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IOT Based Automated Feedback System for Nonfunctional Streetlights

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ABSTRACT:

The "IoT-Based Automated Feedback System for Non-Functional Streetlights" is a cutting-edge solution aimed at enhancing urban infrastructure maintenance. Utilizing Internet of Things (IoT) technology, the system detects streetlight failures and provides real-time reports. Each streetlight is equipped with sensors and controllers that continuously monitor its status, transmitting operational data to a centralized server. In the event of a malfunction, the system instantly generates feedback and alerts municipal authorities, enabling swift intervention. Additionally, the system incorporates automation based on sunlight detection, ensuring that streetlights operate only when needed, thereby conserving energy. This approach minimizes reliance on manual inspections, allowing for quicker repairs and optimized resource management. Furthermore, the system enhances energy efficiency, improves urban safety, and streamlines city management by maintaining the reliable functionality of streetlights. By automating the reporting and operation process, it facilitates proactive maintenance, reducing downtime and elevating service quality. Through this smart monitoring approach, cities can effectively oversee streetlight maintenance while promoting sustainable urban development.

Keywords: IoT (Internet of Things), Automated feedback system, Smart solution, Real-time detection, Sunlight Automation

1. Introduction

Maintaining functional streetlights is crucial for urban safety, energy conservation, and infrastructure efficiency. However, traditional maintenance methods depend on manual inspections or public complaints, leading to delays in fault detection and repair. Malfunctioning streetlights can cause poor visibility, increased accident risks, and unnecessary power consumption. To address these challenges, this project introduces an IoT-Based Automated Feedback System that modernizes streetlight monitoring and maintenance. This system integrates sensors and controllers into streetlights, allowing continuous monitoring of their operational status. When a fault occurs the system instantly generates alerts and transmits them to city maintenance teams, ensuring quick response and minimal downtime. Moreover, sunlight detection technology is incorporated, enabling streetlights to automatically adjust based on natural light availability, reducing energy waste.

Beyond immediate repairs, the system also analyzes failure patterns, facilitating predictive maintenance and more effective resource management. By eliminating inefficiencies in traditional maintenance, this IoT-based approach enhances reliability, sustainability, and urban safety, contributing to the development of smarter and greener cities.

2. Objectives

Our aim is to develop an IoT-based automated fault detection system that utilizes sensors to detect non-functional streetlights, removing the reliance on manual monitoring. By implementing real-time tracking, the system will continuously assess streetlight performance, enabling the instant identification of faults. Upon detecting a malfunction, it will promptly transmit alerts to municipal authorities, ensuring quicker response times and improving maintenance efficiency.

In addition to fault detection, the system will incorporate sunlight-based automation, allowing streetlights to operate only when necessary, thereby optimizing energy consumption and reducing unnecessary power usage. This proactive maintenance strategy will help sustain consistent streetlight functionality, minimizing safety risks and lowering the likelihood of crime by ensuring well-lit urban environments. Through real-time monitoring and automated control, the system aims to enhance urban safety, improve resource efficiency, and contribute to sustainable city infrastructure.

3. Literature Review

[1] Sampath Kumar (2022) in "IoT-Based Street Light Auto Intensity Control" explores IoT-based streetlight systems with auto-intensity control and fault detection. These systems improve energy efficiency, reduce maintenance costs, and enhance public safety by adjusting brightness based on real-time needs. They contribute to operational savings and support smart city initiatives by ensuring well-lit public spaces.

[2] Eisley Dizon (2022) in "Smart Streetlights in Smart City: A Case Study of Sheffield" examines the impact of smart streetlights in Sheffield. The study highlights their role in enhancing energy efficiency, reducing costs, and improving urban safety, making them a valuable model for future smart city developments.
[3] Mayank Solanki in "Automated Feedback System for Non-Functional Streetlights" discusses a real-time fault detection system that minimizes manual inspections and reduces downtime. This improves maintenance efficiency, optimizes resource allocation, enhances public safety, and fosters confidence in municipal services.
[4] Badam Srivani in "Smart Street Light System with Automated Feedback" highlights a system that continuously monitors streetlights, detects faults instantly, and ensures timely repairs. This reduces accident risks, improves urban safety, and enhances infrastructure efficiency by minimizing manual intervention.
[5] Prakash (2021) in "Automatic Street Light Intensity Control" presents a system using LDRs and ultrasonic sensors to adjust light intensity based on movement and daylight. This cost-effective, remote-controlled solution conserves energy and enhances safety, making it suitable for various urban settings.

4. Problem Statement

The current streetlight maintenance system relies on routine inspections and manual reporting, leading to delays in identifying and repairing faulty streetlights. These delays contribute to safety risks, increased accident rates, unnecessary energy consumption, and inefficient resource management. By implementing an IoT-based automated feedback system, real-time monitoring and immediate malfunction reporting can be achieved. This ensures quicker repairs, improved public safety, and enhanced energy efficiency, ultimately leading to a more effective and reliable streetlight management system.
Acknowledgements
Acknowledgements and Reference heading should be left justified, bold, with the first letter capitalized but have no numbers. Text below continues as normal.

5. Resources Used

Table 1 - Resources Used

Components	Description
Microcontroller	Arduino UNO
Sensors	LDR (Light Dependant Resistor)
Communication Module	ESP8266 Wi-Fi module
Power Supply	Battery-powered system
Software	Web Development using HTML, CSS, Javascript

6. Methodology

6.1. System Architecture

The IoT-Based Automated Feedback System for Non-Functional Streetlights is designed to enable efficient monitoring and automated fault detection. The system utilizes multiple Light Dependent Resistors (LDRs) to assess streetlight functionality. Five LDRs detect whether individual LEDs are ON or OFF, while a sixth LDR measures ambient sunlight levels, ensuring that streetlights automatically turn off when natural light is sufficient, thereby reducing energy consumption. The Arduino Uno acts as the central processing unit, gathering sensor data and evaluating the operational status of the streetlights. Once analyzed, the data is transmitted via the ESP8266 Wi-Fi module to a web-based platform, enabling remote access and real-time monitoring. A web dashboard visually displays the status of each streetlight, allowing authorities to promptly identify malfunctions and take necessary action.

By integrating automated monitoring, wireless connectivity, and real-time data visualization, this architecture enhances streetlight maintenance, improves urban safety, and supports energy-efficient infrastructure.

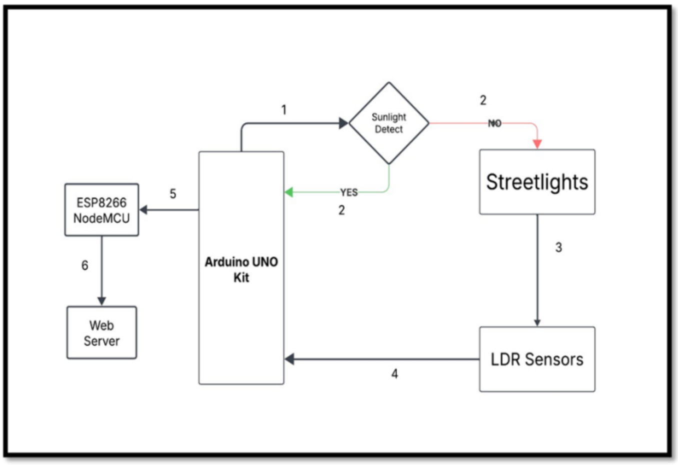
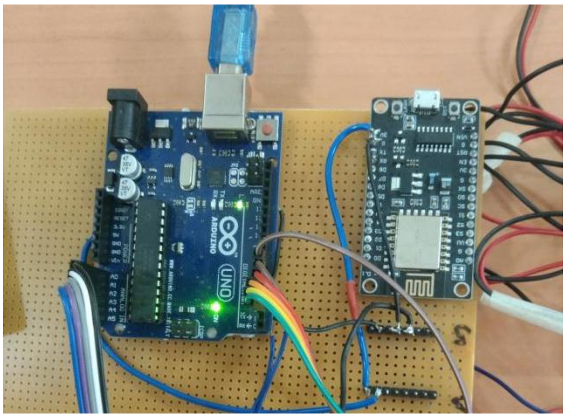


Fig.1 - System architecture of the project

6.2. Hardware Implementation

The hardware setup for the IoT-Based Automated Feedback System for Non-Functional Streetlights is designed to enable precise monitoring and efficient communication. Jumper and connecting wires are used to finalize the PCB connections, ensuring stable electrical pathways. The system includes five LEDs and five LDRs to monitor the functionality of individual streetlights by detecting whether they are ON or OFF. Additionally, a sixth LDR is implemented to measure ambient sunlight levels, allowing the system to automatically control all LEDs, ensuring they operate only when needed to optimize energy consumption. An Arduino Uno is used to process sensor data, while an ESP8266 NodeMCU manages wireless communication, transmitting real-time status updates to a web-based platform. This combination of hardware components enables seamless data collection, processing, and remote monitoring, making the system highly effective for urban streetlight management.



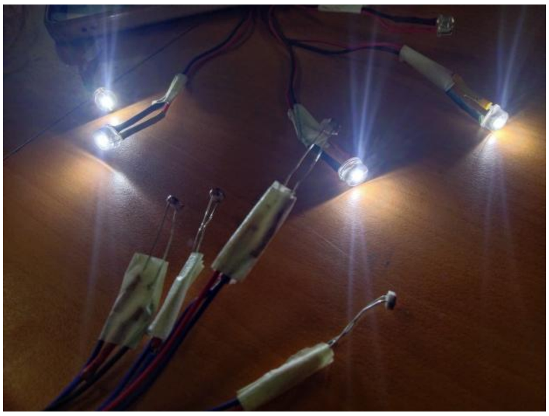


Fig.2,3 - Connections

6.3. Software Implementation

The software system combines Arduino programming for processing sensor data and ESP8266 for wireless communication. A web interface, built using HTML, CSS, and JavaScript, provides a user-friendly dashboard for monitoring streetlight status. This interface allows authorities to receive real-time updates, enabling swift decision-making and efficient maintenance. The integration of automated data collection, wireless transmission, and interactive visualization enhances the overall effectiveness of streetlight management.

```
LDR_SUN: No Sunlight
No Sunlight: Turning ON all LEDs
LED1 is OFF
LED2 is ON
LED3 is ON
LED4 is ON
LED5 is ON
--------------------------
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No Sunlight: Turning ON all LEDs
LED1 is OFF
LED2 is ON
LED3 is ON
LED4 is ON
LED5 is ON
--------------------------
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Fig.4 - Arduino IDE serial moniter

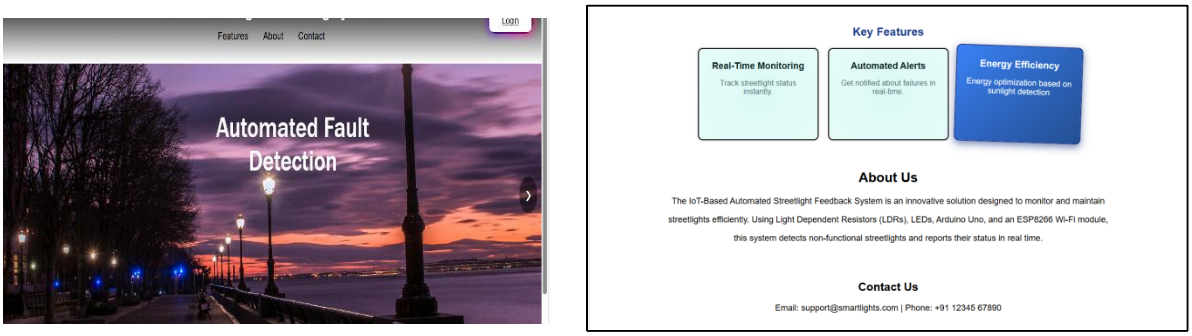

Fig. 5,6 - User webpage

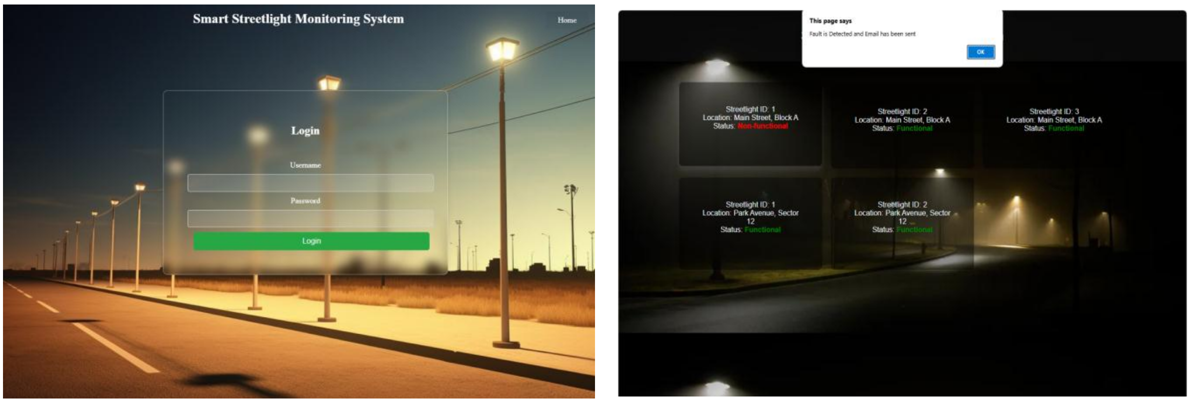

Fig. 7,8 - Admin webpages (Login,Monitoring)

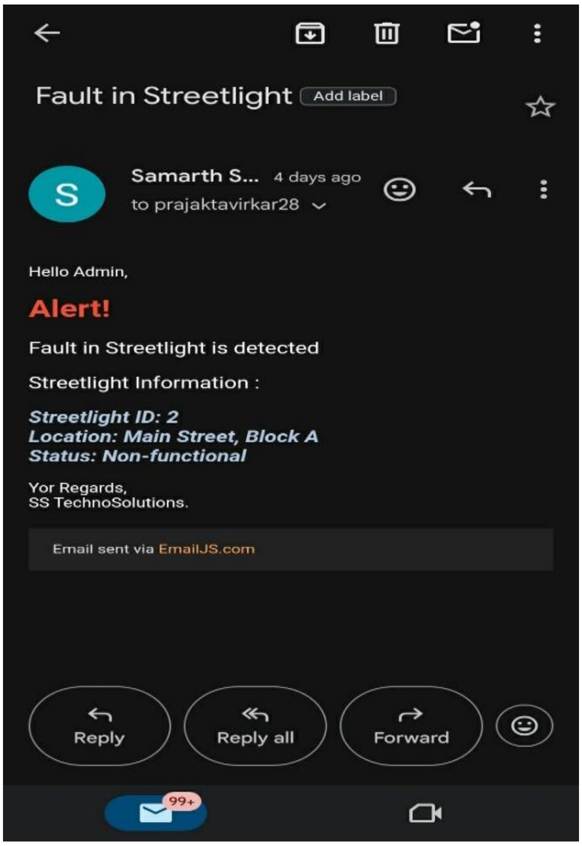

Fig. 9 - Alert notification

6.4. Model Development

Fig.10 - Project model

7. Future Scope

- AI-Based Predictive Analytics: Machine learning can predict streetlight failures, enabling preventive maintenance.
- Integration with Renewable Energy: Solar panels or wind power can create self-sustaining streetlights.
- Self-Healing Networks: IoT protocols can allow streetlights to self-diagnose and resolve minor issues.
- Multi-Functionality: Streetlights can support Wi-Fi hotspots, air quality monitoring, and EV charging.
- Edge Computing: Processing data at the streetlight level can reduce server load and improve response times.

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4. Badam Srivani, "Smart Street Light System with Automated Feedback," International Journal of Modern Developments in Engineering and Science, India, 2022.
5. Prakash, "Automatic Street Light Intensity Control," 2021. The study incorporates a Light Dependent Resistor (LDR) and ultrasonic sensors to adjust streetlight brightness based on movement, improving energy efficiency.