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Implementation of Energy Efficient Solar Street Light

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***Abstract*—**This paper proposes energy efficient and energy free system for streetlighting system. As there is no energy demand from grid hence we use solar panel for street lighting purpose. A standalone solar street LED light system is proposed consisting PV panel, battery, LED lamp, sensing and controlling device. The main objective is to design energy efficient LED streetlightfor energy conservation in existing streetlights.The smart streetlight is controlled on the basis of traffic on road at night time. The system is programmed so that it can automatically turn off during the hours of daylight and only operate during the night. In most of the cases street lights remain switched ON even during day time. This is a total of waste of electricity, while our area is facing lack of electricity. Another issue is the conventional street lamp i.e. Sodium vapour, Incandescent, Fluorescent lamps use more power ascompared to the Led Lights. Streetlights can beoperated at no working cost by using automatic control and self-powered LED street light.

Keywords*—LED street light; Sensing device; Control technique; self-powered LED*

I. INTRODUCTION

The street lights which are implemented today in India are customarily a simple lamp linked with the grid power. These lamps are switched on in the dusk and turned off at dawn. The illumination of the lamp remains persistent throughout the period of its operation irrelative to the traffic or the pedestrians on the road. Street lights are one of the most crucial parts for public lighting systems which consume a major part of the generated electricity. The conventional or manual controlled street lighting system has demerits like high power consumption, high cost and absence of effective monitoring system. Dr. Babasaheb Ambedkar Technological University has newly constructed road which require new street lightning system. Basically a smart street lighting system is a flexible street lighting system consists of various sensors and a controller which make it an intelligent street lighting system. This system can effectively overcome the demerits of any conventional street lighting system. From many decades all street lights are switched manually andthus due to manual error they are not switched at proper time,sometimes streetlights remains ON during daytime.Hence, sensor based streetlights in addition with to turn on in heavy rain and cloudy environment. In addition of this use of motion sensor allows controlling light intensity which ensures energysaving and economical.The proposed solar LED streetlight can be operated on free working cost. The system can be made by more convenient technique in whichstreetlight is automatically switched ON and OFF.

With the help of light sensor (LDR), in dusk, streetlightautomatically turns on with 30% of intensity and battery starts discharging. If there is any movement of vehicle or person then intensity of light will increase from 30% to 100% for preset time period. After this preset delay intensity will gradually reduce to 30%. In-between this if any movement is detected then again intensity will increase to its maximum. This ensures optimum lighting as well as energy saving. With this automation technique, capacity (Ah) of battery required is much less a compared to conventional solar LED streetlight. The Arduino microcontroller receives command signal from LDR light sensor, motion sensor and charge controller and controls streetlight according to program loaded into it.[1]

II. SYSTEM COMPONENTS

A. Hardware details

1) Solar PV panel:

It is the most important equipment of the system. These are the cells that are grown from a single crystal. The Monocrystalline solar PV panel has agreater efficiency of about 18% while that of polycrystalline panel. Here, monocrystalline solar panel generateselectricity during day time and it is stored in battery through the charge controller.[5]

2) Sensor:

a) LDR (Light Dependent Resistor):

Light Dependent Resistor is the resistance dependent upon the light incident on its surface. The resistance of the LDR changes with light intensity.With increase inlight intensity the resistance offered by the sensor reduces. An LDR sensor gives analog input value to control circuit. This value can be used to automatically switch on/off the streetlight.

b) PIR (Passive Infrared Sensor) Sensor:

The infrared sensor is an electronic device which emits in order to sense objects in the vicinity. It can measure the heat as well as the motion.The IR sensors measure only these types of sensors measures only IR, rather than emitting it, that is called as a passive IRsensor. Usually in the infrared spectrum, all the objects radiatesome form of heat radiations. These radiations are nor visible to our eyes and can be sensed by only IR sensor.

3) Battery:

Lead acid type of batteries are used for the self-contained solar street light. Though the weight, life and energy density factor are not in favour of its use, we still prefer it due to its lower cost for the bulk installation. Also, the latest type of lead acid battery are having very low maintenance costs.

4) Charge Controller:

Charge controller is the link between multiple Solar PV module and battery bank. Itsfunction is to protect the battery fromovercharging. Hence, it increases the life of the batterybank to a greater extent.

5) LED lamp:

The progress in technology has brought the LED lamps in picture. It produces light within visible rangespectrum, and hence it has highest efficiency as compared to incandescent, sodium vapour and other lamps.ThereforeLED lamps are used in lightingapplications in household purpose along with Street lighting purpose. These lamps have lifespan from 50,000Hrs. to 1,00,000Hrs. while, efficiency ranging from 100 to 120 lm/w.

6) Arduino:

Arduino Uno R3[6] details are ATmega328 microcontroller, operating voltage of 5v, input voltage of 7 to 12v, maximum input voltage of 20v, digital I/O pins 14, analog pins 6, DC current 40mA, flash memory 32KB. SRAM of 2KB, EEPROM of 1KB and clock speed of 16 MHz. The Arduino UNO provides power pins for other devices, for types of V, 3.3V.[2]

III. CONTROL TECHNIQUES FOR LAMP

A. Control Using LDR Sensor

In this method real time actions aredeployed using 8051 microcontroller, LDR and PIR sensor. The system is arranged as shown in the block diagram. The LED lamps used are energy efficient in operation and have flexibility in illumination variance.The LDR detects the presence of sunlight and automates the system to be active only during dusk, resulting in automatic switching of lamps. The PIR sensor enhances the energy efficiency of the system by maintaining the higher illumination during the traffic hours and if not, the lamps are dimmed to conserve energy. The sensors are coupled to the microcontroller which orders the correct switching sequence and time slabs for the period of precise illumination.[3]

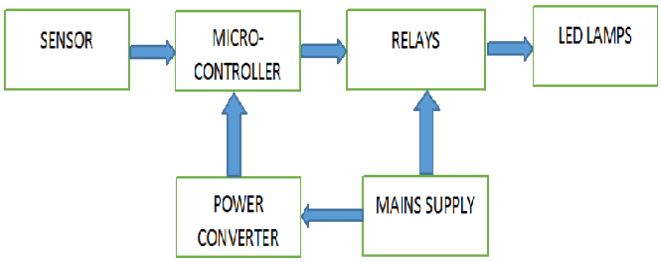

Figure 1: Block diagram of the system components

The flow chart of the program execution decided by the microcontroller can be given in following figure.

The LDR is connected to the microcontroller which activates the whole circuitry of the system. LDR detects the sunlight and keeps the system to be un-operational until there is no light incident on the LDR. Upon dusk LDR activates the system and PIR sensor is operational and continuously monitors the movements in the vicinity of the sensor. As soon as the PIR sensor detects any movements it generates the signal which is amplified by the internal PIR signal amplifier which is further fed to the microcontroller.[4]

This scheme of brightness controlled street lighting can save considerable amount of energy and lead to higher efficient economics of operation.

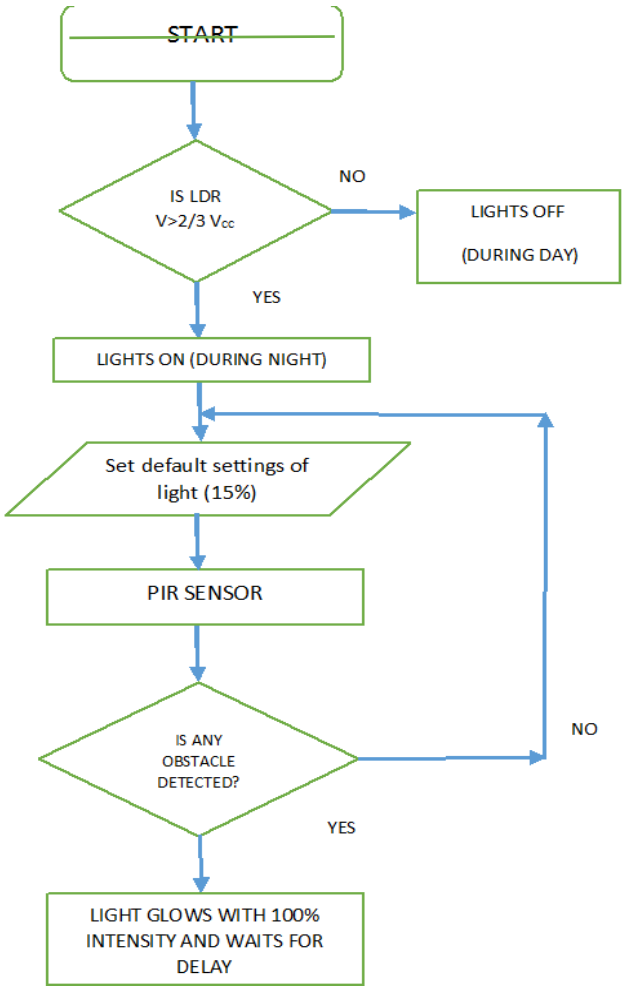

Figure 2. Flow Chart of Street Light Control Using LDR Sensor

IV. TECHICAL SPECIFICATIONS AND COSTING OF SYSTEM

According to the university construction, there is a requirements of street light poles. So the proposed work includes following data:

Total number of poles required = 15 Nos.

Considering 35 W LED lamp, total connected load of street light will be [7]

= 15 × 35 = 525 W.

Table 1: Solar Panel Specifications

Module Type	Poly-crystalline
Peak Power (W)	100 Wp
Maximum Power Voltage (V)	17 V
Maximum Power Current (A)	5.26 A
Open Circuit Voltage (V)	21 V
Short Circuit Current (A)	5.63 A
Module Efficiency (%)	13.1 %
Weight	8.6 Kg
Size Of The Panel (L×B×H) (mm)	1145×665×34 mm

Table 2: Cost Estimation of The System

Items	Cost
Solar PV panel	Rs.5000.00
Battery	Rs.3500.00
Charge controller	Rs.4000.00
LED lamp	Rs.3500.00
Erection, installation, connection, etc	Rs.12000.00
Total cost of one pole	**Rs.28000.00**

CONCLUSION

In this paper automatic LED street light system is illustrated with intelligent control technique using LDR and PIR sensor so that maximum energy can be conserved. As street light system is operated on self-contained mechanism, it helps to reduce load on grid and indirectly helps to conserve the fuel which is used for generation. Furthermore, the street light is operated at free working cost. LED lights system provides greater and glare free illumination as compared to conventional type of system.

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