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AUTOMATED CONTROLLER FOR STREET LIGHT MANAGEMENT SYSTEM

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ABSTRACT:

In most urban and semi-urban cities, the street lights are installed and maintained by municipalities. The most cities are still using a combination of high-pressure sodium lamps, fluorescent, CFL and metal halide bulbs, which does not meet area-wise lighting needs. The aim of this project is to develop a comprehensive and efficient system for the real-time detection of street light faults, precise location tracking, and streamlined maintenance processes in urban areas. This IoT-based system tackles manual street light monitoring. Sensors automatically detect malfunctions. GPS modules pinpoint faulty light locations for faster repairs. GSM modules send alerts with details to respective addresses. This offers several benefits: eliminates manual efforts, enables quicker response times, improves maintenance management through real-time data, and has the potential to optimize energy use. By leveraging advanced technologies, the goal is to enhance the overall urban lighting infrastructure, ensuring optimal functionality and energy efficiency.

Keywords:

Automated,Controller,StreetlightManagement System, IoT Energy Efficiency, Sensor Networks, Real-time Control, Smart City.

INTRODUCTION:

Street Lights have become an essential part of our lives as they are an important source of light at evening and nighttime Collisions. Street lighting is a critical component for ensuring public safety, security, and comfort. However, traditional street lighting systems often suffer from inefficiencies, such as excessive energy consumption, unnecessary illumination during low-traffic hours, and delayed maintenance responses to faults or failures. The project involves automating lighting systems that are powered by solar trackers for effective lighting system use. Currently, The IOT-based auto sunshine tracker-driven light control system encourages the use of renewable energy in addition to reducing power usage through light management. We accomplish this by continuously monitoring ambient lighting conditions and human presence using IR sensors and LDRs. Compared to a standard solar panel that is stationary, the solar tracker is 30% more efficient. Using solar energy-captured solar panels will also help us to solve that problem. With IOT, devices can be remotely controlled and monitored, leading to improved performance, accuracy, and cost-effectiveness in various applications. It offers opportunities for energy-saving solutions, such as automatic control of street lights based on sunlight intensity.

➢ RELATED WORK :

- ✓ The implementation of an IoT-based Automatic Street Lighting System is the primary goal of this project. As traffic gradually decreases during the late hours of the night, the intensity gradually decreases until morning to conserve energy; as a result, at dusk street lights are turned on and automatically turn it off at dawn.
- ✓ Solar-panel movement tracking
- ✓ IoT-based device monitoring and control
- ✓ Development of Power Saving devices.

OBJECTIVE:

- Improving street light fault detection: Incorporating the IOT technology to detect the faults in street lights quickly and Precisely.
- Improving tracking location of fault: Utilizing IOT sensors to detect the exact location of faulted street lights for necessary maintenance.
- Accumulate maintenance processes: Integrating IOT data with maintenance systems to automate and minimize the repair workflows.
- Enhancing working efficiency: Minimizing the requirement time by quickly finding and solving the street light faults.
- Minimizing maintenance costs: Optimizing resources through accurate maintenance based on real-time fault detection and location tracking

LITERATURE REVIEW:

[1] Automated Street lighting utilizing PLC presents a newfangled notion employing the XD26PLC controller. Within this framework, manual labor becomes obsolete. The automatic activation and deactivation of illumination based on sunlight levels are facilitated through the utilization of a Light Dependent Resistor (LDR), which assumes a pivotal role. The benefits of this approach encompass the impact of seasonal changes, heightened energy efficiency, as well as reduced operational and maintenance expenses. The assessment and data analysis of this initiative, ensuring the precise functionality of the streetlights, are conducted through the utilization of Crouzet Millennium software.

[2] The GSM-based intelligent street light monitoring and control system is a sophisticated automated system crafted to enhance the productivity and precision of an industry through the automated timing control of street lights. This system comprises two fundamental modules: the client side and the server side. The client side is composed of a GSM modem that is intricately linked to the microcontroller, whereas the server side is equipped with a Java-based web server.

[3] This research focuses on the development of an Automatic Street Light Control System Utilizing a Microcontroller, with the goal of implementing advancements in embedded systems to enhance energy efficiency in street lighting. Contemporary society is characterized by a high level of busyness among individuals, leading to a lack of time for manually switching off unnecessary lights. The proposed solution presented in this study addresses the issue of electrical power consumption. Furthermore, manual operation of the lighting system is entirely replaced. The utilization of two sensors is highlighted in this study: the Light Dependent Resistor (LDR) sensor for distinguishing between light and dark periods, and the photoelectric sensors for detecting movement on the street. The microcontroller PIC16F877A serves as the central processing unit for governing the street light system, with the software programmed in C language for execution on the microcontroller.

[4]The utilization of GSM in conjunction with RFID technology for the automation of street lighting systems is proposed in this study. A novel approach is presented to minimize power consumption within this system. This innovative system has the potential to decrease the duration of recovery following a power outage. Furthermore, it

facilitates the monitoring and maintenance of street lights and loads, while also enabling prompt notification of any power-related concerns via GSM technology. It is anticipated that the implementation of this system by the Electricity department will result in significant power and time savings. Additionally, by leveraging RFID technology, the processing time for new power connection requests can be greatly reduced through system extensions.

[5] The project concerning Automatic Street Lights aims to regulate power consumption on the streets while reducing the need for manual intervention. Implementation involves designing a circuit for street lights equipped with specific sensors, LDR, and microcontrollers to operate during both day and night. This project relies on three fundamental elements: LDR, sensors, and a microcontroller. During the daytime, street lights stay dormant due to the Light Dependent Resistor (LDR) inhibiting the passage of electric current to the transistors' base, a reaction triggered by the detection of diminished light intensity or frequency. This process leads to an increase in LDR resistance, effectively hindering the activation of the streetlights.

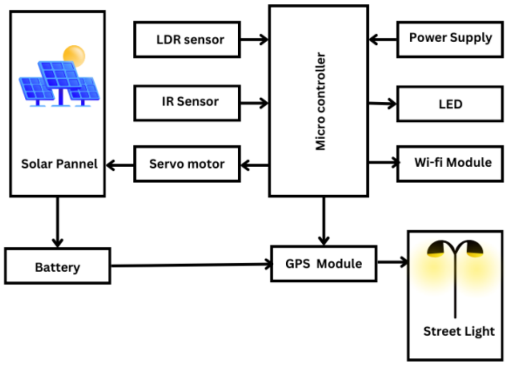
[6] In 2016, Manish Kumar [4] conducted a study on the regulation of streetlights utilizing a Zigbee wireless module. The components included a transmission module, an LDR, and a microcontroller. Zigbee enables wireless communication with the lamp module. The system utilizes two LDR sensors to analyze day-night fluctuations and ensure lamp safety. Once the LDR data is collected, it is transmitted to the microcontroller and subsequently to the transmission module. The information is then wirelessly transferred to the control center via Zigbee technology, which oversees and controls each streetlight. The device establishes a connection to a Zigbee wireless network with a restricted coverage range [1].

[7] A GSM-based automated streetlight control system was developed by Professor K.Y. Rajput and three other researchers from TSE Mumbai for the computation of various parameters. The system comprises a server microcontroller along with sensors like smoke sensors, noise sensors, light sensors, and others. It is designed to detect ambient temperatures and noise levels, subsequently sending an intervention signal to the equipment. The main drawback identified is the necessity of mounting a GSM modem on each streetlight, resulting in high overall costs. Moreover, there exist compatibility challenges with this system. The elevated cost of this particular model is attributed to its heavy reliance on hardware components for computer monitoring and control.

[8] A smart street light monitoring and control system based on GSM technology is a technological system that implements scheduled switching of street lights to enhance operational efficiency and precision within an industrial setting. The system comprises two distinct modules, designed for both client-side and server-side operations. The client module incorporates a GSM modem that interfaces with a microcontroller, while the server module utilizes a java-based application server on the user end.

METHODOLOGY:

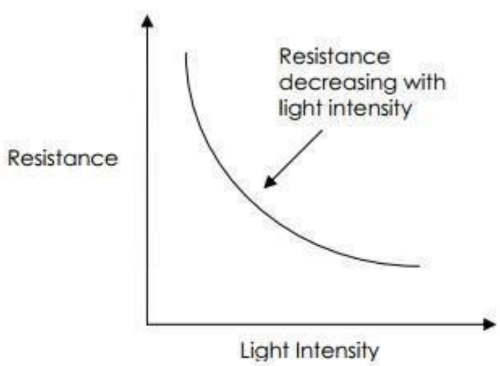
Switching to an automatic street lighting system that detects faults eliminates any wasted time and error in detecting and reporting malfunctions. Whenever a fault occurs along the grid, it is automatically detected by sensors and becomes a problem in just a few seconds.



LDR SENSOR:

An LDR is a component that has a (variable) resistance depending upon the light falling upon it that changes its intensity. This LDR senor is being used in light sensing based circuits.

