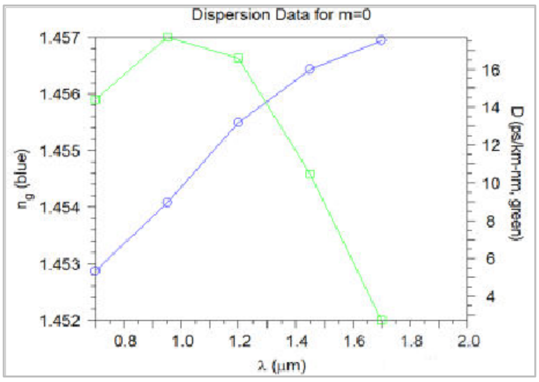


Figure 42-6 Dispersion curves of the proposed design at d= 1.5µm

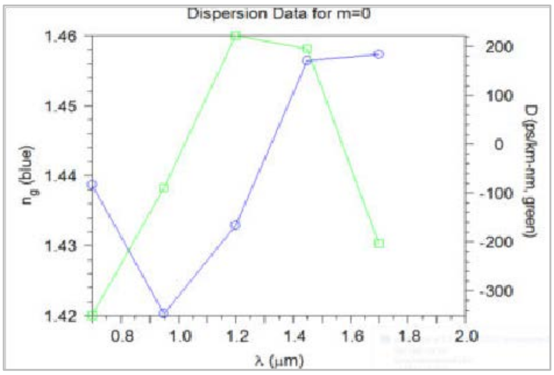


Figure 42-7. Dispersion curves of the proposed design at d=1.8µm

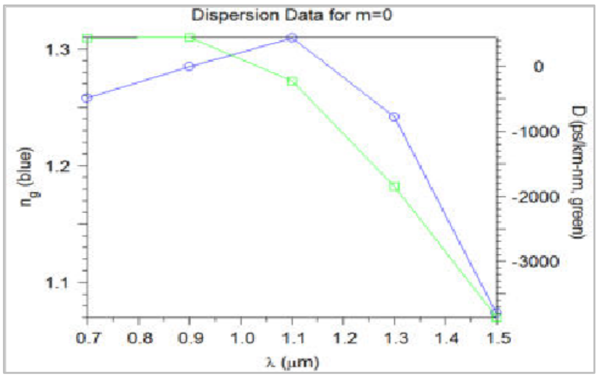


Figure 42-8 Dispersion curves of the designed hexagonal solid core PCF with methanol filled inner Cladding ring at d= 2.1µm

CONCLUSIONS

In this PCF, important design parameters such as the refractive index, confinement loss and negative dispersion have been thoroughly investigated and presented. By increasing diameters of air holes better results for birefringence, confinement loss and negative dispersion is obtained. It shows that innermost ring have maximum impact on the values of birefringence, confinement loss and dispersion. Moreover, study has shown that it is possible to achieve high birefringence and low confinement loss simultaneously. Methanol as filling material is focused because as it holds applications in chemical industries and in making chemical and biological solutions. Propound PCF holds great latency in optical parameter so it is applicable in chemical sensing applications.

REFERENCES

[1] P. Russel, "Trapping light behind bars", Proceedings of 2002 4th International Conference on Transparent Optical Networks (IEEE Cat. No.02EX551), vol. 2, pp. 7, 2002.

[2] A. Ortigosa-Blanch, J. C. Knight, W. J. Wadsworth, J. Arriaga, B. J. Mangan, T. A. Birks and P. S. J. Russell, "Highly birefringent photonic crystal fibers", Opt. Lett., vol. 25, pp. 1325–1327, 2000.

[3] T. A. Birks, J. C. Knight and P. S. J. Russell, "Endlessly single-mode photonic crystal fiber", Opt. Lett., vol. 22, pp. 961–963, 1997.

[4] D. C. Tee, M. H. A. Bakar, N. Tamchek and F. R. M.Adikan, "Photonic crystal fiber in photonic crystal fiber for residual dispersion compensation over E + S + C + L + U wavelength bands", IEEE Photonics Journal, vol. 5, 2013.

[5] M. F. H. Arif, K. Ahmed, S. Asaduzzaman and M. A. K. Azad, "Design and optimization of photonic crystal fiber for liquid sensing applications", Photonic Sensors, vol. 6, pp 279–288, 2016.

[6] D. S. Bomse and Marwood N. Ediger, "Simultaneous detection of multiple gases by Raman spectroscopy with hollow-core fibers", Conference on Lasers and Electro-Optics (CLEO): application and technology, pp. 1-2, 2014.

[7] Q. Xu, M. Wang and S. Lin, “Theoretical study of novel dual core microconstructed photonic crystal fiber”, Optik, vol. 127, pp. 34273429, 2016.

[8] D. Lu and J. Liu, “Broadband Single-Polarization Single-Mode Operation in Photonic Crystal Fibers With Hexagonally Latticed Circular Airholes”, Journal of Lightwave Technology, vol. 34, no. 10, pp. 2452-2458, 2016.

[9] A. M. Heikal, F. F. K. Hussain, M. F. O. Hameed and S. S. A. Obayy, “Efficient polarization filter design based on plasmonic photonic crystal Fiber”, Journal of Lightwave Technology, vol. 33, pp.28682874, 2015.

[10] R. R. Mahmuda, S. M. A. Razzaka, M. I. Hasanc and M. S.Habib “A New Photonic Crystal Fiber Design on the High Negative UltraFlattened Dispersion for Both X and Y Polarization Modes”, vol. 127, pp. 8670-8677, 2016.

[11] S. Asaduzzaman, K. Ahmed, M. F. H. Arif and M. Morshed, “Proposal of a simple structure photonic crystal fiber for lower indexed chemical sensing”, 2015 18th International Conference on Computer and Information Technology (ICCIT), 2015.th

[12] Yongqin Yu, Xuejin Li, Xueming Hong, Yuanlong Deng, Kuiyan Song, Youfu Geng, Huifeng Wei and Weijun Tong, “Some features of the photonic crystal fiber temperature sensor with liquid ethanol filling”, Optics Express, vol. 18, July 2010.

[13] J. C. Knight, T. A. Birks, P. St. J. Russell and D. M. Atkin, “All silica single mode optical fiber with photonic crystal cladding”, Optics Letters, vol. 22, pp. 484-485, 1997.

[14] Q. Xu, M. Wang and S. Lin, “Theoretical study of novel dual core microconstructed photonic crystal fiber”, Optik, vol. 127, pp. 34273429, 2016.

43. Discrete Fractional Fourier Transform based OFDMfor 5G Mobile Communication

Abhishek Kumar Singh, Vinay Kumar Trivedi, and Preetam Kumar
(1811ee01, vinay.pee14, and pkumar)@iitp.ac.in
Wireless Communication Research Lab, Electrical Engineering, Indian Institute of Technology Patna, India

ABSTRACT

State of the art radio access technologies (RAT) relies on the exclusive allotment of available time-slots and frequency bands or overlapped allotment using code and power domain multiplexing. Orthogonal frequency division multiple access (OFDMA) has been widely adopted to provide high data rate services for 5G mobile communication. OFDM is robust to frequency-selective wireless channels and enables a simplified mobile receiver design. Apart from the high peak to average power ratio (PAPR) problem that attracts significant research, the performance of OFDM systems is highly sensitive to synchronization errors and this problem will likely remain a significant challenge as higher frequency bands are utilized for next-generation wireless mobile applications. In this paper, the discrete fractional Fourier transform (DFRFT) based OFDM system is motivated in the presence of carrier frequency offset (CFO) for next-generation wireless mobile applications. Preliminary parametric results are presented to emphasize the performance gain with DFRFT based OFDM system and its comparison with conventional DFT based OFDM system. Some major implementation challenges for DFRFT based OFDM system is also indicated as future works.

Index Terms— *5G, OFDM, CFO, ICI, and DFRFT.*

INTRODUCTION

The next generation of the wireless mobile communication system is designed to deliver significantly increased operational performance in terms of high data rates, high spectral efficiency and low latency achieved with significantly low implementation complexity. Moreover, the high data rate wireless link should support the performance with high mobility and in the presence of synchronization error at the receiver. Orthogonal frequency division multiplexing (OFDM) is the baseline physical layer technique for 4G and LTE. Apart from being spectrally efficient, the OFDM system enables a very simple receiver implementation [1]. The third generation partnership project (3GPP) in its recent release [2] still agrees to OFDM and DFT spread OFDM as 5G new radio (NR) waveform for downlink and uplink respectively. Other more advanced and sophisticated waveform options are postponed mainly because of high implementation complexity or low backward compatibility. The reliable performance of the OFDM system mainly relies on orthogonal sub-carriers, and hence a OFDM system is highly sensitive to the presence of carrier frequency offset (CFO) [3], [4]. It violates the sub-carrier orthogonality that creates inter-carrier interference directly degrading the error rate performance. OFDM system also has a problem with high PAPR that results in low amplifier efficiency and thus reduced battery power and coverage. Among other solutions, precoding is studied as a simple technique for PAPR reduction without any increase in complexity or feedback [5]. DFT precoded OFDM (or) multiple access version of which is single-carrier FDMA (SC-FDMA) is used in the uplink for 4G and LTE.

DESIGN AND ANALYSIS

In Fig. 42-1 hexagonal solid core PCF with inner ring filled with methanol is shown. The background material is chosen as silica having the refractive index of 1.45. The diameter of air holes is same throughout the structure for ease in fabrication. This inner ring is filled with the liquid methanol having refractive index of 1.317. The distance between two air holes, which is known as pitch (Λ) is considered same in proposed structure i.e. 3μm.

The proposed work consists of micro-structured fiber whose air holes are of the same size. Also, the diameter of air holes of cladding region to has been varied from 1.5μm to 2.1μm and keeping the pitch (Λ) constant at 3μm throughout to compare and analyzed the results of the effect of air holes size. The proposed work is stimulated using FEMSIM module of R-Soft software and further all the requisite optical parameters are calculated and performance analysis has been done.

