International Conference on Recent Trends in Data Science and its Applications
DOI: rp-9788770040723.214

Design and Implementation of Thyristor Controlled System to Function and Control the Illuminance of Lamp Using Matrix Keypad with IoT

S.Sathappan,
Associate Professor, Department of Computer science and Engineering, Chaitanya Bharathi Institute of Technology,
Gandipet, Hyderabad, India,
ssathappan_it@cbit.ac.in

G Satish,
Associate Professor, Department of EEE, Sree Dattha Institute of Engineering and Science,
Hyderabad, India,
gsatish227@gmail.com

Poonam Verma,
Assistant Professor, School of computing, Graphic Era Hill University, Dehradun R/S, Graphic Era Deemed To Be University,
Dehradun, 248002, pverma@gehu.ac.in

M.Ramarao,
Associate Professor, Department of Mechanical Engineering, Bharath institute of Higher Education and Research,
Chennai, Tamilnadu,India,
ramarao.mech@bharathuniv.ac.in

Kaushik Mishra,
Assistant Professor, Amity School of Communication, Amity University
Kolkata, West Bengal, India,
kaushikmishra28@gmail.com

Samrat Srivastava,
Department of Commerce, KES Shroff College,
samrat@kessc.edu.in

***Abstract*—The lighting is the important phenomena that are used in our day to day life. They must be utilised in a proper way without any consequences. The rise in the demand is caused due to functioning of equipment unnecessary that leads to increase in the consumption of power. To overcome these drawbacks, the digitalization is implemented. This is done through the internet of things. This helps to function through evolving the two way communication system. The lighting system must be properly functioned through analysing the illuminance and luminance. Higher or lower illuminance level can cause various constraints in physical and mental health. To overcome these constraints, the proposed system is implemented. This is done through the thyristor controlled system. The thyristor is a solid state switching devices that are used to withstand the rated voltage until it gets triggered. The thyristor once triggered, the current through the triggering phase can be removed without turning off the equipment. The illuminance percentage is visualised through matrix keypad. The overall system is functioned and monitored through internet of things.**

Keywords—Illuminance, luminance, digitalization, matrix keypad, lamp, voltage control, inverters, rectifiers, voltage source converters, internet of things

I. INTRODUCTION

The lighting is considered as one of the essential system in our day to day life. They are mandatory in every field. This much be obtained with correct functioning parameters. Any deviation in the lighting system leads to various problems such as eye strain, health issues and various accidents occur in roads due to poor lighting system [1]–[3].

Hence the lighting system must be functioned with optimum care. The proper functioning of the lamp is determined through the illuminous. The illuminous is defined as the quantity of light that cover the surface. The SI unit of illuminance is referred as lux. This is frequently represented as brightness. This is replaced through the SI unit to attain equality in standards. The increased value of light is obtained when the value of lux is higher in range. They are expressed in candela and lumen. The range of lighting must be maintained properly without minimum or maximum lux. The maximum illuminance can also causes various barriers to human health. The increased in the illuminance does not recommended as proper lighting [4], [5].

The average level of illuminance must be maintained. This is also relied on the surface in which if the surface area is smaller, the illuminance reflects brighter. If the same amount of light falls on a larger area, the illuminance becomes lesser leads to dim in appearance. Thus the surface of the area also play an important role in the illuminance of lamp. If the lux values are obtained higher, this helps to provide higher level to light to the surface [6]–[8].

The lighting system must analyzed for domestic and industrial purposes, based upon the needs the illuminance are needed to provide. This helps to obtain exact lighting for the particular area. The reduction and rapid increase in the lighting system leads to imbalance in the surface area. The value of lux is maintained using the lux meters. These instruments are only used to measure the light and they are cheaper in cost. The level of illuminance is denoted by the lux value through which the lighting system is obtained. This helps to adopt a proper lighting system to the particular area. There are various types of lighting system is designed based upon the usages and the needs. This includes domestic purposes, industrial purposes and designing purposes [9]–[12]. These lighting varies in color in the designing purposes. There is a vast difference between the luminance and illuminance. The illuminance is the amount of light that falls in unit area whereas the luminance is the amount of light that are reflected back to the surface after the light

DOI: rp-9788770040723.214

absorbed through illuminance. These two technology plays a vital role in the lighting system. The measurement of light based upon the luminance and illuminances determines the intensity of the lighting arrangement. The detection of light waves are denoted as optical radiometry. This is the amount of light waves that falls in the optical portion of the electromagnetic spectrum. These waves are referred as visible light, infrared light and ultraviolet light [13]–[16].

