Smart street light management system for conservation of electrical energy

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Abstract: The street light control frameworks are broadly utilized to screen and control the progression of vehicles through the numerous streets to conserve the electrical energy. In traditional manual and automatic street lights monitoring system even though uses renewable resources like solar and wind energy, they were turned ON in the evening i.e. when there is not sufficient sunlight and transitioned in the morning i.e. when there is an adequate light outwardly. The lights once turned ON, remain in the same state continuously for about twelve hours a day. This leads to wastage of electrical energy. To overcome this, this paper proposed a method, to conserve the electricity that is being utilized to light up the streetlights on Highways, Village roads, streets in urban and rural areas, parks etc. the proposed system monitors the obstacles on the road and controls the street lights. This system is not only to turn ON and OFF the lights and also control the intensity of the streetlights on the basis of the movements of vehicles and pedestrians in turn conserving the energy. This system also updates the status of street lights onto the cloud server.

Keywords: cloud server, LDR, PIR, street light, ultrasonic sensor

1. Introduction:
In human’s every day schedule the disclosure of electrical vitality has been filling light and life. To control the house appliance and street lights, much of electrical vitality is determined from different control stations. The majority of the roads in India are lit up throughout the night in an average about twelve hours per day regardless of vehicles or pedestrians across the road. This is clear that even though there are no vehicle or pedestrians passing through these streets throughout the night the lights were glow. Here comes the major problem of Power Consumption where these Street lights consumes high power and they are large in number as we have length of 1.3 million km of highways and streets. Loss of Electricity is the major issue that impacts the government more. If this continues the same there would be the lot of power wastage caused by these Street lights. The government is maintaining the essential
and expensive need of Street lighting. Waste of energy is the result where an inefficient lighting system occurs with manual operation is tedious and time taking [1].

In traditional manual control of street light systems there is a wastage of electrical energy because there would be no traffic on the roads but lights will glow especially in midnights. To overcome this limitation, the proposed system will save energy and there will be a raise in national economy.

To overcome these problems, the authors of [2], implemented a system to save the power with automatic street light controller using solar power whereas the authors of [3-4], designed a system to control the street lights and update the status of lights with GSM communication. The authors of [5-7], implemented a system for monitoring and controlling of street lights to save the electrical power with LED street lights.

There are different kinds of lighting innovation, for example, mercury fume, metal halide, sodium lights, and LED etc. in keeping with the sort of lamps, administration life of a light, service lifetime of a lamp, bright efficiency are brought to classify the street light [8]. Keeping in view of these parameters, LED lights are the best productive with various favourable circumstances such as long-life time, high lumen, and energy saving etc.

2. System Description:

This paper proposed to build a system as shown in figure 1, to control the streetlights in a smart way i.e., by installing this system to the streetlight poles, it detects the movement of vehicles and pedestrians and turn the light ON and OFF accordingly. This system not only to switch the status of street lights but also control the intensity of the street lights in accordance with the detection made in-order to avoid the possibility thefts and crimes in the OFF state of streetlights at night when there is no detection. On highways, when a vehicle or person is detected it turn ON the streetlights of next five consecutive poles and in case of the street lights within villages, cities, public gardens and parks, install a device for every individual pole so that the lights can controlled much efficiently.

![Figure 1. Block diagram of proposed system](image)

The controller section is configured to read the sensed data from sensors such as ultrasonic sensor, Passive Infrared (PIR) sensor, and Light Dependent Resistors (LDR). Furthermore, it is used to process the sensed data and control the state of street lights with their intensity to save the power conservation. The street lights status is updated into the cloud server [9-12]. The controller unit used in this system is ESP32.