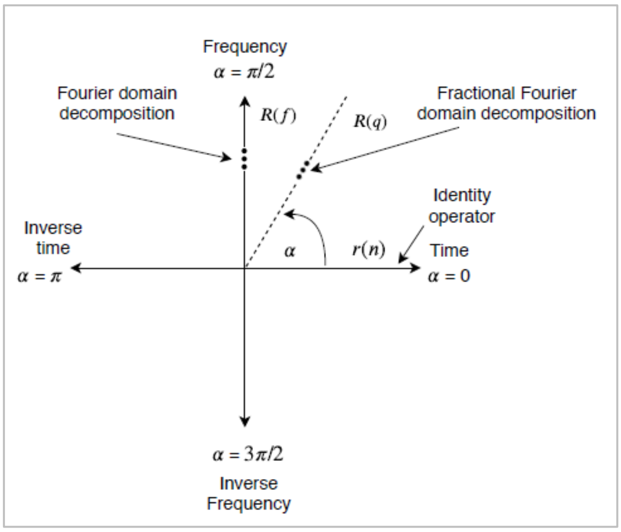


Figure 43-1 Represenation of time-frequency plane and corresponding fractional Fourier domain representation rotated by an angle of α in counter-clockwise direction

The fundamental task of multicarrier communication is to select the transmission basis such that the projection of the received signal to an identical basis at the receiver provides the estimates of signal that was transmitted. Therefore, the transform used for multicarrier communication must exhibit reversibility property. In this regard, several alternate orthogonal trigonometric transforms like discrete cosine transform (DCT) are also studied and analyzed for OFDM application [5]. The conventional DFT based or trigonometric transformbased OFDM system relies on interference compensation at the receiver to preserve the interference-free performance in the presence of CFO. This is because the channel partitioning established by Fourier transform loses its optimal decomposition to time-frequency localization. The optimal solution should now be able to project non-stationary received signals into basis waveform with time-varying sub-carrier frequencies. For this purpose, discrete fractional Fourier transform (DFRFT) employing chirp harmonics basis function instead of the complex exponential basis of DFT is studied as a potential multicarrier transform. FRFT is a rotation operator in a time-frequency plane as shown in Fig. 43-1 in counter-clockwise direction [6]. DFRFT at $\alpha=\pi/2$ is essentially a DFT (or) 90° rotation of signal representation in time-frequency plane. DFRFT based OFDM system is similar to a conventional DFT based OFDM system with IFFT and FFT replaced by IDFRFT and DFRFT at transmitter and receiver respectively [7]. By using the sampling-based DFRFT [8], the implementation cost can be brought similar to FFT i.e. $O(\frac{N}{2}\log_2 N)$. This is another important motivation apart from performance gain to use DFRFT based OFDM system for wireless mobile communication with CFO.

DFRFT based OFDM system is studied by many researchers in [7]- [12] for both multicarrier and single-carrier communication to provide robust error rate performance over multipath fading channel in presence of residual CFO. The ICI and signal to interference ratio (SIR) for the DFRFT-OFDM system is studied by authors in [9] which show that the ICI always degrades the performance no matter which transform is utilized for the purpose. The performance degradation from ICI is comparatively very less for DFRFT based OFDM system. Authors in [10] analytically established an optimum DFRFT angle rather than performing an exhaustive search.

In this paper, a consolidated performance evaluation of the DFRFT-OFDM system is considered and the system configuration is motivated as a potential candidate for next-generation mobile communication with CFO. The preliminary parametric result is presented and a detailed comparison is made with conventional and state of the art DFT based OFDM system. Through the results presented in this paper some possible future work is also indicated considering DFRFT based OFDM system.

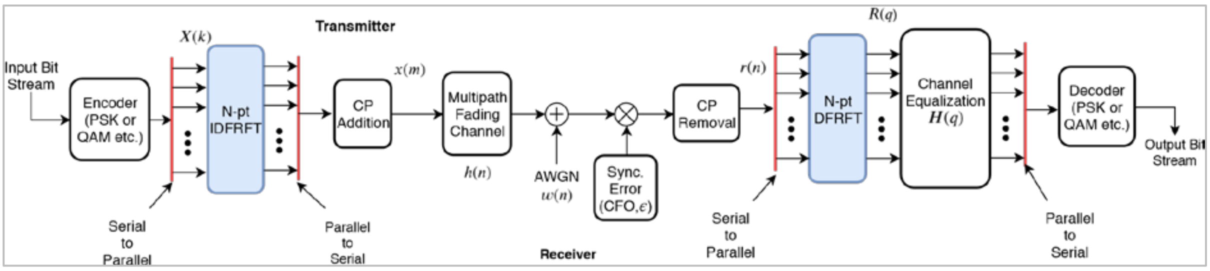


Figure 43-2 System model for the DFRFT based OFDM system

SYSTEM AND SIGNAL MODEL

In this section, the system and signal model of the DFRFTOFDM system over multipath fading in the presence of CFO is outlined with definitions of the IDFRFT and DFRFT kernels. Figure 43-2 presents the schematic of both the transmitter and receiver for the DFRFT-OFDM system. A set of N independent and identically distributed (*iid*) modulated symbols $X(k)$ generated using phase shift keying (PSK) are first processed with N-point inverse DFRFT (IDFRFT) block. A cyclic prefix (CP) is then appended to every block of IDFRFT processed symbols before transmitting over a multipath wireless channel. The m^{th} sample of this resulting output sequence from the transmitter is $N-1$,

$$x(m) = {}^{X} X(k)F_{-\alpha}(m,k), -N_{cp}\ 6\ m\ 6\ N-1 \qquad (1)$$

$k=0$

where $F_{-\alpha}(m,k)$ is the sampling based IDFRFT kernel that can be found in [8] as

$$F_{-\alpha}(m,k) = \sqrt{\frac{sin\alpha + jcos\alpha}{N}} e^{-\frac{j}{2}m^2T_s^2cot\alpha} e^{-\frac{j}{2}k^2u^2cot\alpha} e^{\frac{j2\pi mk}{N}} \qquad (2)$$

The angle between the time domain and fractional Fourier domain is represented as $\alpha = p\pi/2$ where 0 6 ($p \in$ R) 6 2 and the chirp rate is $cot\alpha$. It can be checked that at $\alpha = \pi/2$, the above kernel is nothing but IDFT. The sampling interval in time domain (i.e T_s) and in fractional Fourier domain (i.e., u) are now related as $u \times T_s = 2\pi |sin\alpha|/N$. The n^{th} sample of the received OFDM symbol over the multipath wireless channel and in the presence of normalized CFO () is

$$r(n) = e^{\frac{j2\pi\epsilon n}{N}} \sum_{m=-N_{cp}}^{N-1} x(m)h(n, n-m) + w(n) \qquad (3)$$

where $h(n,l)$ is the l^{th} coefficient of multipath channel impulse response (CIR) with L number of paths at time nT_s, $w(n)$ is additive white Gaussian noise (AWGN) at the receiver and is the CFO normalized to the subcarrier spacing. We have assumed the block fading channel model where the coefficients don't change significantly during one OFDM symbol period, i.e., $h(n,l) \approx h(l)$. At the receiver, after removing the CP, the DFRFT is performed to the received block of symbols, the q^{th} output sample of which in fractional Fourier domain is

$N-1$

$$R(q) = {}^{X} r(n)F_{\alpha}(q,n) + W(q) \quad (4)$$

$n=0$

where $W(q)$ is the DFRFT of the AWGN samples and

$F_{\alpha}(q,n)$ is the DFRFT kernel defined in [8] as

$$F_{\alpha}(q,n) = \sqrt{\frac{sin\alpha - jcos\alpha}{N}} e^{\frac{j}{2}n^2T_s^2cot\alpha} e^{\frac{j}{2}q^2u^2cot\alpha} e^{-\frac{j2\pi nq}{N}} \qquad (5)$$

The DFRFT at the receiver is followed by OFDM per subcarrier conventional channel equalization in fractional Fourier domain with channel response $H(q)$ at the q^{th} subcarrier obtained from the DFRFT of an $(N-L)$ zero padded channel filter, i.e., $[h(0),h(1),...,h(L-1),0,...,0]$.

PERFORMANCE EVALUATION

Symbol error rate (SER) is an important end to end performance measure for the OFDM system in the presence of CFO and is also considered for performance evaluation here. Uncoded PSK modulated symbols are transmitted over Rayleigh multipath fading channel with CFO at the receiver for Monte Carlo simulation of SER. The DFRFT based OFDM system is interpreted as a modified OFDM configuration with IFFT and FFT in conventional DFT based OFDM system replaced by IDFRFT and DFRFT at transmitter and receiver for multicarrier modulation/demodulation respectively with channel equalization in fractional Fourier domain. The DFRFT angle at which minimum SER is achieved is termed as optimum DFRFT angle (α_{opt}).