Variation in resistance with changing light intensity:



Application of LDR sensor:

The most definite application for an LDR is to automatically switching the light at a certain level. For an example this could be a garden light or a street light.

LED:

A two-lead semiconductor light source is a light-emitting diode (LED).The LED is a p–n junction diode and when it gets activated it emits light. When an appropriate current is being applied to the leads, electrons are able to recombine with electron holes inside the device and releasing energy in the form of photons.

Advantages of LED:

Efficiency:

Efficiency: LEDs use low energy compared to established incandescent bulbs, leading to very low operating costs.

Lifespan: LEDs have a consequential of extended lifespan than that of incandescent bulb and minimizing the maintenance frequency.

WI-FI Module:

In this project, the Wi-Fi module acts as the bridge between the microcontroller unit (MCU) and the cloud platform, enabling wireless communication for data transmission and potential remote control. The Wi-Fi module acts like a translator, connecting the microcontroller (MCU) to the Wi-Fi network using a password (like joining Wi-Fi on your phone. The MCU gathers sensor data (light level, motion, etc.) and tells the Wi-Fi module what to say to the cloud platform (internet).The Wi-Fi module packages the data and sends it wirelessly to the cloud platform over the Wi-Fi network.

GPS tracker:

In this project, the GPS module plays a crucial role in precise location tracking of the street lights, facilitating efficient fault detection and repair.

Satellite Communication:

The GPS module is a small electronic device that can receive signals from a network of GPS satellites orbiting the Earth. These satellites transmit data containing their positions and timestamps.

Position Calculation:

Based on the time difference between receiving signals from different satellites and their known positions, the GPS module can determine its own latitude, longitude, and altitude.

Data Transmission (to MCU):

Once the GPS module calculates its location, it typically converts it into a standard format and transmits the message to MCU.

Cloud Platform Integration (via MCU):

The MCU receives the location data from the GPS module. The MCU might process this data further before transmitting it to the cloud platform the cloud platform receives the location information along with other sensor data from the MCU through the Wi-Fi module

Benefits of Using a GPS Module for Street Lights:

Accurate Fault Location: When a fault is detected by the system, the GPS data allows for pinpointing the exact location of the faulty street light on a map. This is crucial for efficient dispatch of maintenance personnel to the correct location.

Improved Response Time:

Faster localization of faults leads to quicker repairs, minimizing downtime and ensuring better public safety and illumination at night.

Data Analysis and Optimization:

The collected location data can be analyzed over time to identify areas prone to faults or excessive energy consumption. This information can be used to optimize maintenance schedules and potentially improve system design**.**

SOLAR PANEL AND BATTERY:

Provides Self-Sufficiency: When combined with a solar panel, the battery creates a self-powered system. The solar panel generates electricity during the day, which charges the battery. The stored energy in the battery then powers the LED light at night and the microcontroller unit (MCU) for continuous operation. Grid Independence: This eliminates the need for a direct connection to the electrical grid, making the system suitable for off-grid locations or areas with frequent power outages. Reduced Operational Costs: By relying on solar power, the project minimizes dependence on grid electricity, potentially leading to lower long-term operational costs.

IR SENSOR:

Motion Detection:

The IR sensor emits infrared light invisible to the human eye. When an object (like a car or pedestrian) moves within the sensor's range, the infrared light pattern is disrupted. The sensor detects this disruption and sends a signal to the microcontroller. Based on the IR sensor's signal indicating movement, the microcontroller could dim the LED (street light) during low-traffic periods. This reduces energy consumption without compromising safety when someone approaches.

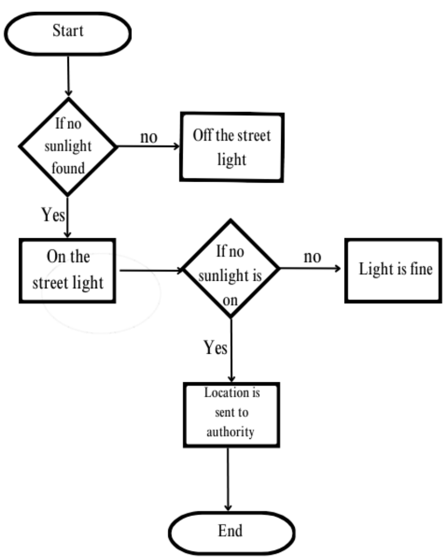
MICROCONTROLLER:

The microcontroller acts as the maestro of the entire street light system, conducting the intricate dance between sensors, communication, and light control. It continuously gathers data from the LDR sensor, acting like a tiny eye that determines if its day or night based on ambient light levels. Additionally, it might receive input from an IR sensor, functioning as a motion detector to potentially dim the lights during low-traffic periods for energy saving. But the microcontroller's role doesn't stop at mere data collection. It interprets this information, acting as the brain of the system. Based on LDR readings and pre-programmed logic, it decides if it's nighttime and instructs the LED (street light) to illuminate the path. Furthermore, the microcontroller safeguards the system's health. It vigilantly monitors the LED's current or voltage, and any deviation from expected values becomes a red flag, signaling a potential fault like a burnt-out bulb or a power supply issue. When such a fault is detected, the microcontroller seamlessly transitions into communication mode. It prepares an alert message containing crucial details like the type of fault and, if a GPS module is present, the location of the malfunctioning street light. This message is then relayed via the cellular or LPWAN module, effectively calling for help. In essence, the microcontroller is the tireless conductor, meticulously monitoring sensor data, making critical decisions, controlling the light's operation, and orchestrating communication in case of emergencies.

RELAY DRIVER AND BOARD:

A relay driver is an electronic circuit that allows a low-current control signal from the microcontroller to manage a high-current device like a powerful incandescent bulb or a heavy-duty motor**.** Therefore, the need for a relay driver depends on the specific type of street light and the desired level of safety isolation. In the case of a system built around low-power LEDs, the microcontroller's built-in capabilities are sufficient, making a relay driver unnecessary.

FLOWCHART:



Communication and Data Flow:

The process starts

Sensor readings are collected, including light level and motion data (optional).

The microcontroller processes the data and identifies potential faults.

If a fault is detector - Yes), an alert is triggered through SMS, email, or a dedicated dashboard notification.

If no fault is detected (D - No), the system might adjust light intensity for dimming (optional) based on LDR and motion sensor readings (optional).

All data (sensor readings, fault status, and location if using GPS/cellular) is then transmitted to the cloud platform using the Wi-Fi module.

The cloud platform receives the data, stores it, displays it on a user interface for monitoring, and manages

Benefits:

Improved Public Safety:

Faster Fault Detection and Repair: Real-time monitoring allows for immediate identification of issues like burned-out bulbs or power outages. This prompt detection ensures faster repairs, minimizing periods of darkness and enhancing public safety at night.

Enhanced Energy:

By incorporating an LDR sensor (optional), the system can adjust light intensity based on ambient light levels. Self-power: Integrating a solar panel and battery creates a self-sustaining system.

Reduced Maintenance Costs: Efficient Fault Detection and Location Tracking:

Precise fault identification and location tracking (through GPS or cellular network triangulation) minimize wasted time and effort for maintenance crews. They can be directed straight to the problematic street light, streamlining repair processes.

Data-Driven Insights (Potential for Future Optimization):

Real-time Data Collection: Sensor data like light levels and (optionally) motion activity can be collected and analyzed over time. This data can be used to identify areas with frequent faults, optimize maintenance schedules, and potentially explore further energy-saving strategies. Overall, this IoT-based street light system offers a significant advancement over traditional street lighting by providing an intelligent, efficient, and sustainable solution for urban illumination.

PROCESS:

This IoT street light system shines a light on efficiency and safety. By constantly monitoring light levels with the LDR sensor, the system automatically illuminates streets only when needed, saving energy. Additionally, the vigilant microcontroller detects faults in the LED lights and sends out SOS messages with location details (if GPS is included), ensuring swift repairs and minimizing dark periods. This not only reduces maintenance costs but also keeps streets safer for everyone. Furthermore, the system can be scaled to encompass a whole city, creating a smarter and more sustainable lighting infrastructure for the future.

FUTURE SCOPE:

Integration with other smart city systems:

The system could be integrated with other smart city systems, such as traffic management systems, public safety systems, and environmental monitoring systems. This would allow for a more extensive and accommodate response for the fault of street light and other events.

Predictive maintenance:

This system can be used to the collect data on street light maintenance and other environmental conditions over time. This data could then be used to develop predictive maintenance models that can identify and address potential problems before they cause failures.

Energy efficiency:

This system could be used to make an adjustable street light brightness levels based on real-time traffic and also weather conditions. This has the potential to result in substantial energy conservation.

Public engagement:

This system could be used to provide the public with real-time information on street light status and repair schedules. This could be done through a mobile app, website, or social media.

APPLICATION:

- ✓ On Highway
- ✓ On society road line
- ✓ At hospital
- ✓ At School
- ✓ At Industry

RESULT & ANALYSIS:

Initially, a prototype is developed to assess the arrangement process of the entire system and can be considered a component of future research and development endeavors. Upon the completion of the project, a proposed system is devised, as illustrated in Fig. 3. Following the system's development, an extensive testing phase spanning several months is conducted to validate its full functionality in real-time settings. The implementation of our methodology led to enhanced fault detection accuracy and the automation of lighting operations, resulting in energy conservation. In the aforementioned figure, the initial street light remains inactive due to a malfunction. Consequently, a red LED will illuminate at that juncture. In instances where the street light functions correctly, no further actions are necessary. For experimental purposes, standard LEDs were utilized in lieu of traditional lighting fixtures. Fig.1 outlines the notification dispatched to authorized individuals through the application platform. The message, denoted as "Damage," serves as an alert, supplemented by a GPS derived

URL. The indicator provides precise information regarding the location

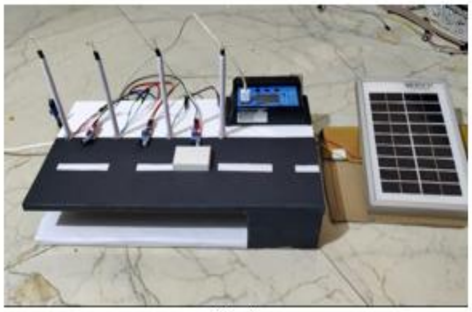
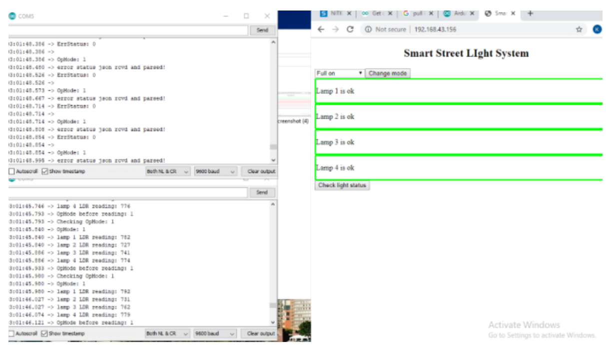


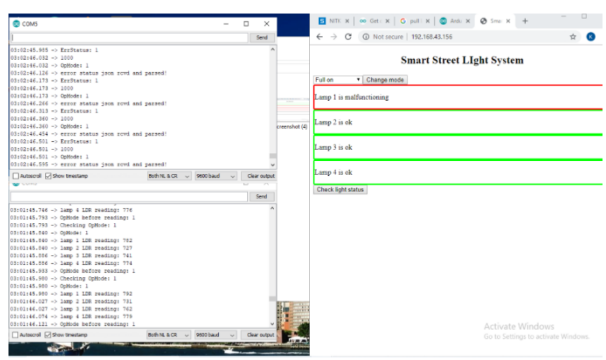
Fig 1

In scenarios where multiple lights are clustered together, a defective light can be identified through the activation of a red LED.

Blynk app with IOT:

Blynk represents a platform that encompasses iOS and Android applications for the purpose of managing Arduino, Raspberry Pi, and similar devices via the World Wide Web. Within this realm, it functions as a digital interface where individuals have the ability to construct a visual representation for their projects by employing a straightforward process of dragging and dropping various interactive elements. The setup process is notably uncomplicated, allowing users to engage in experimentation within a time frame of fewer than five minutes. Furthermore, Blynk does not exhibit a dependency on any particular board or protective covering; rather, it accommodates the hardware that users prefer. Regardless of whether an individual's Arduino or Raspberry Pi is connected to the Internet through Wi-Fi, Ethernet, or the innovative ESP8266 chip, Blynk ensures seamless online connectivity, thereby facilitating engagement with the Internet of Things.





CONCLUSION:

The LDR detector can be used in which can be used to cover the status of LED condition like ON/ OFF status. Controlling the LEDs is established with the help of the relays motorists connected to each LED. Eventually Faults are set up and also informed to the stoner by the fault pointers. The road light is being observed at all the times with the help of the IoT platform. Analysis of data regarding power consumption and position shadowing in each road is done with the IOT grounded model. This work aims to reduce the force related to road light problems and also, it saves a time conditions and the fault related problems are being answered more effectively. Therefore the proposed model aids in monitoring, amending road light problems fluently and efficiently and controlling of road light conservation is established.

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