iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: III Month of publication: March 2025

DOI: https://doi.org/10.22214/ijraset.2025.67322

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

IOT-Based Smart Traffic Management System

Nitish Kornu[1], Pavan Kumar Kasarapu[2], Nammi Srinivas[3], Putti Siddhartha[4], Ch Seshadri[5]
Raghu Engineering College, India

Abstract: Using a four-lane configuration outfitted with LED traffic signals for efficient traffic control and infrared sensors for real-time vehicle density monitoring, this project showcases the creation of an intelligent traffic management system utilising Internet of Things technology. To optimise traffic flow, the Arduino Uno and Node MCU WiFi module act as the central controller units, analysing sensor data to modify the traffic lights in real-time. In order to improve road safety and efficiency, the system has a mobile application for tracking traffic density and remotely controlling the signals. Through a useful and interactive model, this creative approach shows how IoT technology may be used to address urban traffic issues.
Keywords: Smart Traffic Management, IoT, Arduino Uno, NodeMCU, IR Sensors, Traffic Density Detection, Real-time Traffic Control, Urban Traffic Optimization, Intelligent Transportation System, Remote Monitoring.

I. INTRODUCTION

Urban traffic congestion is a growing challenge due to rapid population growth, increased vehicle usage, and limited road infrastructure. Traditional traffic management systems operate on pre-set signal timings, often failing to adapt to real-time traffic conditions. This inefficiency leads to unnecessary delays, increased fuel consumption, and higher pollution levels. As cities continue to expand, relying on conventional methods such as road widening is not a sustainable solution. Instead, the focus should shift toward intelligent systems that optimize traffic flow dynamically.

To address this issue, a smart traffic management system using IoT is proposed. The system integrates IR sensors for real-time vehicle density detection and uses Arduino Uno and NodeMCU WiFi modules to dynamically adjust traffic signals. By extending green signal durations for high-traffic lanes and reducing wait times for low-traffic areas, the system ensures a smoother and more efficient traffic flow. Additionally, a mobile application allows remote monitoring and manual control of signals, providing greater flexibility. This IoT-driven approach not only reduces congestion and improves travel efficiency but also minimizes fuel wastage and environmental impact, making it a practical and scalable solution for modern cities.

II. EXISTING SYSTEM

Traditional traffic management systems operate on fixed time-based signal controls, where traffic lights change at predetermined intervals regardless of real-time traffic conditions. These systems do not account for vehicle density on different lanes, leading to inefficient traffic flow. As a result, vehicles often experience unnecessary delays at intersections, even when certain lanes have minimal or no traffic. This fixed scheduling approach increases congestion, travel time, and fuel consumption, contributing to higher pollution levels and overall inefficiency in urban transportation.

The traffic police are often in charge of the exiting traffic system. The primary flaw in this traffic police-controlled system is that it lacks the intelligence to handle traffic congestion. The choice may not be well-considered, and it is up to the traffic police officer to decide whether to block a road for an extended period of time or let traffic on another route to pass. Furthermore, the amount of time that cars will display a green or red signal is predetermined, even while traffic lights are in place. As a result, traffic congestion may not be an issue it can resolve. It has been observed in India that traffic police officers remain on duty even in the presence of traffic lights, indicating that this system is not cost-effective and requires extra labour.

III. PROPOSED SYSTEM

The wireless sensor nodes made up of sensors are the initial and most important component of this system. While the local server transmits the sensor data to the central microcontroller, the sensors engage with the actual world, such as the presence or absence of cars. The 4*2 array of sensor nodes is used in every aspect of this system. This denotes two lanes in each direction and four traffic levels. The sensors are ultrasonic sensors that send out a status message as a car approaches. At predetermined intervals, the sensor nodes provide data to the central microcontroller stationed at each junction. After receiving the signal, the microcontroller determines which lane and which route, depending on the traffic density, need to be selected. Wi-Fi connection is then used to send the microcontroller's calculated data to the nearby server.

The controller uses the information gathered to carry out intelligent traffic routing. The main goal of this system is to collect data on moving vehicles using WSN in order to offer them a clear route to their destinations. Traffic signals should also automatically change to allow these cars to travel freely.