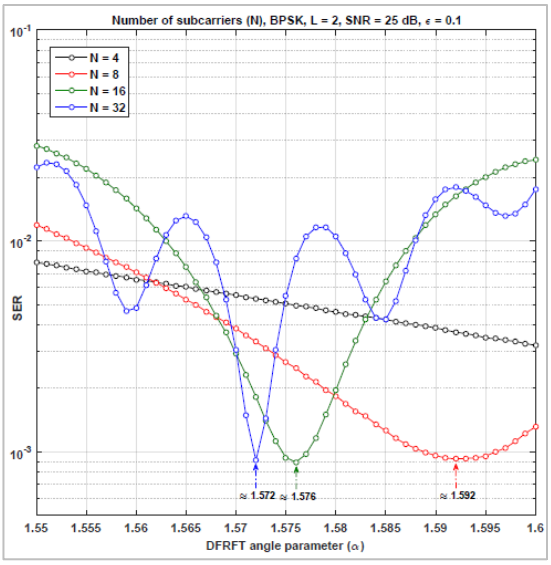


Figure 43-3 SER vs DFRFT angle (α) for different number of subcarriers

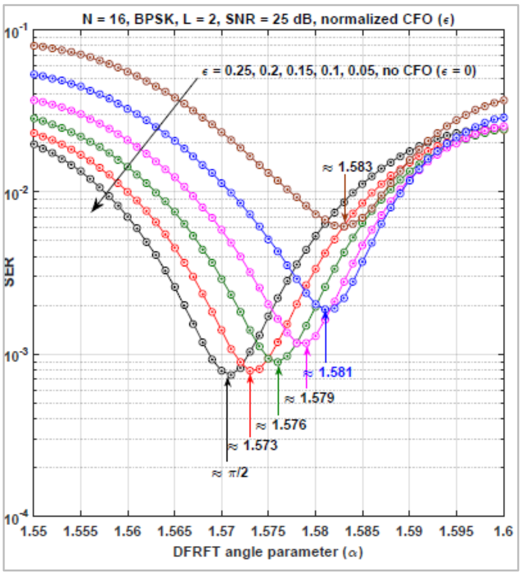


Figure 43-4 SER vs DFRFT angle (α) for different value of normalised CFO (ϵ)

Figure 43-3 shows the variation of SER with DFRFT angle(α) when transmitting BPSK modulated symbols using different number of OFDM subcarriers (N) over two tap Rayleigh multipath fading channel with normalized CFO value of 0.1 at an SNR of 25 dB. It can be observed that for a fixed value of CFO, optimum DFRFT angle (α_{opt}) is different for different number of OFDM subcarriers. With increasing number of subcarriers, α_{opt} shifts closer to $\pi/2$. For a high number of subcarriers, the accurate value of α_{opt} should be evaluated with increased decimal places in α and hence we have considered only 16 subcarriers or $N = 16$ for presenting remaining results.

Figure 43-4 shows the variation of SER with DFRFT angle α for different values of normalized CFO over two tap Rayleigh multipath fading channel given $N = 16$ at an SNR of 25 dB. It is clear that when no CFO is present, the optimum performance is at $\alpha = \pi/2$ or DFT based OFDM system. In the presence of CFO, performance at $\alpha = \pi/2$ is not optimal and minimum SER is achieved at $\alpha = \alpha_{opt}$, i.e., indicated for different values of normalized CFO. With increasing value of CFO, α_{opt} shifts away from $\pi/2$. It can be observed that at high values of CFO, the minimum SER obtained at α_{opt} with DFRFT based OFDM system is also degraded. This implies that although the DFRFT based OFDM system achieves interference-free performance at low values of CFO, this is not the case in the presence of high values of CFO.

Figure 43-5 shows the variation of SER with DFRFT angle α for different number of channel taps L when transmitting BPSK modulated symbols in the presence of normalized CFO of 0.1. For flat fading channel or L = 1, the performance is nearly independent of α. It can be also observed from the plot that the optimum value of

DFRFT angle (α_{opt}) to achieve minimum SER remains unchanged with the different number of channel taps (L) for a given value of normalized CFO (). Moreover, the SER performance at α_{opt} is nearly independent of the number of multipath components. This implies that the DFRFT based OFDM systems nearly achieve multipath free performance.

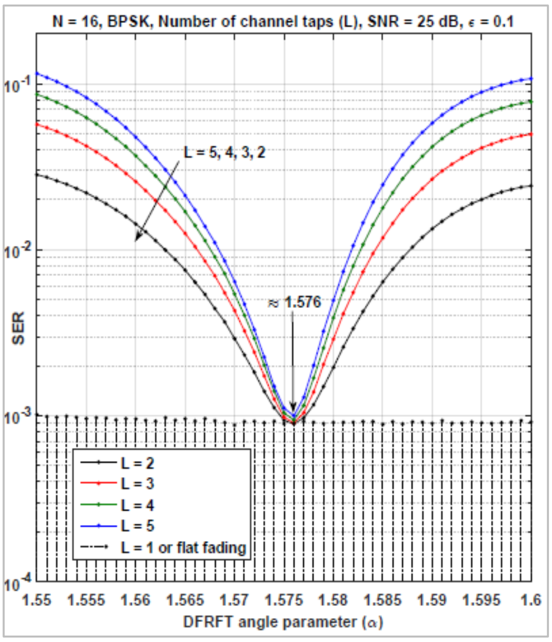


Figure 43-5 SER vs DFRFT angle (α) for different number of channel taps (L)

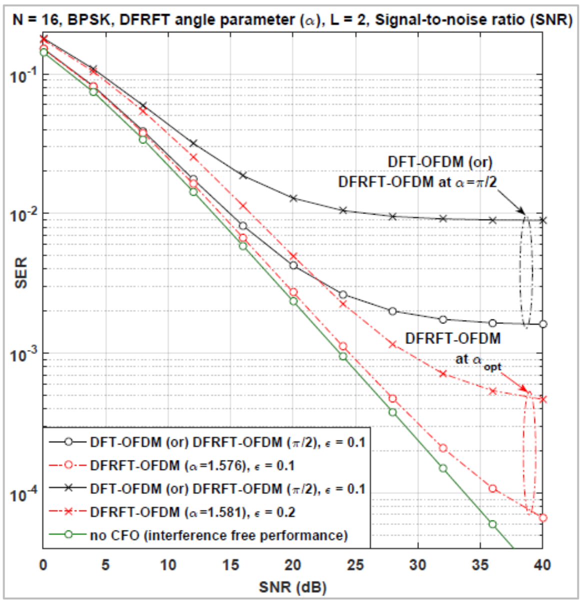


Figure 43-6 SER vs SNR (dB) with BPSK modulation over two tap Rayleigh fading channel with normalized CFO () of 0.1 and 0.2 for both DFT and DFRFT based OFDM systems

The DFRFT based OFDM system at α_{opt} over multipath fading channel nearly retains the flat fading performance corresponding to different values of CFO. It is important to note that the DFRFT based OFDM system needs not to aligned to distinct values of α_{opt} every time the CFO values changes. Any close value can always provide significant performance gain like $\alpha_{opt} = 1.573$ can efficiently serve the CFO values between 0.01 to 0.07, $\alpha_{opt} = 1.576$ between 0.08 to 0.13 , $\alpha_{opt} = 1.579$ from 0.14 to 0.17 and so on.

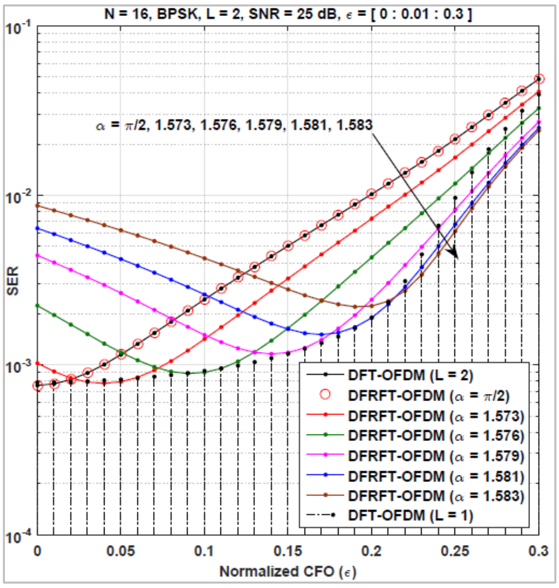


Figure 43-7 SER vs CFO for different values of αopt obtained in Fig. 43-4

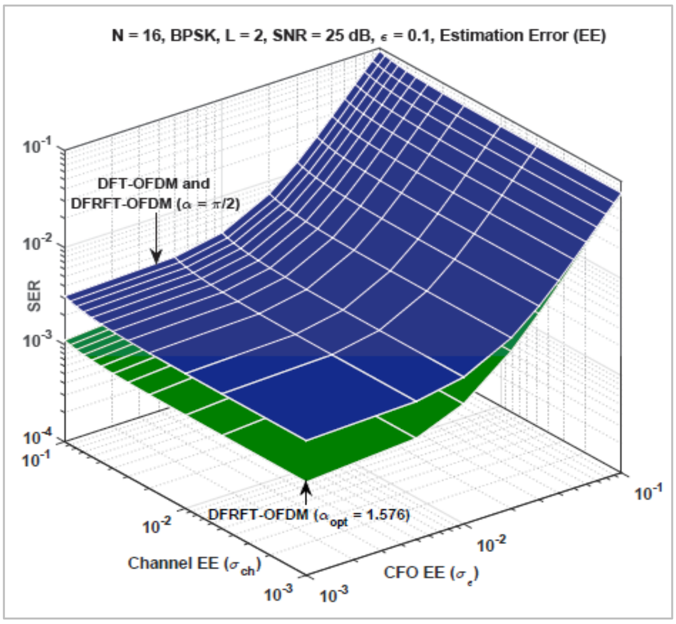


Figure 43-8 SER vs simultaneous channel and CFO estimation error for both DFT and DFRFT based OFDM system with normalized CFO (ϵ) equals 0.1

Perfect estimation of both the multipath channel and CFO is utilized to generate all the previous results. Moreover, estimation errors arising out of incorrect or approximate estimator leads to performance degradation. Estimation error also arises in a fast varying channel, where the estimator is unable to track the fast-changing channel. In Fig. 43-8, the performance of DFT and DFRFT based OFDM system are compared in the presence of both channel and CFO estimation errors at the receiver. The performance gain achieved by using DFRFT based OFDM system reduces as the CFO estimation error increases. Fortunately, the range of tolerable estimation error is well within the conventional estimator performance that motivates the performance gain with DFRFT based OFDM system.

CONCLUSION AND FUTURE WORK

DFRFT based OFDM system outperforms the conventional DFT based OFDM system in the presence of CFO. The SER performance gain is evaluated for different values of CFO, OFDM subcarriers, and multipath channel taps. The variation/dynamics of optimum DFRFT angle are observed with different OFDM parameters assuming both perfect estimations and in the presence of estimation errors. Preliminary results strongly motivate the potential use of DFRFT based multicarrier modulation/demodulation and equalization in the fractional Fourier domain for next-generation wireless mobile communication with CFO. Moreover, it is important to note that DFRFT and IDFRFT can be implemented using similar computational complexity as FFT and IFFT that justifies the immediate advantage of employing DFRFT based OFDM system.

