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CENTRALIZED MONITORING SYSTEM FOR STREET LIGHT FAULT DETECTION AND LOCATION TRACKING

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ABSTRACT

The centralized monitoring system prioritizes efficient street lamp management by focusing on detection of faults. Utilizing sensor networks and analytics, the system aims to streamline maintenance, improve fault detection, and optimize energy consumption in urban areas. With urbanization on the rise, effective public infrastructure management becomes crucial. This proposed system integrates smart sensors on street lamp for real-time fault detection. Data is transmitted to a centralized server, where advanced algorithms predict faults and optimize maintenance schedules. As urbanization increases, the demand for efficient publicinfrastructure management grows, with street lighting playing major role in urban safety and functionality. In summary, the incorporation of the ESP32 microcontroller and IoT-based sensors into the centralized monitoring system offers a state-of-the-art solution for managing smart streetlights.

Keywords — *IoT (Internet of Things), LED (Light Emitting Diode), GSM (Global System for Mobile), GPS (Global Positioning System), LCD (Liquid Crystal Display).*

I. INTRODUCTION

A well-designed system aims to ensure safe and comfortable night-time travel by providing adequate visibility. This involves strategically placing lightsto minimize dark spots, using appropriate brightness levels, and minimizing glare to enhance overall safety. Additionally, the system should be designed to reduce malfunctions, ensuring reliability and consistent functionality during night-time hours. It provides safety but also contributes comfortable and efficient nocturnal urban environment. The proposed system goes beyond merely identifying faults in street lights; it also incorporates precise location tracking, a feature that significantly enhances maintenance efficiency. The main goal is to achieve individual faults repaired within less hours instead oftaking days or months' time spent in the current situation when lineman goes to "light patrols" six/eight times a month to check for such faulted lamps. Our system not only identifies faults in street lights but also precisely pinpoints their locations, streamlining maintenance and improving overall efficiency. The primary challenge in the existing electricity system lies in connectivity issues, as major connections are manually managed by multiple contractors. This manual handling introduces inefficiencies and potential points of failure in the overall network. The dependence on various contractors coordination challenges, delays, and inconsistencies in the installation of connections. At its core, IoT technology forms the backbone of this system, enabling seamless communication between the physical world of streetlights and the digital realm. The integration of ESP32 microcontrollers enhances the intelligence of individual streetlights, facilitating real-time data collection and communication. By strategically deploying sensors on streetlights to identify faults promptly, ranging from bulb malfunctions to wiring issues. This ensures a proactive approach to maintenance, minimizing downtime and improving overall reliability. The ESP32 microcontroller serves as a central hub, collecting information from the deployed sensors and transmitting it to a centralized monitoring platform. This platform acts as the nerve center, aggregating and analyzing the incoming data to generate actionable insights. Beyond fault detection, the system incorporates location trackingcapabilities, allowing city authorities to pinpoint the exact location of malfunctioning streetlights. It streamlines maintenance operations but also contributes to energy conservation by addressing faults swiftly, thereby reducing unnecessary power consumption. Improved lighting quality ensures that roadways and pedestrian pathways are well- illuminated, reducing the likelihood of accidents due to poor visibility.

Additionally, expanded services, such as the precise identification of faulty lights and swift maintenance, contribute reliable and consistently well-lit environment. This combined approach not only enhances safety by preventing potential hazards but also fosters a sense of security for those navigatingthe area, making it a safer space for both drivers and pedestrians alike.

II. RELATED WORKS

The Street Light Monitoring System aims to represent a smart technological advancement by leveraging wireless technology, specifically GSM. Dr. H Ravishankar Kamath's paper titled "Street Light Monitoring Using IoT" discusses the current situation where street lights play a vital role [1]. Given the considerable electricity wasted by these lights, there's an essential need to conserve power. This system monitors each street light through a server-based operation, transmitting information via a wireless network (GSM Module). This approach ensures efficient supervision and is crucial for the energy-saving dominance of the streetlight monitoring system.

Nookala Venu [2] proposed an IoT based Real Time Street Lights controlling on Motion Detection. A streetlight serves as an elevated light source positioned along roads or walkways, activated at a specific time each night. It comprises LEDs, PIR sensors, IR sensors, and LDR sensors, all interconnected and managed via a Raspberry Pi. Ahead of a designated number of streetlights, PIR sensors detect approaching vehicles, triggering the simultaneous activation of all streetlights for a predefined duration. Additionally, each streetlight pole is equipped with an IR sensor, which detects motion and activates the corresponding streetlight. This system is enhanced with a solar module, regulated by an Arduino Uno, utilizing solar power as the primary energy source for the streetlights..

Bhairi et al [3] reported a study on the Design and implementation of smart solar LED street light. This study focuses on a smart solar LED streetlight designed to automatically deactivate during daylight hours and activate only at night. In adverse weather conditions such as heavy rain or severe weather, the bulb dims to 30% brightness. However, when a person or vehicle is detected nearby, it brightens to 100%. Notably, the system does not incorporate any error detection mechanism.