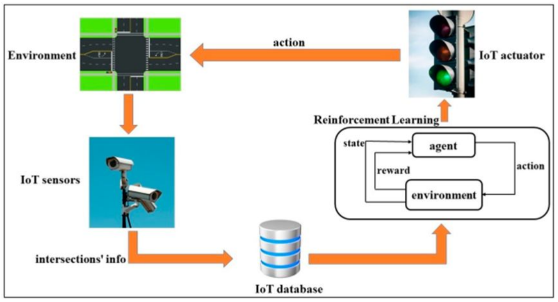


Fig.1. General Block diagram

IV. COMPONENTS USED AND DESCRIPTION

A. Arduino UNO

The Arduino UNO is an open-source microcontroller board created by Arduino.cc that is based on the Microchip ATmega328P microprocessor. The board has sets of analogue and digital input/output (I/O) pins that may be connected to different circuits and expansion boards (shields). The board can be programmed using the Arduino IDE (Integrated Development Environment) with a type B USB connector and features 14 digital and 6 analogue pins.

Fig.2. Arduino UNO

B. Power Supply

Either an external power source or a USB cable can be used to power the Arduino Uno. An AC to DC converter is the most common external power source; batteries are sometimes used. The adapter can be connected to the Arduino Uno by plugging into the power jack of the Arduino board. The Vin and GND pins of the POWER connector can also be used to connect the battery leads. Seven to twelve volts is the recommended voltage range.

C. Arduino Mega 2560

The Atmega 2560 serves as the foundation for the Arduino Mega 2560 microcontroller board. It features a 16 MHz crystal oscillator, four UARTs (hardware serial ports), sixteen analogue inputs, fifty-four digital input/output pins (15 of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. Everything required to support the microcontroller is included; to get started, just use a USB cable to connect it to a computer or power it with a battery or AC-to-DC converter. The majority of shields made for the Uno and the older Duemilanove or Diecimila boards work with the Mega 2560 board.

Fig.3. Arduino Mega 2560

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

D. IR Sensors

Anyone interested in robotics, automation, or electronics will find this project useful: connecting an Arduino to an infrared sensor module. Infrared (IR) sensors are widely employed in communication systems, object detection, and distance measurement. The goal of this project is to use an infrared sensor module to identify barriers and react appropriately. This tutorial will teach you how to connect an Arduino to an infrared sensor, comprehend how it operates, and use the information for useful purposes. This An electrical gadget that analyses and picks up infrared radiation in its surroundings is called an infrared (IR) sensor. Infrared light reflection is the basis for the operation of the IR sensor module. The IR sensor emits infrared light, which strikes an item when it approaches it and bounces back towards the sensor. The distance, shape, and surface properties of the item all affect the kind and strength of the reflection.

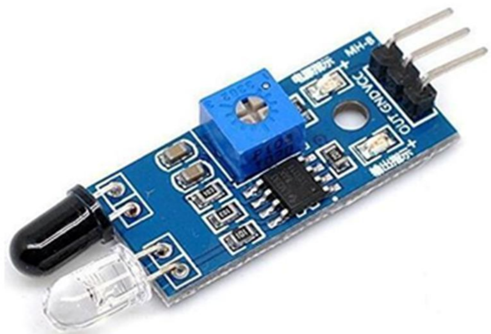


Fig.4. IR Sensor

E. Buzzer

A buzzer is used to provide audio feedback for system notifications. It sounds an alert when an order is placed, a payment is completed, or when a customer presses the waiter call button. This feature ensures staff members are immediately notified, reducing response time and enhancing service quality.

Fig.5. Buzzer

F. LED Traffic Lights

LED-based traffic lights display red, yellow, and green signals based on the processed data from the microcontroller. They help regulate vehicle movement efficiently by adapting to real-time traffic conditions.

Fig.6. LED for Traffic Lights

G. Jumper Wires

Jumper wires are used to establish electrical connections between various components in the circuit. They facilitate smooth data transmission and ensure proper functioning of the system.

Fig.7. Jumper Wires

V. WORKING

The proposed system operates based on the following step-by-step process:

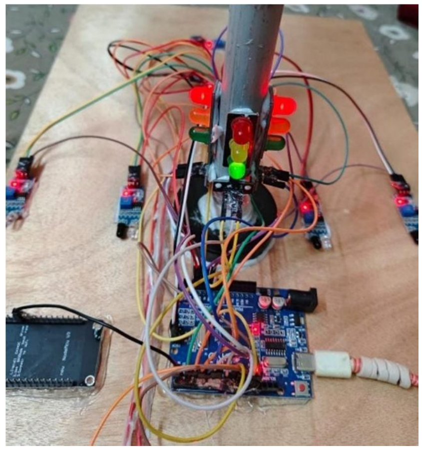
1) Vehicle Detection: IR sensors installed at each lane detect the presence and density of vehicles. These sensors continuously monitor the number of vehicles waiting at the signal and send real-time data to the microcontroller for processing.
2) Data Processing: The Arduino Uno microcontroller processes the received sensor data and determines the traffic density in each lane. Based on the number of vehicles, it calculates the optimal duration for green and red signals to minimize congestion.
3) Traffic Signal Control: The system dynamically adjusts traffic lights using LED signals. Lanes with heavy traffic receive extended green light durations, while less congested lanes get shorter green signals. This real-time adaptation improves traffic flow efficiency.
4) Wireless Communication: The NodeMCU (ESP8266) WiFi module transmits live traffic data to a cloud-based platform or mobile application. This enables real-time monitoring of traffic conditions and ensures effective communication between the system and traffic authorities.
5) Remote Monitoring and Control: Traffic authorities can use a mobile application to monitor vehicle density and adjust signal timings remotely if necessary. This feature provides flexibility in managing traffic and handling unexpected congestion.
6) Emergency Handling (Optional): If an emergency vehicle, such as an ambulance or fire truck, is detected, the system prioritizes clearing the respective lane by turning the signal green. A buzzer can also be used to alert authorities in case of system malfunctions.
7) Efficient Traffic Flow: The system continuously updates traffic signals based on real-time conditions, reducing unnecessary wait times, fuel wastage, and air pollution. By adapting to live traffic data, it ensures smooth and intelligent traffic management in urban areas.

VI. RESULTS

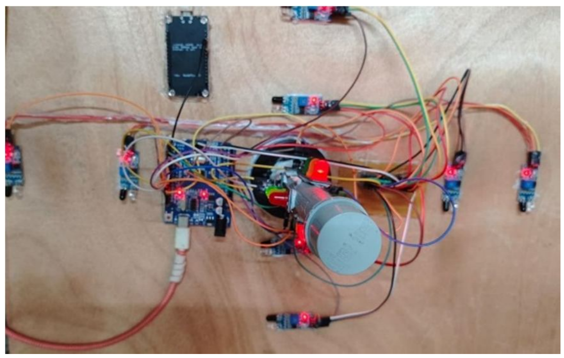
The implementation of the smart traffic management system using IoT has demonstrated significant improvements in traffic flow efficiency. By utilizing IR sensors to detect real-time vehicle density, the system dynamically adjusts traffic signal durations, reducing unnecessary wait times at intersections. This adaptive approach minimizes congestion, leading to a smoother and more organized traffic movement.

The integration of wireless communication through the NodeMCU (ESP8266) enables real-time monitoring and remote control of traffic signals. Traffic authorities can manually override signal timings when required, allowing for better management during peak hours or emergencies. This feature enhances the flexibility and reliability of the system compared to traditional fixed-time traffic signals.

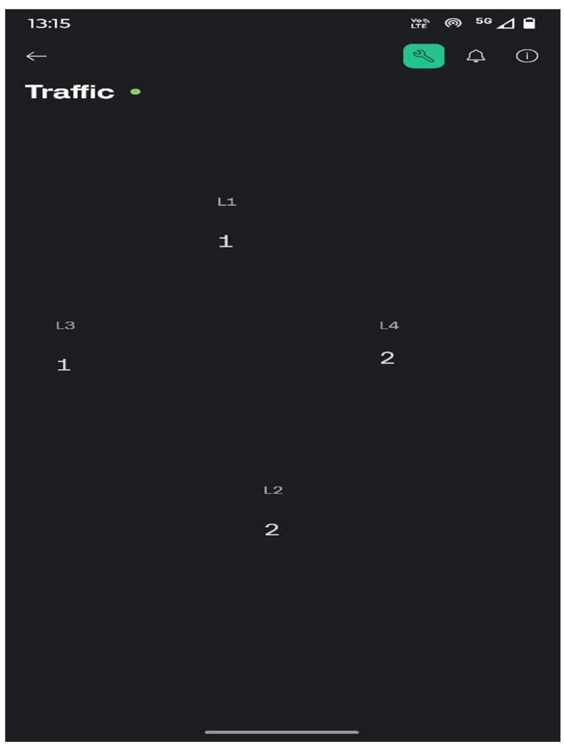
Additionally, the system contributes to environmental benefits by reducing fuel consumption and emissions. Since vehicles spend less time idling at signals, there is a noticeable decrease in air pollution and fuel wastage. The practical application of this technology highlights its potential as a scalable solution for modern cities, addressing urban traffic challenges effectively.



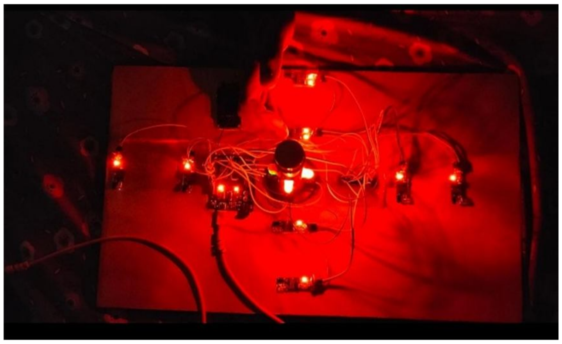
Connecting Arduino board and battery



Connecting Wifi module to Battery



Connected to Blynk IoT App



Detection of vehicles in a lane

VII. CONCLUSION

The Smart Traffic Management System was created by utilising a variety of IoT hardware component characteristics. Using an Internet of Things platform, traffic optimisation is accomplished by effectively allocating different amounts of time to each traffic light based on the number of cars on the road. To effectively address the issue of traffic and carry out rerouting at road junctions, a smart traffic management system is put into place.

This study offers a practical remedy for the fast expansion of traffic flow, particularly in large cities where the population is growing daily and conventional systems have some drawbacks due to their inability to efficiently handle existing traffic. To better regulate traffic problems on the roads, a smart traffic management system is suggested, taking into account the state-of-the-art approach for traffic management systems. More efficiently than ever before, it communicates with a local server to control traffic flow and automatically adjusts the signal timing based on the traffic density on the specific roadside. Because the system functions even in the event of a local or centralised server disaster, the decentralised method makes it efficient and optimised. Additionally, the system gives higher authorities valuable information for road design, which aids in resource efficiency.

REFERENCES

[1] Li Z, Shahidehpour M, Bahramirad S & Khodaei A, “Optimizing traffic signal settings in smart cities”, IEEE Transactions onSmart Grid, Vol.8, No.5, (2017), pp.2382-2393.

[2] Singh L, Tripathi S & Arora H, “Time optimization fortraffic signal control using genetic algorithm”, InternationalJournal of Recent Trends in Engineering, Vol.2, No.2, (2009), pp.4-6.

[3] Pable SN, Welekar A & Gaikwad-Patil T, “Implementationon Priority Based Signal Management in Traffic System”International Journal of Engineering Research Technology(IJERT), Vol.3, No.5, (2014), pp.1679-1682.

[4] Milanes V, Villagra J, Godoy J, Simo J, Pérez J & OnievaE, “An intelligent V2I-based traffic management system”,IEEE Transactions on Intelligent Transportation Systems,Vol.13, No.1, (2012), pp.49-58.

[5] Krishnan S, “Traffic Flow Optimization and Vehicle Safetyin Smart Cities”, International Journal of InnovativeResearch in Science, Engineering and Technology, Vol.5,No.5, (2016), pp-310-318

[6] Zadeh, L. A. 1965. Fuzzy sets, Information and Control8(3): 338–353. http://dx.doi.org/10.1016/S0019-9958(65)90241-X Zhang, G.; Chen, J. 2009. “Study onsaturation flow rates for signalized intersections”, inInternational Conference on Measuring Technology andMechatronics Automation, 2009. ICMTMA’09. 11–12April 2009, Zhangjiajie, Hunan, China,Vol. 3, 598–601.

[7] Ahn K, Rakha H, Trani A. 2004. “Micro Framework forModeling of High Emitting Vehicles”. TransportationResearch Record: Journal of the Transportation ResearchBoard,No. 1880. Washington, D.C.: TransportationResearch Board of the National Academies, pp. 39–49.

[8] Barker WG. 2005. “Can a Sustainable TransportationSystem Be Developed for San Antonio”, TexasTransportation Research Record: Journal of theTransportation Research Bard, No. 1924. Washington,D.C.: Transportation Research Board of the NationalAcademies, pp. 120–128.

[9] Allsop, R.E. (1976). “SIGCAP: A computer program forassessing the traffic capacity of signal-controlled roadjunctions”. Traffic Engineering and Control, 17, 338–341.

[10] Heydecker, B.G. and Dudgeon, I.W. (1987). “Calculationof signal settings to minimise delay at a junction. inTransportation and Traffic Theory”, edited by N.H. Gartnerand N.H.M. Wilson. Elsevier, New York, pp. 159–178.

[11] Sheikh, Sajid M., Lebone Powder, and Ibo Ngebani. "ASMART MICROPROCESSOR-BASED FOUR WAY STOPROAD TRAFFIC CONTROLLER." International Journal ofElectrical and Electronics Engineering (IJEEE) 7.4(2018):9-22

[12] Kabrane, M., S. Krit, and L. Elmaimouni. "REDUCINGTRAFFIC CONGESTION IN MODERN CITIES: ACHALLENGE BASED ON PHYSICO-MATHEMATICALTHEORIES AND WIRELESS SENSOR NETWORK."International Journal of Mechanical and ProductionEngineering Research and Development (IJMPERD) 8.1(2018):495-504

[13] Kemoabe, Rapelang K., et al. "CORRELATION ANDCRITICAL PATH ANALYSIS BASED ROAD TRAFFIC ROUTING ALGORITHM." International Journal of Electrical and Electronics Engineering (IJEEE) 7.6 (2018):17-30

[14] AGUSTA, DEANDRHA, and FRISKA NATALIA FERDINAND. "DJIKSTRA ALGORITHM BASED APPROACH TO SHORTEST PATH MODEL IN PUBLIC BUS TRANSPORTATION." International Journal of Computer Science Engineering and Information Technology Research (IJCSEITR) 7.6 (2017):1-8

[15] MATHUR, GEETIKA, HARSHIT SHARMA, and RISHABH PANDEY. "A STUDY ON SELF-DRIVING CAR AN APPLICATION OF IoT." International Journal of Computer Networking, Wireless and Mobile Communications (IJCNWMC) 9.1 (2019):25-34

[16] TANVEER, SHAKERA. "APPLICATION OF GRAPH THEORY FOR SCHEDULING OF TRAFFIC LIGHTS." International Journal of Mathematics and Computer Applications Research (IJMCAR) 7.5 (2017):21-24

[17] LOGESWARAN, S., and S. ELAVARASAN. "DESIGN OF TRAFFIC INTERSECTION AT MOOLAPATTARAI IN ERODE CITY." International Journal of Applied Engineering Research and Development (IJAERD) 9.1 (2019):13-20

[18] Babu, P. R. K.S. M.R.(2016). Real-time smart traffic management system for smart cities by using internet of things and big data. 2016 International Conference on Emerging Technological Trends (ICETT).

[19] Chandana K K, Dr. S. Meenakshi Sundaram, C. D. M. N. S. N. K. (2013). A smart traffic management system for congestion control and warnings using internet of things (iot). Saudi Journal of Engineering and Technology, 2.

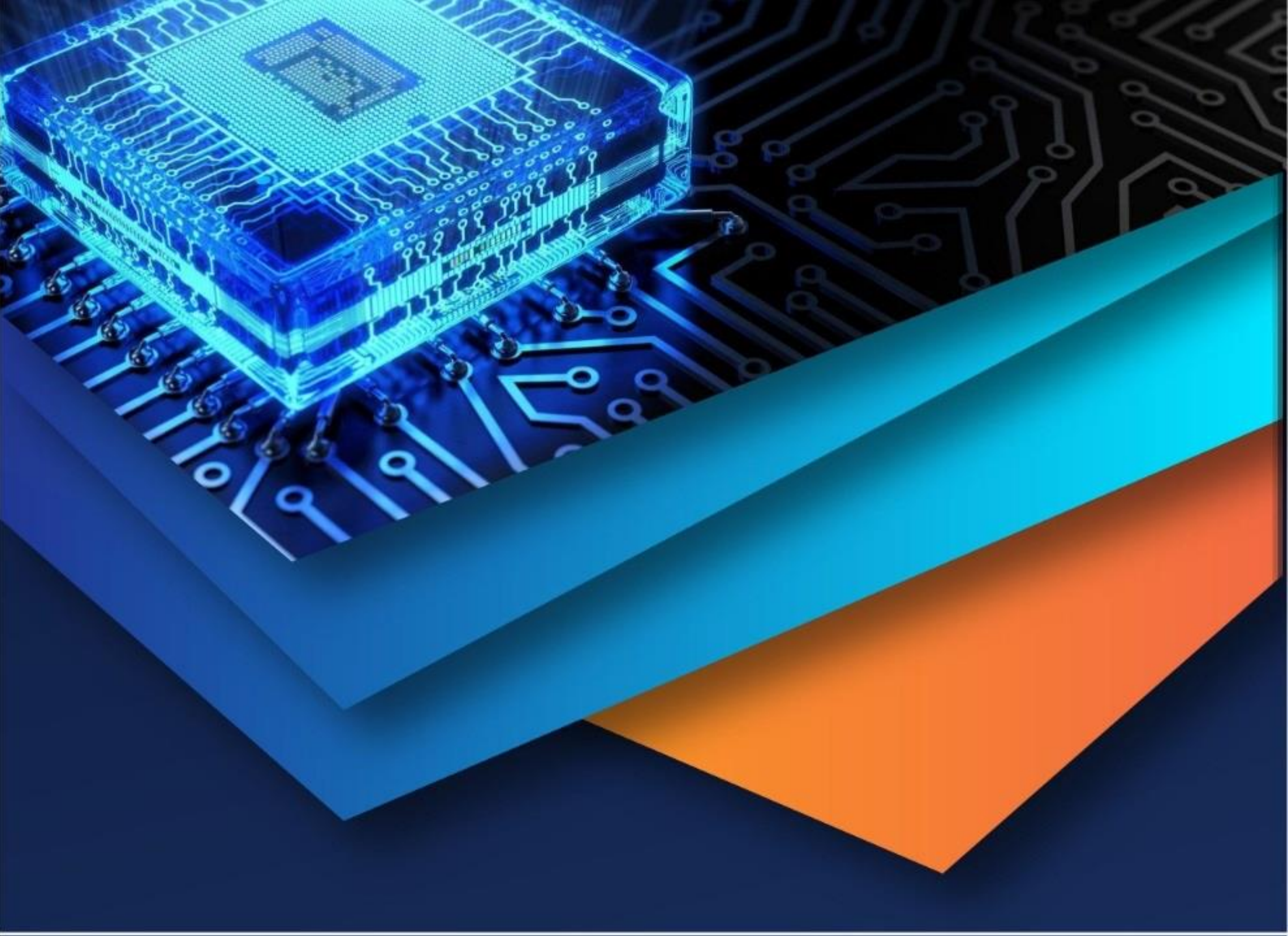
[20] Dave, P. N. D. M. . P. S. P. (2018). Smart traffic management system using iot. International Journal of Computer Engineering and Applications, 12.

[21] Sabeen Javaid, Ali Sufian, S. P. M. T. (2018). Smart traffic management system us ing internet of things. 20th International Conference on Advanced Communication Technology (ICACT).

[22] Viswanathan, V. and Santhanam, V. (2013). Traffic signal control using wireless sensor networks. 2nd International Conference on Advances in Electrical and Electronics Engineering (ICAEE'2013).

[23] Yucheng Huang, Linbing Wang, Y. H. W. Z. Y. Z. (2018). A prototype iot based wireless sensor network for traffic information monitoring. volume

[24] Zantout, S. (2017). Traffic light controller project final report.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY