

Street Light Fault Detection And Energy Monitoring System

Mr. L. Karunakar, M.Tech¹, E. Divya Sai Teja²

Assistant Professor, EEE Department, Andhra Loyola institute of engineering and technology, Vijayawada¹

Student, EEE Department, Andhra Loyola institute of engineering and technology, Vijayawada²

Abstract: Street lighting plays a vital role in modern urban infrastructure by improving road visibility, ensuring pedestrian safety, and supporting nighttime transportation activities. However, traditional street lighting systems operate with limited automation and lack proper monitoring mechanisms, which often leads to excessive energy consumption, delayed fault detection, and increased maintenance costs.

Keywords: IoT, ESP32, Street Light Fault Detection, Energy Monitoring, Smart Street Lighting, Fault Detection System

I. INTRODUCTION

Street lighting is an essential component of urban development and public safety. Proper illumination of roads, highways, residential areas, and public spaces plays a crucial role in reducing accidents, improving visibility during nighttime, and ensuring the safety of pedestrians and drivers. As cities continue to expand and urban populations increase, the demand for reliable and energy-efficient street lighting systems has grown significantly. However, traditional street lighting systems often rely on manual monitoring and maintenance, which leads to several operational challenges.

One of the major issues with conventional street lighting infrastructure is the lack of real-time monitoring and automated fault detection mechanisms. In many cases, street light failures are identified only when residents or maintenance personnel report them. This delayed fault detection results in extended periods of darkness in public areas, which can compromise safety and security. Additionally, electrical faults such as abnormal current flow, voltage fluctuations, and lamp malfunctions may remain undetected, potentially causing energy wastage and equipment damage.

Another important concern is the growing need for energy management in public lighting systems. Street lighting accounts for a significant portion of municipal electricity consumption. Without proper monitoring and control mechanisms, energy losses and inefficient power utilization can occur. Therefore, implementing intelligent monitoring systems that can track electrical parameters and detect faults automatically is essential for improving the efficiency and sustainability of street lighting networks.

II. LITERATURE REVIEW

1. Street Lighting System

Street lighting is an essential part of urban infrastructure that provides illumination for roads, highways, and public areas during nighttime. Proper street lighting improves road safety, reduces accidents, and enhances public security. It also helps pedestrians and drivers to move safely in low-light conditions. However, traditional street lighting systems usually operate continuously or based on fixed timers without monitoring the condition of the lights or the amount of energy consumed.

2. Light Dependent Resistor (LDR)

A Light Dependent Resistor (LDR) is a type of sensor whose resistance varies according to the intensity of light falling on it. When the surrounding light intensity is high, the resistance of the LDR decreases, and when the light intensity is low, its resistance increases. Due to this property, LDR sensors are widely used in automatic street lighting systems for detecting day and night conditions.

3. Current Sensor

A current sensor is an electronic device used to measure the flow of electric current in a circuit. It helps in monitoring electrical parameters such as current, voltage, and power consumption. In street lighting systems, current sensors play a crucial role in detecting faults and monitoring energy usage.

Current sensing is essential in many electrical applications. Different types of sensors are used depending on the required current range and operating conditions. These sensors convert the measured current into a proportional voltage signal, which can be processed by a microcontroller.

III. SYSTEM DESIGN AND COMPONENTS

The given block diagram represents an IoT-based smart electrical monitoring and control system built using an Arduino Uno, ESP32, and various supporting modules.