However, DFRFT based OFDM system involves the use of IDFRFT for multicarrier modulation that requires the chirp rate (α) information to be relayed by the receiver to the transmitter through a feedback channel. Apart from occupying feedback bandwidth, this can be more problematic with fast changes in CFO that needs to update the DFRFT angle (α) at the transmitter. DFRFT based OFDM system is shown to achieve approximately the interference-free performance at low values of CFO. However, with high CFO and high modulation order, residual interference compensation is still needed and has to be figured out for envisioning such systems. Moreover, DFRFT based OFDM system involves the equalization in the fractional Fourier domain after DFRFT at the receiver. Also, the DFRFT at the receiver doesn't follow the circular convolution property as DFT. Therefore, conventional channel estimation algorithms are required to be reconfigured for DFRFT based OFDM system.

ACKNOWLEDGEMENT

This work is supported by Ministry of Electronics and Information Technology (MeitY), Government of India, Project no: 0429.

REFERENCES

[1] R. van Nee and R. Prasad,”OFDM for Wireless Multimedia Communications,” Boston, MA: Artech House, 2000.

[2] 3rd Generation Partnership Project, 3GPP TS 38.211 V15.4.0,”Technical Specification Group Radio Access Network; NR; Physical channels and modulation (Release 15),” Dec. 2018.

[3] Jungwon Lee, Hui-Ling Lou, D. Toumpakaris and J. M. Cioffi, ”Effect of carrier frequency offset on OFDM systems for multipath fading channels,” IEEE Global Telecommunications Conference, 2004. GLOBECOM ’04., Dallas, TX, 2004, pp. 3721-3725 Vol.6.

[4] A. Omri, M. Shaqfeh, A. Ali and H. Alnuweiri, ”Synchronization Procedure in 5G NR Systems,” in IEEE Access, vol. 7, pp. 41286-41295, 2019.

[5] V. K. Trivedi, K. Ramadan, P. Kumar, M. I. Dessouky, and F. E. Abd ElSamie, “Trigonometric Transforms and Precoding Strategies for OFDMbased Uplink Hybrid Multi-carrier Non Orthogonal Multiple Access,” Transactions on Emerging Telecommunications Technologies, 2019.

[6] L. B. Almeida, ”The fractional Fourier transform and time-frequency representations,” in IEEE Transactions on Signal Processing, vol. 42, no. 11, pp. 3084-3091, Nov. 1994.

[7] M. Martone, ”A multicarrier system based on the fractional Fourier transform for time-frequency-selective channels,” in IEEE Transactions on Communications, vol. 49, no. 6, pp. 1011-1020, June 2001.

[8] Soo-Chang Pei and Jian-Jiun Ding, ”Closed-form discrete fractional and affine Fourier transforms,” in IEEE Transactions on Signal Processing, vol. 48, no. 5, pp. 1338-1353, May 2000.

[9] J. Zheng and Z. Wang, ”ICI Analysis for FRFT-OFDM Systems to Frequency Offset in Time-Frequency Selective Fading Channels,” IEEE Commun. Lett., vol. 14, no. 10, pp. 888–890, Oct. 2010.

[10] Z. Mokhtari and M. Sabbaghian, ”Near-Optimal Angle of Transform in FrFT-OFDM Systems Based on ICI Analysis,” in IEEE Transactions on Vehicular Technology, vol. 65, no. 7, pp. 5777-5783, July 2016.

[11] V. K. Trivedi, S. Kumari and P. Kumar, ”Generalised error analysis of FRFT-OFDM over Nakagami-m fading channel with arbitrary m,” in IET Communications, vol. 11, no. 9, pp. 1497-1502, 2017.

[12] KW. Huang, R. Tao, Y. Wang, ”Fractional Fourier domain equalization for single carrier broadband wireless systems”, Sci. China, 2012.

44. Improved End to End Delay Bound analysis in Software Defined Mobile Edge Vehicular Networks

Banoth Ravi, Anmol Gautam, Jaisingh Thangaraj and Amitesh Kumar

Department of Electronics Engineering, IIT (ISM), Dhanbad, India-826004

ravibanoth.iitdhn@gmail.com, anmolgautam@gmail.com, t.jaisingh.iitism@gmail.com, amitesh@iitism.ac.in

ABSTRACT

Optimization of the data traffic has an essential role for efficient congestion control in software defined vehicular networks (SDVN). Recently, software-defined mobile edge vehicular networks (SDMEVN) have been emerging as promising for the future generation of vehicular networks. It controls the vehicular ad hoc networks systematically. In SDMEVNs, link connectivity of moving vehicles may fail from central SDN controller. This affects the efficiency and communication performance in terms of loss connectivity between vehicles to infrastructure. We analyse network performance in dense and sparse network. Maximize the buffer occupancy in Software-defined vehicular networks to control the low latency and delay bound analysis in communication by integrating the heterogeneous systems like IEEE 802.11p and mobile base station technologies in vehicular ad-hoc networks (VANETs).

Index Terms— *Software Defined Vehicular Networks, Mobile Edge Computing, Intelligent Transportation System, End to End Queueing Bound.*

INTRODUCTION

In future vehicular networks, emerging technologies have integrated into 5G mobile communication, and Softwaredefined networks are overcoming to reduce latency and improve the reliability [1], [2]. SDN provides reliable data and flexible problems to solve and to control the entire systems. Moreover, to connect wired and wireless networks to the users. SDN controller controls the whole networks with the help of the control plane, and the data forwarding from vehicle-to-vehicle communication helps with the data plane. With cooperative data dissemination, based on SDN is to develop the performance of the V2V and vehicle to infrastructure (V2I) communications [3], [4]. The main enabling platforms playing a vital role in the traffic of next-generation intelligent transportation system (ITS), includes cellular networks dedicated short-range communications (DSRC)-based IEEE802.11p. SDN controls the controller to provides priority for the connected vehicles as flexible and road safety and efficiency (e.g., collision avoidance) [5]. Using information exchange from V2V and V2I cooperative data dissemination service provides and controlled the entire network is SDMEVN towards RSUs and V2BS(vehicle to base station) to reduce the latency and packet loss [6]. With SDVN provides logically centralized controlling for reliable communications in VANETs. On the other hand, the mobile edge computing (MEC) to deal with a variety of services, such as data scheduling and resource utilization of multi-hop cooperation vehicular networks [7].

In queuing theory, we have an analysis of M/G/1 queueing model analysis that can provide stochastic QoS provisioning for any of the traffic arrival and service approximation, and the servers are statistically independent. Our contribution is as follows.

- Edge nodes have to improve resource utilization for an end to end-users. Applying the queueing theory model, the number of flow rules increases to optimize the control the traffic congestion control.
- SDVN-based heterogeneous architecture to control the packet scheduling based on priority and non-priority considered resource utilization, to minimize the latency and end to end delay.

The remainder of the paper is organized as follows: related work has discussed in the next section. Section 3 describes system models and preliminaries. Section 4 presents our problem formulation. In Section 5, we present the performance analysis. Finally, we conclude the paper in Section 6.

RELATED WORK

In this section, the literature works have done in SDN concepts to vehicular networks and confirmed it to be an excellent solution to enhance the traffic of resource utilization and data distribution, SDN the centralized controller has a comprehensive view of the network topology, being able to make better decisions in network-wide. Table 44-1 represents the comparison of related work in SDN based mobile edge vehicular networks. We have compared the majority of workrelated of a centralized SDN architecture. The main issue of these networks is connectivity loss, reliability, and delay in VANETs. Our solution is to improve the network performance analysis with the help of SDN based mobile edge VANETs. Moreover, high mobility of vehicles, due to more connectivity losses in the VANET system, the authors have been proposed to reduced latency control in SDMEVN in [2]. Moreover, the proposed buffer management creates the queueing model to develop the quality of service (QoS) parameters or resource utilization needs with the network status to attempt the user’s request.

Table 44-1 Comparison of Related work

Work Done	Architecture	Contribution	Method	Delay Bounds
2	Centralized	SDMEVN	Optimization	√×
3	Centralized	SDUDN	Queueing model	√
4	Centralized	CPU Utilization	Queueing Model	√
5	Centralized	Packet Scheduling	Queueing Model	
7	Centralized	SDN-based VANETs	QoS Resources	√×
8	Centralized	Data Scheduling	Queueing Model	√
9	Hierarchical	SDVN	CPP	√
10	Hetrogeneous	SD5GNet	Queueing Model	√
Our Analysis	Heterogeneous	SDMEVN	Queueing Model	

SYSTEM MODEL

The SDMEVN, considering service provisioning of network function virtualization, is to control whole network data in the SDN system in this paper have illustrated in Fig. 44-1. The SDN controllers are the main components of SDMEVN in the ITS. Resource utilization and quality of service (QoS) are the essential functions of SDN controllers. SDN controllers have connected with the IP of the internet via packet scheduling [2], [3]. With the SDN-based controller for data scheduler in a cooperatively disseminates data in a roadside unit (RSU) have controlled the heterogeneous vehicular environment [7], [8]. Consider an SDMEVN architecture shown in Fig.44-1, in which the SDMEVN required appropriate resource allocating at the events based because resource allocation is available on an Adhoc basis and must be used efficiently and effectively for V2V and vehicle to base stations (V2BSs) communication. Although the separate control plane of SDN intelligently allocates resources should be enabled to ensure the successful management of road traffic and vehicular networks. In VANETs, various types of systems are involved in providing connectivity among vehicles. However, the lack of efficient internet-working mechanisms leads to connectivity issues among heterogeneous networks in a VANET. In the

SDHVN model was a Reliable packet transmission with prioritization of minimum transmission delay is the main challenge in designing broadcast schemes for [9], [10]. We create a novel packet scheduling solution on top of SDMEVN. In this solution, we perform centralized data scheduling of all network resources in the control plane of SDMEVN is to minimize the end to end connectivity of delay bounds [15]. However, SDMEVN can adaptively choose the optimal path from all available vehicles.

