Design and Analysis of 24 Hours Solar Panel

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Abstract. The design of a 24/7 solar panel using artificial method of producing Infra-Red (IR) has been proposed in this paper. This arrangement ensures that the solar panel can produce energy even during night time. The major disadvantage of a solar panel is that it cannot be used during night time and when the panel is shaded. Our project aims to eliminate these disadvantages of solar panel. In this work, a Light Dependent Resistor (LDR) resistor is used to sense day or night conditions and the analog sensed value is sent to the PIC microcontroller. During night hours, only specified load will be on, so that the battery works without getting discharged fully even in the midnight. The IR Light Emitting Diodes (LEDs) that are used in night are placed in inner side of the shutter which is placed on top of the panel. The shutter is opened and closed using a motor which is controlled by using relay. The charge and discharge conditions of the battery are monitored by a Global System for Mobile Communications (GSM) module. The efficiency and economic analysis of the system has been presented.

1 Introduction

The demand for power has skyrocketed with the ever increasing population and standard of living. The conventional sources of energy have proved to be inadequate to meet the power requirements. Several research works have been undertaken to tap maximum power from renewable resources efficiently. Solar energy is one of the most promising field in renewable sources. Solar power is sometimes used as a synonym for solar energy or more specifically to refer to electricity generated from solar radiation. But the major disadvantage of the solar panel is that the maximum output of panel is only twenty percent of the total amount of sunrays falling on the panel. Solar electric systems use solar cells to convert the Sun's radiant energy into electricity. This is done using a principle known as the photovoltaic effect. Since a solar cell only generates about 1-2 Watts of power, it is necessary to combine them into solar power panels in order to generate more power. The solar panel is able to convert the light energy of the sun falling on the panel into electricity. This energy is called as photovoltaic energy. A solar cell, or photovoltaic cell (PV), is a device that converts light into direct current using the photoelectric effect. The first solar cell was constructed by Charles Fritts in the 1880s.

Since then, solar energy has been increasingly tapped for several purposes. A brief survey of literature on application of solar energy in street lighting has been presented here.

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Development of solar street lighting with energy management algorithm has been presented in [1]. A smart street lighting system using solar energy is discussed in [2-5]. Harnessing solar energy for residential purposes has been discussed in [6]. Fig. 1 depicts the block diagram of the proposed model.
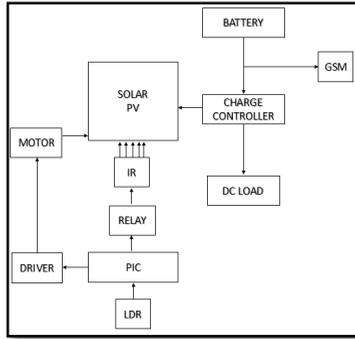
Fig. 1. Block diagram of the proposed system

2 Proposed system

In the proposed system, during the day time the power from sun is captured by the solar panel and stored in the battery and is used for load. But during the night time the power stored in the battery is insufficient to meet the load required. Hence IR LEDs are used to produce the illuminations that can be absorbed by solar panel to produce energy. This energy that has been produced by IR LEDs serves as an additional source of power to the load. It is because the power stored in battery serves the load as well as the LEDs and the power from the IR rays keeps the battery charging. The IR LEDs are placed in close contact with the solar panel. The IR LEDs are connected in serious and parallel and are placed on the shutter. The shutter will be controlled by a motor with the help of a driver. The shutter is kept open during the day time to allow sun rays to fall on the panel directly to produce power. During the night time the shutter is in close position and the IR LEDs are given power. The shutter works based on the information given by the LDR to the PIC controller. The LDR varies the resistance depending on the intensity of light falling on it. The varied resistance is converted into voltage signal. Then the voltage signal is given to ADC. The LDR senses whether it is a day or night and gives the analog values to the PIC controller. The GSM is used to give information about the charging and discharging conditions of the battery and the information is displayed on the LCD display.

2.1 Block diagram

The LDR senses as day or night and sends the analog value to the controller. The LDR varies the resistance depending on the light fall. The LDR, LCD display, GSM are powered from the battery through the controller. The IR LEDs and the relay are powered directly from the battery. The driver circuit is used for the clockwise and anticlockwise rotation of the motor for the opening and closing of the shutter.

2.2 Software simulation

During day time, as depicted in Fig. 2, the LDR senses and gives the analog information to the microcontroller. As per the information given, the controller instructs the motor to run which is controlled by a relay and the limit switches. The relay supplies the motor with power

and allows it to rotate in the clockwise direction. This makes the shutter to be opened. When the LDR has given information to the controller, immediately the supply to the IR LEDs cuts off using a relay. When the shutter is opened, the panel gets exposed to direct sunlight. The energy falling on the panel is converted to electricity and is given to the load.

