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Implementation of Hybrid and Secured Solar Street Light System using Arduino

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Abstract- Nowadays solar driven street light are widely used and this trend will be continued. As the solar panels and batteries are costly therefore they are more vulnerable to theft. Accumulation of dirt or particles like dust, sand and moss on the surface of solar photovoltaic panel obstruct the light energy from reaching the solar cells thereby reducing the efficiency of the system. Production of solar energy is low in rainy days. When the street light gets fuse there is no maintenance for many months. To overcome these problems faced by solar street lights, we are proposing use of a hybrid solar street light system with security and maintenance. The system consists of magnetic door contact switch to detect the displacement of solar panel and battery, light dependent resistors to check whether the light is fuse or not. Wipers are used to clear the dust on solar panels. Arduino Uno is used to process the data from the sensors and GSM module is used to provide information to the concerned authority. The system is able to switch to electricity when the batteries are not able to charge.

Keywords: *Hybrid solar system, Anti-theft solar system, Arduino.*

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I. INTRODUCTION

Stand-alone solar street lights are raised light sources which are powered by photovoltaic panels. A solar street light is independent, eco-friendly, requires lesser maintenance than conventional street lights, and reduces risk of accident. But there are certain drawbacks of solar street lights such as risk of theft of solar panel and battery is relatively higher because solar street light has higher monetary value compared to the regular street lights, accumulation of dust or snow on the surface of solar panel and stoppage of energy production and also energy production is low in rainy days. The main objective of the system is to prevent theft of solar panel and battery, to avoid the accumulation of dust on the surface of solar panel, to provide a better maintenance of street lights and to provide supply to solar street lights even in rainy days.

II. LITERATURE SURVEY

Dr. D. S. Jangamshetti et al[1], showed that the solar power energy sources and the batteries are often located in open fields and remote areas. Therefore, the batteries are more vulnerable to theft and also the maintenance of battery is difficult and expensive. In their work, they designed a theft and maintenance monitoring system consisted of an accelerometer that detected displacement of the battery from its place and temperature sensor that measured the temperature. Sensor output was processed by the microcontrollers. Microcontrollers and GSM system were used to raise an alarm, display the status of the batteries, send alert messages, and call authorized person. The system was tested on nine batteries of stand- alone SPV system installed in Energy Park which was able to address the theft and maintenance problem of batteries.

Simon Siregar et al[2], designed a solar panel and battery monitoring system using GSM wireless communication. In their work they used voltage and current sensor for monitoring the system and GSM for communication. A microcontroller was employed to process the information from the sensors. The data from the microcontroller was transmitted through GSM in the form of SMS to the server followed by the web server. An experiment was performed in which the information of the voltage and current level was sent to the server in every 5 minutes interval and also the weather conditions in the test were observed. The results revealed that the voltage generated and current flowing was high when the sun was bright whereas it was low when the

rain fell and as soon as the rain stopped the voltage had climbed back again.

Gyanendra Singh et al[3], developed a hybrid solar system for a building. In their work, they showed because of lack of infrastructure and rising energy demand around 400 million Indians are still not interconnected to our national grid system. For supplying energy to our total population in remote areas they suggested the use of a hybrid system. In their work, they proposed a model which was the combination of wind energy system, photovoltaic array, converter, battery, and grid. The optimization was done using HOMER software. The power was purchased from the grid only when the peak power demand rose or when the PV system generated lesser electricity according to the demand. The results revealed that the cost of energy and pollution was reduced significantly.

Gaurav Verma et al[4], presented a remote sense based street light system that was able to vary the intensity of light according to the density of traffic and pedestrians. A solar panel and battery was used to generate power. The high intensity discharge lamp was replaced by LEDs. LDR sensor was used to differentiate between day and night. IR sensor was used to detect the presence and absence of a vehicle and pedestrian. The vehicle and pedestrian was differentiated on the basis of their time arrival difference, more time arrival difference indicated that it was a pedestrian and vice versa. A 16 bit microcontroller which supported PWM was used for processing the data obtained from the sensors. The PWM technique was used to switch the power supply 5V to 3.3V for dimming purpose. The developed system was tested successfully and the results revealed that the system saved power up to 50%.