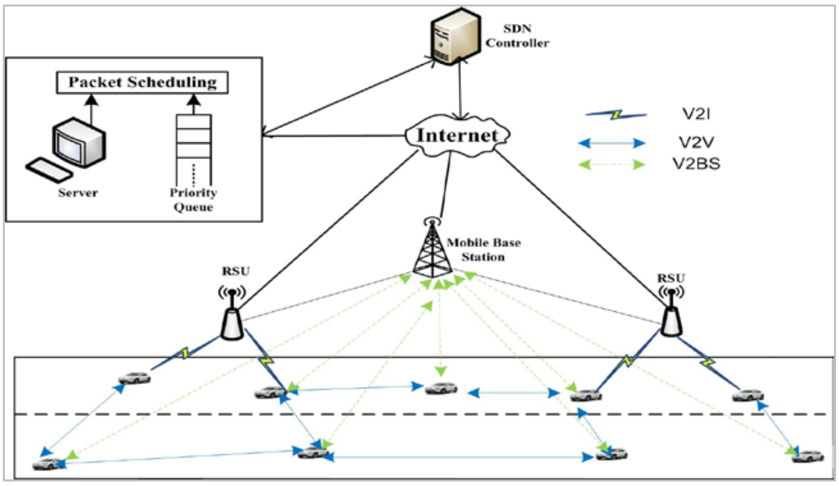


Figure 44-1 Service Provisioning of NFV in SDMEVN system.

PROBLEM FORMULATION

In this section, we defined the proposed model to evaluate the performance of buffer management and data scheduling for V2I, and V2V connectivity in SDN controlled heterogeneous networks. SDN is an essential technology for ITS. SDN controller is programmable and connected through infrastructure with open-flow switch [14]. The trade-off between latency, throughput, and cost. The proposed work considers both service priority of network utility performance and QoSguarantee resource allocation of vehicles in the roadside unit and base station to decide for better data dissemination across a highway in the VANET system.

A. BUFFER OCCUPANCY IN SDMEVN

The packet scheduling algorithm is needed to decide which data packets have toe served first from the buffer queue to perform efficiently in a vehicular ad-hoc environment when the buffer occupancy of waiting for queue length is more, work focused in [16]. Routing strategy awareness provides a higher priority randomly to the traffic flow classes for data packets that have gives the highest positions. It is helpful to optimize the congestion control at the intermediate node through the destination node and fully utilize resource allocation. We propose a packet scheduling techniques on the arrival rate of new traffic flow rules is calculating its arrival rates and degree of centrality values to reduce delivery delay, while maximizing throughput [16]. The first type of packet scheduling algorithm uses non-priority scheduling. The second type of packet scheduling algorithm has used for priority considered packet scheduling in data packets. Therefore, multiple scheduling algorithms are available for prioritization in traffic such as multi-hop packet scheduling [11], [12], [16]. The simple priority based scheduling scheme cannot perform efficiently in real networks when the rate of congestion is high, since simple scheduling algorithm do not have the information of wireless channel capacity from its neighbors [16].

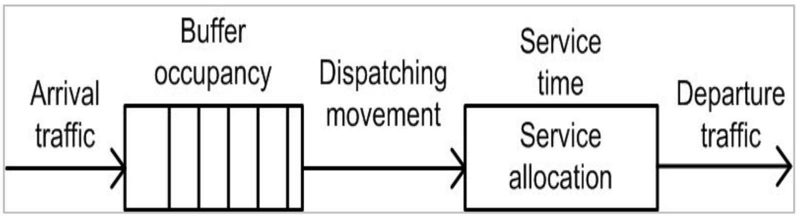


Figure 44-2 M/G/1 Queueing System.

B. M/G/1 QUEUEING SYSTEM

In this section M/G/1 queueing model used in network performance analysis, we assume arrival is Poisson, and service time is exponential. We have focused on delay bound performance play an important role in real-time traffic modeling in the SDMEVN system. M/G/1 queueing system, in Fig.44-2, where the number of vehicles arrived according to a Poisson process with arrival rate λ_t and have served by a single server of general service time distribution x_t. The capacity of the waiting queue or buffer occupancy is, as usual, infinite and vehicles have served in the order they arrived service discipline is FCFS. Performance measures of M/G/1 queue. We calculate the number of customers are waiting in the queue [13]:

$$N_{W_Q} = \lambda_t W_Q = \frac{\lambda_t^2 x_t^2}{2(1-\rho_t)} \tag{1}$$

We calculate the number of vehicles time spent in the queue

$$t = x_t + \frac{\lambda_t x_t^2}{2(1-\rho_t)} \tag{2}$$

The number of vehicles in the SDMEVN system response time (mean queue size of packet flow distribution):

$$N_t = \rho_t + \frac{\lambda_t^2 x_t^2}{2(1-\rho_t)} \tag{3}$$

Resource utilization for no.of users given by

$$U_r = \lambda_t N_t \tag{4}$$

PERFORMANCE ANALYSIS

In this section, we have performed the delay bound analysis and response time as a key role for SDN improving the network performance evaluation of edge nodes in VANETs for analytical and simulations analysis using MATLAB and Java Modelling Tools (JMT). In Table 44-2 as shown in the simulation performance of various parameters, we have considered. The SDMEVN performance analysis depends on packet arrival rate, service rate, and flow in the queue for providing resource allocation. We have compared the dense and sparse traffic of networks if the flow distribution is increasing due to high vehicle density. According service rate distribution in sparse traffic $\mu_t = 1$. The maximum confidence interval is 99%; the infinite system capacity and station queue policy is preemptive scheduling of FCFS queue policy. With the routing, the strategy is random. We set the N= 2000 is traffic flow and time (t) = 20μs. We have focused on data transmission with packet arrival rates in VANETs with performance evaluation of delay bound analysis. We have considered the customer classes type is open arrival rate is 0.1 to 1 packets/sec, service rate is 1 to 2 packets/sec ($\lambda_t \geq \mu_t$) has model in service demands. In sparse traffic medium traffic density (ρ_t)=0.998veh/sec. It has seen that the SDN based on the traffic flow rules in denser medium is N=2000 to 8000 flow distribution probability leads to response time decreases. We have shown the relationship between average response time and traffic flow distribution probability.

Table 44-2 VARIATION OF NETWORK PARAMETERS IN DIFFERENT CASES

Network Performance	SDMEVN	VANET	Packet Scheduling	M/G/1
Avg.Response Time	Low	Medium	High	Moderate
Resource Utilization(%)	Provides Excellent	Good	Less	Good
System Throughput ($\lambda_t \leq \mu_t$)	Packet Loss Less	Medium	More	Good
System Response Time ($\lambda_t \leq \mu_t$)	Service Good	Service Provides Less	Congestion more	Better Controlling
System Utilization(%)	Performance Good	Medium	Congestion	Provides Better Utilization

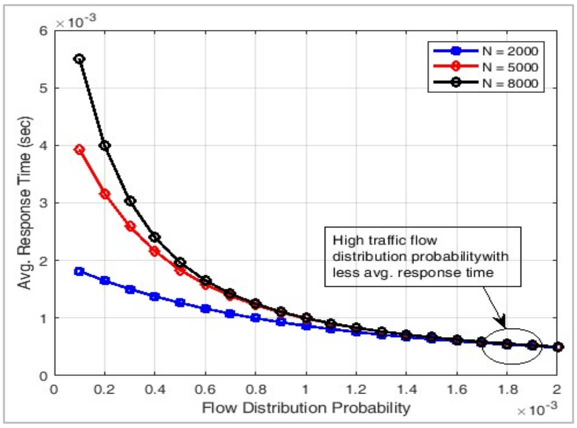


Figure 44-3 Avg. Response Time analyzed by the Traffic flow distribution in SDMEVN.

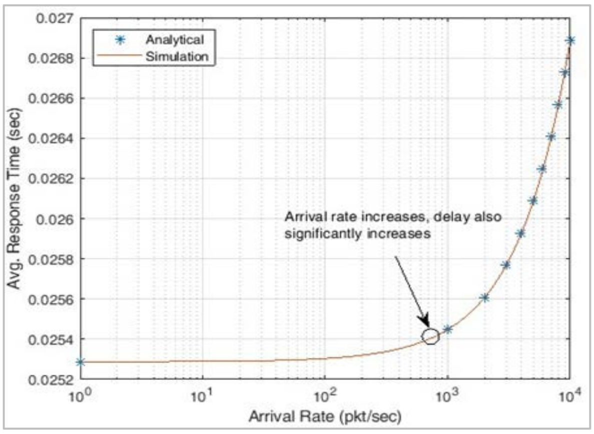


Figure 44-4 Response Time analyzed by the Arrival Rate in SDMEVN.

However, the high flow rules of packets distribution probability results in the average number of response times are less, as shown in Fig.44-3. As we illustrated in Fig.44-4 shows that the average response time with arrival rate; however, the arrival rate increases in the system by the significant delay increases. Fig.44-5 indicates traffic is the denser medium the resource utilization and given the arrival rate of different flow rules increases, the utilization curve increases. We have focused on priority scheduling of low and high priority queueing for flow modeling of data transmission. Fig.44-6 shows the data distribution with a random unit of time in the SDMEVN system. Moreover, the arrival and service rates depend on system performance of the number of classes for the server are fixed service time is to increases of arrival rate with increases of system response time due to increases of waiting time and service time accordingly. With the help of the M/G/1 queueing system is improved the system response time.