The electromagnetic radiations are also measured using radiometry. This is done through the application on sensing the detecting the brightness across the surface. The terminology used for the detection of light system is called photometry. This includes the detection of visible light in the electromagnetic spectrum. This helps to measure the light based upon the human perception towards brightness. Thus the photometry is the branch of science that contracts with the measurement of intensity of light. The sensitivity level at which the brightness of light affects the human health is analyzed. This helps to separate wavelength through the electromagnetic spectrum [17]–[20].

The ultraviolet rays can be detected through the photometry. Thus the important part of photometry includes the differentiation of the visible light with that of human perspectives. This helps to neglect the disadvantages caused by the brightness level through proper functioning and detection of the illuminance level.

The usage of spectrometer in analysis and detection in the measurement is referred as spectrometry. The spectrometry is the interaction of matter and light. This is the relationship between the reactions and the adverse measurements of the intensity and wavelength. The application of spectrometry includes in diverse areas. They are largely used in astronomy, improvement in the structure of drugs and in biomedical applications. They are used to analyze the objects far away. The another process of measurement of light at the particular wavelength at a particular electromagnetic spectrum are referred as the spectroradiometer. They are measured through the spectrum or through wavelength. The two important concepts that are involved in the spectroradiometry includes spectral radiance and spectral irradiance [21]–[23].

The intensity of the light is measured through the source of light and the direction in which the light radiates. This is denoted as the number of lumens that falls on the unit area. This helps to find out the illuminance and light intensity. The instrument used to measure the light are termed as photometer. This is used to observe the intensity of light. This is also refers as the instrument that are used to measure the visible light. The luminance and illuminance both are measured to obtain proper lighting system. The measurement of luminance and illuminance are estimated through the measuring device known as luminance meter and illuminance meters [24], [25].

The accumulation of electromagnetic radiation is done through the integrating sphere. The lights are measured and break into spectral components are done through the spectrometer. This helps to digitalize the obtained signals and can able to display through computers. The measurement of depth of light is measured through the light meters . The level of light falls on the surface is measured through plane. Illumination of high power is mandatory to achieve effective lighting system. The illumination can be controlled through power electronic devices. The various power electronic devices used for illumination are thyristor, transistor and diode. The various kinds of thyristor includes silicon controlled rectifier (SCR), triac, programmable unijunction transistor. The thyristor is a three terminal controllable device which works much efficient in power frequency.

The proposed system is used to maintain the illumination of lamp using thyristor. This is adopted with matrix keypad with IoT. The internet of things (IoT) helps to enable the two way communication system through which the functioning can be monitored even at remote places. The illumination of the lighting system is employed through varying the voltage across them. The matric keypad is defined as the circuit that are used to monitor the amount of illumination used by the user end. This is indicated through percentage. The total functioning of the system are adopted through the solid state mechanism through switching control parameters.

The overall process is performed and controller through microcontroller for enhancing and maintain the illumination control through the surface area. The display unit is used to visualize the percentage of illuminance that are used. Thus the proposed system is much efficient in functioning and controlling illuminance of lamp through thyristor control accompanied with internet of things. The overall process of illuminance is visualized in the matrix keypad.

II. Proposed System

The planned system involves the regulation of the illuminance of lamp through the thyristor control. The most frequently used thyristor are silicon controlled rectifier (SCR). The SCR contains three terminal in which the conductor is allowed to control by the input current. The three terminals are anode, cathode and gate. The gate is used for triggering the device into latch through minimum voltage.

