Simulation and Performance Analysis of PDSCH in 5G NR

Santosh M Nejakar[1], Suprith P G[2], Mohammed Riyaz Ahmed[3] , Santosh Herur[4]

[1]*Associate Professor, Dept. of Electrical and ElecronicsEgineering, Jain Institute of Technology, Davangere, Email Id: nejakarganu@gmail.com*

[2]*Research Scholar, School Electronics and Communication Egineering, Reva University, Bangalore, India Email Id: pgsuprith@gmail.com*

[3]*Associate Professor, School Electronics and Communication Egineering, Reva University, Bangalore, India Email Id:riyaz@reva.edu.in*

[4]*Associate Professor, Dept. of Electrical and ElecronicsEgineering, Jain Institute of Technology, Davangere, Emai Id:santoshmherur@gmail.com*

Abstract

5G is the new upcoming digital wireless communication network, which has a high-speed data transmission cellular network also called New Radio (NR). It is industry associated 3rd generation partnership project (3GPP) that defines any system using "5G NR". Beyond the speed, it will allow many new mobile capabilities to be realized-high data capacity, low latency, and IoT capability. The significant exploration issue for 5G is to plan productive and reliable Physical Downlink Shared Channels (PDSCH). In this paper, the design, simulation, and its results are discussed, based on different parameters like subcarrier spacing and modulation schemes such as 64QAM and 256 QAM techniques using MATLAB. The overall discussion and its conclusion will benefit to development of a better 5G communication system.

Keywords: Multiple-Input-Multiple-Output (MIMO), Physical Downlink Shared Channel (PUSCH), Physical Downlink Shared Channels (PDSCH), New Radio, Paging Channel (PCH)

1. INTRODUCTION

Digital 5G cellular network uses millimeter waves, which provide a short range of communication. The antenna used for communication is of smaller size (Several Centimeters). To enhance the data rate, Multiple-Input-Multiple-Output (MIMO) concept is used; every cell comprises of a few recieving wires speaking with the remote gadget, consequently numerous bitstreams of information will be sent at the same time in equal.The 5G systems consist of mainly three channels such as transport, logical, and physical channels, these interns are subdivided into downlink and uplink channels. The downlink consists of Paging Channel (PCH), Broadcast Channel (BCH), Downlink Shared Channel (DL-SCH), Physical layer Downlink Shared Channel (PDSCH), Physical Downlink Control Channel (PDCCH). Uplink channels consist of Uplink layer Shared Channel (UL-SCH), Physical Downlink Shared Channel (PUSCH), Physical Downlink Control Channel (PUCCH)[1]. 5G wireless mobile network employments the orthogonal frequency division multiple access (OFDMA) technique, which is one of the popular modulation schemes in digital modulation and has capable of converting the wide-band recurrence specific channel into a bunch of numerous fading sub-channels[2]. These channels have the capability of acceptance from optimum receivers, indeed, even on account of MIMO transmission with sensible complications[3]. PDSCH has most of the utility to support numerous MIMO transmissions, Hybrid Automatic Repeat Request (HARQ), MAC layer scheduling, and many additional functions. This paper describes and analyzes the 5G physical channel (Downlink) based on the 3GPP criterion. The proposition carries out a standard-consistent of 5G downlink with its significant depiction being Error-checking, MIMO transmission, and Adaptive Modulation and Coding (AMC). It will in general be used to process the presentation of PDSCH and bear the expense of the important reference for the useful arrangement of the 5G system.

2. THEPHYSICAL DOWNLINK SHARED CONTROL CHANNEL DESIGN

The physical channel (PDSCH) holds encoded client data and paging information to that of User Equipment (UE) on a dynamic as well as an opportunistic basis. In fig. 1, it shows how the transmission block is passed to DL-SCH, which gives an output of 1 or 2 codewords, and information of every codeword is encrypted as well as regulated to create a lump of complex-esteemed difference representation. The portrayals are moved toward upto 4 MIMO layers. A PDSCH can have two codewords to help up to 8-layer transmission[5].The layers are associated with radio wire ports in a prerequisite straightforward way, consequently, the bar shaping or MIMO precoding process is conveyed to organize execution and straightforward to the UE. For each radio wire port (layers) utilized for the broadcast of the PDSCH, The RBs are allocated with images[6].