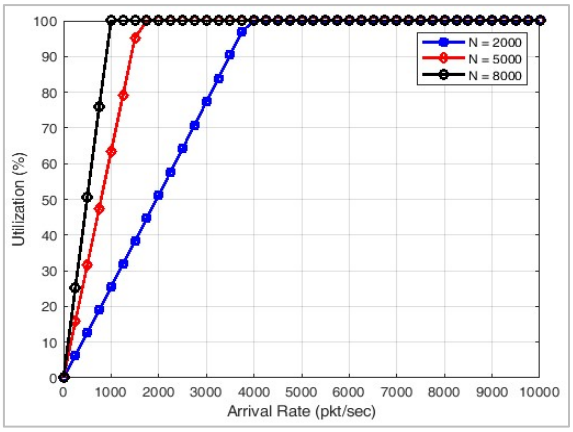


Figure 44-5 Resource Utilization with different arrival rate of the SDMEVN system

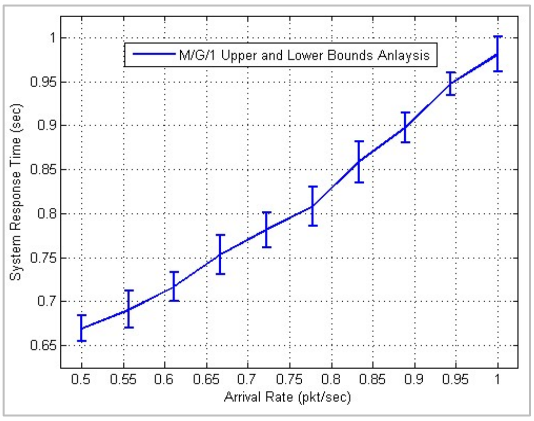


Figure 44-6 System Response Time with different arrival rate of the SDMEVN system

Fig.44-7 shows that the system throughput to improve the SDMEVN to maximize the data transmission and to receive from edge nodes, i.e., for RSUs, which provides better performance with the order of increasing arrival rates. Here, the number of customers is received and transmits the data from the station (RSU or BS), the number of requests completed in a time unit. Fig.44-8 shows that the utilization based on SDN observed to the different base stations and RSUs to users utilized the resource utilization with respective of increasing order of arrival rate. It depends on load balancing in queue; the SDMEVN system improves the resource utilization. Fig.44-9 shows that the system utilization of packet scheduling is to connect the internet based on the SDN controller control the base station and RSUs to provide better resource utilization used customers. SDMEVN provides as the end to end connectivity for maximizing the service rate. It depends on the traffic queue in the buffer; SDMEVN system maximizes the bound delay analysis.

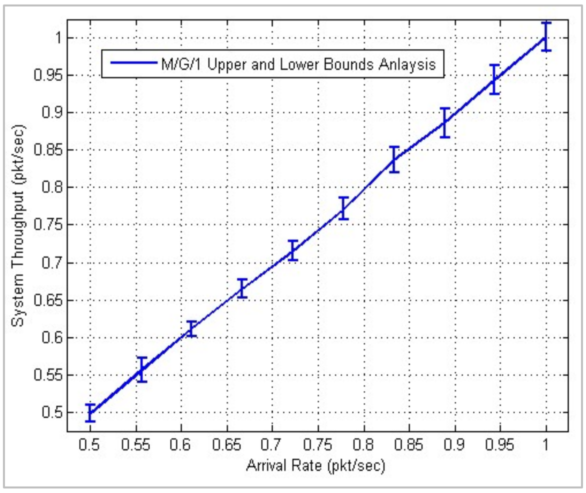


Figure 44-7 System Throughput with different arrival rate of the SDMEVN system.

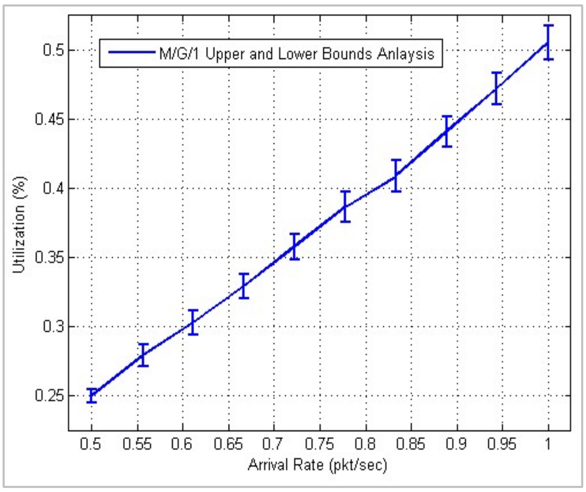


Figure 44-8 System Utilization with different arrival rate of the SDMEVN system.

Fig.44-10 shows that the no.of customer's utilized data is 100% causes of increment utilization about the 10% of server utilization. However, each customer spent a particular time to wait for service at stations. Moreover, service time increases customers' increases uniformly.

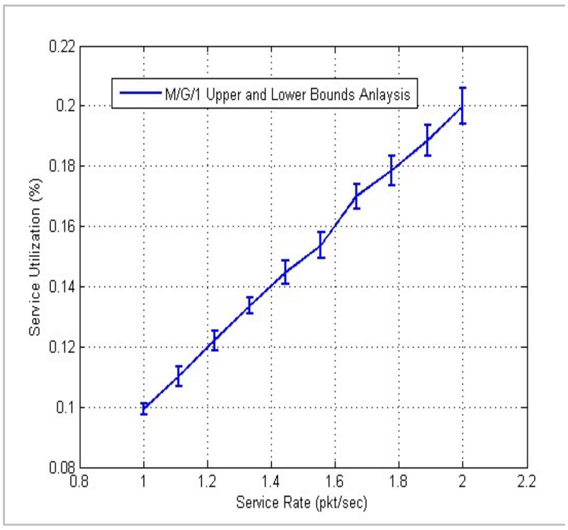


Figure 44-9 Service Utilization with different service rate of the SDMEVN system.

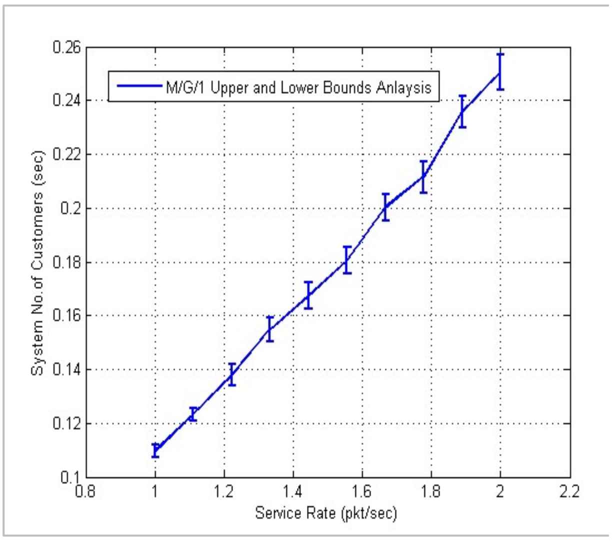


Figure 44-10 System No.of Customers with different service rate of the SDMEVN system

Fig. 44-11 shows that the packet scheduling for delay bound analysis of improved with an increased service rate of the system. However, in the system number of customers waiting for service, when the queue length is more, therefore the system reliability down due to more number of customers waiting for service. As we observed, the system performance is reliable, and we have maximized the service time.

Fig. 44-12 shows that the system throughput with the service rate of a single server monitoring the system with the time to increment of per unit time. From the server or base station user uploading and downloading of data, the controller sends the data to the user at the particular waiting time that happened in the system for increases the delay and throughput performance has reduced. The SDMEVN system provides better system performance to maximize throughput.

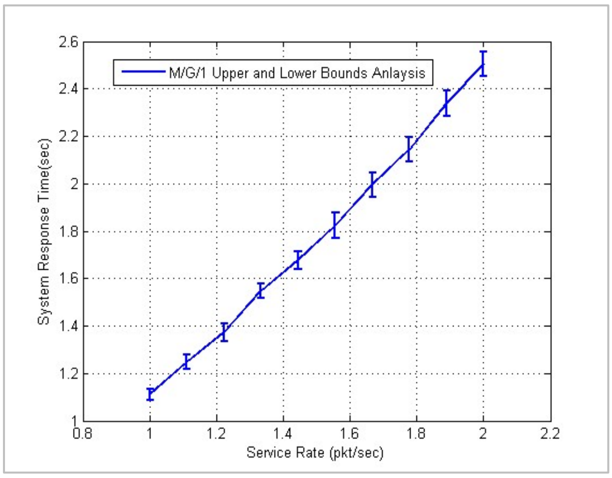


Figure 44-11 System Response Time with different service rate of the SDMEVN system

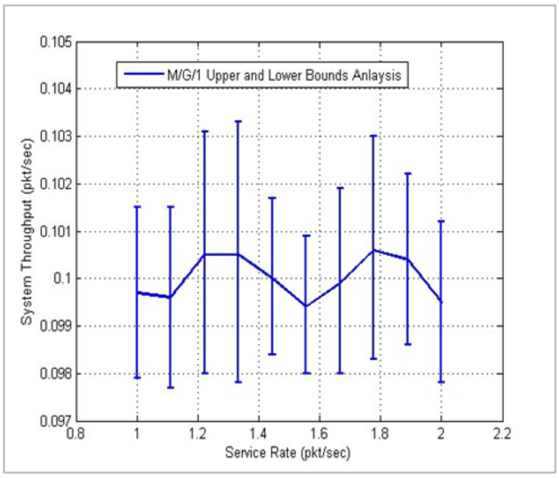


Figure 44-12 System Throughput with different service rate of the SDMEVN system

CONCLUSION

In this paper, we have focus on the dense and sparse network performance for software-defined mobile edge vehicular networks. With the help of M/G/1 buffer occupancy for selection of FCFS scheduling policy towards improving delay bound analysis. Moreover, in SDMEVN, we have analyzed different network performance parameters of arrival and service rate increases due to measures the avg.response time, utilization, and throughput for different network scenarios. Applying queueing models, With the analytical results have verified that the proposed SDMEVN system model performs the M/G/1 queue with an internet-based SDN controller in terms of delay bound analysis. We have improved the system performance and resource utilization. In the future, we have evaluated the network utility maximization using software-defined heterogeneous vehicular networks at different parameters of network scenarios using SDN.

