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IOT based Street Lighting Control System

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ABSTRACT

A large number of street lights present around the world which consume enormous amounts of electrical energy. As it is a huge system, it is very difficult to monitor and control them manually. It is important to develop a smart system that can monitor and control the lights as well as provide communication to the user. This communication is established using IoT. This system monitors the status of every street light (ON/OFF state) by observing the power consumption of light. As the usage of street light is required only during the night, the system automatically turns ON the light at 6 pm and turns it OFF at 6 am. This conserves energy consumption by optimizing the usage period. When a fault occurs in the street light, this system disconnects the street light from the supply and an indication is sent to the User. Using this information, the User can rectify the fault and turn ON the light. This increases the reliability and maintainability of the street light. A portal for real-time monitoring of voltage across light, current through the light, the power consumed by the light and fault status is established using the Thingspeak IoT platform. This real-time information can be accessed from anywhere around the world at any time using the Internet.

Key words: Arduino UNO, NodeMCU, Thingspeak, current sensor,ArduinoDue,Arduino voltage sensor, Street light.

1.INTRODUCTION

Most people in the rural areas of the country do not have access to power. Individuals living in the land are watching genuine burden shedding because of the age deficiency. The enduring of its residents could reduce by an appropriate burden the executive's framework. In this paper, the creators have structured and manufactured a circuit that can control the (on/off) conveyance line of a particular area dependent on the power of the sunshine (LUX)[1]. At present, in street lighting applications, high-pressure sodium (HPS) and metal halide (MH) lights are the most broadly utilized light sources. HPS lights are utilized as a result of a long light lifetime and high iridescent adequacy and MH lights offer high glowing viability, great shading rendering properties, and better fringe perceivability at low brightening levels. LEDs are not prepared for street lighting applications since the glowing yield of LEDs isn't high enough[2].

A road light, light post, road light, light norm, or light standard is a raised wellspring of light on the edge of a street or walkway, which is turned on or lit at a specific time each night. Significant preferences of road lighting remember the avoidance of mishaps and an expansion for security. Studies have indicated that murkiness brings about countless accidents and fatalities, particularly those including walkers; person on foot fatalities are 3 to 6.75 occasions more probable in obscurity than in light [3]. The Street Light Control System which works consequently isn't just most effortless yet in addition an astute framework. The framework in [4] includes a fly back converter equipped for providing the LEDs by battery or by mains. A similar converter is utilized for energizing the battery just as for the force factor revision stage. During top burden time, the control organize separates the road lights from the mains. So, this takes into consideration diminished force utilization, decline in cost for the executives, and screen every road lighting unit effectively.

This framework in [5] can be set to work in automatic mode, which controls the streetlight as indicated by light force, brightness, and dimness Algorithm. This control can make a sensible change as per the occasional variety. The initiative has been done to control road lights through the PC screen terminal. This road light framework likewise incorporates a period cut-out capacity, and an automatic control design for significantly greater power saving, when vehicles cruise by, the light will turn on automatically, later turn off. This design can save a lot of power contrasted with road lights that keep alight during nights.

The cloud-based system involves reading and writing data in the cloud using the internet. ZigBee-based wireless devices are used in this street light monitoring model. Data acquisition is done by dimming control and infrared sensor. These data are transferred to the station using Zigbee for monitoring the street lamps.[6]. The proposed system in [7] consists of data acquisition systems at each lamp post of the street and wireless communication systems that enable communication between street light and the base station. For communication, the system uses microchip wireless communication protocols. When there is no pedestrian near the lamp, the lamp will be in minimum brightness and if someone is there, then the lamp will glow in maximum brightness. The system in paper [8] was developed with the aim of reducing the effort in fault identification and system maintenance. Depending on the output from the real time clock and light dependent resistor, the controller switches on/off the lamp.

The IR sensor in the system turns on the light when presence is detected. Further, current sensors and voltage sensors are used to calculate the power consumed by the system.

In [9] an IR sensor is used to detect the presence of the vehicle and if it senses, a signal is generated and it is sent to the arduino. The signal provided by arduino is used by the relay to turn lamps on and off. If current or voltage becomes zero, the data is transferred to the webpage through Wi-Fi module. The system also consists of a gas analyzer which sends information on air mixture to the webpage. In the proposed system [10],the information regarding the status of light can be retrieved from anywhere. This system uses an LDR to identify whether it is dark and an IR sensor to detect the presence of the vehicle. This output is given to a relay and the relay turns the light on and off. The design in [11] uses a sensor, ZigBee, and GPRS wireless communication. The coordination control technique for different sorts of sensors is utilized for intelligent lighting parameters adjustment. The collection of street light's information is done through different ZigBee nodes topology network and data is transmitted through the GPRS network. The street lamps can be turned ON or OFF automatically according to the environmental conditions.

This system in paper [12] makes use of sensors like LDR, PIR to monitor the street and microcontroller to control the street lights. This system gets information of no units consumed per day/month/year and it also stores it. The Street light Lamp is enabled with IoT i.e. sensors, Microcontroller, and a WIFI module. The sensors sense the motion and the light occurrence and send the data to the microcontroller which controls the lamp as well as sends the information to the client application with the assistance of Wi-Fi. In the proposed smart street lighting system[13], the power consumption is minimized using sensors when there is no movement of objects on the road. This system optimizes energy consumption by increasing the intensity of light by sensing the movements using the sensors. The fault in the light is detected and it is resolved by adjusting the nearby poles in the street.

Many places in India consist of manual street lighting systems and have been taken care of by the municipality of the place. The lights are turned ON before night and turned OFF in the first part of the day. Another scenario is that the timer is set to turn ON and OFF during night time. There is a wastage of power in these scenarios. The energy-efficient way is turning ON the lights only when there is a movement of vehicles or humans. This proposed system [14-15] offers a fully automated energy-efficient system to perform switching ON and OFF only when need. This system consists of intelligence to communicate to the municipality office during fault conditions. This system is designed using Light Dependent Resistance(LDR), Arduino UNO, Motion Sensor, and Bluetooth devices.

One of the major issues in the city is the usage of large amounts of electricity for the street light. This proposed framework is used for keen and atmosphere versatile road lighting. In this system[16] the road lights are turned ON during evening time and killed during day time consequently and the control can be gotten to anyplace on the planet utilizing the web. Cameras are put on head of the Street lights to follow the exercises acted in the road and can be put away in the cloud storage for additional use. Every street light in an area is associated with corresponding area's police stations with cloud account accessibility for surveillance. With this idea, there can be an assurance of safety and energy consumptions.

2. SMART STREET LIGHTING SYSTEM

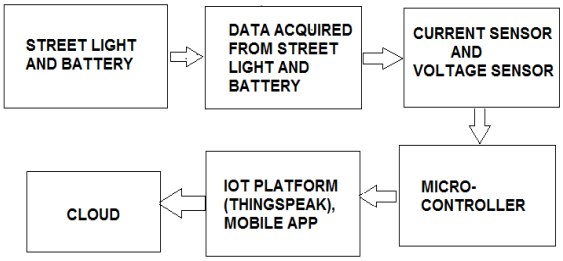

Figure 1: Block diagram of the smart street lighting monitoring system

The data is acquired from the street lights as mentioned in figure 1 and the battery (if solar) which is detected by the sensors (current and voltage) and these values are assessed by the microcontroller. These values from the microcontroller are updated to the IoT platform and that particular mobile app. Finally, these values are uploaded to the cloud for future reference.

Monitoring and controlling the street lights nowadays has become a very tedious task and it is slowly moving into automation. The proposed model monitors and controls the street lights. The modelincludes traditional lights as well as solar lights. Sensors are used for acquiring the values of the current and voltage of the street light and to make sure they are in a safe operating region(range) as mentioned in figure 2. These collected data are sent to the microcontroller and exported to IoT platforms for monitoring. In the IoT platformmonitoring of the street lights will be possible, at the same time it will be known if any fault occurs (when the values go out of the given range). If any fault occurs the data goes back to the NODEMCU and controls the street light accordingly.

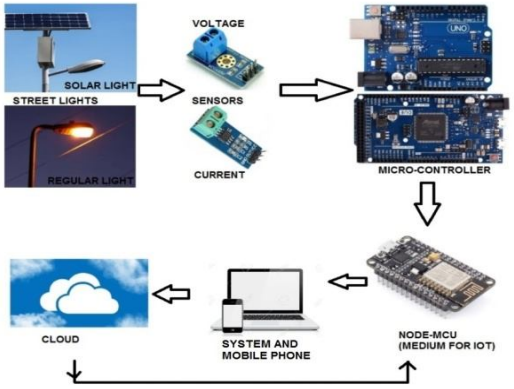

Figure2: Overall Street light system structure

3.SIMULATION

Proteus:-The Proteus Design Suite is an exclusive programming instrument suite utilized principally for electronic design computerization. The product is utilized for the most part by electronic design architects and experts to make schematics and electronic prints for assembling printed circuit sheets.

ThingSpeak: -ThingSpeak is an IoT examination stage administration that permits the client to total, picture, and investigate live information streams in the cloud. You can send information to ThingSpeak from your gadgets, make moment perception of live information, and send cautions. ThingSpeak is an open-source Internet of Things (IoT) application and API to store and recover information from things utilizing the HTTP and MQTT convention over the Internet or by means of a Local Area Network. ThingSpeak empowers the formation of sensor logging applications, area following applications, and an interpersonal organization of things with announcements.

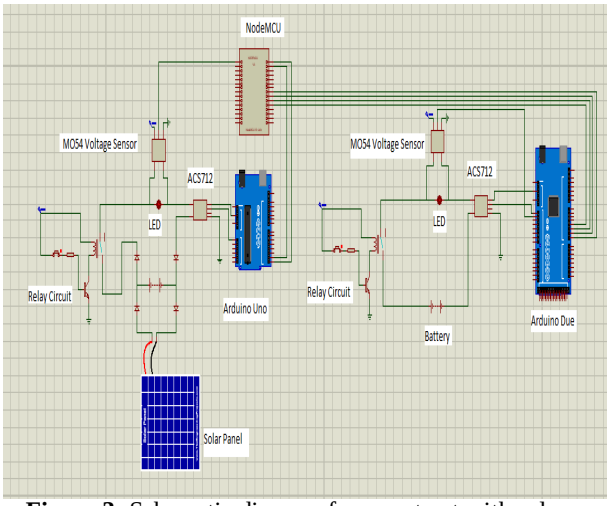

Figure 3: Schematic diagram for one street with solar-powered light and another with lead-acid battery

Solar Lighting: In the figure 3 the first street during day time the solar panel charges the battery. This is used for lighting the LED at night. The sensors take the voltage and current readings. These are sent to NodeMCU which sends the data to the ThingspeakIoT platform. A relay circuit is also there which helps in disconnecting the circuit by the user in case any fault occurs.

Normal Lighting: In the second street the LED is lit by AC mains. Both the voltage and current readings are taken by sensors and sent to NodeMCU which sends the data to the ThingspeakIoT platform. In this street also a relay circuit is present which is used for disconnecting the circuit in case any fault occurs.

4.WORKFLOW CHART

The workflow chart for the proposed model is depicted in Figure.4. The data is acquired using Arduino DUE, Arduino UNO, ACS-712, and M054 voltage sensor and is transferred to nodemcu through serial communication. This collected data is uploaded to the IoT cloud using nodemcu. The transferred values are plotted in the IoT platform. If the time is between 6 pm and 6 am, the relay is turned ON, else it is turned OFF and Indicator is also turned OFF. Further, the current value is analyzed to check the status of the light. If the current value is greater than zero, the status indicator is turned ON, else OFF and if the current is greater than zero, then there is no fault.

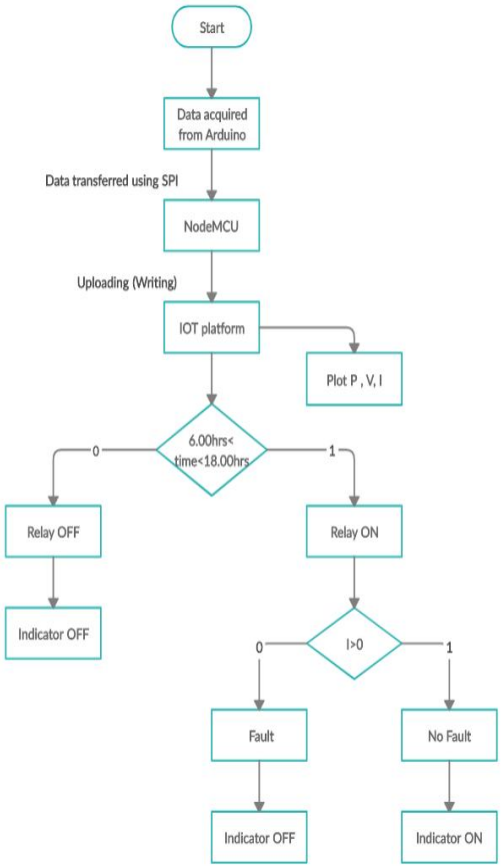

Figure 4: Workflow chart

5. HARDWARE IMPLEMENTATION

a)**Arduino UNO:** -Arduino Uno is a microcontroller board dependent on the ATmega328P. It has 14 computerized input/yield pins (of which 6 can be utilized as PWM yields), 6 simple data sources, a 16 MHz fired resonator (CSTCE16M0V53-R0), a USB association, a force jack, an ICSP header, and a reset button. It contains everything expected to help the microcontroller; essentially associate it to a PC with a USB link or force it with an AC-to-DC connector or battery to begin.

b)NodeMCU:-NodeMCU is an open-source firmware and advancement unit that causes clients to model or construct IoT items. It incorporates firmware that sudden spikes in demand for the ESP8266 Wi-Fi SoC from Espressif Systems, and equipment which depends on the ESP-12 module. The firmware utilizes the Lua scripting language. It depends on the eLua venture and based on the Espressif Non-OS SDK for ESP8266.

c)Sensors:-The ACS712 Current Sensor is a result of Allegro Microsystems that can be utilized for exact estimation of both AC and DC flows. This sensor depends on Hall Effect and the IC has an incorporated Hall Effect gadget. Going to the yield of the ACS712 Current Sensor, it creates a simple voltage that is corresponding to AC/DC flows (whichever is being detected). A voltage sensor is a sensor that is utilized to figure and screen the measure of voltage in an article. Voltage sensors candecide both the AC voltage or DC voltage levels. sensor can be the voltage

d) Arduino DUE:-The Arduino Due is a microcontroller board dependent on the Atmel SAM3X8E ARM Cortex-M3 CPU. It is the first Arduino board dependent on a 32-piece ARM center microcontroller. As mentioned in table 1 it has 54 computerized input/yield pins, 12 simple data sources, 4 UARTs (equipment sequential ports), a 84 MHz clock, a USB OTG able association, 2 DAC (advanced to simple), 2 TWI, a force jack, a SPI header, a JTAG header, a reset button and an eradicate button. It is the ideal board for incredible bigger scope Arduino ventures.Figure-5 represents the hardware prototype. The prototype consists of Arduino DUE, Arduino UNO, NodeMCU, current sensors, voltage sensors, and LEDs

Table 1: Name of the Components and the Quantity Used

Item Name	Quantity	Item Name	Quantity
Arduino UNO,	1	M054 Voltage sensor	2
Arduino DUE	1	Lead Acid Battery	1
NodeMCU(ESP8266)	1	Solar panel	1
LEDs (3.3V)	18	LCD module	1
ACS-712	2		

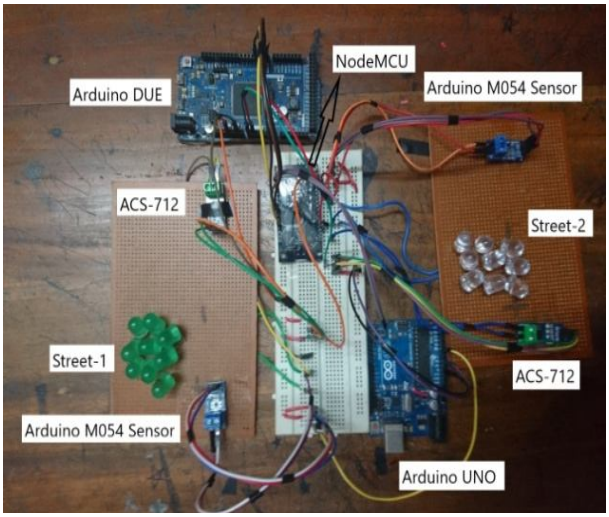

Figure 5: Hardware prototype

Figure 6a represents the graph of voltage measured across street-1 against time. Figure 6b represents the current vs time graph of street-1.Figure 6c represents the power consumed by the street light against time. It is found by multiplying voltage measured across the lamp to current. Figure 6d represents the voltage measured across street two.

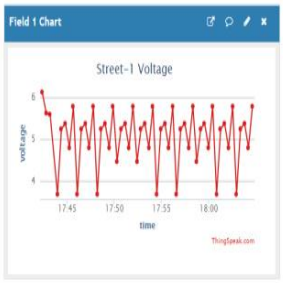

Figure 6a: Voltage of Street 1

Figure 6b: Current of Street 1

Figure 6c:Power consumed by Street 1

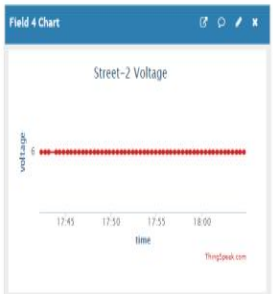

Figure 6d : Voltage of Street 2

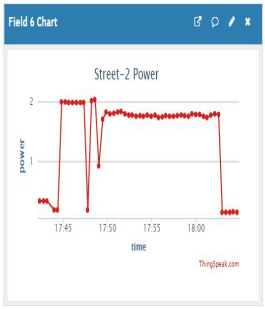

Figure 6e: Current of Street 2 **Figure 6f**: Power consumed by Street 2

Figure 6e is the current vs time graph of street two. Y-axis represents current and X-axis represents time. Figure 6f is the power vs time graph corresponding to street two.

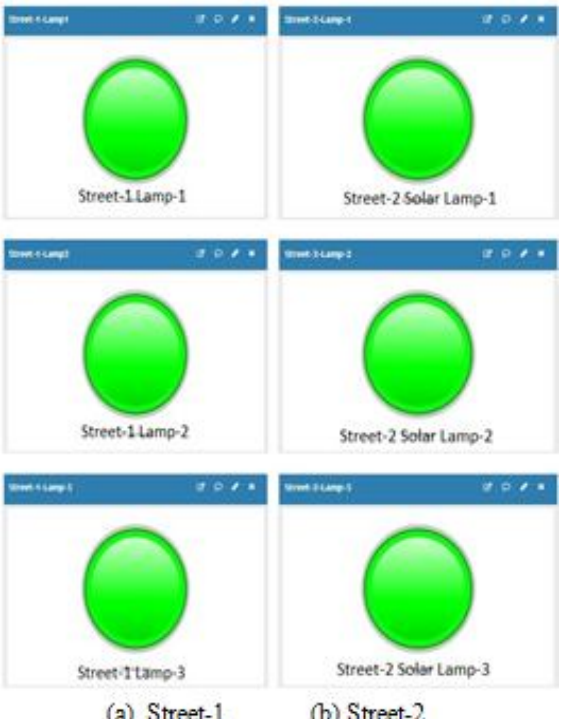

Figure 7: Street light status indicator –ALL ON

Figure 8:Street light Fault indicator

Figures 7a and 7b represent the status of lights of streets one and two. Bright green color indicates that the street is ON and faded color indicates that the light is OFF. All the lights of streets one and two are ON now.

Figures 8a and 8b represent the status of streets one and two. Bright green color indicates that the street is ON and faded color indicates that the lamp is OFF. In figure 8a, the first and third lamp is in ON state while the second lamp is OFF. Since the indicator is in OFF state during the period 6 pm-6 am, we can confirm that some fault has occurred near light two of the first street. Similarly, in figure 8b,lamp-3 is OFF which indicates some fault has occurred near lamp-3 of the second street.

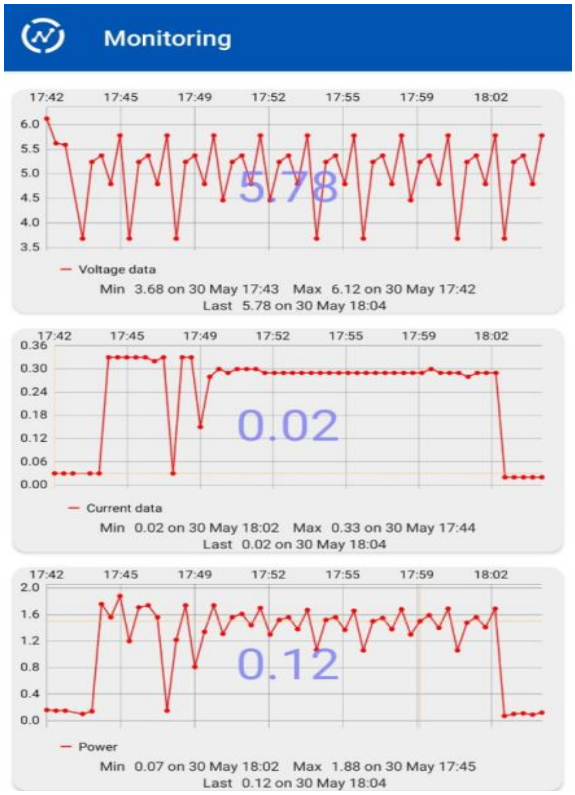

Figure 9a: Mobile Application Screen 1

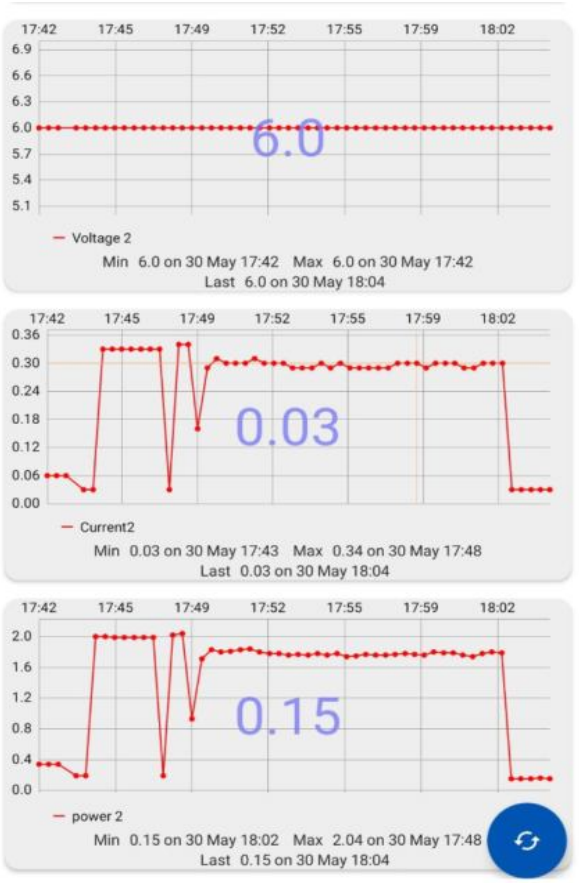

Figure 9b: Mobile Application Screen 2

Figure 9a and 9b is the screenshot of the mobile application that displays the thingspeak data. Thus the user can access the data from anywhere around the globe with his phone

The street light monitoring system is designed for two streets in which one street is powered by solar energy and another street by an AC main. This model consists of nine LEDs for each street in which there are three parallel lines and, in each line, three LEDs are connected in series. In Arduino, a library to support Thingspeak is added. Coding is done in Arduino and NodeMCU. NodeMCU has only one analog pin. So the Voltage sensor from street 1 is connected to it. The current sensor ACS712 from street 1 is connected to Arduino Uno which in turn is connected to the NodeMCU. We used Arduino Due for getting values from ACS712 and Arduino M054 from street 2. Three fields for voltage, current and power for street 1 and another three fields for voltage, current, power for street 2. Graphs for voltage vs time, current vs time, and power vs time for two streets are plotted. The status of voltage, current, and power is sent to the Thingspeak for every second. So if there is any problem with any of the LEDs the user can find out easily by seeing the graph. The user can also compare the two streets and check out if there is any problem and rectify it as soon as possible.

This proposed model makes use of solar as well as conventional methods for lighting the LEDs. This model automatically switches on LEDs when the time is 6 pm and switches off at 6 am. The manual mode of switching off the LEDs possible with the help of relays. Both automatic control and manual control are possible. Fault indications are also shown in this model. Voltage, current, and power are plotted for each street so a comparison between each street is possible. This makes it easy for the analysis of data regarding power consumption. IoT helps in improving the monitoring, control of the operation, reduces labour, and saves money and time.

7.CONCLUSION

This model elaborates on the design and construction of street light monitoring systems for two streets. The voltage and current power of each street are plotted as a graph. Problems associated with any of the streets can be observed in the graph. The user can identify the street where the problem lies and rectify it soon. Separate light indications for each LED lights are included which monitor the LEDs ON/OFF status. Controlling the LEDs is possible with the help of the relays connected to each LED. Faults are found and then informed to the user by fault indicators. The street light can be observed at all times with the help of the ThingspeakIoT platform. Different graphs for each street about current, voltage, and power makes it easier to observe each street and how much power is consumed in each street. Analysis of data regarding power consumption in each street is easy with this model. This work aims to reduce the manpower related to street light problems. Also, it saves a lot of time and the problems are solved more efficiently. Thus the proposed model aids in monitoring, controlling, and rectifying street light problems easily and efficiently.

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