During night time, as seen in Fig. 3, the LDR gives the information to the controller as night in analog values. The controller immediately instructs the motor to rotate in anticlockwise direction so as to close the shutter using a relay switch. When the shutter is in close contact with the panel, the controller supplies the IR LEDs with power from the battery using a relay switch. These IR LEDs illuminate radiations constantly. The shutter is closed so that the radiations don't escape. These radiations make the electron in the panel to combine with holes and produce power. This power is given to the load through the battery. As the load is on, the battery gets charged simultaneously so there load will sustain for more working hours during the night. The algorithm of the proposed work is presented in Table 1.
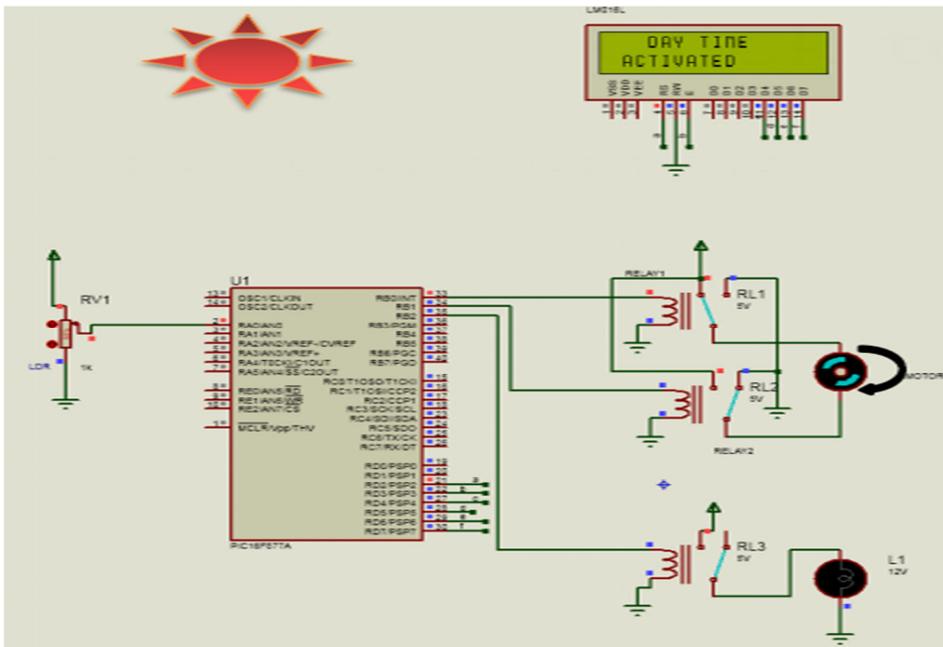
Fig. 2. Schematic diagram for day time implementation

Table 1. Algorithm of the proposed work

Step 1:	Turn on the kit and note down the LDR readings.
Step 2:	If the analog values received by the PIC is greater than 200, day time is activated, else go to step 5.
Step 3:	LCD displays "Day time Implemented".
Step 4:	Supply is given to the motor from the driver circuit which opens the shutter and energy is trapped and stored in the battery.
Step 5:	If the analog value is less than 200, night time is activated.
Step 6:	LCD displays "Night time Implemented".
Step 7:	Supply is given to the motor from the driver circuit which closes the shutter and brings the IR LEDs closer to the panel.
Step 8:	Switch on the IR LEDs using relay.
Step 9:	IR rays fall on panel and energy is trapped and stored in battery.
Step 10:	Monitor the battery charge and discharge condition using GSM Module.
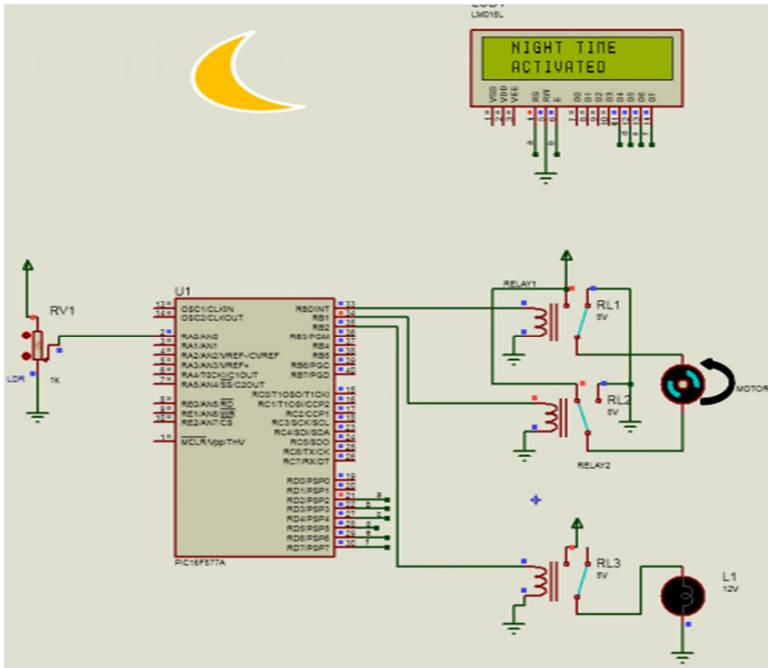
Fig. 3. Schematic diagram for night time implementation

2.3 Hardware implementation

The experimental setup of the proposed system is depicted in Fig. 4 and Fig. 5. It includes IR LEDs that are used instead of visible light so that, charging can be done even during night and cloudy condition. Hence, charging and discharging time can be reduced and result can be obtained even when there is no sunshine. The power intake of IR LEDs is 0.366W and the panel output is 0.5275W. Since the IR LEDs are placed very close to the panel, the electromagnetic waves emitted by it is trapped by solar panel so the output is comparatively high.

Sunlight consists of visible light, x-rays, IR rays, UV rays and radio waves. Mostly solar panel traps IR and UV rays. UV have more intensity compared to other rays. To create artificial UV rays we require high power equipment's like mercury lamps which is also hazardous to nature. So the IR system which can be operated in low power is chosen.

Fig. 4. Working module during day time

Fig. 5. Working module during night time

3 Results and analysis

3.1 Performance of the set-up

The maximum efficiency of the panel is obtained only during standard testing conditions. Fig. 6 and Fig. 7 depict the VI characteristics of panel during day time and night time respectively. According to the readings taken the input current given to the IR LEDS is 0.03A and the output current obtained from the panel is comparatively higher. The power and time curve for the output power from the panel during night time is given in Fig. 8.
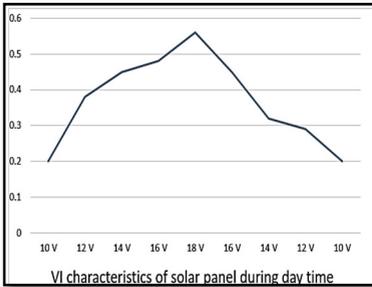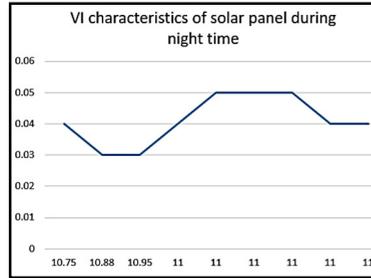

Fig. 6. VI characteristics during day time

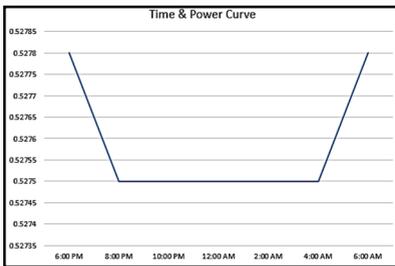**Fig. 7.** VI characteristics during night

Fig. 8. Power vs Time curve

3.2 Energy savings calculation and cost analysis

The cost analysis of the proposed work is presented in Table 2. During night time, output from the solar panel is comparatively higher than the input given to the IR LEDS. This is proved from the following calculation given in Table 3.

Table 2. Cost Analysis

Components	Price (in Rs)
SOLAR PANEL	1000
MOTOR	800
PIC	500
BATTERY	700
GSM	500
DRIVE	300
FRAME	2000
TOTAL	**5800**

Table 3. Energy savings calculation

POWER	= V (Voltage) * I (Current)
P_{in}	= 12.22 V * 0.03 A = 0.366 W
P_{out}	= 10.55 V * 0.05 A =0.5275 W
Efficiency %	= P_{out} / P_{in} = 0.5275/0.366 = 1.4412 %
Power Effective	= (0.5275) – (0.366) = 0.1615 W
Energy at night	= 365 * 24 * 0.1615 W = 1.414 kWh
Energy at day	= 365 * 24 * 60 W = 525.60 KWh
Energy Total	= Energy at day + Energy at night = 525.60 + 1.41474 = 527.014 ~ 527 KWh
Annual saving in terms of Cost @Rs. 5 per unit	=527 * 5 = Rs. 2635
Return of investment	= Product cost analysis / saving of year =6000 / 2635 =2.277 ~ 27 Months

3.3 Other applications of proposed technology

This technology can be used in solar street lamps to sustain the street lamp for a longer time during night due to simultaneous charging of the system. The duty ratio of the battery is been affected when the battery is being over charged. In olden bikes the charging time of battery is high but the utilizing time of power from battery is comparatively less, so in modern bikes daytime running lights are implemented to increase the duty ratio of the battery. The similar concept is implemented in the above discussed module i.e., in the module the charging and discharging is done in equal intervals so that the duty ratio of the battery is maintained and the life of battery is long lasting.

4 Conclusion

Solar energy is the most promising source of energy to meet the requirements of energy. Effective and eco-friendly utilization of solar energy is a challenging task. This paper has detailed information about using the solar panel even during the night time to produce power. This is a cost effective method to recharge the battery and keep the load on continuously. The proposed project serves to make use of the panel during the night time and in the day time when the panel is being shaded by means of trees or buildings. For example, in a solar street light the battery must be capable of providing power to the load connected during the night time. To achieve this the battery size should be of a higher capacity. This makes the cost of initialization to be very high. If the proposed setup is applied in a street light the size of the battery required will be comparatively smaller in size thereby reducing the initial cost.

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