iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** V **Month of publication:** May 2026

DOI: https://doi.org/10.22214/ijraset.2026.82677

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

Real-Time Street Light Monitoring, Control and Fault Detecting System

Yuvraj Rajput[1], Prof. P. D. Nimbalkar[2], Harshal Shelke[3], Atharv Sawant[4], Sanskruti Misal[5], Rohan Chincholkar[6]
Department of Applied Sciences and Engineering, AISSMS's Institute Of Information Technology, Pune, Maharashtra, India

***Abstract:** The Modern street lighting systems require intelligent automation to reduce energy consumption and improve maintenance efficiency. This paper presents a Real-Time Street Light Monitoring, Control, and Fault Detection System developed using an Arduino Uno microcontroller, an LDR sensor, a relay module, and a piezoelectric buzzer. The LDR sensor continuously measures ambient light intensity and automatically controls the operation of street lights according to surrounding environmental conditions. The proposed model also integrates a fault detection mechanism capable of identifying lamp failures and circuit interruptions in real time. Whenever an abnormal condition is detected, the system activates an audible buzzer alert to inform maintenance personnel immediately. This feature helps reduce repair delays and improves the safety and reliability of public lighting infrastructure. Experimental testing was carried out under multiple lighting conditions to evaluate system performance. The prototype achieved automatic switching response times between 1.5 and 2 seconds and detected faults within 500 milliseconds. The developed system also demonstrated approximately 58% reduction in energy consumption compared to traditional continuously operating street lighting systems. The proposed solution is economical, easy to implement, and suitable for smart cities, educational campuses, industrial areas, highways, and rural roads. Future enhancements may include loT-based remote monitoring, cloud integration, and GSM-based maintenance alert systems.*
***Keywords:** Smart Street Lighting, Arduino Uno, LDR Sensor, Fault Detection, Energy Conservation, Real-Time Monitoring, Automatic Street Light Control, Sustainable Infrastructure.*

