Centralized monitoring system for street light fault detection and location tracking

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Abstract: The Street Light Faulty Detection and Monitoring System is an energy-efficient idea that is straightforward but effective. This technology eliminates manual on-site labor 100% and has two operating modes that allow it to be accessed from anywhere over the internet (IoT). In one setting, when sunlight becomes invisible to human vision, it automatically turns on the power source for the lights. An instrument known as a Light Dependent Resistor (LDR) senses light in a manner similar to that of human vision. When sunlight becomes visible to the human eye, it immediately turns off the power source to the lights. In a different mode, it only activates the lights when motion is detected automatically. Lights turn off on their own when there is no movement and it is done by using Passive infrared sensor (PIR). And it is energy efficient because of solar panel generates the electricity.

I. INTRODUCTION
Street lights used to have to be operated by hand, which might result in inefficiencies such lights being on till morning if the operator was running late and wasting electricity. Older systems relied on technician manual checks instead of real-time fault detection. Postponing these inspections may increase the risk of mishaps. IoT-based street light systems were proposed to overcome these problems. With the use of timers, these systems may automatically turn lights on and off at predetermined intervals, such as 10 p.m. and 6 a.m. [12]. Due to seasonal and climatic variations that impact sunrise and sunset times, this strategy is limited. The suggested system has an LDR (Light Dependent Resistor) sensor to detect the presence of sunshine, enabling the lights to automatically adapt to the ambient light level and save energy. Vehicles and people are detected by the use of an IR (Infrared) sensor. Energy conservation and increased safety are achieved by having the lights turn on when there is movement and off when there is not. When a street light goes out, a Wi-Fi module in the circuit uses the Blynk IoT software to communicate information about the particular malfunctioning light to a control center, allowing for prompt problem diagnosis and fixing. alternative energy sources such as solar panels are used to charge the system.

II. OBJECTIVE
Because of the high consumption of electricity in cities and industries, shortages frequently occur in rural areas. Water scarcity limits the use of hydroelectric power and other conventional methods of generating electricity. Oceans contain enormous amounts of water, but because of their salinity, they are not suitable for producing electricity. The project suggests producing electricity with solar power and other renewable energy sources. These can be especially helpful in rural areas where there may not be as much traditional power infrastructure. Prevent Wastage of Light: Put in place mechanisms that use light only when absolutely necessary to save energy. An intelligent, autonomous, and efficient lighting system can be created by utilizing Internet of Things technology. Utilizing sustainable energy sources to power the lighting system is known as renewable energy. Longer Life Expectancy: To ensure longevity, the system should be designed with durable components. Energy conservation: A reduction in power usage overall that helps create a more sustainable environment.

Problem statement:
Statement 1: Street lights are turned on even when there is sufficient light in the immediate area.
Statement 2: Street lights are turned on when there are no cars or pedestrians.
Statement 3: The detection of light failure is absent.

III. LITERATURE REVIEW
Street lighting accounts for a significant portion of the global power consumption. India is not an exception. Street lighting accounts for 18–38% of the total energy bill, according to global trends in the industry. For this reason, if we want to reduce energy consumption by increasing power consumption efficiency, we must give this area serious consideration. According to the CEA, Ministry of Power, India's installed capacity as of December 31, 2014, was 255681.46 MW. According to sector, the installed capacity is divided as follows: 37% of state-owned units, 36% of private units, and 27% of central units [1]. An intelligent wireless street light control and monitoring system that incorporates new technologies and provides ease of use was developed by B. K. Subramanyam[1 et al. [2] upkeep and energy conservation. More power and energy can be saved by using a solar panel at the lamp
post with an LDR. Additionally, we can monitor and control the street lights with a GUI application that displays the status of the lights in highway or street lighting systems. In their study, ZigBee Based Remote Control Automatic Street Light System, Srikanth M et al. [3]. This streetlight control system extends the system's lifespan, reduces maintenance time, detects malfunctioning lights, and saves energy. In their work on the Design of Wireless Framework for Energy Efficient Street Light Automation, P. Nithya et al. [4] proposed an intelligent management of the lamp posts by using ZigBee wireless communication to send data to a central station. The recommended system allows for easy and effective planning of maintenance from the central station, resulting in further savings. In their two publications [5, 6], Hannan et al. created a real-time data-driven LDR and ultrasonic sensor street lighting system. However, they did not specify the methodology they used to gather data, analyze their findings, or store real-time data in their prototype. Smart solar Light Emitting Diode (LED) streetlights that are set to turn off automatically during the day and only turn on at night were the subject of research by Bhai et al. [7]. The light will illuminate at 30% brightness during heavy rain or bad weather, but it will illuminate at 100% brightness if there is a person or car nearby. There isn't an error-detection system in place here. The Internet of Things (IoT) is a system that uses computers, sensors, and contemporary devices dispersed across the globe to communicate with one another and assign unique identifiers, or UIDs, to each device. They communicate and transfer information using it [8,9,10]. With a mobile monitoring and control system linked to an IoT cloud server, along with an intuitive web application, you can save more energy and promptly address errors as soon as they are discovered. [11].

