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Automatic Solar Panel Cleaning System

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ABSTRACT

This paper is about the cleaning of a solar panel. In rural areas most of the solar street lights are used. After the installation of solar street light it only works for two to three months. Because, that panels are installed at height near about 15 to 20 feet, at this height cleaning is not possible by using ladder. If solar panel is not cleaned regularly, then the dust in environment accumulates on the surface of the solar panel. This dust converts into a thick sticky layer due to morning dewdrops. Due to this dust solar panels not gives a sufficient charging current that required for the charging of a battery. If the battery is not fully charged, then it does not gives desired output and we have to replace that battery. It increases the cost of maintenance. In this paper we design a cleaning system for a solar street light. which can be operated automatically and it helps us to clean solar panel without any efforts. This system reduces human efforts, it save time, it works automatically at specified time. Overall it increases the efficiency of solar street light. This system is designed using ATmega16A microcontroller due to its advance features. It also uses GSM module, linear actuator, limit switches, DC gear motors, Roller brush and DC submersible pump. Here, GSM Module is used for real time operation, linear actuators for the movement of brush. The gear motors are coupled with brush for the rotation of brush, pump is used to lift the water from ground surface to upper surface of solar panel for water cleaning purpose.

Keywords- Solar Energy, Self Cleaning System, GSM for Real Time Automatic System, ATMEGA 16A Microcontroller & DC Motors.

1. Introduction

Energy is one of the major issues that the all countries in the world are facing this problem. India is a developing country it also facing a problem of energy supply. The energy supply is one of the major problems for both urban and rural households. Near about 60% to 70% of the energy demand of the country is met by non renewable sources like petrol and diesel. Solar energy is a renewable source of energy which is freely available in nature, which has a great potential and it is radiated by the sun. Renewable energy is important to replace the generation of electrical energy that can be done by petroleum. Solar power is a source of renewable energy and solar energy application should be enhanced. The solar PV modules are generally employed in open and dusty environments in tropical countries like India. The dust gets accumulated on the glass surface of solar PV module and it blocks the incident light i.e, sun rays from the sun. It reduces the power generation capacity of the solar PV module. The power output is continuously reduces if panel is not cleaned for a long period of time and then battery performance of the system is decreases then we have to requires to replace the battery. It increases the maintenance cost of system to avoid this cleaning system is required. So we designed the cleaning which can be operated automatically and it can be controlled through microcontroller. To remove the dust on the solar PV modules which helps to improve the power quality and increase the efficiency of system.

1.1. OVERVIEW OF THE SYSTEM

Now a days world moving towards starting the use of renewable energy mostly solar energy is used to generate an electricity. In developed countries like india solar modules suffers from dusty environment due to dust particles efficiency of solar panel reduces. This dust accumulated on glass surface of solar PV panel. In winter seasons this dust is thick cover of dust on surface of panel due to dewdrops. This dust block sun rays which is very useful to

generate an electricity. but due to this dust the output of solar PV is reduces upto 50% of its rating , if it is not cleaned .Therefore to clean the solar PV module is necessary activity but it required man power ,time, water and this cleaning activity dangerous for street light solar panel place at top of the pole. This height is near about 15 to 20 feet at this heights cleaning is not possible . This automatic solar panel cleaning system is used which can regular basis at defined time. This system is design using ATMEGA 16A microcontroller, GSM Module, DC gear motor, sensor like LDR limit switch & pump system. In previous technology wiper mechanism is used to clean the solar panel or also spryer mechanism to clean is used to clean the solar this technology we use both mechanism which run using GSM and Microcontroller. In this paper we discuss about an designed system which is useful to increase in solar panel efficiency and avoid maintenance.

1.2. OBJECTIVE

- To clean the solar panel effectively.
- To clean the solar panel on daily basis.
- To improve overall solar panel efficiency.
- To avoid the manual work.
- To avoid dust, dirt and moisture associated on solar panel.

