

Solar Powered Automatic Street Light System

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Abstract: Street lights play an essential role in ensuring the safety of any neighbourhood. Possessing proper functioning street lights is a sign of a well-maintained and safe neighbourhood. On the other hand, street lights are one of the significant power-consuming systems in our country. More innovations can be adopted into the traditional street lighting system. One of the ways to implement efficient power consumption is by incorporating the Internet of Things (IoT) and automation into street lighting systems. The proposed model is a combination of both efficient power generation and smart power consumption. By detecting the presence of people or vehicles, the street lights are made to glow at maximum brightness to minimize energy consumption. Thus, power consumption can be reduced by turning off the lights automatically, when there's no vehicle crossing by. In short, the street lights are controlled based on the traffic density. This paper also proposes the usage of renewable energy sources instead of conventional energy sources. Being environment friendly and a great relief to the problems overcome by excess power consumption, solar street lights are a major benefit for the society.

Keywords: Solar energy, Street Light, Light Sensing, Solar Panel, LDR (Light Dependent Resistor), IR (infra-red) sensors.

I. INTRODUCTION

Today much debate has been going on in scientific circles about how real is the phenomenon of global warming and what would be mankind's response in averting the consequence of it. Realizing this, steps have been taken to reduce the use of fossil-based energy and substituting the same with renewable sources such as solar and wind energy etc. The main aim in this project is to save the non-renewable energy. Sun light is naturally available to us so power can be generated from sun by using solar panels.

The streetlight's primary purpose is to illuminate light to the street at night. Every city needs street lights because they enable safer roads, improved night time visibility, and increased exposure to public spaces. Manual control is prone to mistakes, results in energy waste, and is impractical during the middle of the night. The possibility exists that the streetlights could sustain damage. As a result, the street light is turned off for a certain amount of time until the maintenance staff arrives and fixes or restores the defect. Hence the project is based on advanced light-emitting diode (LED) street lighting with automatic intensity control powered by solar energy from photovoltaic cells and automatic streetlight damage notification utilizing IoT technology.

This model will demonstrate how an artificial tree (Artificial tree contains solar panels as leaves) will produce the electrical energy by using solar energy and that generated power is stored in rechargeable battery, from this battery power supply is given to street lights. The heart of the project is Arduino Uno, this controller will control all the street lights. In our project automatic control of street lights is done by sensing the light and vehicles. LDR sensor used to sense day and night conditions, IR sensor used to sense the vehicles. Streetlight intensity is controlled automatically based on the movement of vehicles, also detection of physical damage in all the street lights by using another LDR is done and by using WiFi module the state of each streetlight's damage is notified.

II. LITERATURE SURVEY

Urja Jain , Anindya Jain , Deepali Shukla, developed Microcontroller Based Solar Powered Automatic Street Light Intensity Controller. According to the proposed plan, when it was a dark time it will on automatically all the street lights. When the vehicle or any person passed through a block of street light then it will increases the intensity of the light, if any vehicle is not detected then it decreases the intensity of the light.so that if light is in off condition, there is more reducing in the power consumption. And also it will support to energy saving aspects, automated system were less

in manual operation, high flexibility, and accuracy. The main disadvantages is transmission loss will be more in this case[1].

Using Renewable Energy for Safety for the Turtle Mountain Band of Chippewa. These street lights are not connected to the electrical power grid: solar panels will generate the own power by using an renewable sources like a sun(photovoltaic cell), electrical system where it transmits the electricity from the producer and a consumer where it is interconnected to network, micro grid are using in these concept where this system is large in size and out of feilds The disadvantage is It would have been too expensive to try to connect to the grid and the stand-alone systems were easier to work with versus a micro grid system[2].

An energy saving streetlight controller where that integrate both solar power and the power grid and use inductive sensing to control the streetlight's brightness. The streetlight can be powered by using solar energy stored in a battery and only alternates are grid when the battery levels are very low. The disadvantages that the chosen LEDs only turns on at very high voltages.