IV. COMPONENTS

Following components were used to make centralized monitoring system for street light fault detection and location tracking system:

<table>
<thead>
<tr>
<th>s.no</th>
<th>Components</th>
<th>specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Solar panel</td>
<td>4V,100mA</td>
</tr>
<tr>
<td>2.</td>
<td>LDR sensor module</td>
<td>3.3-5v, 15mA</td>
</tr>
<tr>
<td>3.</td>
<td>PIR sensor</td>
<td>4.5V- 20V, 60uA</td>
</tr>
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<td>4.</td>
<td>Arduino</td>
<td>UNO</td>
</tr>
<tr>
<td>5.</td>
<td>Node MCU</td>
<td>ESP8266</td>
</tr>
<tr>
<td>6.</td>
<td>LEDs</td>
<td>6 LEDs</td>
</tr>
<tr>
<td>7.</td>
<td>Usb cable</td>
<td>Micro USB</td>
</tr>
<tr>
<td>8.</td>
<td>Jumper wires</td>
<td>10-12</td>
</tr>
<tr>
<td>9.</td>
<td>Current sensor</td>
<td>0-30A, 0-1V @ 30mA</td>
</tr>
<tr>
<td>10.</td>
<td>Voltage sensor</td>
<td>5-30v</td>
</tr>
<tr>
<td>11.</td>
<td>Rechargeable Battery</td>
<td>2600 Mah</td>
</tr>
<tr>
<td>12.</td>
<td>Relay</td>
<td>4 relay module</td>
</tr>
</tbody>
</table>

By using Blynk iot app to integrate the system to the app for remote monitoring and fault detection and location tracking.

Integration of blynk iot app with NORD MCU esp8266:

Make sure you have the ESP8266 development board, the Arduino IDE on your computer, and Wi-Fi access before beginning to set up a smart device control system with it. Install the Blynk library and add support for the ESP8266 board in the Arduino IDE. Next, create a project and obtain an Auth Token using the Blynk app. Write the code in the Arduino IDE, indicating the GPIO pins for LED and other device control, using the token and your Wi-Fi credentials. Ultimately, utilize the Blynk app to test and manage your hardware after uploading your code to the ESP8266.

V. WORKING AND METHODOLOGY

During the day, Direct current electricity is produced by solar panels using sunlight as a source of energy. This electricity must first be converted from DC to AC in order to be stored in batteries. Sensors such as LDR and IR are linked to the Arduino Uno. An LDR sensor is used to identify the source of light. In the case that there is low light. Extremely high LDR resistance. under bright lighting conditions. It faces minimal opposition. A circuit that utilizes this difference in resistance at varying light levels allows the lights to be turned on and off automatically during the day and at night. The street light's intensity rises when the infrared sensor picks up movement from passing cars, people, and animals on the road. The light automatically gets less strong when there are no moving vehicles. The street lights are programmed to switch off automatically when the weather turns sunny. A Wi-Fi module coupled with the Blynk IoT app relays a message to the control center when a street light malfunctions. This makes it easier to replace broken street lights quickly, which reduces the number of accidents. Solar panels are another tool we utilize to create electricity.

Presence Detection: At night, the system employs a PIR sensor to identify the presence of cars or people on foot. A high-intensity LED bulb is activated in response to the detection of a vehicle or pedestrian. The battery provides the energy for the LED light. The intensity of the LED lamp returns to 50% as a car or pedestrian passes by.

Tracking of Status: The LDR (light dependent resistor) sensor and the PIR sensor are both regularly monitored by the system. The LDR sensor aids in detecting the lighting conditions outside. The voltage and current sensors are continuously monitored by the system.

Dimming Strategy: The LEDs go back to a dim state when the car or pedestrian departs the area illuminated by street lights. This dimming technique was created especially to use at night in order to save energy. This scenario doesn't happen during the day because the main emphasis is on energy conservation at night.
Power Efficiency and LEDs: The system's goal is to extend the LEDs' lifespan. The lifetime of LEDs may be negatively impacted by frequent on/off switching. The selection of LEDs was based on their lower power consumption when compared to other light kinds.

Solar Energy Generation: During the day, direct current (DC) power is produced by solar panels by absorbing sunlight. It is necessary to store the DC energy produced in a battery for later use.

Integrating Sensors with the Arduino Uno: Two sensors are integrated into the system: an IR (infrared) sensor and an LDR (light dependent resistor). Ambient light levels are detected by the LDR sensor. In strong light, its resistance is low, whereas in darkness, it is high. The IR sensor tracks movements of cars, pedestrians, and animals on the road.

Automated Lighting Control: The system turns on or off the street lights automatically based on the input from the LDR sensor: Nighttime: Street lights come on when it becomes dark (low LDR resistance). Daylight: The street lights go out when the light is bright (high LDR resistance). The IR sensor also senses movement, so as a car or pedestrian approaches, the light intensity increases.

Sunlight based auto shutdown: The technology makes sure that the street lights are off during the day. During the day, this tactic aids in lowering power usage. Notifying Failures and Preventing Accidents. A Wi-Fi module notifies the control room when a street light goes out. Utilizing the Blynk IoT app. By enabling the prompt replacement of faulty street lights, this timely notice helps to reduce the risk of accidents.

VI. RESULTS AND DISCUSSION

Throughout the day, the light will be off. The intensity of light increases when the sun sets and whenever there is a vehicle or pedestrian. When a car or person approaches within a range, the IR sensor recognizes it and turns on the light. There will be a weak glow before that. The LDR sensor will identify any light outage and send a message via the Wi-Fi module to the control room. Thus, regulating the intensity of LEDs without compromising their lifespan can result in significant energy savings through the use of renewable resources. and by remote monitoring, it is possible to identify when there is a light outage that requires less labor.

Energy Saving

In the project there were two modes for energy saving mentioned below:

(a) By using solar energy

Using solar energy for the street light reduces the consumption of the energy produces by conventional methods uses for the street lights.

(b) By using the movement-based intensity control

The movement-based intensity control is developed by using the PIR sensor which detects the presence of the any vehicle or the person and sends this information to the Arduino uno which process this information and increases the intensity of the streetlight.

Automatic ON and OFF of streetlights:

The automatic ON and OFF of the streetlight is done with the use of the LDR sensor by, During the day, when there’s sufficient natural light, the LDR’s low resistance turns off the streetlights. At night, when it’s dark, the LDR’s high resistance allows the lights to turn on automatically.

Fault detection and location tracking:

The fault detection is done by the outputs of the sensor and then its data live stream on the blynk iot app which h is connected through wi-fi with the help of the Node MCU ESP 8266, through which we have the exact location of the pole which have the fault so it eliminates the manual search and discomfort of the people by faulty streetlight by rapid fault cleating.

Therefore, our project uses a huge amount of solar energy to generate electricity. This energy can be preserved for our coming generations. Locating the malfunctioning street light and minimizing labor costs are two benefits of remote monitoring. When compared to the previous system, we can save power by utilizing the dimming effect. If we can execute our project in real-time, we can save a significant amount of energy and generate a significant amount of electricity using a variety of methods. The use of IoT to turn street lights on and off automatically based on weather conditions is covered in this paper. When the environment changes, the LDR sensor detects it and turns the street lights on or off automatically. Whenever the street light got damaged or not working,
the LDR sensor senses it and sends the notification to the authorized person that the light is damaged and the location (using blynk app integrated with esp8266) where the light is damaged. It reduces human efforts, delays in fixing the issues.

REFERENCES

[1] Street Lighting in India and Need for Energy-efficient Solutions | My India.