A. Downlink Shared Channel (DL-SCH)

DL-SCH channel holds client data as well as other pieces of information such as different types of System Information Block (SIB). The coding chain consists of Rate Matching, Code block (CB) Segmentation, cyclic redundancy code (CRC), LTEC, and CB. In the above fig. 2, the Transport block is forwarded to CRC which first appends error detection code, followed by section the transport block becomes codeblocks further the code blocks into CRC attachment achieved. Each code block is freely a Low-Thickness Equality Actually take a look at Code (LTEC). LTEC is a channel encoding technique that clears errors of the channel by defining parity bits for a selection of the data bits. Later, LPDC coded blocks are independently rate matched [8].

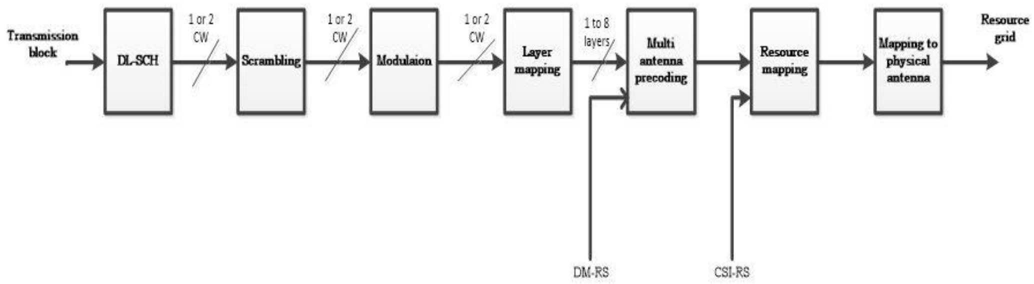

Figure1. Processing physical layer chain of PDSCH

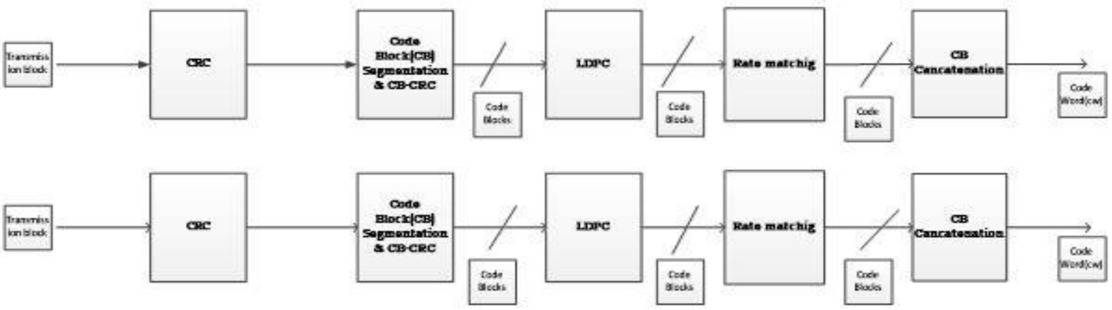

Figure2. Physical layer processing chain of downlink shared channel

The fundamental reason for the rate matching module is to match the number of pieces that can be communicated in the manage the cost of assignment to the number of pieces in the transport square and it likewise draw in sub-block interleaving, bit assortment, and pruning[9]. Ultimately, code block concatenation is done to produce a codeword, and a maximum of 2 codewords can be broadcasted at the same time on the PDSCH. Actual channels relate to a bunch of time-recurrence assets utilized for broadcasting specific vehicle channel information, control, or marker data.Each transport channel data and control, indicator information is mapped to its respective physical channel and it is further classified as PBCH, PDSCH, and PDCCH.

A. PDSCHScramblingandModulation

A maximum of two codewords can be broadcasted in a subframe and for each codeword; the data bits are scrambled with a various variety of scrambling patterns. The scrambling design is introduced toward the beginning of each subframe and relies upon RNTI, NCellID, NSubframe, and the codeword record. The regulation program form structures PDSCH are PDSCH are 'QPSK', '16QAM', '64QAM', or '256QAM', and these specify the modulation category of the codeword and the number of bits used per modulation symbol.

B. PDSCHsurface draw

The multi-layered changed images are furthermore intended to single or many layers as per the transmission rules used.The ports used for the single-layer are generally 0, 5, 7, or 8 and usually, for the broadcast diversity, the only single codeword is permitted. For the most part, the number of layers such as 2 or 4 should be equivalent to various antenna ports that are utilized for the broadcast of the actual channel[10]. For spatial multiplexing, codeword (1or2) can be broadcasted on up to 8 layers. The number of communication antenna ports larger than or equivalent to a number of layers to be used for the broadcast of the physical channel.