In the traditional street lights where it will glow during day time also so that there are more increases in the power consumption. And also due to rapid growth in the urbanization, the maximum power can require, now it's time to save the energy and power and utilize the power to the residential and commercial areas. And the main advantage is save the accumulated energy by optimized utilization of the street lights due to the use of sensors and programmed Arduino Uno R3. Accumulated the cost of Smart Street light will be reduced. The disadvantage is transmission loss is more[4].

To replace the growing energy demand by using renewable energy source as solar. The solar energy can be converted into electrical energy by the photovoltaic cells, where the received electricity can be stored in the battery. During night-time the lamp will turn on automatically and the electricity already stored in the battery gets consumed. The battery gets recharged during the day-time and the process keeps on repeating every day. The main disadvantage is detecting physical damage of bulb is done manually[5].

The automatic street lights works depending on the light intensity from natural sources. Here the uses transistor as switch to switch ON or switch OFF the street light automatically. This work is done by a sensor called LDR. They used because energy consumption is reduced. This main purpose is to minimize the cost and electricity loss and also man power. This idea proves to be very useful for city infrastructure to reduce the conventional power and also the confirmed that 48% of energy is conserved, but the batteries replaced by solar panels for usage of energy [6].

Researches came up to conduct street lighting system powered by solar panels. They designed a prototype and they focused on the development, evaluation of a lighting system and a sensor device that automatically lights up the lamp at night. They also study another application into development of a street light which stores charges and stores the energy at daytime. Here the LED consumes less power and a longer life span. In this idea the prototype was built with super capacitors, solar panel and a battery of 12VDC[7].

The photovoltaic panels charges a rechargeable battery, most solar panels turn on and turn off automatically by sensing the lighting a light source. They installed solar lights in windy regions are equipped with flat panels cope with winds. In this Technology can operate a network with each light performing on or off the network. In this idea it can implemented economically affordable solution to the energy crisis and also we can drive the DC loads[8].

Yared brhane implements the design and simulation of solar-powered generation system of automatic street lighting for Adigrat University, by using this system the energy consumption is reduced. This work was begun by investigate on the solar power generators. Here the solar panels are given in the form of solar radiation for the panels and this finds the renewable energy resources. They used simulation design by doing using proteous based micro C and cost analysis by software. By this simulation results have been generate street lights. In this project, they used to reduce your electricity bill and in return saving money[9].

Som Sanguan passago and his team implement the model of Research and development of Renewable energy: Prototype of LED street lighting from solar energy .This was investigated in Rajabhat Maha Sarakham University. The solar panels include solar cell of 80 Watts and the street lamps. In this the street lights consisted of the height of electricity poles as 6 meters. A rapid return on investment and added the benefits due to save the energy through the

LED's. With this idea, they focused on the prototype of street light for inventing and designing the renewable energy from the solar energy in Maharashtra Campus area[10].

The advanced light-emitting diode street light with auto intensity control and automatic streetlight system. The circuit is stationed in a suitable location and is exposed to sunlight so that the lamps will switch "ON" if it is dark and when the illumination is above 50 lux they automatically switched "OFF"[11]. Implement a system for detecting the fault in the battery or solar panel & provide theft detection using the Internet of Things (IoT) as well as conservation of energy by reducing electricity wastage. In this paper, they present a system for monitoring the battery/solar voltage or if in case, it gets removed, and then an SMS will be generated and sent to the provided mobile number[12].

Ajay M and his teammates worked on solar powered LED street lighting with auto intensity control. In this paper, auto intensity controlled solar power driven LED streetlight is implemented. In conclusion, around 30% to 45% of the power utilization can be saved with existing streetlights without any control[13]. System works on the relay timer which constitutes a timer and relay. When the signal through the LDR sends to the relay timer module the timer starts and the led street lights also start glowing when the timer stops the led street light stops[14].