Thiago Matheus Martins de Moraes et al[5], Presented a way to simultaneously reduce crime rates and save energy. They designed a sustainable and ecofriendly lighting system at bus stops that was driven by solar energy and could be easily installed at any public place. The solar panel was able to charge the whole battery in an enlightened day. They used an electronic system and a controller to control the intensity of light in relation to the natural light and in absence or presence of people at the bus stop. For vandal protection to all electronic components such as controllers, circuits and battery was placed in a steel box and was covered by a layer of cement. By the implantation of this illumination system, local criminality indices, occasional acts of vandalism were reduced.

p. du Toit et al[6], worked on smart street lighting system that provided an intelligent method for conserving and monitoring street light faults by using power line communication. They designed a light dependent resistor based light sensor with a scaling circuit and the illumination was provided by a light emitting diode luminaire along with a built in power meter. The proposed system used PLC as a communication method which was implemented on the existing power line. The system was able to communicate over the power line using modified frequency phase shift keying modulation. Different sensors were used for monitoring and providing the necessary data for fault finding and energy optimization. Then these faults were sent to a display/server through the PLC unit.

III. SYSTEM DESCRIPTION

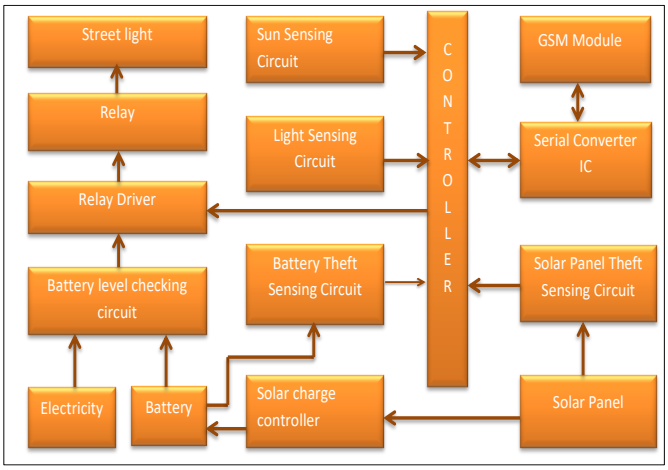

Fig. 1. Block Diagram of Hybrid and Secured Solar Street Light System

A functional block diagram of a single unit of solar street light system with security and maintenance is shown in Fig. 1.

Brief description of each block is given in the following section

A) **Solar panel:** Solar panel is one of the most important parts of solar street lights as the solar panel will convert solar energy into electricity. Solar panels use a special process of converting photons to electrons to generate a current by making use of a special type of cell known as photovoltaic cell. The photovoltaic cells are made up of semi conductive materials such as silicon. The semiconductor absorbs light from the sun. When this happens, the photons in the sunlight knock some of the electrons in the semi conductive material loose which allows them to flow in an electrical current. The electricity produced from solar panel during day is stored in a battery.

B) **Solar charge control circuit**: It is basically a regulator to keep batteries from overcharging. If there is no regulation then the battery may get damage due to overcharging. Therefore solar charge control circuit is used to regulate the voltage and current coming from solar panel going to the battery.

C) **Battery level checking circuit:** This circuit is used to check the voltage level of the battery. If the voltage level of the battery is below the threshold level then it passes electricity supply.

D) **Sun Sensing Circuit**: It senses whether it is day or night depending upon the sunlight. For this a Light Dependent Resistor (LDR) is used whose resistance will be low in day and high in night. The output of LDR is given to the Operational Amplifier which compares the input and the output of comparator is then given to the controller.

E) **Light sensing circuit**: It is used to sense whether the street light is fused or not. For this an LDR is placed below the street light. The output of the LDR is given to OP-AMP which compares the input and for further processing the output of OP-AMP is given to the controller.