C. PDSCH Multi-Antenna Precoding and Resource Mapping

To map more layers, the precoding technique is accomplished. Using matrix multiplication with the pre-corner the numerous layers go through precoding antenna ports [13-14]. The exceptional instance of precoding is planning one layer to numerous antenna which empowers beamforming for line-of-sight, transmission this would probably mean focusing on specific one more instance of precoding is planning a few layers to various receiving wires this more broad case is here and there alluded to as spatial multiplexing one critical part of precoding in 5G is that the related demodulation reference transmissions or DM-RS should go through the equivalent precoding thus the UE shouldn't be made mindful of precoder as the impact of a precoder is remembered for channel assessment this is the reason the specific precoder the G node B is to utilize isn't determined in the standard the pre-code indicated in the standard the pre-coder out is additionally connected to actual asset impedes either straightforwardly or by implication [15-16]. PDSCH at first planned to Virtual Asset Blocks (VAB) one planned to lattice PDSH images stay away from areas saved for different purposes, this incorporates all actual sign DMRS, CSI-RS. Planning of VAB to actual asset blocks are interleaved or Non-interleaved planning. [17] Non-Interleaved Mapping comprises straightforwardly planning each virtual square to a similar situation in the actual asset network. Interleaving planning gives recurrence variety by dispersing virtual squares over the entire data transfer capacity part [18-19]. The Interleaving granularity is 2 or 4 assets obstructs this plan how about we relegate back-to-back virtual asset square to a PDSCH design that is not difficult to flag just with an asset square and number of assets block while as yet getting recurrence variety. In this paper, we measure the PDSCH throughput execution boundary of a 5G NR and understand the vehicle and actual correspondence channels [20].

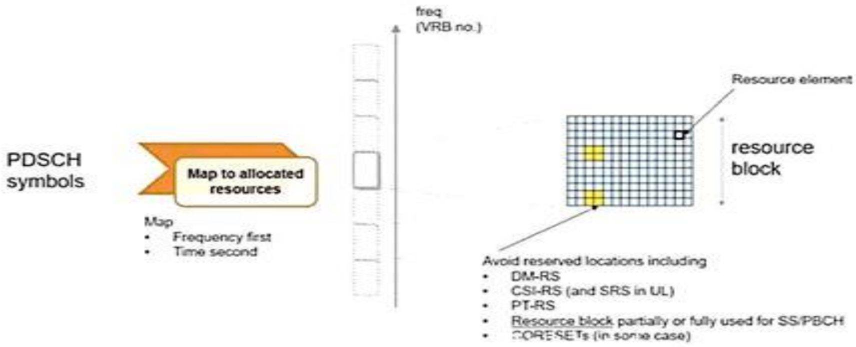

Figure3.Mapping toVRB

TableI.Parameter settings for different subcarrier Spacing/mapping techniques in the simulation

ParametersUsed	***Values***
Signal to Noise Ratio(dB)Range	-5,0,5
Number of 10ms Frames	2
Modulation Technique	64QAMand 256QAM
Number of UE Receive Antenna	2
Subcarrier dispersing in terms of KHz	15,30,60,120&240
Number of PDSCH Layers	2
PDSCH Transmission Antennas	8
Number of Codewords	2
PDSCH symbol allocation in each slot	0:13
Propagation Channel Type	CDL