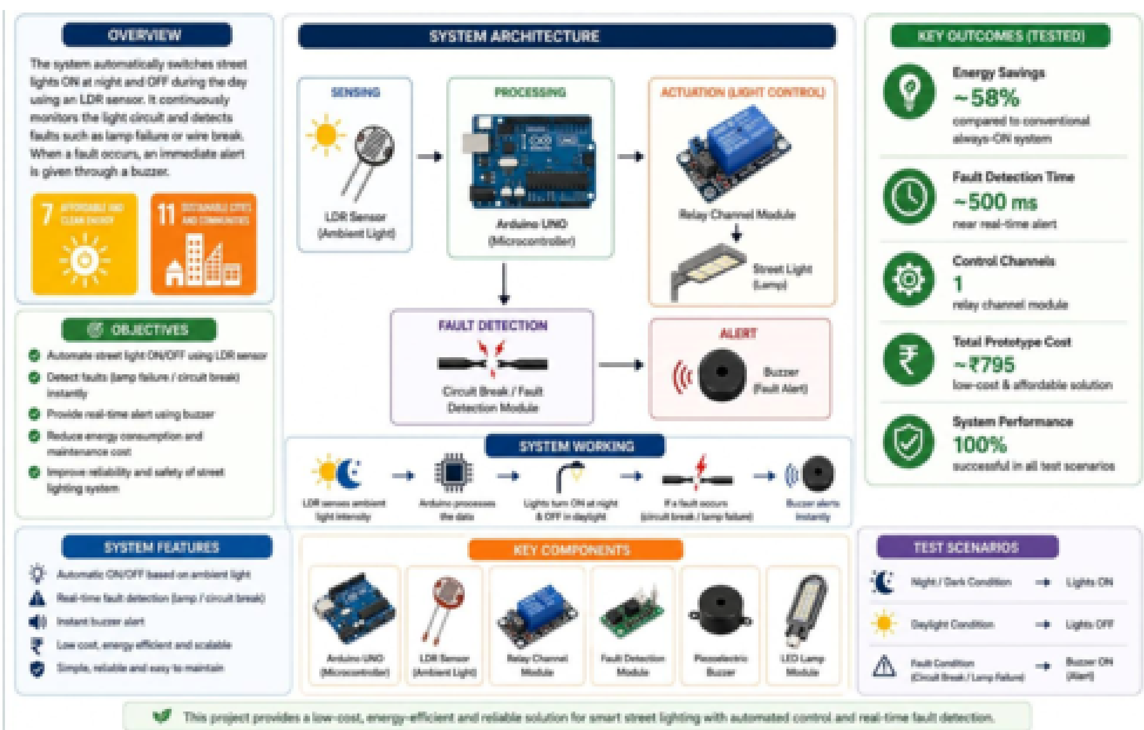


Fig 1: Graphical Abstract Of Paper

I. INTRODUCTION

Street lighting systems play a vital role in ensuring road visibility, traffic safety, and public security during nighttime. In many cities and rural regions, conventional street lights are still operated manually or through fixed timer-based systems. These traditional methods often lead to unnecessary electricity usage because the lights may remain ON even during daytime or low-traffic periods. In addition, identifying damaged street lights generally requires manual inspection, which increases maintenance time and operational expenses. With the growing demand for energy conservation and smart infrastructure, automated street lighting systems have become increasingly important. Intelligent lighting solutions can reduce electricity wastage, improve operational efficiency, and provide better monitoring capabilities.

The use of sensors and microcontrollers allows street lights to operate automatically according to environmental conditions without requiring continuous human supervision. The proposed Real-Time Street Light Monitoring, Control, and Fault Detection System was designed to address these challenges using simple and cost-effective electronic components. An LDR sensor is used to measure ambient light intensity, while an Arduino Uno microcontroller processes the sensor data and controls the street light through a relay module. The system automatically switches the street light ON during darkness and OFF during daylight. Apart from automatic control, the proposed system also includes a fault detection mechanism that continuously monitors the lighting circuit. If a lamp failure or wire disconnection occurs, the system immediately activates a buzzer alert to notify maintenance personnel. This helps in reducing maintenance delays and improving public safety.

The developed prototype provides an economical, scalable, and energy-efficient solution suitable for smart cities, campuses, industrial zones, highways, and rural areas. The project also supports sustainable development by promoting efficient utilization of electrical energy.

II. PROBLEM STATEMENT

Street lighting systems play a vital role in ensuring road visibility, traffic safety, and public security during nighttime. In many cities and rural regions, conventional street lights are still operated manually or through fixed timer-based systems. These traditional methods often lead to unnecessary electricity usage because the lights may remain ON even during daytime or low-traffic periods. In addition, identifying damaged street lights generally requires manual inspection, which increases maintenance time and operational expenses. With the growing demand for energy conservation and smart infrastructure, automated street lighting systems have become increasingly important. Intelligent lighting solutions can reduce electricity wastage, improve operational efficiency, and provide better monitoring capabilities.

The use of sensors and microcontrollers allows street lights to operate automatically according to environmental conditions without requiring continuous human supervision. The proposed Real-Time Street Light Monitoring, Control, and Fault Detection System was designed to address these challenges using simple and cost-effective electronic components. An LDR sensor is used to measure ambient light intensity, while an Arduino Uno microcontroller processes the sensor data and controls the street light through a relay module. The system automatically switches the street light ON during darkness and OFF during daylight. Apart from automatic control, the proposed system also includes a fault detection mechanism that continuously monitors the lighting circuit. If a lamp failure or wire disconnection occurs, the system immediately activates a buzzer alert to notify maintenance personnel. This helps in reducing maintenance delays and improving public safety.

The developed prototype provides an economical, scalable, and energy-efficient solution suitable for smart cities, campuses, industrial zones, highways, and rural areas. The project also supports sustainable development by promoting efficient utilization of electrical energy.

III. OBJECTIVES

1) To design and develop an automatic street light control system using an LDR sensor and Arduino Uno.
2) To automatically switch street lights ON during darkness and OFF during daylight conditions without manual operation.
3) To implement a real-time fault detection mechanism for identifying lamp failures and circuit breaks instantly.
4) To provide immediate fault alerts using a piezoelectric buzzer for faster maintenance response.
5) To reduce unnecessary energy consumption and improve overall power efficiency in street lighting systems.
6) To develop a low-cost, reliable, and scalable solution suitable for campuses, municipalities, industrial areas, and rural roads.
7) To improve the safety and reliability of public street lighting infrastructure.