2. MAIN COMPONENTS REQUIRED

Components	Specification	Purpose
Solar Panel	Max. Power (Pmax)= 20 Watt Max. Power Voltage(Vmp)=16.5 Volt Max. Power Current (Imp)=1.22 Amp Open Circuit Voltage (Voc)= 20 Volt	This solar panel is used to convert solar radiation into a direct current (DC) for charging purpose of battery.
Battery	Voltage= 12Volt Capacity= 10Ah	This battery is use for energy storage. Battery charge with the help of solar panel and stored energy is used for the operation of cleaning system.
GSM Module	Operating Voltage= 3.4V- 4.4V Real Time Clock= It supports RTC Power consumption in slip mode =0.7 mA	This GSM Module is use for real time operation of clean system. Also, this modem is also useful for various
		purpose like SMS text message, Make or receive phone calls, connecting to internate through GPRS
Helical Gear DC Motor	Operating Voltage = 12Volt Speed = 30 RPM Rated Torque = 5 kg-cm Stall Torque = 18.8 kg-cm Load Current = 0.3 Amp No Load Current = 60 mA	Four motors are used in this system. Two for brush and other two for movement of brush holder from right to left or left to right.
Limit Switch	Voltage Rating = 12 Volt Current Rating = 2 Amp Switch Type = Mechanical	This switch is used as a sensor, to check the position of brush movement
DC Submersible Pump	Operating Voltage = 2.5 - 6 Volt Operating Current = 130 to 220 mA Flow rate = 60 to 80 L/H	To lift the water for water cleaning of solar panel

<p>Microcontroller</p>	<p>Series = ATmega16A Operating Voltage = 2.7 to 5.5 Volt No. of timers and counters =3 No. of I/Os = 32 Type = 8 bit Microcontroller Max. clock frequency = 16MHz Data bus width = 8 bit Program memory size = 16 KB Data RAM size and type = 1KB, SRAM Data ROM size and type = 512 B EEPROM Operating temp. range = -24° C to 84° C</p>	<p>Microcontroller controls the whole cleaning system. microcontroller will control various devices of this system i.e, Spray Mechanism, Motor and Spray Valve Control, Position of brush etc. As per the coding we can control these blocks. For coding programming is required.</p>
<p>LCD Display</p>	<p>Operating Voltage = 4.7V to 5.3V Current consumption = 1mA 16×2 Display = 16 characters and 2 rows</p>	<p>This display use to show the stetus of the system.</p>
<p>Brush</p>	<p>Roller brush made by nylon material is used.</p>	<p>Nylon brush is use due to it's non sticky property. It is use to clean the panel with its rotary motion.</p>
<p>Frame</p>	<p>1 inches square pipe Mild steel material</p>	<p>Whole parts of cleaning system like, Roller brush, linear actuators, gear motors or limit switches are place on this frame.</p>

3. PRPOSED SYSTEM

3.1Block Diagram

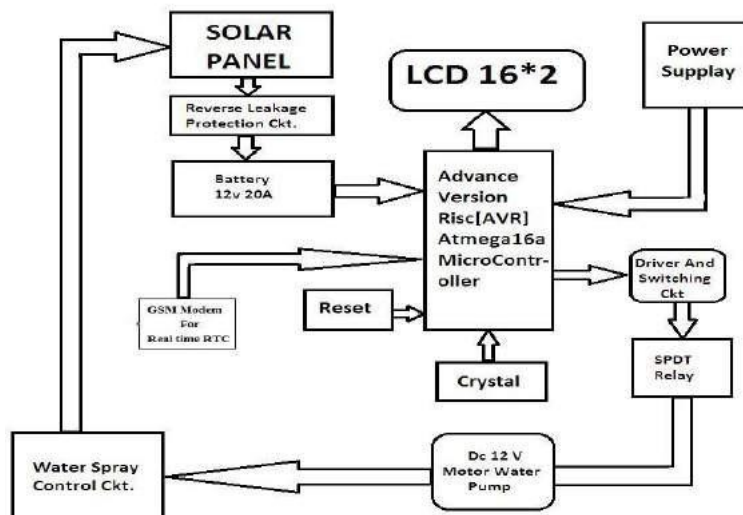


Fig.1 Block Diagram

3.2 Working

This system works at a particular time. This time is set for the operation of cleaning system. The real time is taken from GSM module, at this time relay circuit is operated and motor starts running. Here, Two motors are connected for the movement of brush motors and other two motors are used for rotation of motor. The brush motors are placed on linear actuator mechanism which can slide over left to right or right to left using rubber belt. To detect the actual position of brush limit switch is used. By using this switch movement of brush can be changed for this motors are used for the movement of linear actuator. Linear actuator can moves left to right or right to left by changing the direction of motor clockwise and anti-clockwise.



