Engineering Universe for Scientific Research and Management
ISSN (Online): 2319-3069
Vol. XVI Issue III
March 2024

Solar Powered Street Light System with Energy Saving Function

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Abstract

This paper proposes energy efficient of automatic Street lighting system based on motion sensor the main objective is to design energy efficient smart street light for energy conservation in existence street light. The system consists of LED luminar LED driver, PV panel charge controller light sensor motion sensor and arduino. Many times we see that street lights are remains switched ON even during when no vehicles cross the light, this is lot of waste of electricity while India is facing that lack of electricity. The another thing is that be traditional Street lamps examples sodium vapors, metal halide, incandescent, Fluorescent lamps consumes more power for a specified Lumen per Watt as compared with new advanced LED lights. Street lights can be operated free of cost by using automatic controlled, self –powered, efficient solar LED street light.

Keywords: Solar Energy Efficient Street Lighting, Arduino UNO, Sensor, Battery, Relay.

1. Introduction

There are more than 300 million street lights in use worldwide, which produce 100 million tonnes of carbon dioxide annually and squander 40% of their energy at a cost of about 20 billion dollars. Consequently, for cost-effective street light operating and a decrease in carbon footprints. The current need and requirement is for high-efficiency LED luminaire with intelligent illumination level management. Regarding India, the country uses 18% of its power for residential and street lighting, with street lighting accounting for the majority of this usage.

The Indian government planned and began using LED luminaires in streetlights in December 2014. India would profit financially and with a reduction in CO2 emissions if all current streetlights were replaced with LED lights. This is advantageous from a variety of perspectives, including economic, environmental, illumination performance, a decrease in traffic accidents, theft, and crime. According to statistics, 77 crore incandescent, fluorescent, and 40 crore CFL bulbs are purchased annually in India for home lighting. These bulbs have a lifespan of one to four years at most and require power consumption of 60 to 100 Watts and 30 to 40 Watts, respectively. Therefore, it would be advisable to purchase LED lights that have a 10 to 15 year lifespan. Due to its characteristics and benefits, which are emphasised in [1]–[3], LED is thought to be a promising replacement for the current street lighting system. In addition, the advantages of LED will probably cause them to displace incandescent streetlights. Future fluorescent lamps and HPS lamps will be replaced by LED technology, but this is a very challenging process that calls for a combination of cutting-edge production lines, premium materials, and high-precision manufacturing techniques. As a result, this article emphasises the use of LED bulbs with clever sensor interfaces to create energy-efficient street lighting [4]. Since almost all street lights are still turned on by hand today, there is a chance that they won't turn on at the right time. On sometimes, daytime street lights remain on. Using a motion sensor or low-controlling light intensity will assure energy savings and economic operation, and will help you avoid the aforementioned switching issues. With enough sun charging, the suggested smart solar LED streetlight can be used for free. The auto changeover approach, which automatically switches a streetlight to a utility supply if the battery storage is low on charge, can increase the system's dependability. The PV solar panel begins charging the battery during the day. At dark, a streetlight automatically turns on with 30% of its original strength and the battery begins to discharge thanks to a light sensor (LDR). For a predetermined amount of time, the light intensity will rise from 30% to 100% whenever a person or vehicle moves. The intensity will progressively drop to 30%[6] after this predetermined delay. For higher voltage supply, other components like relays and transistors are also utilised.

2. Hardware Implementation

A. Solar Panel:

These are cells that are grown from a single crystal. The mono- crystalline solar PV panel is more effective than

polycrystalline panel. Efficiency is about 18%. High Efficient Monocrystalline solar panel generates electricity during day time and it is stored in battery.

B. Battery:

It is a type of rechargeable battery, which uses lithium ion Phosphate as a cathode material. Li ion Ph batteries have somewhat high energy density, light weight offer longer lifetime. Inherently safer hence lithium ion Phosphate is popular among all storage batteries[7].

C. Motion Sensor:

An electrical device that produces infrared light in order to sense certain features of the environment is called a sensor [8]. An IR sensor can monitor an object's heat while also spotting movement. These kinds of sensors are referred to as passive IR sensors because they simply measure infrared radiation rather than emitting it. Typically, all items emit some type of thermal radiation in the infrared range. These radiations can be detected by an infrared sensor even if they are undetectable to human vision.

D. LED (Light Emitting Diode)

A LED lamp offers the maximum efficiency compared to incandescent, sodium vapour, and other lamps since it produces light within the visible range spectrum thanks to technical advancements in semiconductor materials. As a result, LED lights are accepted worldwide for use in a variety of lighting applications, including street lighting. LED lamps have the highest lifespans of 50.000 to 1,00,000 hours and an efficiency of 100 to 120 lm w.

E. Arduino:

Arduino Uno R3 specifications are ATmega328 microcontroller, operating voltage at Sv, input voltage 7 to 12v, input voltage limit up to 20v, digital 1O pins 14, analog pins 6 [4]. DC current 40mA, flash memory 32KB including 0.5KB used by boot loader. SRAM of 2KB, EEPROM of IKB and clock speed of 16 MHz some of the Features of Arduino UNO are power can be USB connection or external power supply, with 7 to 12 volts recommended. The Arduino UNO provides power pins for other devices, the variants are Sv, 3.3v and Vin IOREF pin for optional power. The microcontrollers are primarily programmed using a dialect of features from the C and C++ programming languages. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing project

F. Relays:

Relays are electrical switches that can be operated remotely but are really controlled by a different switch, like a horn switch, or by a computer, such in a power train control module. Relays let a circuit with a low current flow rate regulate one with a higher current flow rate. Relays can be 3-pin, 4-pin, 5-pin, or 6-pin devices with a single switch or two switches. Relays are utilised as remote control switches and available in a variety of sizes, ratings, and applications.

3. Proposed Methodology

The block diagram in figure 1 depicts how all of the system's components are arranged.Sunlight illuminates the solar panel made up of PV modules throughout the day. it's a solar battery. Before the battery is charged, the current generated by the PV module passes via a charge controller circuit. The battery is protected from overvoltage and overcharging with the help of the charge controller, which could shorten the battery's lifespan. A light sensor and a road-user sensor are installed in the streetlights [8],[9]. The microcontroller uses the information from the light/dark sensor to determine whether to switch the street lights "ON" or "OFF" depending on the amount of light present.

An additional sensor utilised here is an infrared sensor, commonly known as a vehicle detector or a road user sensor. This sensor is turned on for a specific period of time, in this case from after 12:00am to 5:00am. According to the timed settings, the IR sensor is engaged when the street light turns "OFF" after 12:00am. When a car or a person approaches the road, the vehicle or person senses the object's presence and communicates the information to the microcontroller, which then sends a command, and the lights turn "ON" in accordance with that command. The lights then automatically turn "OFF" once the object has passed the road.

The sensor node's detection range is thought to be 13 m [9]. A sensor is built into each street light to identify moving objects. By sensing the approaching thing, the object turns "ON" before it reaches the light. The light then gradually dims and turns "OFF" when the moving object passes over it, at which point the sensor for the following light activates.

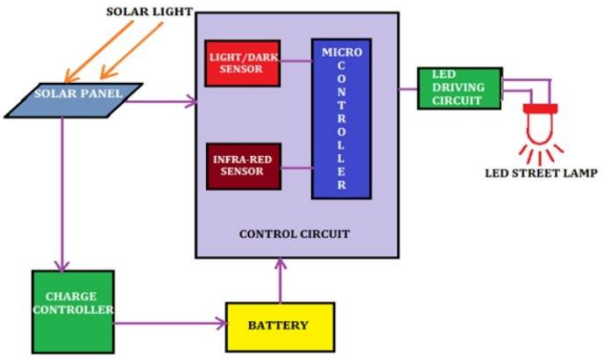

Fig 1. Block Diagram of Proposed System

The figure 2 shows the prototype model of the system. The proposed system is useful to save electricity when there is no vehicles passes by and provides automatic on and off.

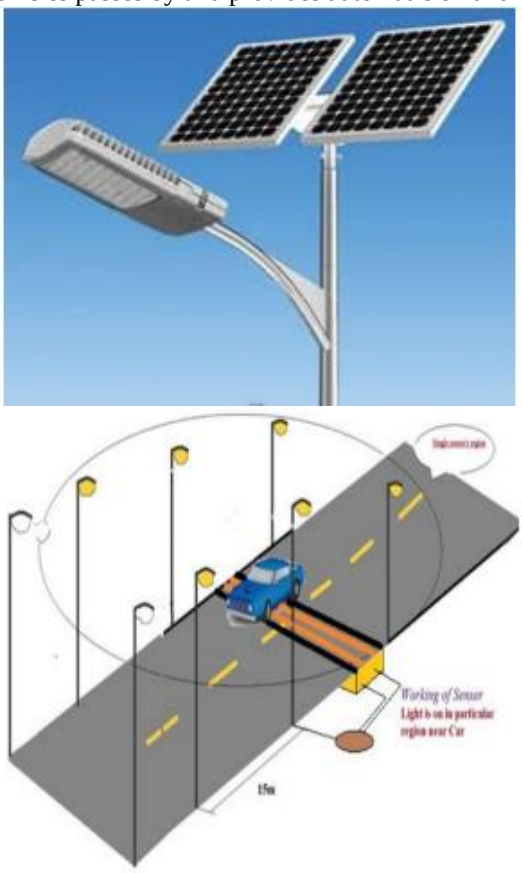

Fig 2 : Prototype Model

4. Conclusion

In this paper, the smart solar LED streetlight is presented. As a conclusion, around 70% to 85% of power consumption can be reduced by using this system as compared with existing sodium vapour streetlights. This is best solution to current street lighting system. Furthermore, if a reliable solar panel and battery are used, the streetlight can be powered for free. In comparison to high pressure sodium lamps and other streetlights, the smart solar LED streetlight system offers superior illumination, optimal electricity use, and reduced operational and maintenance costs after installation. Using a wireless sensor, the number of streetlights may be regulated while maintaining communication between them. The footstep generation technology can potentially be used to power streetlights. Areas close to IT parks, malls, and educational institutions can be offered with amenities like mobile charging stations and Wi-Fi hotspots. The suggested streetlight can be connected to systems for monitoring air quality, water levels, and CC TV cameras. People in the city and the surrounding area might be warned for any emergency conditions by monitoring the aforementioned numerous criteria.

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