IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 8 Issue 4, April 2021
ISSN (Online) 2348 – 7968 | Impact Factor (2020) – 6.72
www.ijiset.com

Development of Automatic Controller for Solar Operated Light

Mr. A.S.Kamble , Er. R. M. Dharaskar, Dr.K.G.Dhande, Dr.P.R.Kolhe, Er.N. B. Mirajkar
College of Agricultural Engineering and Technology, DBSKKV, Dapoli.

ABSTRACT:
Automatic Street Light Control System is a very essential now a days to reduce the electricity consumption. Automatic Street Light Control System uses transistor as a switch. By using this system manual works are 100% removed. It automatically switches ON lights when the sunlight goes below the visible region of our eyes. This is done by a sensor called Light Dependent Resistor (LDR) which senses the light. It automatically switches OFF lights whenever the sunlight comes visible to our eyes.
Keywords: Solar panel , Controller,Transistors, LED, LDR

I. INTRODUCTION

Solar powered automatic light controller is an very efficient device which regulated the street light working. It automatically turns on when there is dark at the dusk time and turn off at the dawn when the sun shines. Solar powered automatic street light controller is one of the applications of electronics. Here the facility of ordinary street light is increased by the making it controlled automatically. In solar powered automatic street light controller there is a provision in which the energy required to run the street light is provided by the solar energy . For detecting the light the LDR is used as the sensor.

II. MATERIAL AND METHOD

2.1 Component required:

A system of Automatic Controller for Solar Operated Light consists of different components as given below:

2.2 Solar Panel :-

The solar PV panels are currently one of the most-important long-term power sources. This is considered as the most important source of power that can be obtained from the sun as it can convert sunlight to electricity at a high efficiency. Also it can produce this electricity at a very low cost. It is also eco-friendly since it does not emit any greenhouse or pollutant gases.

2.3 Batteries:-

The battery stores the energy produced by the panels that is not immediately required by the load. This stored energy can either be used during the time of low solar irradiance where the current from the panel is not enough to drive the loads, or during night when solar power is unavailable. The common type of battery used here is maintenance-free lead-acid batteries. They are 12V sealed, lead-acid rechargeable batteries that is popular for use of multiple purpose applications.

2.4 LDR (Light Dependent Resistor): -

A Light Dependent Resistor (LDR) is also called a photo resistor or a cadmium sulphide (CdS) cell. It is also called a photoconductor. It is basically a photocell that works on the principle of photoconductivity. The passive component is basically a resistor whose resistance value decreases when the intensity of light decreases. This optoelectronic device is mostly used in light varying sensor circuit, and light and dark activated switching circuits. Some of its applications include camera light meters, street lights, clock radios, light beam alarms, reflective smoke alarms, and outdoor clocks.

2.5 Transistors. (NPN transistor): -

BC547 is an NPN transistor hence the collector and emitter will be left open (ReverseBiased) when the base pin is held at ground and will be closed (Forward biased) when a signal is provided to base pin. BC547 has a gain value of 110 to 800, this value determines the amplification capacity of the transistor. The maximum amount of current that could flow through the Collector pin is 100 mA, hence we cannot connect loads that consume more than 100 mA using this transistor. To bias a transistor, we have to supply current to base pin, this current (IB) should be limited to 5 mA.

2.6 Resistor: -

A resistors a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

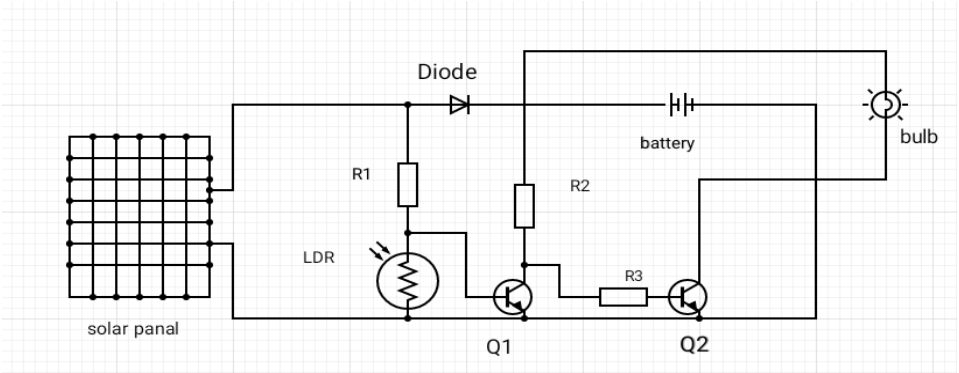
2.7 Light emitting diode (LED) –

A light-emitting diode (LED) is a semiconductor light that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

2.8 Connecting wires-

Use single-core plastic-coated wire of 0.6 mm diameter (the standard size)-You can use wire that is used for Computer Networking.

III. DEVELOPMENT OF CIRCUIT DIAGRAM: -



Automatic Light Control System.(Sensor using LDR & Transistor.)

IV. WORKING OF AUTOMATIC SOLAR LIGHT:

Circuit of a compact and true solid-state automatic light is described here. The circuit can be used to switch on incandescent light bulbs at dusk and switch off them at dawn. A 10 mm encapsulated light dependent resistor (LDR) here works as the twilight detector. The whole circuit can be housed in a very small plastic cabinet. With a little skill and patience, you can easily modify this circuit to drive a number of white LED strings, instead of the incandescent bulb load at the output. When ambient light is normal, transistor T1 is reverse biased by the low resistance of LDR. Multi turn plastic trimpot P1 sets the detection sensitivity. If ambient light dims, transistor T1 turns on to drive the triac T2. Now the lamp load at the output of T2 energises. When the ambient light level restores, circuit returns to its idle state and light(s) switched off by the circuit. Working voltage for the circuit is derived directly from the AC supply input through components R1, R2 and R3. This obviates the requirement of a bulky. If you wish to operate the, light bulb(s) on a little reduced power, just replace the triac T2 with a suitable silicon controlled rectifier (SCR). This may give a long life to the incandescent load. Finally, the LDR should not be mounted to receive direct sunlight. It may be mounted at the top of the enclosure, pointing to the sky say southwards. LDR offers very high Resistance in darkness. In this case the voltage drop across the LDR is more than 0.7V.This voltage is more sufficient to drive the transistor into saturation region. In saturation region, IC (Collector current) is very high. Because of this IC. The relay gets energized, and switches on the lamp. LDR offers Very low Resistance in brightness. In this case the voltage drop across the LDR is less than 0.7V. This voltage is not sufficient to drive the transistor into saturation region. Hence, the transistor will be in cut-off region. In cut-off region, IC (Collector current) is zero. Because of this IC, The relay will not be energized, and the lamp will be in ON state only. Diode is connected across the relay to neutralize the reverse EMF generated.

V. CALCULATIONS OF SIZE OF SOLAR PANEL, BATTERY AND CHARGE CONTROLLER:

Solar panel sizing:

Total Daily Load Requirement (Wh) = 5W × 8h = 40 Wh

Consider solar energy is available for at least 7 hours daily then,

Solar panel power (W) = $\frac{40\ \text{Wh}}{7\ \text{H}}$ = 5.714 W = 6 W

Consider, 30% loss in the system then= 6 x $\frac{30}{100}$ = 1.8 W

Hence, 1.8 + 6 = 7.8 W = 8 W

Therefore, minimum 10 W solar panel is required. In the market 18W solar panel is available which was selected for the system.

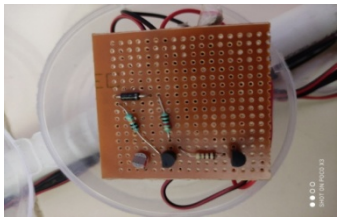
Battery sizing:

Load demand (Ah) = $\frac{40\ \text{Wh}}{12\text{V}}$ = 3.34 Ah

$$\text{Battery capacity} = \frac{\text{Load demand (Ah)} \times \text{Ds}}{\text{DODmax} \times \text{nb}} = \frac{3.34 \times 1}{0.80 \times 0.85} = \frac{3.34}{0.68} = 4.91 \text{ Ah}$$

The battery capacity should be greater than the requirement hence, in the market battery with 12 V and 7.2 Ah is available which was selected for the system. The load was operated on the 12 V hence, battery and charge controller should have 12V voltage. The charge controller available in the market is 12V, 5A which was selected.

Battery



Automatic Controller

Developed System

VI. RESULTS AND DISCUSSION

6.1 Battery charging behavior of developed system:

The battery charging behavior was carried out with load. The testing was carried out on three consecutive days in month of December. Various parameters like solar intensity, panel voltage, panel current, battery voltage and battery current were measured during no load testing.

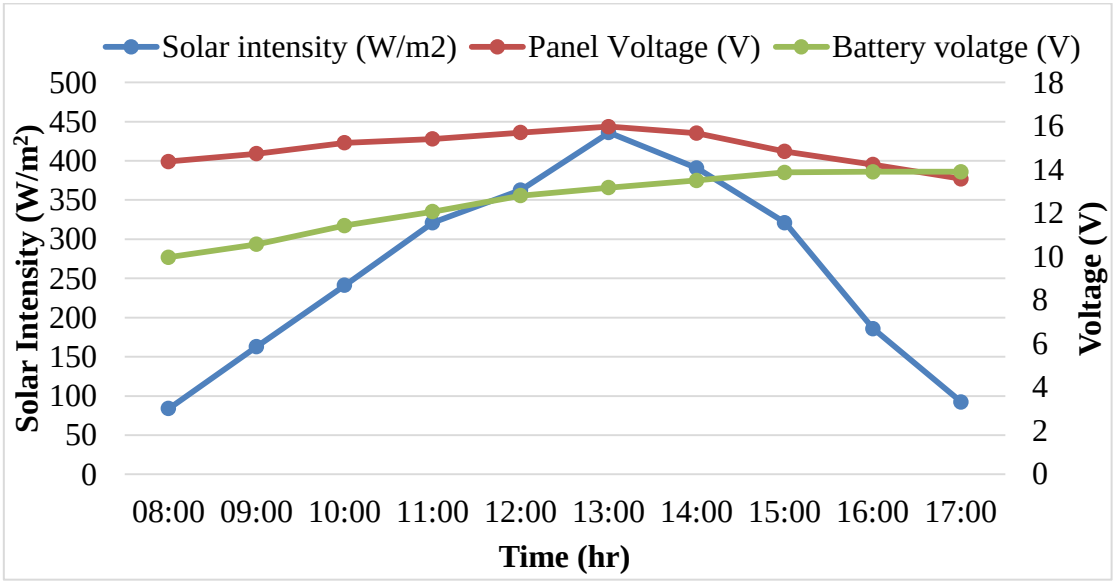


Fig: 6.1 Battery charging behavior of developed system

It was observed that the panel voltage increased with the increase in solar intensity. Similarly the battery voltage increased with respect to the solar intensity. At 8.00 h solar intensity was found to be 84 W/m^2 and the panel voltage and battery voltage were found to be 14.37 V and 8.97 V respectively. At 17.00 h solar intensity was found to be 92.3 W/m^2 and

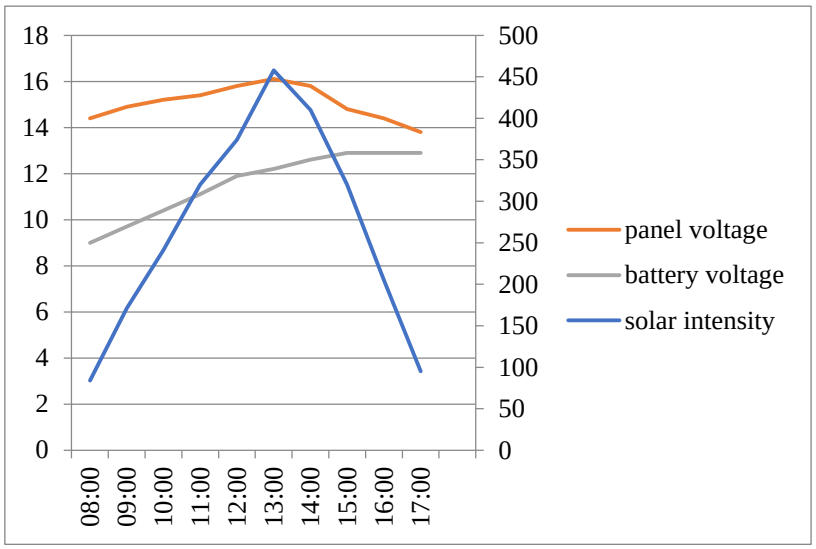
the panel voltage and battery voltage were found to be 13.57 V and 11.9 V respectively. The peak solar intensity was found to be 436 W/m^2 at 13.00 h. Also the peak panel voltage was found to be 15.97 V and the corresponding panel current and battery voltage observed was 0.917 A and 11.17 V at the time of 13.00 h. The battery was fully charged within 8 hours at the voltage of 12.9 V at the time of 16.00 h (Fig:6.1).

6.2 Battery discharging behavior of developed system:

The battery was charged by solar panel which was fully exposed in sunlight and the battery was used for operating only Light bulb. Hence, battery was only used by the light bulb for operation at night time. The fully charged battery was used for the testing. The 5W LED bulb was connected to the solar automatic light and hourly readings of the battery voltage and current were recorded until the battery gets discharged fully. The readings were recorded. The testing was carried out on three days in month of December .Parameters like battery voltage and battery current were measured hourly till the battery gets fully discharged. The total time taken by the battery to get fully discharged was observed to be 16 hours. The battery voltage was decreases from the 12.9 V to 9 V.

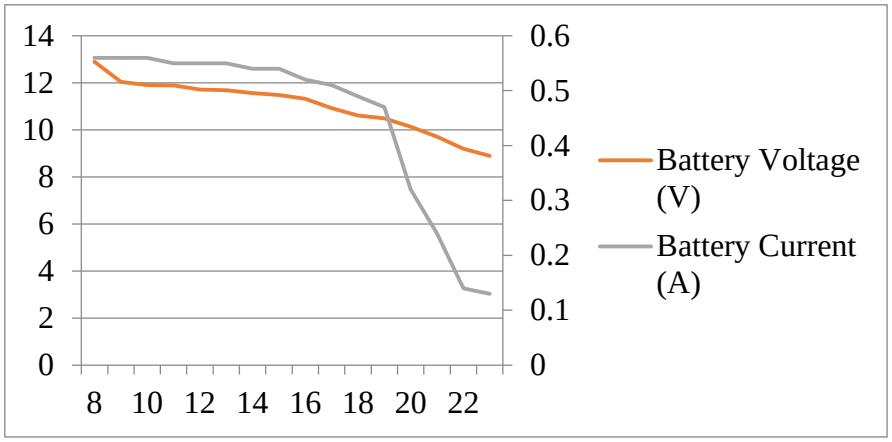
6.3 Graphical representation of data collected on battery charging

Graphical representation of panel voltage, battery voltage, and solar intensity in one hour interval from 08:00 to17:00 . Intensity of solar radiation was maximum at 13:00 pm that was 458 W/m^2 .Battery get charged from 9V to 12V .The maximum voltage of panel was 16.1 V and current 0.92 A at 13:00 pm



6.4 Graphical representation Battery discharging characteristics:

Graphical representation of battery current and voltage with respect to time from 08:00 to 23:00 pm has carried out in three trials. Time required getting battery fully dischargedis around 16 hour. Voltage get decreased from 12.9 V to 8.9 V and Current get decreased from 0.55 to 0.15 A by using 5W load (bulb)



VII. CONCLUSION:

Circuit works properly to turn solar operated lamp ON/OFF. LDR sensor and the photoelectric sensors are the two main sensor used in the circuit, each sensor controls the turning ON or OFF of the light. Furthermore the drawback of the solar operated light system using timer controller has been overcome..

VIII. REFRENCES:

1. P.Nithya, N.Kayalvizhi, “Design of Wireless Framework for Energy Efficient Street Light Automation”, International Journal of Innovative Research in Computer and Communication Engineering (An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014
2. Srikanth M1, Sudhakar K N, “ZigBee Based Remote Control Automatic Street Light System” P.P 2321 - 3361, IJESC June 2014
3. Anila Devi Y, V. Jaya Prakash, “GSM Based Remote Control System of High Efficiency Intelligent Street Lighting System Using A Zigbee Network of Devices and Sensor” International Journal of Science and Research (IJSR) P.P 2319-7064
4. Pan Shiquan "Application Research in the Solar Street Lamp Management Based on the LED Light-emitting Diodes" Bulletin of Science and Technology, Vol.28 No.4 Apr.2012.
5. T. Esram. "Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques" Energy Conversion, IEEE Transactions on(Volume:22 Issue: 2). 2007.
6. Wang Yongqing. "Design of Solar LED Street Lamp Automatic Control Circuit". National Testing Center of Iron & Steel. 2009
7. Mustafa Saad, Abdalhalim Farij, Ahamed Salah And Abdalroof Abdaljalil “Automatic Street Light Control System Using Microcontroller “Department of Control Engineering College of Electronic Technology/ BaniwalidBaniwalid- Libya LIBYA, Mathematical Methods and Optimization Techniques in Engineering
8. Z. Rasin, H. Hamzah, and M. S. M. Aras, “Application and evaluation of high power zigbee based wireless sensor network in water irrigation control monitoring system,” in Proc. IEEE Symp.Ind. Electron. Appl., Oct. 4–6, 2009, vol. 2, pp. 548–551.