The idea of maintaining maximum utilization and minimum loss of available energy. The plenty of solar energy available during the day time is stored in a battery and the stored energy is used to glow the street light whole night, so that street light will glow automatically when is required and it will be turned OFF automatically if sufficient light is unavailable in surrounding. Hence the loss of energy due to unnecessary glow of the street lights can be avoided. This model will not only save the electricity produced from non-renewable source but also will illuminate the path in an eco-friendly way[15].

Designing energy efficient Smart Street light for energy conservation in existing streetlight. While controlling and managing of the system is based on the movement of vehicles this is detected by PIR Motion sensor. This system was programmed to automatically turn off during the hours of daylight and only operated during the time when vehicles cross the motion sensor during night. As of this model power consumption was reduced around 60% Compared with existing sodium vapour street light[16].

Kalainathi B and team proposed Efficient Power Generation to Automated street lights based on Traffic Density. In this model the street light is OFF on the traffic density i.e., street light is turned OFF in the absence of people and vehicles. The IR Sensors are used to sense the people and vehicles. IoT system uses various sensors to detect the presence of vehicles or pedestrian and illuminates itself based on the requirements. The Proposed model will have longer life than usual, as they are operated only when necessary but when someone passes between two streetlight it will be completely dark[17].

A smart street light using wind-solar Hybrid Energy system with an idea of generating electric power by making use of Renewable sources of energy like solar energy and wind energy and supplied the same to street light. After implementation it is concluded that the additional energy generated is around 25-30% with very less consumption by the solar PV system itself. This idea is useful when sun radiation are unavailable with the use of wind turbine but also finding some problem like wind turbine height, slope angle as given limitation[18].

The automatic street light control with solar where worked on automatic switching ON/OFF of street light based on sunlight. This is done by the LDR(light dependent resistor) sensor which senses the sunlight exactly like human eyes. This system uses the electric power generated by the solar energy. This idea has lower chances of the automatic street light overheating and cost of operating is far less when compared to the conventional street lights but rechargeable battery were replaced few times[19].

III. METHODOLOGY

Making use of renewable source like solar energy for production of electricity. The solar energy is converted into electric power by photovoltaic cells. These cells consist of one or two layers of semi conducting material(silicon). When light falls on the cell it creates an electric field across the layers causing electricity flow. The greater the intensity of light, greater the flow of electricity. One photovoltaic cell/ solar cell can produce 6 to 6.5 watt of electric power. These generated DC current is then converted into AC by the inverter and stored in the storage medium like batteries.

Whereas the automatic street lights has two modes of working light control based on darkness and based on vehicle. LDRs are used for sensing light, it is photoconductivity, which is nothing but an optical phenomenon. When the light is absorbed by the material then the resistance decreases, whereas in dark resistance increases based on the increase on the resistivity the street light is turned ON i.e., when it senses night or day light. As it senses the light/dark microcontroller sends message to relay to ON/OFF of the street lights.

IR's are used for sensing the vehicles. It is based on the principles of optics. An IR proximity sensor works by applying a voltage to a pair of IR light-emitting diodes (LEDs) which in turn, emit infra-red light, this light propogates through the air and once it hits an object it is reflected towards the sensor. As the IR senses the vehicle the street lights associated with respect to that sensor will control the intensity of the light high/low.

This smart system which consists of LDR and IoT wifi module is placed in the public street light. LDR sensor measures the light intensity and this data send it to the cloud through IoT wifi module. If the light intensity becomes less than the limit then the related data send to cloud and same data is notified to concern team in the application which will be built by us.

3.1 BLOCK DAIGRAM:

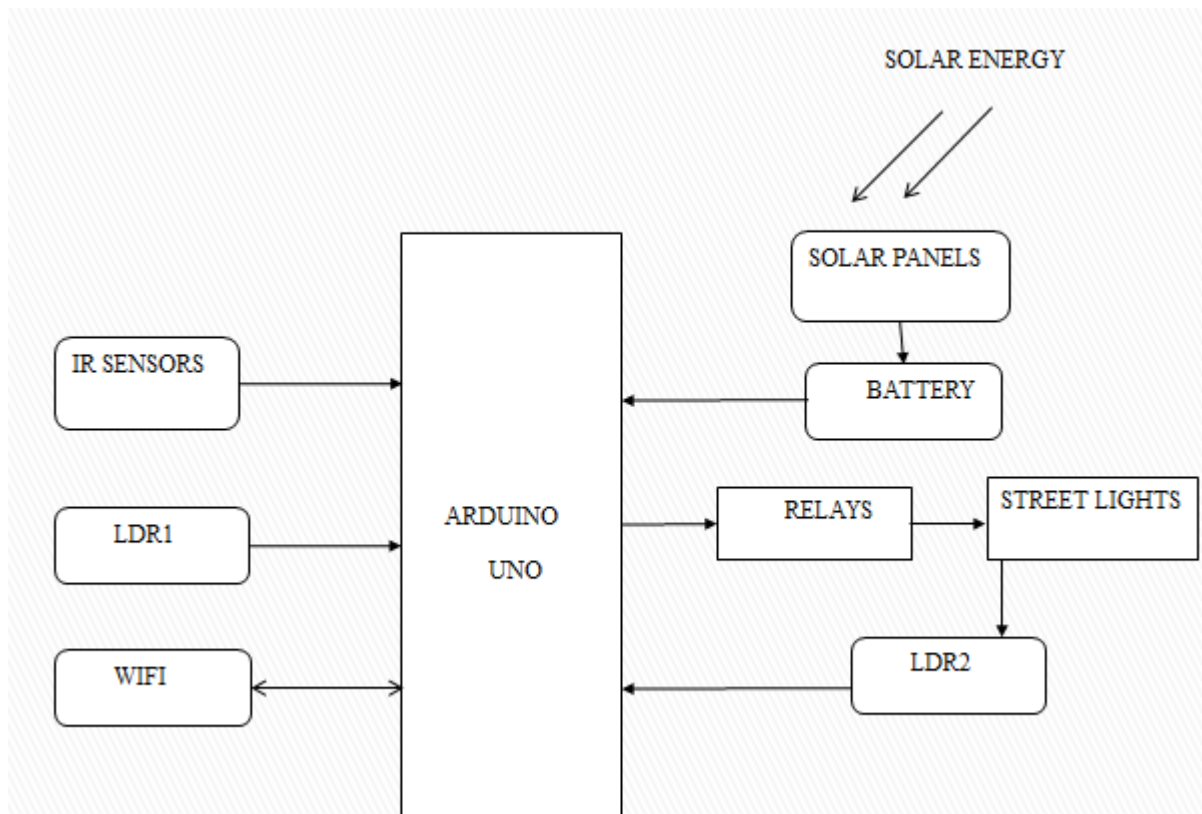


Fig. 3.1 Block Diagram of Solar Powered Automatic Street Light System

3.2 WORKING:

The proposed models produces the electrical energy with the means of solar panels (only the effect of solar energy). This project will demonstrate how an artificial tree will produce the electrical energy by using solar energy .For constructing the artificial tree the first step is to construct the tree with solar panels as leaves. The leaf consists of two transparent conducting layers one at the top and other one at the bottom .Between these two layers thin film photo voltaic layer placed to convert the sunlight into electrical energy and thin film thermo voltaic layer to convert the thermal radiation into electricity. And that generated power is stored in rechargeable battery. From this battery we can supply the power to street lights.

In this project we mainly concentrate on to save the power in street lights. The heart of the project is Arduino Uno. This controller will controls the all the street lights. In this project automatic control of streetlights are done by sensing the light and vehicles. LDR sensor used to sense light. LDR1 senses day and night conditions, at day time all the street light will be turned off automatically, and night time turn on with minimum intensity and also physical damage of streetlights is done by using LDR2. IR sensor used to sense the vehicles, If any vehicles detected by IR sensor the corresponding streetlight's intensity is increased to maximum. Relays are used to switch on/off the streetlight. Wifi module ESP32 Node MCU used to notify the authorized person/team on telegram. In telegram on creating a new bot-ID for ESP32 used in the model will activate the ESP32 to get notification on the telegram.

The electric power generated from solar panels is stored in rechargeable battery. That stored electricity power is given to automatic streetlights. If sun light falls on LDR1 (when sunlight fall on LDR1 reading is greater than ADC value of 500)i.e., during day Arduino sends information to Relay to turn of streetlights, else if sun light does not fall on LDR1(when sunlight does not fall on LDR1 reading is less than ADC value of 500) i.e., at night Arduino sends information to relay to turn ON the streetlights with minimum intensity of light i.e., giving voltage input as 5v to steetlights.

If any vehicles entre at night time the IR sensor gets reflected infra-red radiation i.e., sensing vehicels and that IR sensor will send the information to controller at that time the controller will increase the particular streetlight to maximum intensity i.e., giving voltage input as 12v by to streetlights. Once the vehicle is passed from the street light automatically previous streetlight will automatically down to minimum intensity and next streetlight increased to maximum intensity.

Physical damage of the bulb is identified based on the light falling from the streetlight on the LDR2 sensor. LDR2 readings are considered only when night is detected i.e., when sunlight does not fall on LDR1 and LDR1 reading is less than 500 by the controller(this condition is given in software part of the project). When the streetlight's light falls on the LDR2 the reading of it will be less than 100(ADC value). Hence if LDR2 readings is greater than 100 streetlight considered to be working condition else streetlight damage is detected. That LDR2 readings are given to the controller, controller sends it to WiFi module ESP32 Node MCU, where ESP32 is connected to the same network of authorized person's device/mobile network. Hence the ESP32 will send the notification on telegram to that authorized person/team on telegram.

3.3 FLOW CHART:

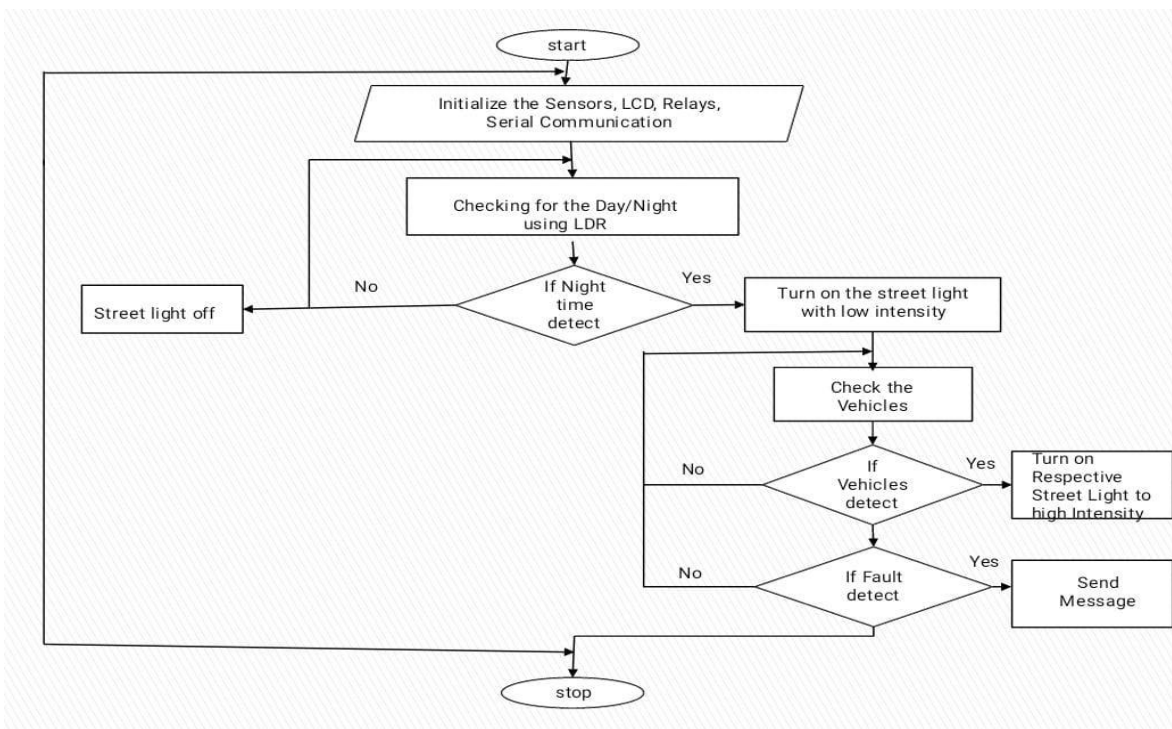


Fig. 3.1 Block Diagram of Solar Powered Automatic Street Light System

IV. RESULT

Providing street lighting is one of the most important and expensive responsibilities of a city. Solar energy in a form of the renewable energy is used in solar street lights. Today it is common to see the solar street lamps along the sides of roads. The solar street lights absorb the solar energy during daytime. The solar energy gets converted into electrical energy by the photovoltaic cells, which is stored in the battery. During night-time the lamp starts automatically and the electricity already stored in the battery gets consumed. The battery gets recharged during the day-time and the process keeps on repeating every day.

This system is designed for outdoor application in un-electrified remote rural areas. The solar energy is one of the important and major renewable sources of energy and has also proven it useful in functioning of applications like street lights. The system could sense brightness environment and act accordingly to seasonal change would not affect the intensity of street light. Also the automatic solar street light system is completely Noiseless, Smoke-free and free from fire hazards. Hence it will not only Save the electricity bill but also will illuminate the path in an Eco-friendly way.

Demo model shows how the solar artificial tree and Streetlights are placed side the road. Power supply given from the stored battery to all street light.

When sun light falls on the LDR 1 the ADC reading the LDR 1 will be greater than 500, During night and cloudy LDR 1 the ADC reading will be less than 500.



Fig. 4.1 LDR1 Reading at night

At night the streetlights are automatically turned ON and maintained minimal intensity of 5v of voltage and when the vehicle is detected from IR sensor the intensity of corresponding Streetlight's intensity is increased and maintained maximum intensity of 12v of voltage.



Fig. 4.2 Automatic Turn ON of streetlights at night and Intensity control

The possibility exists that the streetlights could sustain damage, hence LDR 2 is used find out the streetlight is illuminating or not. When street light falls on the LDR 2 the ADC reading the LDR 2 will be greater than 100, if streetlight's light is not falling on LDR 2 the ADC reading will be less than 100.



Fig. 4.3 Reading when streetlight's light not falling on LDR2

The arduino detects that LDR 2 reading less than 100 which means streetlight is not illuminating light. Hence the processor will display on LCD notifying 'Streetlight Fault Occurs at Node X'.



Fig. 4.4 Displaying on LCD 'Streetlight Fault Occurs at Node X'

Also the same is notified on telegram to the concerned person or team by utilizing IoT technology by connecting wifi.



Fig. 4.5 Notifying on telegram physical damage of streetlight bulb stating 'Streetlight Fault Occurs at Node X'.

V. CONCLUSION

After installation, the system offers superior illumination, optimal energy efficiency, and lower operational and maintenance costs when compared to high pressure sodium lamps and others. Using Arduino for automatic street light intensity control, a straightforward energy-saving solution is put into action. This project can be used in real time with a few minor adjustments and improvements. This study implements an auto intensity regulated solar power-driven LED streetlight, with an effective solar panel and battery, the streetlight can be operated without any ongoing operating costs. The main aim of this technique is to use solar energy as source for electric power generation. Also to reduce the transmission loss by creating substations near the streetlights. To make maximum utilization of solar energy, to reduce the manual work by automations like automatic control to turn ON/OFF of street lights, to automatic control of intensity of streetlights and automatic detection of damage of street light bulb. For future enhancement, the proposed system can be further modified by including a wind wheel on the top of the artificial tree which may be used to generate electricity during cloudy and rainy season. Additionally, a coin sensor with a charging unit can be put to an artificial tree in the summer to allow road users to charge their mobile devices.

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