Sravani [4] reported a study that employs two distinct approaches depending on the application's requirements. In areas with limited coverage or confined spaces, wireless technology connects all devices to a cloud. In contrast, a wired setup, resembling the streetlamp pole, addresses a range of issues that arise when appliances are concentrated in one direction. Upon detecting a problem, the specific pole number is promptly updated on a web page.

Xiaomei Zheng [5] has designed a device for Remote Centralized Monitoring of Streetlights of Intelligent Community. The MSP430 microcontroller serves as the main controller, with a detection circuit that can automatically identify the operational status and fault locations of streetlights. A PC monitoring software has been developed to send fault details to the monitoring center and the designated phone via a GSM wireless network. This design allows for centralized control of all streetlight conditions by a single operator, reducing management costs. Moreover, this system can be adapted for the centralized monitoring and management of urban streetlamps.

Amey Manekar et al [6] have reported the "Design and Implementation of Automatic Street Light Controller for Energy Optimization Using FPGA". Their automated system enhances organizational efficiency and accuracy by automatically adjusting streetlights according to schedules. The system integrates a microcontroller on the client-side server on the server side. The major goal is to maintain power in main streetlamps through embedded systems, facilitated by the microcontroller.

Dhingra & Cho [7] introduced "Street Lighting Control Based on Lon works Power Line Communication". This paper discusses the need for manual intervention. Light Dependent Resistors (LDR) automatically toggle the lights based on sunlight, offering benefits like reduced seasonal variation effects, enhanced energy efficiency, and low operation and low costs.

Rahul et al [8] have developed a GSMBased Autonomous Street Illumination System for Efficient Power Management. Their paper outlines a solution to electricity expenditure, eliminating manual work. It employs LDR and photoelectric sensors to differentiate between light and dark times and detect movement on the street, respectively. The microcontroller PIC16F877A serves as the system's brain, executing programmed instructions in C language to control the street lighting system.

Usha[9] proposed a "Street Light Monitoring and Control System". They introduced an innovative approach using RFID-based GSM for controlling, reducing power recovery time and facilitating timely warnings for maintenance and power-related complaints. Adopting this system could lead to significant power savings for electric departments and streamline the processing time for new power connections through this system.

Ashok Kumar [10] introduced an IoT based Automatic Damaged Street Light Fault Detection Management System. The research aims to automatically control and identify damaged street lights. Typically, street light damage is detected through complaints from residents. However, this proposed system utilizes sensors to capture the working status of these lights without manual intervention, reducing manual efforts and speeding up problem resolution.

III. PROPOSED WORK

The main goal is to implement a system capable of detecting faults in street lights in real- time, implement precise location tracking for quick identification of faulty street lights. Public authorities in developing nations are significantly concerned about street lighting due to its crucial role inmaintaining economic and social stability. The light exhibits poor design, lacks proper maintenance with numerous burned-out lamps, and relies on outdated technology, leading to excessive energy consumption and financial strain. Improve response times for maintenance by providing timely and accurate information about faulty street lights and also to make the system cost effective and also to improve the reliability of LED bulbs to enhance public safety and promote community well-being. The block diagram of the project includes ESP32 which is a core component as the central processing unit. It interfaces with various modules, including a power supply and 7805 voltage regulators to ensure stable operation.The system has SIM800L GSM module for communication, an ultrasonic sensor for proximity detection, an LCD display 20*4 With I2C Interface to showcase reservation messages, a 4x4 keypad for user input, a relay module for control, a NE0-6M GPS module for location tracking, and an LED to activate street lights. This comprehensive setup is designed to efficiently manage parking reservations, providing real- time information through the LCD display andensuring effective control over street lighting based on occupancy.