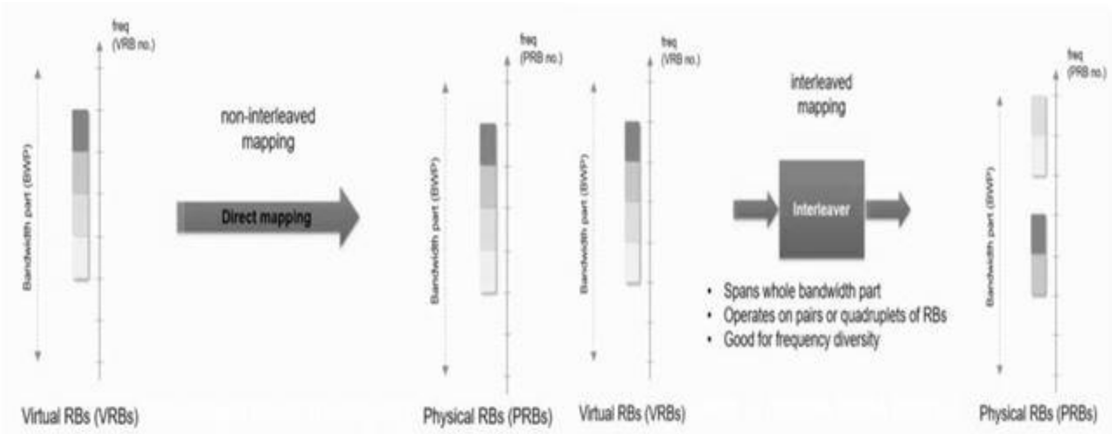

Figure4. Mapping from Virtual RBs to Physical RBs

TableII.Subcarrier Spacing and Throughput for differen tmapping techniques at SNR (5dB)

Subcarrier Spacing(kHz)	***MappingTechnique***	***Throughput (%)***
15	64QAM/256QAM	20/20
30	64QAM/256QAM	40/40
60	64QAM/256QAM	40/40
120	64QAM/256QAM	50/50
240	64QAM/256QAM	100/50

TableIII. Frame Structure

Subcarrier Spacing (μ)	Number of OFDM Symbols per Slot (N_{symb}^{slot})	Number of Slots per Subframe ($N_{slot}^{subframe,\mu}$)	Number of Slots per Frame ($N_{slot}^{frame,\mu}$)
0 *15 kHz*	14 *1 ms*	1 *1 slot x 1 ms = 1 ms*	10 *10 ms*
1 *30 kHz*	14 *500 μs*	2 *2 slots x 500 μs = 1 ms*	20 *10 ms*
2 *60 kHz (normal CP)*	14 *250 μs*	4 *4 slots x 250 μs = 1 ms*	40 *10 ms*
2 *60 kHz (extended CP)*	12 *250 μs*	4 *4 slots x 250 μs = 1 ms*	40 *10 ms*
3 *120 kHz*	14 *125 μs*	8 *8 slots x 125 μs = 1 ms*	80 *10 ms*
4 *240 kHz*	14 *62.5 μs*	16 *16 slots x 62.5 μs = 1 ms*	160 *10 ms*

3. SIMULATION RESULTS

This section shows the experiment result of a 5G NR link and its performance parameters, as expressed according to the standard of 3GPP NR. The outcome of the simulation describes the highest achievable throughput of the link provided by the existing resources for data communication. The graph defines the throughput over Signal to Noise ratio (SNR) across all antennas. Subcarrier dividing of 240 kHz with 64 QAM adjustment plot produces 100 percent of throughput, though 15 kHz with 64QAM/256QAM gives an exceptionally low throughput of 20%.

In 5G remote innovations, we have variable subcarrier separating, more prominent the worth more the quantity of openings per outline, lesser the symbol duration (up to 4μs), and maximum bandwidth (up to 400MHz), minimum scheduling interval (up to 0.06ms) andprovidesbetter performance. (Upto 400MHz), minimum scheduling interval (up to0.06ms) and provides better performance.

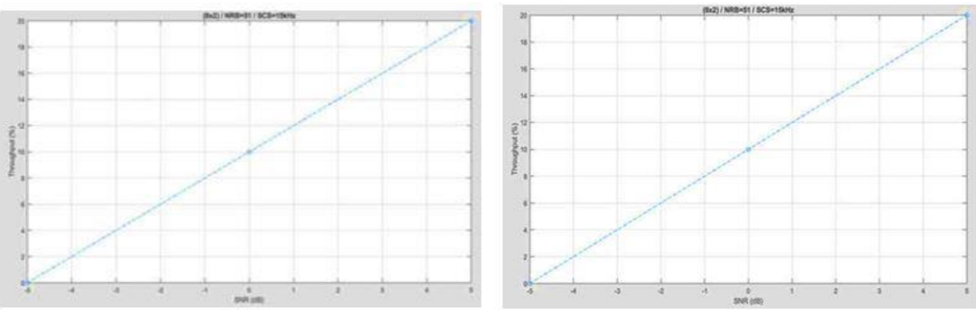

Figure.5(a) and (b):Throughput (%) versus SNR(dB) with 64QAM, 256QAM modulation scheme and subcarrier spacing of 15kHz