ACKNOWLEDGEMENT

This work has supported by the Electronics Engineering Department of Indian Institute of Technology(Indian School of Mines) Dhanbad, India.

REFERENCES

[1] Ge X, Li Z, Li S. 5G software defined vehicular networks. IEEE Communications Magazine. vol. 55, no. 7, pp. 87-93. Jul 2017.

[2] Deng DJ, Lien SY, Lin CC, Hung SC, Chen WB. Latency control in software-defined mobile-edge vehicular networking. IEEE Communications Magazine. vol. 55, no. 8, pp.87-93, Aug 2017.

[3] Bilen T, Ayvaz K, Canberk B. QoS-based distributed flow management in software defined ultra-dense networks. Ad Hoc Networks, vol.78, pp. 24-31, Sep 2018.

[4] Sood K, Yu S, Xiang Y. Performance analysis of software-defined network switch using M/Geo/1 model. IEEE Communications Letters, vol.20, no. 12, pp. 2522-5, Sep 2016.

[5] Miao W, Min G, Wu Y, Wang H. Performance modelling of preemption-based packet scheduling for data plane in software defined networks. In2015 IEEE International Conference on Smart City/SocialCom/SustainCom (SmartCity) 2015 Dec 19 (pp. 60-65). IEEE.

[6] Mondal A, Misra S, Maity I. Buffer size evaluation of OpenFlow systems in software-defined networks. IEEE Systems Journal, vol. 13, no. 2, pp. 1359-66, Apr 2018.

[7] Mahmood A. Towards Software Defined Heterogeneous Vehicular Networks for Intelligent Transportation Systems. In2019 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops) 2019 Mar 11 (pp. 441-442). IEEE.

[8] Liu K, Ng JK, Lee VC, Son SH, Stojmenovic I. Cooperative data scheduling in hybrid vehicular ad hoc networks: VANET as a software defined network. IEEE/ACM transactions on networking, vol. 24, no. 3, pp. 1759-73, Jun 2015.

[9] Liyanage KS, Ma M, Chong PH. Controller placement optimization in hierarchical distributed software defined vehicular networks. Computer Networks. 2018 Apr 22;135:226-39.

[10] Ozc¸evik ME, Canberk B, Duong TQ. End to end delay modeling of¨ heterogeneous traffic flows in software defined 5G networks. Ad Hoc Networks. 2017 May 15;60:26-39..

[11] Atallah R, Khabbaz M, Assi C. Multihop V2I communications: A feasibility study, modeling, and performance analysis. IEEE Trans. Veh. Technol. vol. 66, no.3, pp. 2801-10, Jun 2016.

[12] Salah K, Elbadawi K, Boutaba R. Performance modeling and analysis of network firewalls. IEEE Trans. Netw. Service Manag. 2011 Dec 23 vol. 9, no. 1:12-21

[13] Ng, Chee-Hock, and Soong Boon-Hee. Queueing modelling fundamentals: With applications in communication networks. John Wiley & Sons, 2008.

[14] Ravi, Banoth, Jaisingh Thangaraj, and Shrinivas Petale. ”Data Traffic Forwarding for Inter-vehicular Communication in VANETs Using Stochastic Method.” Wireless Personal Communications 106.3 (2019): 1591-1607.

[15] Ravi, Banoth, and Jaisingh Thangaraj. ”End-to-end delay bound analysis of VANETs based on stochastic method via queueing theory model.” In 2017 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), pp. 1920-1923. IEEE, 2017.

[16] Xia, Feng, et al. ”User popularity-based packet scheduling for congestion control in ad-hoc social networks.” Journal of Computer and System Sciences 82.1 (2016): 93-112

45. Teachers As Vehicles Of Productivity In Education

Prof. Brahma Nand Mishra, DTU, Delhi (Rtd.), India

bnmishra11@gmail.com

ABSTRACT

Pedagogical theory of today gives high priority to social components of learning characteristics. There is very little new which can be said about teachers, their role, the competencies and so on for the Productivity in Education. It is like one of these clichés which get repeated because they happen to be true and in the process of repetition we stop thinking about it. Therefore, over a period of time, certain things are spoken but they are not felt inside. They are not able to create the chemical change which should take place in us when we believe in something. And my purpose is to try and focus on that role once again with the hope that it might be able to excite the kind of chemical passion that this term, the Productivity in Education, deserves.

Index Terms— *Productivity in Education, Teachers Training, Education Systems, Learning Components.*

INTRODUCTION

Today, we have embarked upon a very momentous change. All around us we see a significant shift. And this shift has been described variously such as: economic reforms, structural adjustments, industrial re-structuring, economic re-structuring, etc… All these terms have very specific meanings. But these terms are no longer terms being spoken in India alone.

In the language of economist, it would be easy to describe it in terms of changing or reducing the fiscal imbalance, increasing international trade, greater competitiveness, liberalization of the economy, all these kinds of terms can be said. And if in the structural adjustment we have to depend on international loans and so on then, that is a valid strategy. But at the end, in the very ultimate analysis, whether we succeed or not, will depend on whether we are able to create a human resource which is productive; whether we are able to create attitudes of international competition. Until that happens, no amount of structural adjustments, loans, no amount of balancing the imports and exports and balancing between revenues and expenditures, none of these will result in any substantial and sustainable gains. At the core of all social changes it is human factor which counts. In the end, it is the human resource that makes the difference.

Ultimately, it is human resource development which is at the core of any social growth and teachers are once again at the core of this entire process of human resource development.

Very often, education in times of structural adjustment may find resource crunch, it may also find that the focus has shifted from so-called social investment areas into productive areas like industry. Available figures show, how education is central to the whole process of development and consequently how teachers are central to that process of educational development..

CONCEPTUAL REVIEW

The two sectors viz. education and industry have roughly similar figures for employment, fixed asset and annual expenditure.

These two sectors are comparable. One can take help of statistics to prove it. But that will digress the issue. And yet what kind of effort is being put behind the educational system? In industry one would be terribly worried about efficiency, productivity, better management, preparing the managers, the work force for coping with the changing requirements and tasks. These are the issues consistently discussed day in and day out in the Institutes of Management all over the world. We have a whole set of institutions devoted entirely for looking at the organised industrial sector to focus on how to improve the effectiveness, efficiency, and productivity. On the contrary, there is not even an agreed definition of productivity of an educational organisation. What does one mean by productivity of a university? What exactly is this? How can this be measured? There is no agreed definition of productivity of the educational system. But not so of an industrial organisation. We know of efficiency of an industrial organisation. But what do we now about efficiency of an educational organisation? We know about sickness of an industrial organisation but do we really know what afflicts the educational institutions? The answer is we do not know and even if we know, we know it very vaguely. Is diabetics visible? Is it a disease? Ailments of educational system are very much like diabetics and they, thus, remain obscured. What about arthritis? One can live life with diabetics and arthritis. But what matters is the quality of life. The disease of the educational institutions is similar.

What is the prime mover in the case of educational organisation? It is the teacher. What kind of efforts do we put in while ensuring that the prime mover of this system has the right kind of skills and capabilities? Do we know what skills are to be acquired in the first place? Do we the faculty including the majority of us the Heads of Institutions know it? Do we have any needs-analysis or the profile of the teacher available with us? I think most of us including myself became teachers without any formal training. We were thrown at the deep end and we had to learn to swim. Some of us may have succeeded but a lot many sank not in the sense that they were thrown out of the system, but their inability to learn to swim has resulted in the kind of the educational decay which we see today; because they did not learn to swim.; because they were not able to act as prime movers, therefore, the standard of education has been a matter of such concern in our system. The fish rots from the head. Educational system is rotting from head to toe. It does not mean there is no oasis in the desert. But the number is too infinitesimal.

If we are going to survive in the changed times, I think, we have to professionalize education. What is the meaning of the word 'professional'? A person with a Bachelor's Degree in engineering or a Master's Degree in engineering or a Ph.D., the moment he gets the appointment letter that says he is a teacher, does that make him [professional? Does an appointment letter make a person professional? This calls for a reflection. In good international universities nobody without an earned Ph.D. is appointed as a teacher. It is presumed that while pursuing the Ph.D. degree, he has gone through the process of learning and training. In our country we can not say that this is happening. Even Ph.D. degrees are being put on sale in some cases. So, our situation is very different. Even a B.Tech. degree holder teaches. Therefore, the task for training is of paramount importance in our context than elsewhere.

For a person to be professional, it requires first of all, to know what is the practice in the profession. How many teachers- I mean, primarily those who have joined not long ago and are new, are familiar how this whole process of teaching and learning is practiced? Therefore, some training would have to be given in this area. That is a part of making the person professional. Another part of being a professional is to know what are the value systems of that profession. And I am not referring to usual moral high ground-one must be honest; one must be punctual; those are obvious and apply to every individual, irrespective of what profession one is in – but I am referring to the concerns, the priorities, the value systems of an educational organisation. When one becomes a teacher, in order to be a professional, he needs to know the value system of that profession – that is considered important, that is considered to be of higher priority than anything else. For example, is the concern limited to communicating a certain amount of facts to the students? Is that an important concern? Is that a paramount concern? Or the concern is to create an individual who is capable of thinking on his or her own, and is able to tackle unforeseen situations.

In fact, situations that neither the teacher nor the student would have seen ever or experiences before. So in what terms is the priority? Is the priority in terms of conducting an examination and then evaluating it at the end? Or is it really to use that process to understand what are the real competencies that we have developed in the person and with a feedback, as a formative process for further improvement of the education-learning-experience that a student is subjected to? These are the kinds of values which would have to be discussed. And once an organisation develops certain sets of values, then the entrant in that organisation would have to imbibe those values, and then that person is a professional. It should be the primary concern of ours – the Head of the Institution to understand and imbibe it and percolate it down to all the faculty because he is the fulcrum about which many things are suspended. Here could be various methodologies for the purpose but periodic brain storming sessions and interactions with the faculty freely and frankly may be useful. Whenever we happen to meet a faculty member or a student, we get the golden chance to interact in the backdrop of the value system in the back ground, if we have any. But mostly these chances are frittered as we ourselves have not given enough thought to imbibe the value system nor we are aware of this requirement.