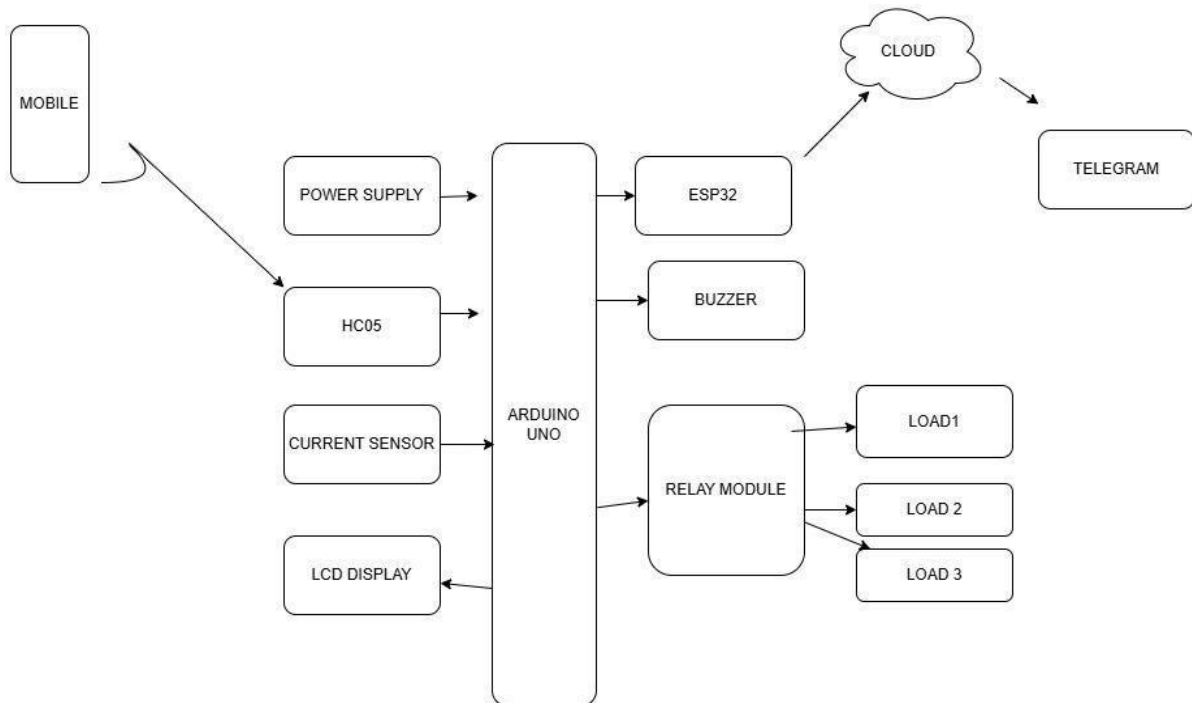


Fig. 1 Block Diagram

The system includes a current sensor, which continuously measures the current flowing through the connected loads. This sensor sends real-time data to the Arduino, which analyzes the values to detect normal or abnormal conditions such as overcurrent or overload. The measured data is also displayed on an LCD display, allowing users to view the system status, current readings, and load conditions directly. For local wireless communication, an HC-05 Bluetooth module is used. This module enables the user to connect a mobile device to the system and control the loads or monitor data within a short range.

For remote monitoring and control, the system uses an ESP32 module, which provides internet connectivity. The ESP32 sends data from the Arduino to the cloud, enabling access from anywhere. Through cloud integration, the system communicates with the Telegram application, where users receive notifications and alerts about the system status. For example, if an overload or fault condition is detected, the Arduino triggers a buzzer to provide an immediate audible alert and simultaneously sends a message via ESP32 to the cloud and Telegram, informing the user about the issue.

IV. WORKING

The proposed **IoT-Based Street Light Fault Detection and Energy Monitoring System** is developed to automatically monitor the condition of street lights, detect faults, and notify maintenance personnel through the internet. The system uses **Arduino UNO as the main controller, ACS712 current sensor for current monitoring, ESP32 for IoT communication, relay module for load control, LCD display for local fault indication, and Telegram application for sending remote notifications.** The system continuously observes the electrical condition of street lights and reports any malfunction in real time.

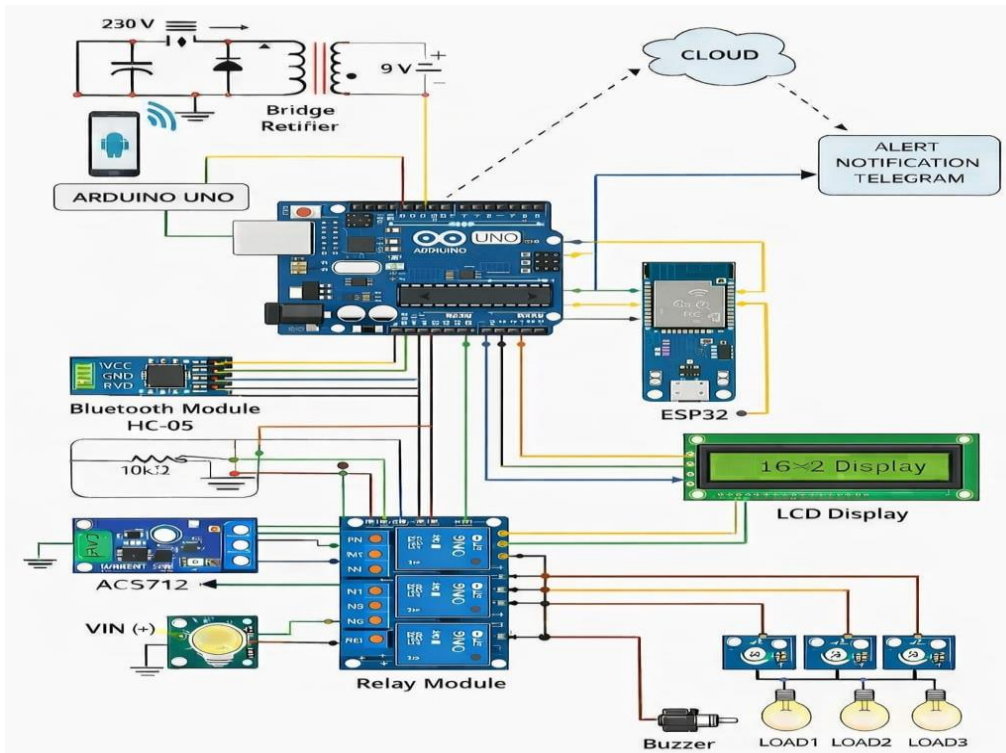


Fig. 2 Circuit Diagram

When the system is powered on, the **Arduino UNO microcontroller initializes all connected components**, including the ACS712 current sensor, relay module, LCD display, and ESP32 module. The ESP32 module then connects to the available **Wi-Fi network** so that the system can communicate with the internet and send alerts through the Telegram application. After initialization, the system begins monitoring the operation of the street lights. In this project prototype, **three bulbs are used to represent Street Light 1, Street Light 2, and Street Light 3.**

The **ACS712 current sensor** is an important component in this system. It is connected in series with the street light circuit so that the current flowing through the street light passes through the sensor. The ACS712 sensor works based on the **Hall Effect principle**, which allows it to measure the magnetic field produced by the current flowing in a conductor. When current flows through the street light circuit, the sensor produces an **analog voltage output proportional to the current value.**

V. RESULT

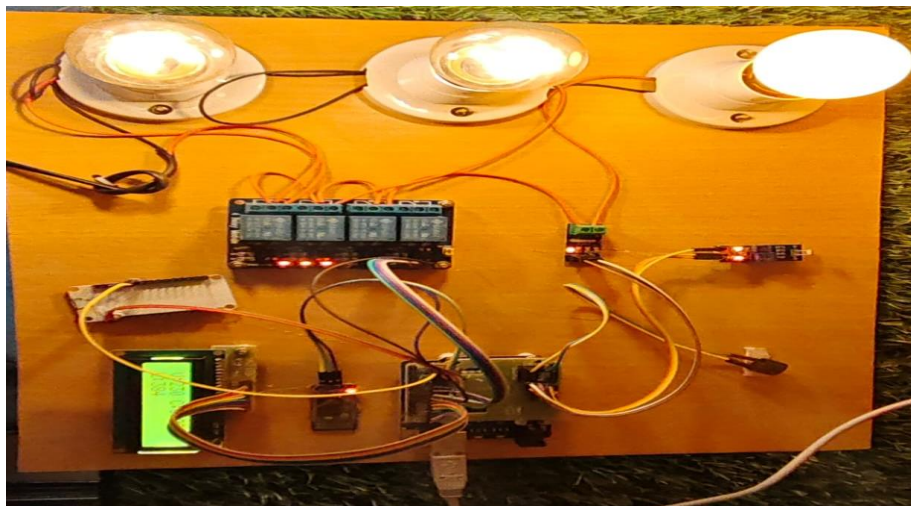


Fig. 3 Output with Hardware Normal condition

To verify the fault detection capability of the system, faults were intentionally created by disconnecting or switching off individual bulbs representing the street lights. When a bulb was disconnected, the current flowing through that particular circuit dropped to zero. The ACS712 current sensor detected this change in current and sent the signal to the Arduino UNO. The Arduino then identified the abnormal condition and recognized it as a **street light fault**.

Once the fault was detected, the system immediately activated the alert mechanism. The **16×2 LCD display connected to the Arduino showed the message “FAULT DETECTED”**, which indicated that there was a problem in the street lighting system. This provided a clear visual indication of the fault at the local monitoring unit, allowing technicians or operators near the system to quickly identify that a failure had occurred.

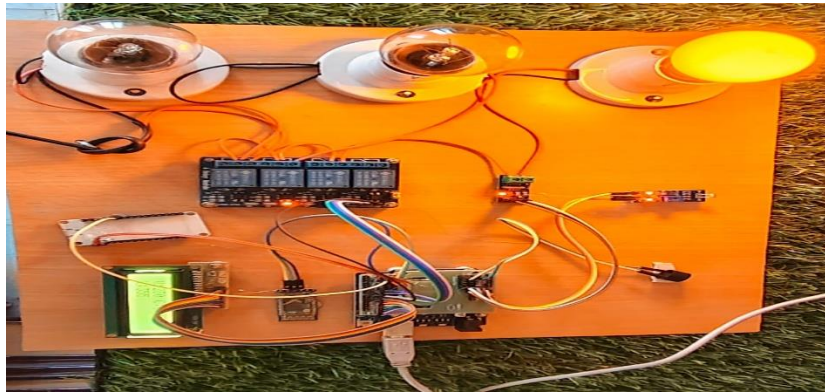


Fig. 4 Output with Hardware Fault Condition

The Telegram notification system proved to be highly effective, as it allowed the user to receive real-time information about street light failures from any location with internet connectivity. This feature significantly reduces the time required to identify faulty street lights and enables faster maintenance response. Instead of manually inspecting each street light, maintenance personnel can directly identify the exact location of the fault through the notification message.

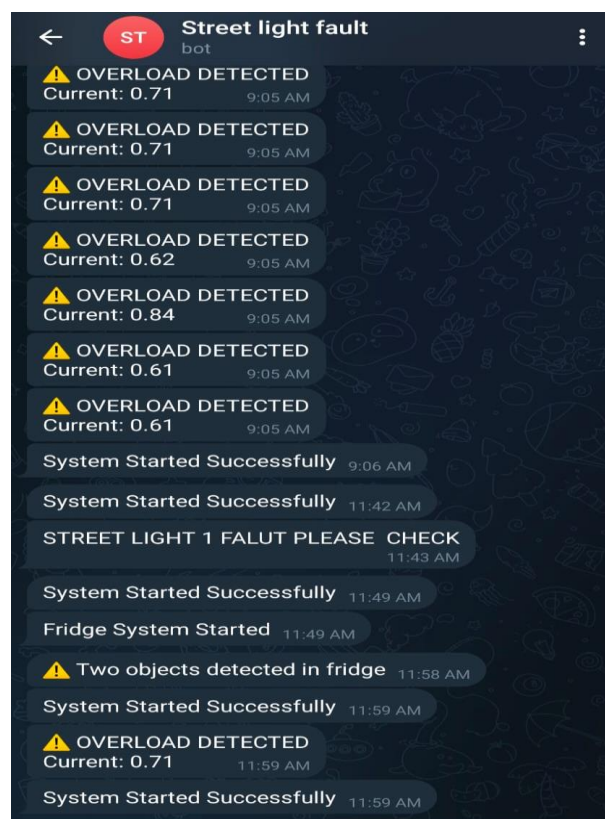


Fig. 5 Output in Telegram

VI. CONCLUSION

The IoT-Based Street Light Fault Detection and Energy Monitoring System developed in this project provides an effective and intelligent solution for monitoring the condition of street lights. By integrating Arduino UNO, ACS712 current sensor, ESP32 Wi-Fi module, relay module, and LCD display, the system is capable of continuously monitoring the current flowing through street lights and detecting faults automatically.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to the management and faculty of Andhra Loyola Institute of Engineering and Technology, Vijayawada, for providing the necessary facilities to carry out this project. I would also like to thank my project guide Mr. L. KARUNAKAR for their valuable guidance, support, and encouragement throughout the development of this work.

REFERENCES

- [1]. A. Kumar, R. Singh, "IoT Based Smart Street Light Monitoring System," International Journal of Engineering Research & Technology (IJERT), Vol. 8, Issue 5, 2019.
- [2]. S. Patel, M. Shah, "Automatic Street Light Fault Detection and Control System Using IoT," International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), 2020.
- [3]. R. Kumar, P. Verma, "Smart Street Lighting System Using Internet of Things," IEEE International Conference on Smart Systems and Inventive Technology, 2018.
- [4]. M. Karthikeyan, S. Ramesh, "IoT Based Fault Detection in Street Lights," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 2019.
- [5]. D. Singh, A. Sharma, "Wireless Monitoring of Street Lights Using IoT," International Journal of Computer Applications, 2018.
- [6]. N. Gupta, V. Mishra, "Energy Efficient Smart Street Lighting System Using IoT," IEEE Conference on Power Electronics, 2020.
- [7]. "ESP8266 Wi-Fi Module Datasheet," Espressif Systems.
- [8]. "Arduino Uno Datasheet," Arduino.
- [9]. "LDR Sensor Applications in Street Light Automation," Electronics Tutorials, 2019.
- [10]. "Internet of Things (IoT) for Smart City Applications," IEEE, 2021.