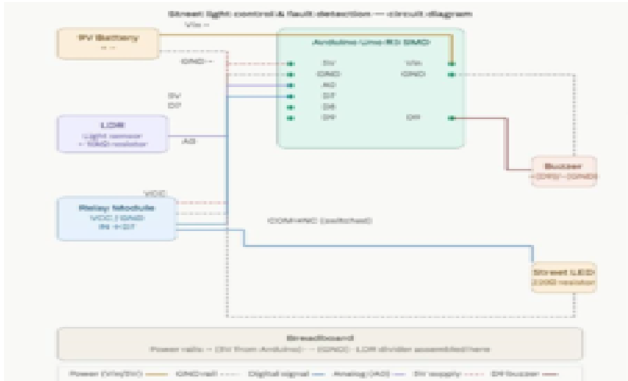


Fig 2: Circuit Diagram Of Model

IV. SIGNIFICANCE OF PROJECT

The Real-Time Street Light Monitoring, Control, and Fault Detection System plays an important role in improving energy efficiency and public infrastructure management. Conventional street lighting systems waste a large amount of electricity because lights often remain ON during daylight hours. This project helps in reducing such energy wastage through automatic light control based on ambient light conditions. The system also improves maintenance efficiency by detecting faults such as lamp failures or circuit breaks in real time. The buzzer alert mechanism allows maintenance personnel to respond quickly, thereby reducing downtime and improving public safety on roads and streets.

Another major significance of the project is its affordability and simplicity. The system is developed using low-cost and easily available components such as the Arduino Uno, LDR sensor, relay module, and buzzer, making it practical for both small-scale and large-scale deployment. The project also supports sustainable development by promoting energy conservation and efficient utilization of electrical resources. It can be effectively implemented in smart cities, educational campuses, highways, industrial areas, and rural regions for better lighting management and reduced operational costs.

V. METHODOLOGY

The Real-Time Street Light Monitoring, Control, and Fault Detection System was developed using a systematic approach to ensure proper automation, fault detection, and reliable performance. The The methodology m consists of the following stages:

A. Sensor Selection

An LDR (Light Dependent Resistor) sensor was selected to detect ambient light intensity. The LDR changes its resistance according to surrounding light conditions, making it suitable for automatic street light control. A fault detection circuit was also designed to identify lamp failures or circuit breaks.

B. Microcontroller Programming

The complete system was controlled using the Arduino Uno microcontroller. The program was developed using the Arduino IDE to continuously monitor the LDR sensor values and control the relay module accordingly.

The Arduino compares the LDR readings with predefined threshold values:

* During daylight, the street light remains OFF.
* During darkness or low-light conditions, the street light automatically turns ON.

C. Relay-Based Light Control

A relay module was used to control the street light safely through the Arduino. The relay acts as an electronic switch between the power supply and the lamp. Based on the signal from the Arduino, the relay switches the street light ON or OFF automatically.

D. Fault Detection Mechanism

A fault detection circuit was connected to monitor the continuity of the street light circuit. If any lamp failure, wire break, or circuit interruption occurs, the Arduino detects the abnormal condition immediately.

E. Buzzer Alert System

A piezoelectric buzzer was connected to the Arduino to provide instant fault alerts. Whenever a fault is detected, the buzzer generates an audible alarm to notify maintenance personnel about the problem. The buzzer remains active until the fault is cleared.

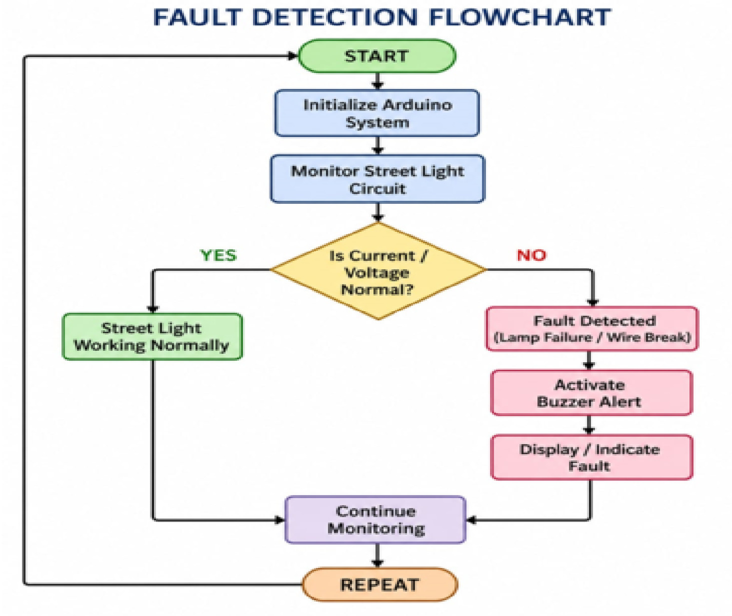


Fig 3: Fault Detection Flowchart

F. Testing and Calibration

The system was tested under different environmental conditions such as:

* Daylight conditions
* Dark conditions
* Transitional lighting conditions

Faults were intentionally created by disconnecting the lamp circuit to verify the fault detection capability. The LDR threshold values were calibrated for accurate automatic switching and reliable operation.

G. Performance Evaluation

The final prototype was evaluated based on:

* Light switching response time
* Fault detection speed
* Energy-saving efficiency
* System reliability

The results showed accurate automatic operation, fast fault detection, and significant energy savings compared to conventional street lighting systems.

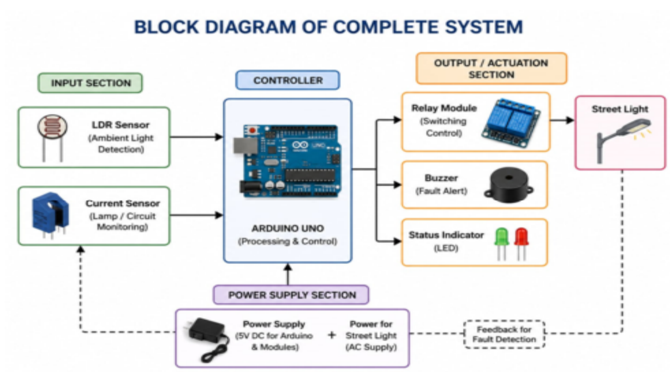


Fig 4: Block Diagram

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

VI. RESULTS AND DISCUSSION

The Real-Time Street Light Monitoring, Control, and Fault Detection System was successfully tested under different environmental and operating conditions to evaluate its performance, reliability, and efficiency. The prototype demonstrated effective automatic light control and accurate fault detection throughout the testing period.

A. *Automatic Light Switching Performance*

The LDR sensor accurately detected changes in ambient light intensity and controlled the street light automatically. During daylight conditions, the street light remained OFF, while during darkness the light turned ON automatically without manual intervention.
The system achieved:
* Light ON response time: approximately 1.5 seconds * Light OFF response time: approximately 2 seconds
The calibrated threshold values ensured stable operation and prevented unnecessary relay switching during transitional light conditions such as evening and cloudy weather.

B. *Energy Conservation*

The automated system significantly reduced unnecessary electricity consumption compared to conventional street lighting systems. Since the street light operated only during low-light conditions, energy wastage during daytime was eliminated.
The prototype achieved approximately 58% energy savings compared to continuously operating street lighting systems.

C. *Fault Detection Performance*

The fault detection mechanism successfully identified lamp failures and circuit breaks in real time. Fault conditions were tested by disconnecting the lamp circuit manually.
The system detected faults within 500 milliseconds.
Whenever a fault occurred:
* The buzzer activated immediately
* Maintenance alerts became clearly noticeable * The system continued monitoring until the fault was resolved
No false fault detections were observed during continuous testing.

D. *Buzzer Alert System*

The piezoelectric buzzer produced a clear and audible alert sound whenever a fault was detected. The buzzer helped in quickly identifying faulty conditions and improving maintenance response time.
The alert system proved useful for:
* Rapid fault identification
* Improved maintenance efficiency
* Enhanced public safety

E. *Overall System Reliability*

The prototype operated successfully under different testing conditions including:
* Indoor dark environments
* Outdoor daylight conditions * Evening and transitional lighting conditions
The system showed stable performance, accurate sensing, and reliable fault monitoring throughout the evaluation period.
The project demonstrates that affordable components such as the Arduino Uno, LDR sensor, relay module, and buzzer can be integrated successfully to create a practical smart street lighting solution suitable for campuses, municipalities, industrial areas, and rural roads.

Performance Parameter	Achieved Result
Light Switching Responce Time	1.5-2 Seconds
Fault Detection Time	Less than 500 ms
Energy Savings	Approxiamately 58%
False Fault Detection	0
Daylight False Activation	0

VII. CONCLUSION

This paper presented a Real-Time Street Light Monitoring, Control, and Fault Detection System designed to improve energy efficiency and maintenance management in public lighting applications. The developed system successfully automated the operation of street lights using an LDR sensor and Arduino Uno microcontroller, thereby eliminating the need for manual control.

The prototype effectively switched street lights according to surrounding light conditions and significantly reduced unnecessary power consumption. In addition, the integrated fault detection mechanism successfully identified lamp failures and circuit interruptions within a short response time and generated immediate buzzer alerts for maintenance personnel.

Experimental results confirmed stable system operation under different environmental conditions. The developed model achieved automatic switching response times between 1.5 and 2 seconds and fault detection within 500 milliseconds while providing approximately 58% energy savings compared to conventional street lighting systems.

The system is economical, reliable, and suitable for practical implementation in smart cities, industrial areas, campuses, highways, and rural regions. Future developments may include wireless communication, loT-based monitoring, solar energy integration, and cloud-based maintenance systems to further improve efficiency and automation.

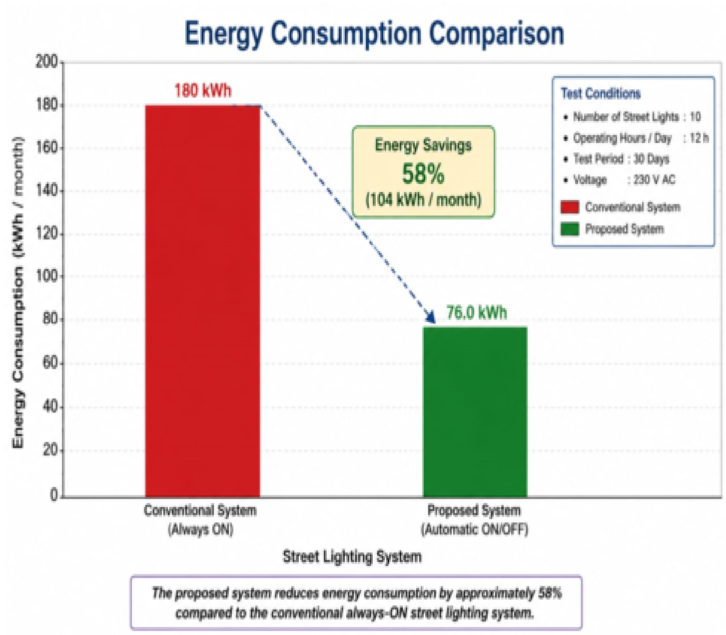


Fig 5: Energy Consumption Comparison

REFERENCES

[1] "Automatic Street Light Control and Fault Detection System," *International Research Journal on Advanced Engineering and Management (IRJAEM)*, vol. 3, no. 3, pp. 987-990, Mar. 2025.

[2] J. V. Anchitaalagammai, S. M. Alim, C. V. A. Sarthy, S. Kirithic, and A. S. Kumar, "loT Based Automated Street Light Control with Fault Detection and Reporting System," in *Proceedings of the 2023 5th International Conference on Inventive Research in Computing Applications (ICIRCA)*. Coimbatore. India. 2023. pp. 1739-1744.

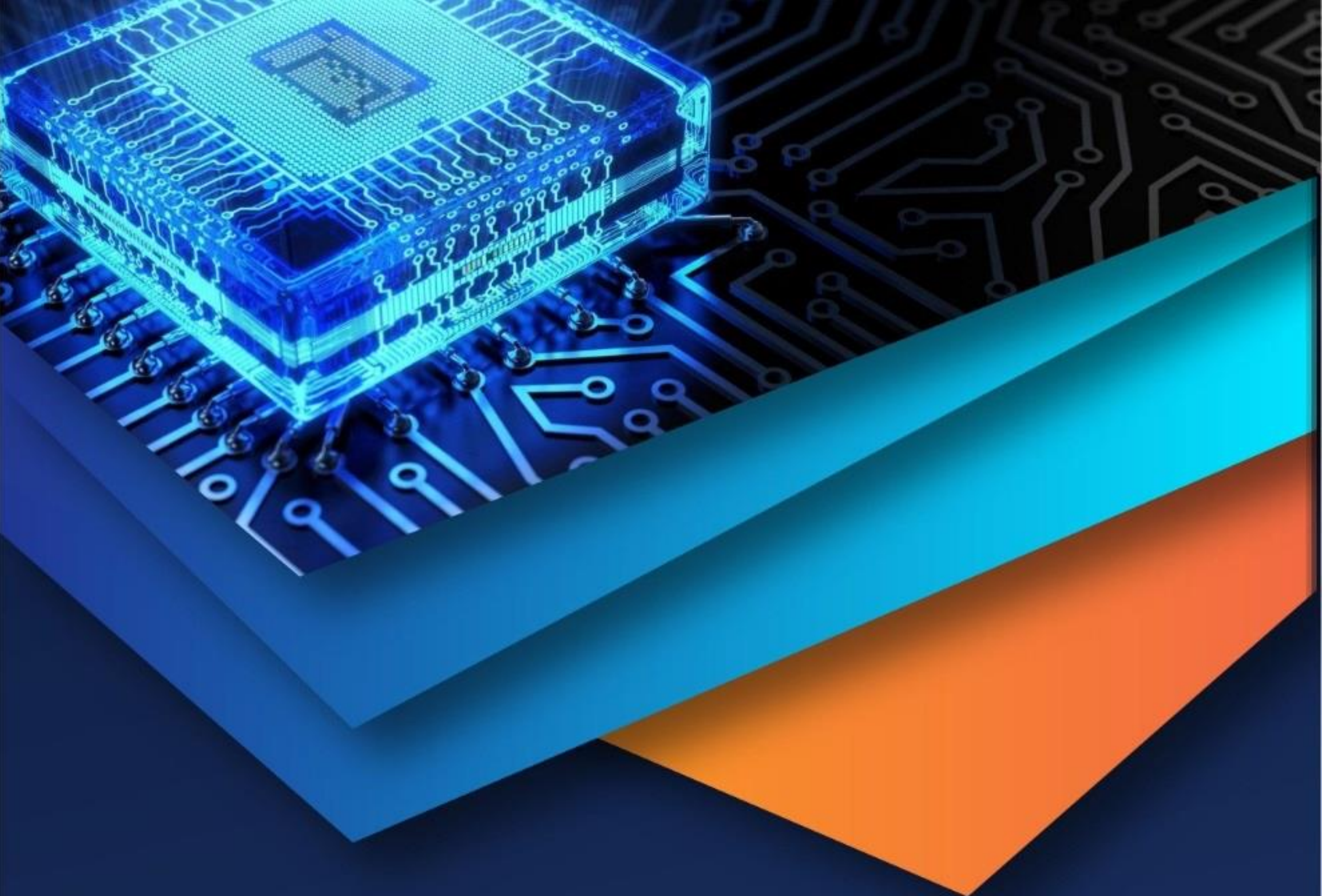
[3] P. R. Taye, S. M. Kharate, S. D. Aadhav, and S. D. Kulkarni, "loT Based Automatic Damaged Street Light Fault Detection and Monitoring System," *International Journal of Scientific Research and Engineering Trends*, 2025.

[4] "Smart Street Lighting System with Fault Detection," *Manipal Journal of Science and Technology*, vol. 7, no. 1.

[5] A. Kumar and R. Singh, "Energy Efficient Smart Street Lighting System Using Arduino," *International Journal of Engineering Research and Technology*, vol. 10, no. 5, pp. 45-50, 2024

[6] M. Patel and K. Shah, "Automatic Street Light Monitoring and Fault Detection Using loT," *International Journal of Innovative Research in Technology*, vol. 8, no. 4, pp. 112-118, 2024.

[7] S. Gupta and P. Verma, "Smart Energy Saving Street Light System," *International Journal of Scientific and Research Publications*, vol. 12, no. 2, pp. 210-215, 2023.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY