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Design and Implementation of Smart Solar Lamp with Automation

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ABSTRACT

This paper proposes design and implementation of energy efficient smart solar lamp with automatic turn on or off mechanism for outdoor lighting purpose. The main objective is to design energy efficient smart solar lamp for energy conservation in existing lighting system in rural area, urban area and exclusively for smart cities. The system consists of LED luminaire, solar panel, light sensor, motion sensor, battery. The smart solar lamp's lighting is controlled on the basis of motion in it's surrounding and day/night time. The system is design to automatically turn off during the hours of daylight and only operate during the night or when the light intensity is very low. Many times we see that our outdoor lights are remain switched ON even during day time, this is total of wastes of electricity while India is facing lack of electricity. Another problem is the traditional lamp e.g. Sodium vapour, Metal halide, Incandescent, Fluorescent lamps consumes more power as compared to new advanced Led Lights. Smart solar lamp can be operated free of cost by using automatic controlled and self powered.

KEYWORDS: *Solar Lamp; LED; Battery; Sensors*

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1. INTRODUCTION

In the current scenario, we are generally using commercial or normal lamp for outdoor lighting purpose. For ex. The portable emergency lamp, garden lamp, etc. but due to the shortage of fuel energy for the generation of electrical energy, it is very costlier; in consequence with this solar powered smart solar lamp can be used for outdoor lighting purpose. Here, in this lamp solar energy is use as main source of energy for our smart solar lamp. And in case of unavailability of sun ray due to bad weather conditions the solar battery will automatically charge through ac mains directly and our light will functions properly without any interruption. In this lamp we provide automatic switching thus it does not require any manual help for switching purpose. This is done with the help of PIR sensor and LDR. And this lamp can be use for security purpose as we provide it with burglar alarm.

2. LED TURN ON MECHANISM

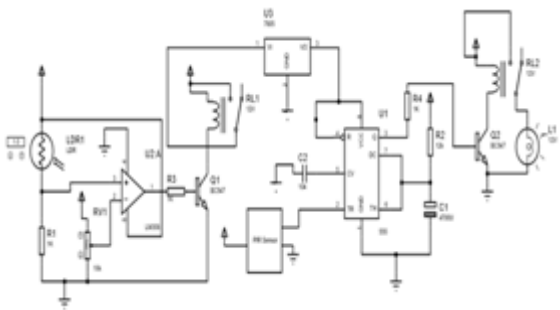

Fig-1:Circuit Diagram for Turn-On Mechanism of LED

The above circuit diagram is mounted on PCB. In above diagram, LM 358 IC is used as a comparator. The LDR is connected in series with resistance R1. The LDR and R1 used as voltage divider. When the light intensity decreases, the voltage drop across LDR also decreases. The non-inverting pin of Op-Amp is connected to LDR. The inverting pin of OpAmp is connected to potentiometer. The potentiometer is used to set the voltage of comparator. When the intensity of light decreases, the output of the Op-Amp is set to high and accordingly the relay is set on and connect the next stage for performance. The next stage is performance of human sensor detection system. In this system, PIR sensor is used to detect the human presence, if the human presence is detected, then at that time the mono-stable multivibrator will set the relay ON for some time. When the human being is present then at that time the LED light will turn ON, and when there is no human in the area then light will automatically turn OFF. Relay is driven through transistor BC547, the relay is used for connecting LED lamp on battery.

3. BLOCK DIAGRAM AND ITS EXPLANATION

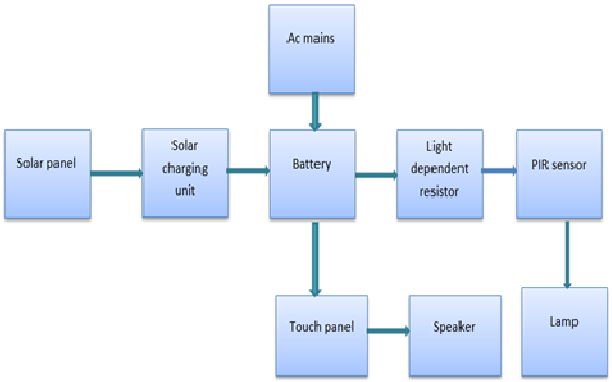

Fig-2:Block Diagram of Solar Lamp

The working principle of this smart solar lamp is it has a solar panel mounted in a proper direction or in a place in such a way that it can receive maximum solar radiation with highest intensity easily from the sun. The solar panel converts solar energy into electrical energy. This electrical energy is stored in batteries by using a solar charging circuit. The main function of solar charger is to increase the current from the panel while batteries are charging. Also, it disconnects the solar panel from the batteries when they are fully charged and reconnect to the panel when the charging in batteries is low. When the solar power is not enough to charge the battery then a connected relay will act and immediately will switch the charging of battery to ac mains automatically. It is to be noted that ac mains is considered as an alternative source in case solar energy not available.

From battery the supply (12V) is passed to the LDR (Light Dependent Resistor) which will sense the intensity of the surrounding light. As we want that the light should turn ON only when the intensity of light is too low i.e. dark. Thus, the LDR will sense the intensity of light and pass the signal to the PIR (Passive Infrared Sensor) when there is darkness. The PIR sensor will sense the motion within its range and thus turn ON the lights for a while and gets turn OFF, if there is presence of any motion in its range it turns ON again and if not then it will remain OFF.

Also supply from the battery given to the burglar alarm circuit. From the burglar alarm circuit two wires are drawn which is to be joint to the ends of the any conductor separated apart from each other. As soon as someone touches both the conductor the circuit gets completed, and alarm starts.

This smart solar lamp consist of following main components:

A. SOLAR PANEL

Fig-3:Solar panel

Solar panel is a devices that convert light into electricity. They are called "**solar**" **panels** because most of the time, the most powerful source of light available is the Sun.

B. LDR (LIGHT DEPENDENT RESISTOR)

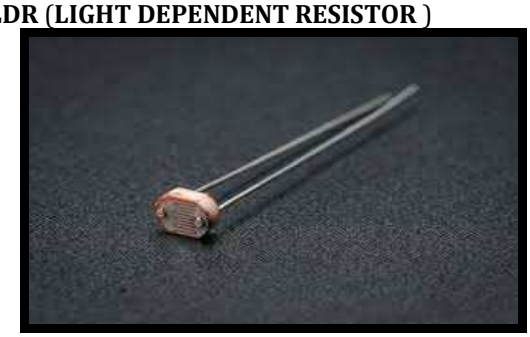

Fig-4:LDR

A Light Dependent Resistor (LDR) is also called a photo resistor or a cadmium sulfide (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.

Light Intensity Value: <10 Lux

C. PIR (PASSIVE INFRARED SENSOR)

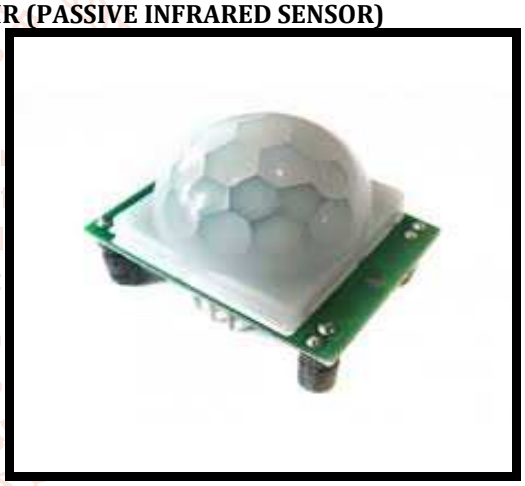

Fig-5:PIR SENSOR

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.

Motion Angle & Distance: 120deg. & 5m

D. LED LUMINAIRE

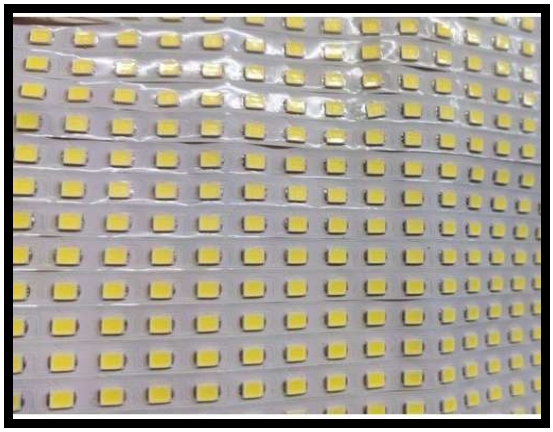

Fig-6:LED panel

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it.
LEDs have many advantages over incandescent light sources, including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching.

4. CALCULATIONS

The lamp will turn ON when the light intensity is low than the set value in LDR and a motion is detected by the PIR motion sensor.

The light will stay in ON condition for a time period of;
T= 0.986RaC

Where Ra= R2 and C= C1 (Refer Fig-1). Ra=12000Ω and C= 1000µf T= 0.986 * 12000 * 1000 =12 sec

After a motion is detected the light will turn ON and stay in glow state for T period. After T time it will automatically turn OFF. The light will stay in OFF till no further low intensity of light sensor is detected.

5. ADVANTAGES

1. Less Maintenance Required: As we are using solar technology therefore we have to do very less maintenance.
2. Reduced Electricity Bill: In this lamp as we are using LED luminaire which consume less power therefore it will reduce electricity bill.
3. It is easy installation.

6. APPLICATIONS

1. Outdoor lighting scheme of home and for security purpose.
2. College's outdoor premises.
3. Garden or park.

7. CONCLUSIONS

As a conclusion, around 70% to 85% of power consumption can be reduced by using this system as compared with existing lights. This is best solution to current outdoor lighting system. The smart solar LED lamp system provides better illumination, optimum usage of electricity when it use with reducing operational and maintenance cost after installation compare to CFLs, Incandescent lights lamp and others.

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