Fig.2 Design of panel cleaning system

When the system is starts automatically submersible pump is also starts, which can use to spray the water on solar panel. This system stops cleaning brush is at it's initial position. This position is can be identified by using another limit switch when it press second time. This process continue everyday using GSM module at it's desired time everyday.

RESULTS

Following tables shows the results of cleaning system:

Day	Voltage (volts)	Current (amp)	Power (watt)
1	15.60	1.25	19.5
2	15.27	1.24	18.93
3	15.12	1.14	17.23
4	15.04	1.08	16.24
5	15.01	1.09	16.36
6	14.92	1.06	15.81
7	14.70	1.01	14.84

Power output reading before installation of cleaning system

Day	Voltage (volts)	Current (amp)	Power (watt)
1	16.00	1.25	20
2	15.98	1.24	19.81
3	15.98	1.23	19.85
4	16.01	1.24	19.82
5	15.99	1.26	20.14
6	15.97	1.25	19.96
7	15.99	1.24	19.95

Power output reading after installation of cleaning system

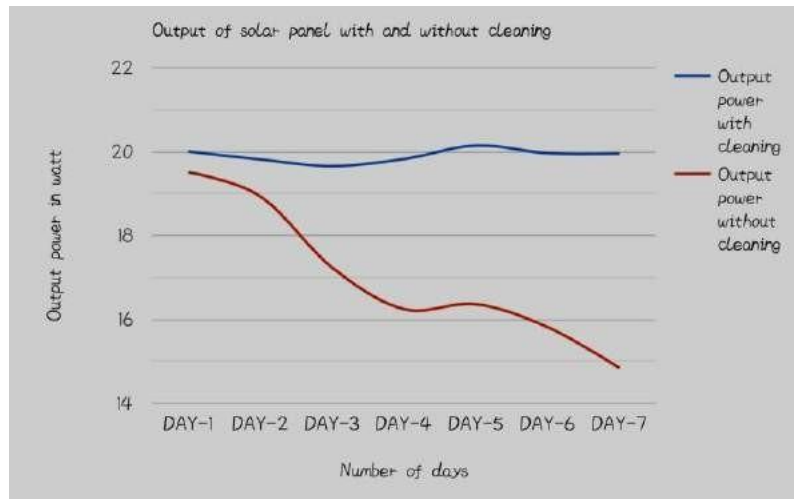


Fig. 3 Output graph

This result graph shows the performance of cleaning system before and after the installation of cleaning system. From this graph we can understand, if cleaning system is not used, Then the graph with red line goes in decreasing order i.e The output power from solar panel decrease day by day. If solar panel with cleaning system is used, Then the graph with blue line tries to maintain it's output power i.e the output power is maintained due to daily cleaning of solar panel. From the blue line graph we can understand how automatic cleaning system is useful for solar street lights

ADVANTAGES

- Cost of production is low.
- No need to purchase heavy machinery.
- Reduces human efforts.
- Manual assistance is not required.
- Working principle is easy.
- Autonomous self-cleaning mechanism that can be attached to solar panels and operated without human operation.
- It is easy to construct, low cost and low maintenance.
- Increase the efficiency.
- Avoided the damage of solar plates.
- Dry cleaning and also wet cleaning.
- Consumption of water.
- It requires brush maintenance

CONCLUSION

This automated cleaning system mainly focuses on small system but adding some normal changes in system it can be useful for over a large arrays. Our system can be installed on solar street light or also on solar roof top systems. The rack and pinion mechanism is also possible to do this work. Linear actuator system works very smoothly, it is able to achieve the designed parameters.

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