TEACHING AS A PROFESSION

A professional is one who is also efficient-efficient in the sense that one does not have unlimited resources, either time resources or infrastructural resources and with these limited resources he has to get the maximum possible output.

A professional also has to be most effective. Effective means that all those stated goals which a teacher is supposed to pursue, are being pursued to the desired degree. Are they being achieved to the desired degree? Are the measuring methodologies for this is in place? Mostly no. If all of those things are being achieved to the desired degree then the person is effective and not otherwise. All these aspects are required to be attended to, before a person can be called a professional. It is said 10 years of experience is 1-year experience multiplied by ten. Should it remain so?

I say that the need of the hour today is that our teachers have to be professional. I am simply reflecting on the fact that, many of us, and perhaps, people before us, were not presented with this kind of challenge and, therefore, we could survive even without being professional. Some may have become professional in the course of acquiring expertise on the job. But the whole thing has become so complex today that without formal interventions or training it is not possible to create the kind of professionals we require.

Let me also emphasis one more aspect and that is, teachers are not just instructors. And I say this word with a great deal of caution. Instruction is considered to be a normal job of a teacher. One has a class of students and then he delivers instructions to them, gives them certain facts, certain concepts, certain processes, certain abilities and he assumes that instruction is all that is needed. What we need to create is autonomous learners. And the teacher has to become part of the learning support system. It is a very difficult role to say ‘I am supporting my students in the process of learning’ instead of just routine instructions. And the two things are very different, because if one is creating an autonomous learner he is creating a student for the real life that he would have to face afterwards.

A person would have to be able to decide what his or her learning needs are because in the real situation as we go around with our job, we come across new situations we have never tackled before. And we need to know how to tackle those situations. It might mean acquiring new information; it might mean acquiring new skills. But the first task in all of this is the ability to identify our own learning needs. And once we know what our learning tasks are, then we have to be able to plan that learning activities. Hence, the emphasis on the learning process of the faculty. Again the Head of the institution has to work as a facilitator. Flapping some dead rules on the face of the faculty is the surest way to kill initiative. Ramanujam was not very finished and accomplished but Hardy was a great teacher to discover him.

There are many strategies for acquisition of learning. Which strategies are going to be employed, how one is going to break his total task into a number of small tasks, the micro level tasks, what would be the sequencing of those tasks, how would that task be accomplished, when would he assume that he has learnt enough about that task, so that one can move on to the next one; hence, the ability of self-assessment. And in the profession of learning one comes across new situations/ questions and then to be able to put them back on the learning objective and then to say, ‘Well’, “I have to change my learning plan, the learning activities, the learning objectives and so on and so forth”. And when a faculty says so it must be nurtured by the Head of the institution in the right earnest even by pushing routine works on the back burner or delegating them to somebody else. Most of the routine jobs can be handled by some middle level personnel. He has to be a FOUNTAIN-HEAD. The stream flowing from the fountain quenches the thrust of those who fall in the direct path but even others around get drizzle of refreshing and invigorating droplets. One becomes moist with wisdom that the droplets contain.

The situation mentioned above will have to be faced by all of us and we will have to undergo that change. And this is what we have to prepare our students for. And, therefore, if a teacher becomes an instructor by just delivering a certain amount of information, then we have at the other end the passive person who has not learnt how to understand learning needs or how to go about meting those learning needs. This is the real reason for students not interested in the class0room lectures. Lectures have to be qualitatively different; a change of paradigm; a difficult but nevertheless accomplishable task. Hence, the need for group discussion and group co-ordination committees etc. to evolve the strategies which will have to be dynamic and not mechanical or static. These committees are not the dead ends. They should be seen as fertile grounds for blossoming pf learning paradigm. Hounding up and hoarding teachers into sheds in not the remedy. Remedy lies in kindling the urge for learning and professionalizing and not in pressure, threat, insecurity and indignity meted out so often at so many places. Can a frightened teacher inject the values of integrity, honesty, truthfulness, courage, dedication and kindle the urge for learning? Never. Are we sure, these attributes are part of our value system? If yes, start with the teachers "What a teacher is, is more important than what he teaches". It has been said "No society can be bigger than its teacher". There is a significant difference between the civil administration and educational administration. These fine nuances need to be fully recognized. The civil administration primarily focuses on development and involves planning, and execution of developmental policy, financial controls and maintaining law and order etc. in the society. Educational administration is about nurturing students and more like gardening which requires development of fertile grounds, putting appropriate manures, irrigation and weeding out weeds. It is more a caring and nurturing system rather than a system of control. So, the requirements of these two systems are different. These nuances are essential.

Viewed thus, creating learners is our major challenge. And that means, that we have to create not only teaching material, not only instructional material but learning-resource material, including use of media to support the learning of persons. A teacher ought to know how to organize. A certain objective has to be set beforehand that one has to be achieved. Now in order to meet that objective, one must have a structured approach and curriculum for that kind of structure. How many of us including the Heads of institutions really know how to develop an effective curriculum? In fact, if a survey is conducted, to ascertain from the teachers to distinguish between curriculum and the syllabus, one would mostly draw a blank. The subtle difference is something that exists between fabric and cloth. We do not really know how to convert that educational objective into a curriculum. That could be an important part of the skill. Then the kinds of teaching, training, learning strategies and, there are a whole variety of them, available today, all these would have to be learnt, acquired and used.

These training skills are extremely important. And these have to be acquired because what we have been entrusted with, is a much more important task of developing the human potential. And, if one does not know, how to go about with one's task, then one will make a mess, as many of us have done in the past and continue doing.

Let me give a quotation. And this comes from a teacher, one of the best known teacher of the century, Prof. Richard Fienman, wo is a Nobel Prize winner in Physics. But his greatest qualification is that he is an unsurpassed teacher, I think, the like of him one does not come across easily.

He says:

"*I think, however, that there is not any solution to this problem for education other than to realize that the best teaching can be done only when there is a direct individual relationship between a student and a good teacher, a situation in which student discusses the ideas, thinks about the things and talks about the things. It is impossible to learn very much by simply sitting in any lecture or even by simply doing problems that are assigned*".

What he is saying is the approach to learning and I hope, this is what one will have to practice.

Learning is more about kindling the urge and instruction is more about passing information. Whereas learning occupies the highest place, good instruction may serve as stairs. The later has a utility but limited. Nevertheless, a teacher having inadequate information will never be able to kindle the urge for learning.

TEACHING QUOTES

Some quotes are given below:

"*I like a teacher who gives you something to take home to think about besides homework*".

"*A teacher who is attempting to teach without inspiring the pupil with a desire to learn is hammering on cold iron*". ~ Horace Mann

"*Good teachers are costly, but bad teachers cost more*". ~Bob Talbert

"*The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The great teacher inspires*". ~ William Arthur Ward

"*Who dares to teach must never cease to learn*". ~ John Cotton Danna

"*To teach is to learn twice*". ~ Joseph Joubert

"*What a teacher is, is more important than what he teaches*".

"*The art of teaching is the art of assisting discovery*". ~ Mark Van Doren

"*A good teacher is like a candle – it consumes itself to light the way for others*".

"*The teacher who is indeed wise does not bid you to enter the house of his wisdom but rather leads you to the threshold of your mind*". ~ Kahlil Gibran

"*The dream begins with a teacher who believes in you, who tugs and pushes and leads you to the next plateau, sometimes poking you with a sharp stick called 'truth'*". ~ Dan Rather

"*You cannot teach a man anything; you can only help him find it within himself*". ~ Galielo Galilei

"*Anyone who stops learning is old, whether at twenty or eighty. Anyone who keeps learning stays young*". ~ Henry Ford

"*We think too much about effective methods of teaching and not enough about effective methods of learning*". ~ John Carolus S.J.

"*No matter how good teaching may be; each student must take the responsibility for his own education*". ~ John Carolus S.J.

"*Good teaching is more a giving of right questions than a giving of right answers*". ~ Josef Albers.

"*The mind is not a vessel to be filled, but a fire to be ignited*". ~ Plutarch

"*God understood our thirst for knowledge, and our need to be led by someone wiser;*

He needed a heart of compassion, of encouragement, and patience;

Someone who would accept the challenge, regardless of the opposition;

Someone who could see potential and believe in the best in others….

So He made Teachers". ~ Author Unknown

"*By learning you will teach; by teaching you will understand*". ~ Latin Proverb

"*It is the supreme art of the teacher to awaken joy in creative expression and knowledge*". ~ Albert Einstein

"*Nine-tenths of education is encouragement*". ~ Anatole France

"*The true aim of every one who aspires to be a teacher should be, not to impart his own opinions, but to kindle minds*". ~ F.W. Robertson

"*I hear and I forget. I see and I remember. I do and I understand*". ~ Chinese Proverb

"*Teachers who inspire know that teaching is like cultivating a garden, and those who would have nothing to do with thorns must never attempt to gather flowers*". ~ Author Unknown

"*The task of the excellent teacher is to stimulate 'apparently ordinary' people to unusual efforts. The tough problem is not in identifying winners: it is in making winners out of ordinary people*". ~ K. Patricia Cross

"*No Society can be bigger than its teachers*". ~ Radha Krishnan

"*I do not teach; I inspire*". ~ Albert Einstein

"*If you plan for a year, plan paddy; if you plan for ten years, plant trees; and if you plan for hundreds of years, plant men*". ~ Chinese Proverb

"*Teaching should be full of ideas instead of stuffed with facts*". ~ Author Unknown

"*The average teacher explains complexity; the gifted teacher reveals complexity*". ~ Robert Brault

"*The best teachers teach from the heart, not from the book*". ~ Author Unknown

"*Everything should be made as simple as possible, but not simpler*". ~ Albert Einstein

"*To arrive at the simple is difficult*". ~ Rashid Elisha

ACKNOWLEDGEMENT

With thanks for the endurance to go through. I thankfully acknowledge various sources for preparing this article.