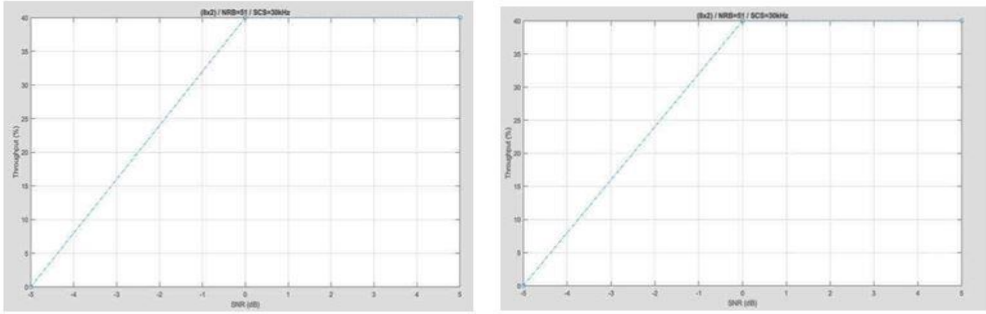

Figure.5(c) and (d):Throughput (%) versus SNR(dB) with 64QAM, 256QAM modulation scheme and subcarrier spacing of 30kHz.

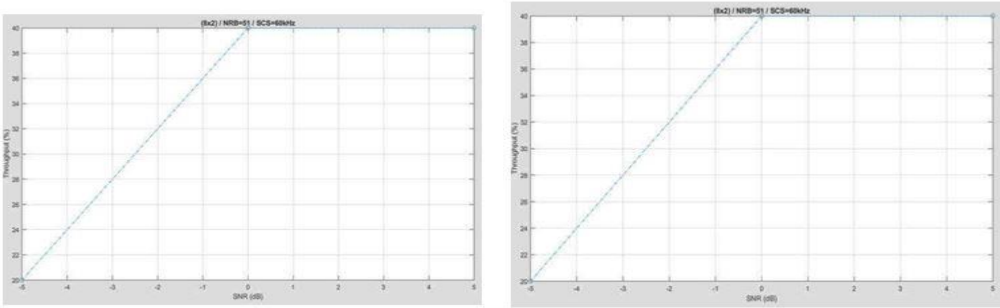

Figure.5(e) and (f):Throughput (%) versus SNR(dB) with 64QAM, 256QAM modulation scheme and subcarrier spacing of 60kHz.

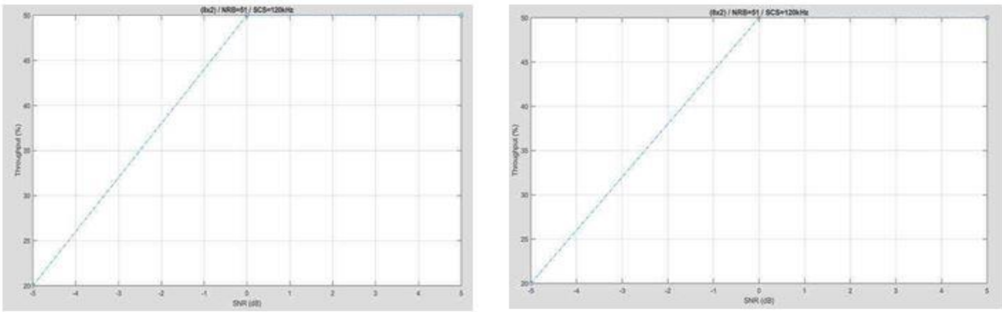

Figure.5 (g) and (h): Throughput (%) versus SNR (dB) with 64QAM, 256QAM modulation scheme and subcarrier spacing of 120 kHz.