F) **Battery theft sensing circuit:** In this circuit a magnetic door contact switch is used as a sensor. The sensor consists of two main parts, a magnet and a switch with terminals to connect the signal wires. The magnet is mounted on a battery, while the switch is mounted on a frame. Whenever the battery will be displaced from its position then the distance between the magnet and the switch will increase and this will inform the controller that the theft of battery has occurred.

G) **Solar Panel theft sensing circuit:** This circuit is similar to the battery theft sensing circuit. The magnet of a magnetic door contact switch is mounted on a panel, while the switch is mounted on a frame. The output of the magnetic door contact switch is given to the processor for further processing of this data.

H) **Controller:** Controller is the brain of the system and is used to analyze process and give output as per written instructions. In the proposed system Arduino Uno is used as a controller**.** Arduino Uno is a microcontroller board based on the ATmega328. It receives output signal from sun sensor, light sensor, battery and panel theft sensing circuit and battery level checking circuit. It analyses and process the data obtained from the sensors and battery level checking circuit and accordingly provide input to the relay and send messages to the concerned authority

I) **Serial converter IC:** The RS232 IC is used to convert the microcontroller TTL logic levels to RS232 logic levels during serial communication of microcontrollers with GSM module.

J) **GSM Module:** A GSM module is a chip or circuit which is used to establish communication between a mobile device or a computing machine and a GSM system.

K) Relay driver is used to amplify the signal from controller to required level to drive the relay. Relay is used to ON and OFF street light supply.

IV. RESULT

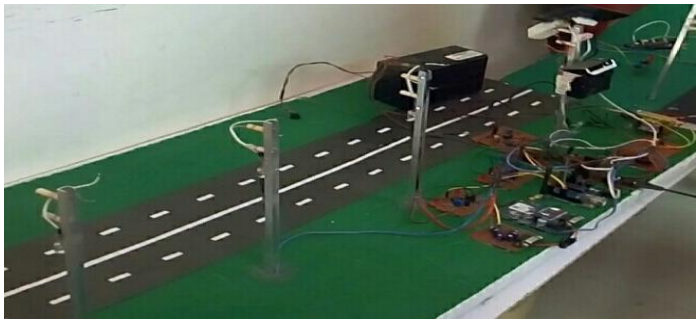

Fig. 2 experimental setup of hybrid and secured solar street light system

Fig. 2 shows an experimental setup of hybrid and secured solar street light system. A simple prototype model is prepared consisting of four street lights. We are using only one system for this four street light model. Testing of the system is done and following results are obtained.

i) The street light was automatically turned on and off. The street light was switched on in absence of light where as it was switched off in presence of light. For indicating presence of light on the prototype model a flash light was used.

ii) Cleaning of Solar Panel: It was observed that the surface of solar panel was cleaned automatically at a fixed time by the wiper installed on it.

iii) Solar Panel Theft: Whenever the solar panel was displaced from its position then the panel theft sensing circuit was able to detect it and an alert message indicating the solar panel theft along with its pole number and location address was received by the cell phone as shown in Fig. 3.

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177– 180

Fig. 3 solar panel theft detection

iv) Battery Theft: Whenever the box containing battery was opened then the battery theft sensing circuit was able to detect it and an alert message indicating the battery theft along with its pole number and location address was received by the cell phone as shown in Fig. 4.

Fig. 4 battery theft detection

v) Fused street light: Below each street light a light sensor was connected to check fused street light. When the street light was switched on then the light sensor was able to detect light which indicated that the street light was not fused whereas when the street light was fused then the light sensor was not able to detect light and a message was received by cell phone indicating that the street light was fused along with its pole number and address as shown in Fig. 5.

Fig. 5 detection of fused light

vi) Hybrid System: It was observed that though the battery was disconnected the system was still working on AC supply.

V. CONCLUSION

Arduino Uno, GSM and sensors was efficiently used to eliminate the various security and maintenance problems faced by solar street light system. Theft of solar panel and battery was prevented by sending message to the authorized person. Dust accumulation was avoided by using wipers. The information of fused light was given to the authorized person. The problem of stoppage of the supply during rainy days was removed using a hybrid system. A more efficient and reliable solar street light system was developed.

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