Ultrasonic sensor used in this system is to measures the distance from the target object. It is configured to identify the objects travelling across the road determine the distance between the object detected and the sensor. It provided with the combination of transmitter and receiver. The transmitter section will deliver sound waves by controlling the control signals provided with the sensor. While travelling sound waves, if any obstacle comes in the path then these waves will reflect back as echo signals which are received by the receiver section of the sensor. The distance between the sensor and the object is calculated using the parameters such as time taken to receive the echo signal and the velocity of sound waves. The distance is given by:

\[
\text{Distance} = \frac{(\text{Time} \times \text{Speed of Sound})}{2}.
\]
Light Dependent Resistor (LDR) is a resistor whose resistance is varying with the intensity of light falling on it and is made up of semiconductor material. The energy contains photons, when these strikes the LDR, the valance electrons of semiconductor material acquire some kinetic energy and jump into the conduction band lead to more conductivity and decrease in resistance of the material. As the intensity of light decreases there is an increase in resistance in a resistor as it is basically a passive component. In this system it is configured to determine the status of sunlight and make the transition into street lights. PIR sensor is used to identify the pedestrians traveling across the streets. The sensor detects the pedestrians and passes the information to the controller unit to switch ON the street lights. The relay module is used to switching between AC and DC power sources. It isolated the AC power source from the controller unit.

Arduino is an open-source IDE platform based on microcontroller to develop embedded applications. It provided with various boards with different features for developing applications. It has standard syntax to develop programs and it contains various Libraries for various functions based on the microcontroller. Arduino is suitable for developing low cost, portable and reliable embedded applications.

3. Implementation:
This system is comprising of an ultrasonic sensor, PIR sensor, LDR, a relay module, street light and a controller unit. The ultrasonic sensor is configured to sense the vehicle traveling across the road and transmit the sensed information to the controller unit. To monitor the objects travelling across the road, ultrasonic sensor transmitter continuously emits sound signals in ultrasonic range and receiver detects the reflected signals as echo. PIR sensor is configured to sense the pedestrians travelling across the streets and send the sensed information to the controller unit. LDR is configured to sense the intensity of sun light and send the sensed information to the controller unit.

![Flowchart of street light monitoring system](image_url)

**Figure 2:** Flowchart of street light monitoring system
The controller unit is configured to receive the sensed signal information from ultrasonic sensor, PIR sensor and LDRs and process the data. Furthermore, the controller unit is configured to control the street light via the actuator relay. In this system the relay module is acts as a switch between AC DC power sources. Furthermore, the controller unit is configured to upload the status of street lights on to the cloud server. system is not only to turn ON and OFF the lights and also control the intensity of the streetlights on the basis of the movements of vehicles and pedestrians in turn conserving the energy. The process of flowchart for monitoring of street lights is shown in figure 2.

4. Results:
The smart street light management system was designed and tested successfully for effective conservation of electrical energy. As shown in figure 3, the hardware system comprised of ESP32 controller, an ultrasonic sensor, LDR, PIR sensor, a relay module and street light. This device is connected to the Street light and installed to the pole. Here the system was installed such that for every single device, five street lights are controlled. This system is going to install individual devices (i.e, for each pole one device), as there would be lot of people passing through different directions in streets. The system uploads the state of street lights into the cloud server as shown in figure 4.

![Figure 3. Hardware prototype of the system](image)

![Figure 4. Status of Street lights in the cloud server](image)
5. Conclusion:
This paper proposed a method, to conserve the electricity that is being utilized to light up the streetlights on Highways, Village roads, streets in urban and rural areas, parks etc. the proposed system monitors the obstacles on the road and controls the street lights. This system is not only to turn ON and OFF the lights and also control the intensity of the streetlights on the basis of the movements of vehicles and pedestrians in turn conserving the energy. This system also updates the status of street lights onto the cloud server. Here we are going to use a 100W Lights, 100 such Lights consume about 120 Units a day which costs about Rs.1,53,300 a year on a tariff of Rs.3.5 per unit. Assume Savings of 50 Units a day which saves about Rs.64,000 a year. By this solution we can save Electrical Energy being wasted. Thus, this system efficiently conserves the electrical energy for effective street light management.

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