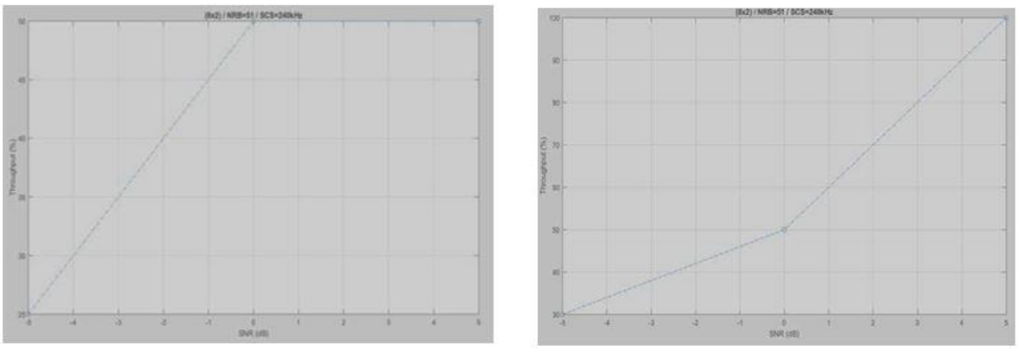

Figure.5(i) and (j):Throughput (%) versus SNR(dB) with 64QAM, 256QAM modulation scheme and subcarrier spacing of 240kHz

4. CONCLUSION

The next generation, digital 5G cellular network uses millimeter waves, which provides a short range of communication. The data rate is enhanced by using the MIMO technique; each cell consists of several antennas communicating with the wireless gadget, in this way different bitstreams of information will be communicated at the same time in equal. The above paper has given a framework of the key of 3GPP NR condition characterizing the condition of art in 5G remote framework, with an emphasis on the actual layer. The simulation result concludes that the throughput performance of a 5G NR link, as expressed by the 3GPP NR criterion is high in the case of subcarrier spacing of 250 kHz, 64QAM modulation with 8×2 antenna feature.

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Biographies

	**Dr. Santosh M Nejakar** received B.E degree in E&C Engineering from VTU, Belgaum in 2008, M.Tech in Digital Electronics and Communication Systems from VTU, Belgaum in 2013 and also awarded with Ph.D. by VTU, Belagavi in 2021. He is currently working as Associate Professor and Head of the Department in the Electrical and Electronics Engineering Jain Institute of Technology, Davangere, Karnataka, India. Totally 14 papers of him are published in reputed journals. He has filed 21 patents out of which 10 patent have received its grant. His area of interest includes Wireless Communication, VLSI and Embedded systems. G Networks and Blockchain Techology.
	**Suprith PG** accepted his four year certification in Electronics and Communication Engineering and expert's in Digital Electronics and Communication System from Visveswaraya Technological University, Belgaum, India, in 2009 and 2013, separately. Presently, he is chasing after a Ph.D. from REVA Unversity, Bengaluru, India. His exploration advantages incorporate Non-Orthogonal Multiple Access (NOMA), millimeter-wave NOMA, and Wireless Sensor Networks. He is a coach for the E-Yantra discussion Robotics at IIT Bombay. He is an individual from ISTE.
	**Dr.** M R Ahmed (S'13–M'15–SM'17) received the B.E. and M. Tech. degree in electronics and communication engineering and computer networking from Visveswaraya Technological University, Belgaum, India, 2007 and 2010, respectively. He received the Ph.D. degree in electronics and communication engineering from the Jain University, Bengaluru, India, in 2016. Since 2011, he has been with REVA University, Bengaluru, India, where he is currently an Associate Professor and Assistant Director of School of Multidisciplinary Studies. He is guide of IEEE EMBS understudy part and tutor to IEEE ComSoc understudy section at REVA University. He has filled in as TPC individual from IEEE ICAECC meeting, and specialized analyst for 7 IEEE diaries and exchanges alongside various accomplished diaries and gathering procedures. His exploration advantages incorporate the computational mental neuroscience, WSNs and 5G. He has distributed in excess of 75 exploration papers in refereed diaries, global gatherings and has filled in as welcomed speaker. Riyaz is the counselor and the advisor to various Higher Educational Institutes for their change into an Entrepreneurial University for Knowledge Economy.
	**Dr. Santosh Herur** gotten B.E degree in E&C Engineering from VTU, Belgaum in 2009, and M.Tech in Digital Electronics from VTU, Belgaum in 2012 and also awarded with Ph.D. by VTU, Belagavi in 2021. He is at present filling in as Associate Professor and Head of the Department in the Electronics and Communication Engineering Department, Jain Institute of Technology, Davangere, and Karnataka, India. Totally 11 papers of him are published in reputed journals. Awarded with Best Research Paper for one of his paper presented in an International Conference. He has filed two patents out of which 1 patent have received its grant. His area of interest incorporates Image Processing, VLSI and Embedded frameworks. He has ISTE life-time enrollment.