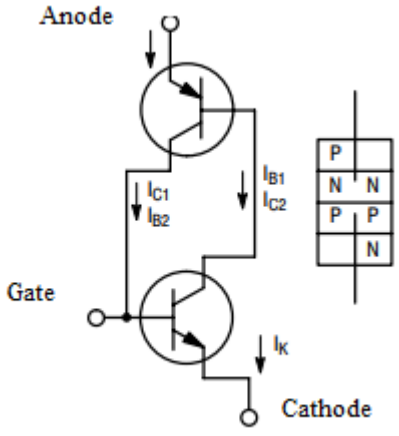


Fig 1: Silicon controlled rectifier

DOI: rp-9788770040723.214

The figure 1 represents the silicon controlled rectifier. The analysis of the SCR provides the bistable operation. The triggering of thyristor requires the intrusion of current to increase the gain. The anode current leads to the avalanche breakdown which results in variation of the breakdown voltage. The thyristor includes the junction temperature. This affects the characteristics of thyristor. The increase in the temperature helps the thyristor to turn on and remain in operating state. The applied voltage attains the breakdown voltage when the gate current is zero. This includes the latching and holding current. The minimum current used for the thyristor to remain in operating conditions rapidly after switching from off state are termed as latching current. The holding current is defined as the slightest current required to maintain the thyristor to remain in on state.

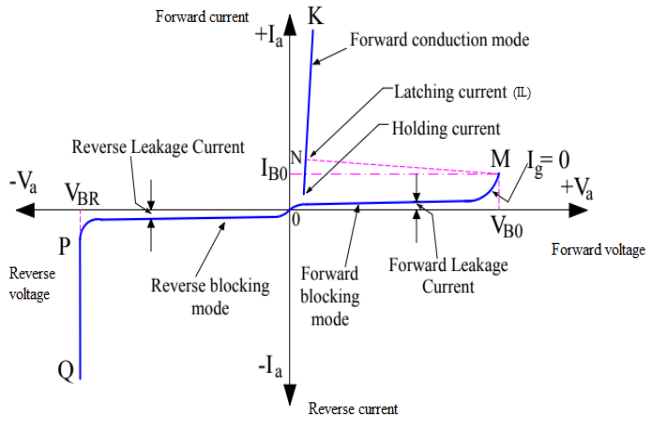


Fig 2: VI characteristics of SCR

The figure 2 demonstrates the VI characteristics of SCR. There are three approaches of process of SCR includes forward blocking and conduction mode and reverse blocking mode. In the forward blocking mode the SCR is at forward bias mode. The gata current is found to be 0.

The figure represents the VI characteristics of SCR.

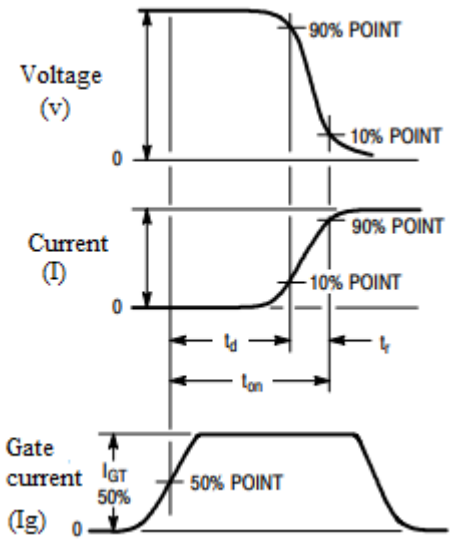


Fig 3: SCR turn on time

The figure 3 represents the turn on time of SCR. The forward breaking voltage is defined as the voltage at which the SCR turns on and when the gate current remains 0. The functional votage falls to the breakover voltage of the thyristor when the gate current becomes zero. Through obtaining particular value of the gate current, the thyristor starts to perform and function as rectifier.

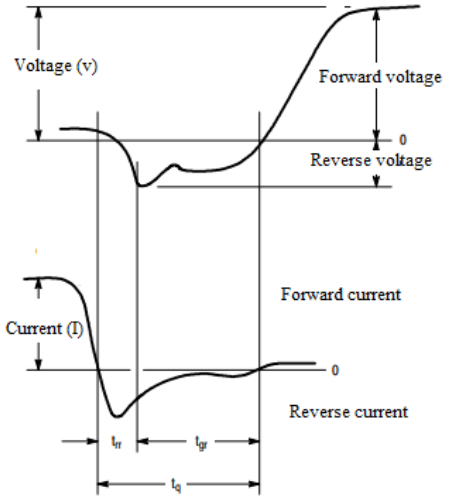


Fig 4: SCR turn off time

The figure 4 represents the turn off time. The turn off in thyristor is defined as the time duration in which the anode current lies to zero and obtainig forward blocking phase.

III. Automatic Illumination Control of Lamp

The control of illuminance of lamp is controlled and performed using thyristor and maintained using microcontrollers. Here 8051 microcontrollers are used. The firing angle is automatically initiates through the microcontroller using input. This helps to control the functioning of thyristor.

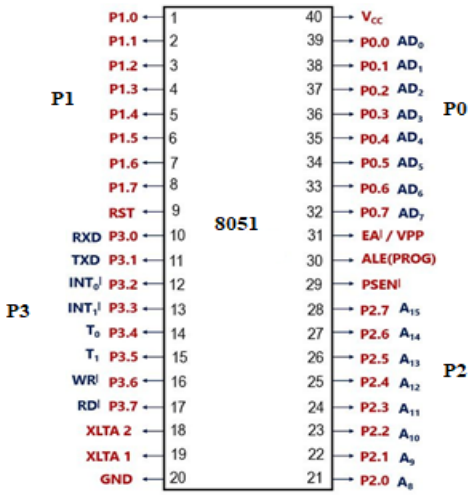


Fig 5: Pin diagram configuration

The figure 5 represents the pin diagram configuration of 8051 microcontroller. The illumination control is classified

DOI: rp-9788770040723.214

into two types such as manual illumination control and automatic illumination control module. The automatic illumination control module is used to replace the manual illumination control. This includes the illumination through adopting the rotor switch to intact through the switching position. They operates based upon the day and night times.

During night time there is no light that falls on the LDR1, this helps to enhance the intensity of the light that causes the lamp to glow automatically without any external assistance. This causes reduction of resistance on LDR2. During day time, the light falls on the LDR2, hence no emission of light is done through LED light. This causes the UJT firing circuit leads the SCR to incapable to trigger. The control strategy must be maintained properly to achieve automation. The automatic illumination of lamp is achieved through firing circuit in the SCR. The lamp with the variations of output voltage need to be maintained and controlled. The another kind of switching includes the complementary switching. The complementary switching is done through the photo sensitive controller [20]. They are accomplished through light source such as sun light. This is done for two lamp. The photoactive elements emits the light in the complementary lighting.

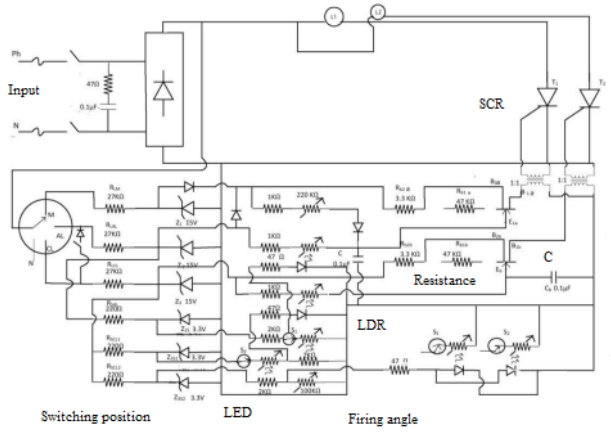


Fig 6: Circuit diagram

The figure 6 demonstrates the circuit diagram representation of automatic control of illuminance of lamp. The device is initiated through the matrix keypad. The matrix keypad are largely used in the embedded applications. They are also used in telephones and fax machines.

The matrix keypad is the integration of four rows and columns through buttons. The functioning of the matrix keypad includes the combination of rows and columns through which touching the button helps connect and perform the operation accordingly. In a 4 × 4 keypad matrix, the 4 connects are in rows and 4 connections are in columns. This constitutes totally 8 connections. There are various kinds of matrix keypad, out of which the 4 × 4 matrix keypad and 4 × 3 matrix keypad are highly used in various applications. The various layers that constitutes the matrix keypad includes overlay through graphic, interior metallic domes, first layer of circuit, spacer unit, button model, adhesive portion with connector section.

These layers helps to constitute the production of the keypad matrix. The overlay through graphic layer are made through polyester due to its increased flexibility in nature. The next layer are obtained with polydomes. The outer circuit layer is the integrated portion to the external environment. This is made up of the combination of polyester with coating done with electrical conductive solutions.