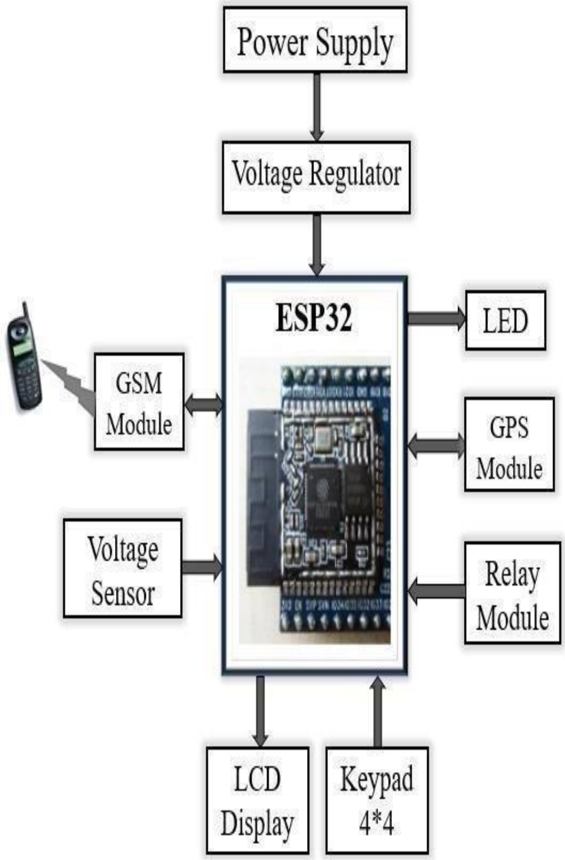

Fig 1: Block Diagram

IV. RESULTS AND DISCUSSIONS

The implementation of a centralized monitoring system for street light fault detection and location tracking, with a focus on lineman safety, I anticipated to yield transformative outcomes for urban infrastructure management. The system swiftly identify and communicate faults in street lights, enhancing operational efficiency by significantly reducing response times. Accurate location tracking will streamline maintenanceefforts, enabling quick dispatch of personnel to specific sites. Moreover, the lineman safety features ensures that maintenance teams are promptly alerted to potential hazards, prioritizing their well-being. Real-time monitoring will not only improve the overall reliability of the street lighting system but also contribute to energy efficiency by allowing for optimized usage based on dynamic data. The implementation of such a system is poised to generate substantial cost savings through reduced downtime and efficient resource allocation.

Ultimately, this comprehensive solution is designed to elevate public satisfaction by ensuring reliable street lighting while prioritizing the safety of those responsible for its maintenance. Centralized monitoring systems can quickly identify faults in street lights, reducing downtime and improving overall reliability. It enables real-time monitoring from a central location, allowing for prompt response to issues without the need for physical inspections. The system can optimize street light usage, automatically adjusting brightness based on environmental conditions and time of day, leading to energy savings also we can incorporate cameras or sensors for improved surveillance, contributing to public safety and security. Immediate notifications for faults or irregularities allow for swift corrective action, preventing prolonged outages.

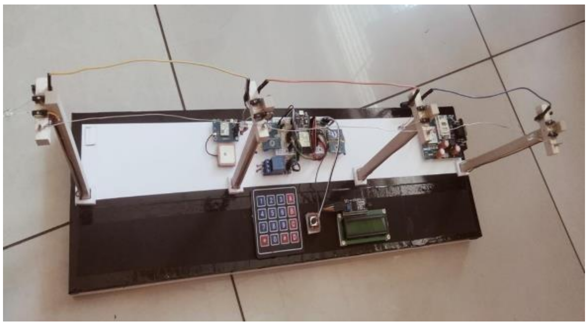

Fig 2: Designed Prototype

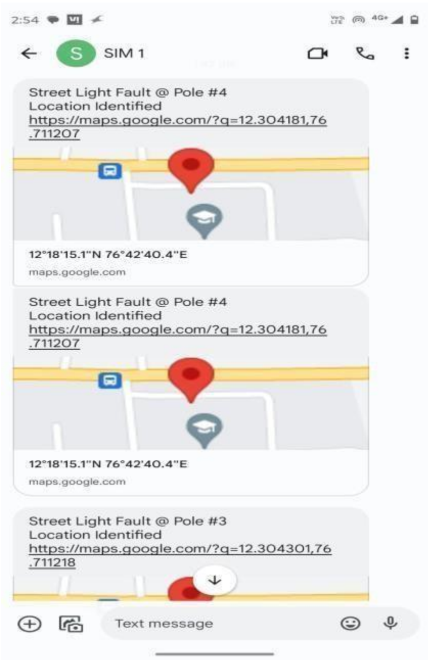

Fig 3: Message Notification

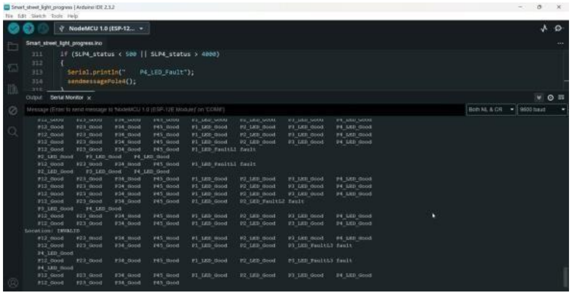

Fig 4: Fault Detection

V. CONCLUSION AND FUTURE WORKS

The control device's experimental results demonstrate its ability to accurately assess the condition of community lights and pinpoint faults. It promptly relays information about faulty streetlamps to the central monitoring center of the host computer and issues alerts. Implementing this device in the management of Intelligent Community street lamps will significantly cut property management costs and lower residents' living expenses, while also minimizing unnecessary damage caused by faulty street lights. Furthermore, this design can be adapted for remote centralized monitoring and management of municipal street lamps. Incorporating connections to other metropolitan city systems like traffic management, public safety, would allow for a more holistic and organized strategy in handling street light issues and other incidents. Furthermore, this integration could streamline the gathering of data regarding street light performance and environmental factors. Additionally, it could facilitate the collection of data of failures.

VI. REFERENCES

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