The switch always remain in open until the keypad is fixed. These in-between layer is termed as spacer unit. The bottom unit of the matrix keypad is also a flexible layer made up of polyester material. The adhesive unit helps to stich the layers without any gap between them internally and externally.

Through touching one button, the connections is adopted between the interconnections with rows and columns. The larger use of the matrix keypad is due to it tends to decrease in the number of pins. The number of pins in the network are reduced through the interconnection of rows and columns in the matrix keypad. This enhances the process of multiplexing. This is a method of functioning of larger number of inputs through lesser number of pins. This is a minute input devices works based upon the user instructions and proceeds to the microcontroller. They are performed through 0 and 1 which demonstrates the high and low values. This scans the rows and columns when pressed. The matrix keypad is connected with the pins in opposite order. The pin 8 defines the starting stage. They are largely used due to the lower cost with higher efficiency with longer withstanding capacity.

TABLE I. Amount of Energy Consumption

Sl.no	Space for illumination	Utility hours	Light intensity (lux)	Output (watts)	Energy (kWh)
1	Living room	24	300	42.5	42.8
2	Dinning room	12	500	12.9	35.9
3	Kitchen	14	200	5.98	24.9
4	Bedroom	10	300	16.8	6.9
5	Studying room	5	400	25.6	35.5
6	Store room	2	150	17.9	20.1
7	Bathroom	1	125	12.1	10.2

The table I represents the amount of energy consumption in each room in a house. Calculating and monitoring the consumption helps to maintain the demand. This is done to reduce the excessive usage of lights even in day time or forget to turn off the lights leads to increase in the consumption. This leads to increase the demand in the supply system. To maintain the demand side management in both the domestic and industrial applications, the proposed system provides a optimum solution. Through proper utilization nearly 35% of the power can be saved.

IV. Simulation Results

The implementation of the proposed system is monitored and calculated through simulation output. This helps to estimate the consumption of power, thyristor functioning, control of illuminance lamp during day and night times are observed. This gives an appropriate value of

DOI: rp-9788770040723.214

illuminance in lux and the amount of power consumed throughout the day and proceeded with months. This is done through the MATLAB Simulink.

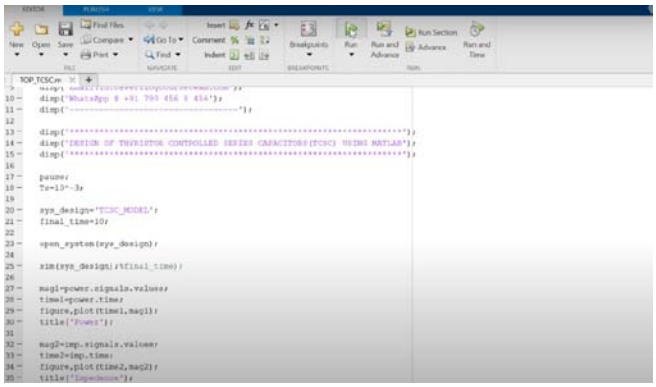
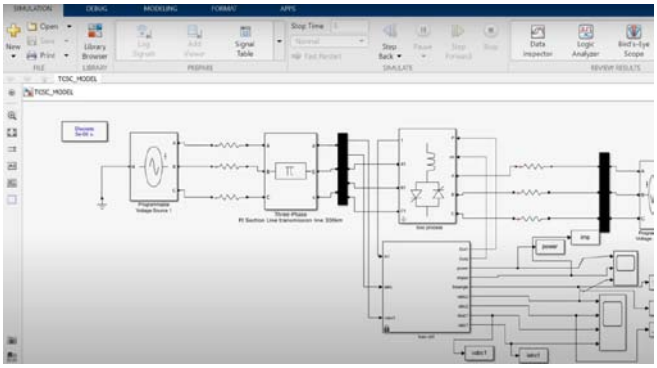


Fig 7 : Implementation of system

The figure 7 represents the implementation of the proposed system in MATLAB.



Fg 8 : Simulation diagram

The figure 8 demonstrates the simulation diagram. This includes thyristor, LDR, sensors and LED lamps. The readings are denoted to extract the output function. They are analyzed through varying the voltage values. Thus the illuminnace of the lamp gets deviated based upon the change in voltage. This helps in the control of illuminance in the lamp.

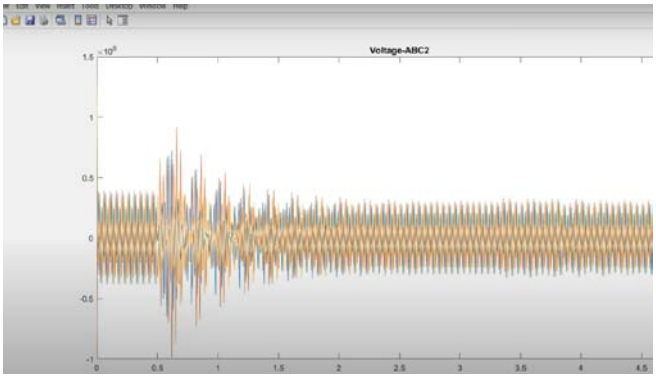


Fig 9 : Capacitor voltage

The figure 9 represents the capacitor voltage at charged condition. The capacitor in the system are connected across the supply system. This is used to make rectifications in the power factor. The occurrence of arc caused by the inductance are reduced by the capacitor.

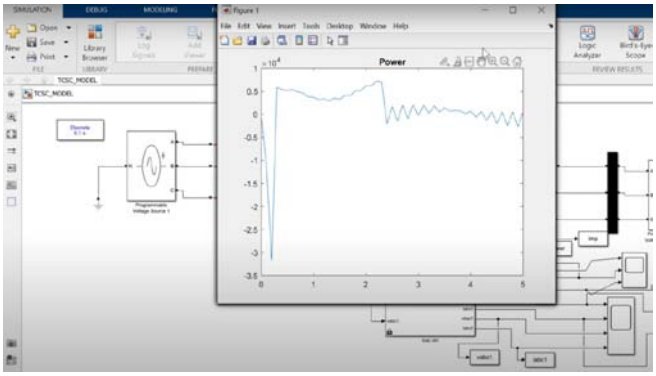


Fig 10: Output power

The figure 10 represents the output power. This helps to estimate and calculate the amount of power consumption.

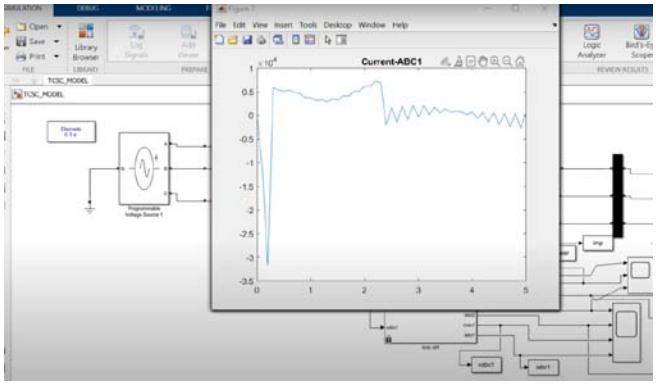


Fig 11 : Output current

The figure 11 represents the output current. The current rating is 0.2 A.

V. Hardware Description

The proposed model is implemented through hardware prototype to estimate and evaluate the functioning of the proposed system. This helps to calculate the amount of energy consumption. The overall illuminance control of lamp is intimated as message to the user's phone. This is implemented through internet of things. This helps to automatically detect the working of the lamp and able to provide instructions to the system.

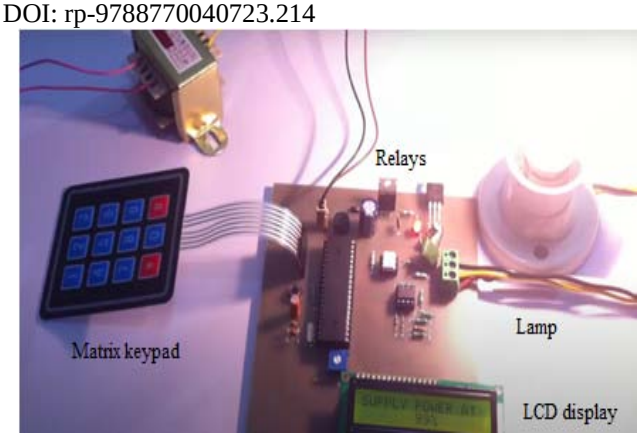


Fig 12 : Hardware representation

The figure 12 demonstrates the hardware representation of the proposed system. Thus the control of illuminance is achieved.

VI. Conclusion

The control of illuminance of lamp is introduced through control and monitoring system using matrix keypad is implemented experimentally through internet of things. They are adopted through controlling the illuminance through manually and automatically. This is also done through balancing switching techniques. The automation in illumination is done through thyristor control with control parameters. This helps to provide optimum illumination through automatic control for both the indoor and outdoor lighting system through balancing the illuminance and luminance. The matrix keypad is used to reduce the number of pins through integrating rows and columns. The internet of things are employed to enhance the communication system from one end to another end. The functioning of the lamp can be controlled through the user even at remote places. Thus the proposed system helps to control the illuminance through thyristor control that helps in reduction of energy consumption. This proposed system helps to obtain higher efficiency when associated to the conventional organisation.

References

[1] A. Anjum, P. Agbaje, S. Hounsinou, and H. Olufowobi, “In-Vehicle Network Anomaly Detection Using Extreme Gradient Boosting Machine,” 2022 11th Mediterranean Conference on Embedded Computing, MECO pp. 7–10, 2022, doi: 10.1109/MECO55406.2022.9797224.

[2] H. Pourrahmani et al., “The applications of Internet of Things in the automotive industry: A review of the batteries, fuel cells, and engines,” Internet of Things (Netherlands), vol. 19, no. July, p. 100579, 2022, doi: 10.1016/j.iot.2022.100579.

[3] X. Krasniqi and E. Hajrizi, “Use of IoT Technology to Drive the Automotive Industry from Connected to Full Autonomous Vehicles,” IFAC-PapersOnLine, vol. 49, no. 29, pp. 269–274, 2016, doi: 10.1016/j.ifacol.2016.11.078.

[4] M. Ammar et al., “Significant applications of smart materials and Internet of Things (IoT) in the automotive industry,” Materials Today: Proceedings, vol. 68, pp. 1542–1549, 2022, doi: 10.1016/j.matpr.2022.07.180.

[5] M. A. Rahim, M. A. Rahman, M. M. Rahman, A. T. Asyhari, M. Z. A. Bhuiyan, and D. Ramasamy, “Evolution of IoT-enabled connectivity and applications in automotive industry: A review,” Vehicular Communications, vol. 27, p. 100285, 2021, doi: 10.1016/j.vehcom.2020.100285.

[6] J. H. Song, C. Kim, and Y. Yoo, “Vein visualization using a smart phone with multispectral wiener estimation for point-of-care applications,” IEEE Journal of Biomedical and Health Informatics, vol. 19, no. 2, pp. 773–778, 2015, doi: 10.1109/JBHI.2014.2313145.

[7] K. Kasat, D. L. Rani, B. Khan, A. J, M. K. Kirubakaran, and P. Malathi, “A novel security framework for healthcare data through IOT sensors,” Measurement: Sensors, vol. 24, p. 100535, October, 2022, doi: 10.1016/j.measen.2022.100535.

[8] Rajesh, M., &Sitharthan, R. (2022). Image fusion and enhancement based on energy of the pixel using Deep Convolutional Neural Network. Multimedia Tools and Applications, 81(1), 873-885..

[9] Z. Chen, X. Feng, and S. Zhang, “Emotion detection and face recognition of drivers in autonomous vehicles in IoT platform,” Image and Vision Computing, vol. 128, p. 104569, 2022, doi: 10.1016/j.imavis.2022.104569.

[10] R. Krishankumar and F. Ecer, “Selection of IoT service provider for sustainable transport using q-rung orthopair fuzzy CRADIS and unknown weights,” Applied Soft Computing, vol. 132, p. 109870, 2023, doi: 10.1016/j.asoc.2022.109870.

[11] P. Kühtreiber, V. Pak, and D. Reinhardt, “A survey on solutions to support developers in privacy-preserving IoT development,” Pervasive and Mobile Computing, vol. 85, p. 101656, 2022, doi: 10.1016/j.pmcj.2022.101656.

[12] V. R. Pathmudi, N. Khatri, S. Kumar, A. S. H. Abdul-qawy, and A. K. Vyas, “Department of Mechatronics , Manipal Institute of Technology , Manipal Academy of Higher Department of Computer Science and Engineering , Koneru Lakshmaiah Education Department of Mathematics and Computer Science, Faculty of Science, SUMAIT Correspondin,” Scientific African, p. e01577, 2023, doi: 10.1016/j.sciaf.2023.e01577.

[13] K. L. Keung et al., “Edge intelligence and agnostic robotic paradigm in resource synchronisation and sharing in flexible robotic and facility control system,” Advanced Engineering Informatics, vol. 52, January, 2022, doi: 10.1016/j.aei.2022.101530.

[14] Y. Guo et al., “Plant Disease Identification Based on Deep Learning Algorithm in Smart Farming,” Discrete Dynamics in Nature and Society, 2020, doi: 10.1155/2020/2479172.

[15] N. Venu et al., “Energy Auditing and Broken Path Identification for Routing in Large-Scale Mobile Networks Using Machine Learning,” Wireless Communications and Mobile Computing, 2022, doi: 10.1155/2022/9418172.

[16] P. I. Priya, S. Muthurajkumar, and S. S. Daisy, “Data Fault Detection in Wireless Sensor Networks Using Machine Learning Techniques,” Wireless Personal Communications, vol. 122, no. 3, pp. 2441–2462, 2022, doi: 10.1007/s11277-021-09001-1.

[17] Y. V. Kistenev, D. A. Vrazhnov, E. E. Shnaider, and H. Zuhayri, “Predictive models for COVID-19 detection using routine blood tests and machine learning,” Heliyon, vol. 8, no. 10, p. e11185, 2022, doi: 10.1016/j.heliyon.2022.e11185.

[18] R. Verma, “Smart City Healthcare Cyber Physical System: Characteristics, Technologies and Challenges,” Wireless Personal Communications, vol. 122, no. 2, pp. 1413–1433, 2022, doi: 10.1007/s11277-021-08955-6.

[19] L. W. Qin et al., “Precision Measurement for Industry 4.0 Standards towards Solid Waste Classification through Enhanced Imaging Sensors and Deep Learning Model,” Wireless Communications and Mobile Computing, 2021, doi: 10.1155/2021/9963999.

[20] A. A. AlZubi, M. Al-Maitah, and A. Alarifi, “Cyber-attack detection in healthcare using cyber-physical system and machine learning techniques,” Soft Computing, vol. 25, no. 18, pp. 12319–12332, 2021, doi: 10.1007/s00500-021-05926-8.

[21] G. M. H. Bashar, M. A. Kashem, and L. C. Paul, “Intrusion Detection for Cyber-Physical Security System Using Long Short-Term Memory Model,” Scientific Programming, 2022, doi: 10.1155/2022/6172362.

[22] M. Fayad, A. Mostefaoui, S. Chouali, and S. Benbernou, “Toward a design model-oriented methodology to ensure QoS of a cyber-physical healthcare system,” Computing, vol. 104, no. 7, pp. 1615–1641, 2022, doi: 10.1007/s00607-022-01058-5.

[23] B. Wan, C. Xu, R. P. Mahapatra, and P. Selvaraj, “Understanding the Cyber-Physical System in International Stadiums for Security in the

Network from Cyber-Attacks and Adversaries using AI," Wireless Personal Communications, vol. 127, no. 2, pp. 1207–1224, 2021, doi: 10.1007/s11277-021-08573-2.

[24] Pazhani. A, A. J., Gunasekaran, P., Shanmuganathan, V., Lim, S., Madasamy, K., Manoharan, R., &Verma, A. (2022).Peer–Peer Communication Using Novel Slice Handover Algorithm for 5G Wireless Networks.Journal of Sensor and Actuator Networks, 11(4), 82.

[25] F. Muchtar, A. H. Abdullah, M. Al-Adhaileh, and K. Z. Zamli, "Energy conservation strategies in Named Data Networking based MANET using congestion control: A review," Journal of Network and Computer Applications, vol. 152, no. April 2019, p. 102511, 2020, doi: 10.1016/j.jnca.2019.102511.