Analysis of Factors Affecting On Solar Panels and Develop Solution for Increasing Efficiency

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ABSTRACT

It is significant to understand the effect of the light intensity and other parameter on output performance of the crystalline solar modules. Therefore, it is possible to evaluate the j-v curves of solar module under various environmental conditions. This thesis discusses the effect of light intensity and other parameter on performance parameters. Accumulation of dust and debris on even one panel in an array reduces their efficiency in energy generation considerably and emphasizes the need to keep the panels' surface as clean as possible. Current labour-based cleaning methods for photovoltaic arrays are costly in time, water and energy usage and lack automation capabilities. Here we design metal frame with wiper system. Wiper is so design that it can remove almost all dust from surface. In wiper system uses motors and some sensors. It can swipe out panel surface that clean all dust. Here water sprinkle system that cleans out sticky dust.

Keywords— Dust, Photovoltaic panels, Arduino etc.

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I. INTRODUCTION

Photovoltaic systems have been installed to provide electricity to the billions of people that do not have access to mains electricity. Power supply to remoter houses or villages, irrigation and water supply are important application of photovoltaic for many years to come. Nowadays, nearly 70 GW of PV power are installed worldwide. The average solar radiation intensity on the Earth's orbit is 1369w/m2. Solar energy is one of the most promising renewable energy since it provides a free, unlimited, clean and environmentally friendly energy. Sunlight is by far the largest carbon-free energy source on the planet. The solar energy converts into three forms of energy such as electricity, chemical fuel, and heat energy. When the p-n junction is hit by the light beam then semiconductors energy hole generates electron-hole pairs. The newly created electric charge carriers are mostly recombined, which generates heat. The condition for the creation of the photovoltaic phenomenon is to separate these pairs before recombination. This requires a presence of an internal electric field. This strong electric field exists in the p-n junction due to spatial cargo. In this electric field the electrons are moved from p-type to n-type semiconductor and holes are moved from the n-type semiconductor to p-type, resulting in separation of generated electron-hole pairs. The electron will jump to the conduction band and initiate a current coming out from the solar cells through the contacts. Separated minority carriers on the one side of the connector, are becoming majority carriers with limitless lifetime on the other side, thus they create voltage (VPH) and current (JPH) of a solar cell.

II. PROBLEM STATEMENT

There are many factors that affect PV power efficiency, such as shadow, snow, high temperatures, pollen, bird droppings, sea salt, dust and dirt. The main factor that affects a PV panel's efficiency is dust, which can reduce its efficiency by up to 50%, depending on the environment. The presence of dust on the surface of the solar cells deteriorates their performance. The characteristics of dust settlement on PV systems are dictated by two primary factors that influence each other, viz., the property of dust and the local environment. Cleaning the solar panels is normally by washing which is tedious and cumbersome and also expensive in terms of the labor involved and time. In practice cleaning of solar panels should be frequently done which makes the process more laborious and expensive.

III. OBJECTIVES

a) There are many losses in solar modules. Dust is the major losses in solar panel. So, we design the

autonomous solar panel cleaning wiper system for increasing the efficiency.

b) As a result of this, it only made sense that the system being designed should be autonomous to prevent having to climb up onto the roof and save money by allowing for the solar panels to be cleaned often.

IV. METHODOLOGY

We design and manufacture the automatic solar module cleaning system to overcome the dust losses. Following flowchart shows simple layout of our automatic solar module cleaning system.

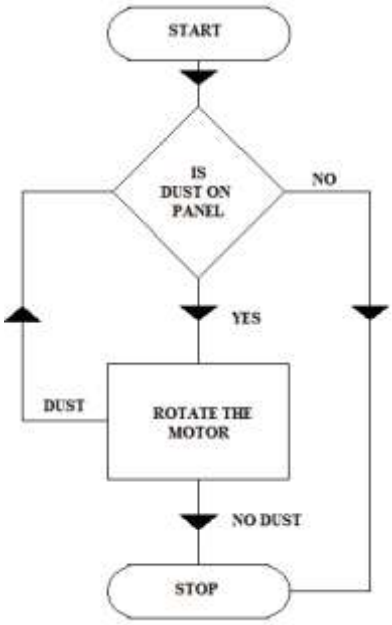

Figure 1: Flow Chart of working of automatic solar panel cleaning system

Following steps are involved in the methodology:

a) Collecting and studying more extra details regarding the effects of accumulated dust on the flat solar panels.
b) Designing the basic prototype of the auto cleaning system.
c) Choosing the proper microcontroller to control the auto cleaning robot and sensor to sense the amount of dust on the solar panel.
d) Designing the microcontroller's algorithm such that the microcontroller can control the robot in the right direction.
e) Execute the algorithm in the real time to investigate and debug the common errors.

V. DESIGN CALCULATIONS

Design of link body-

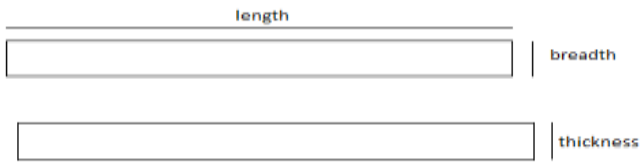

Figure 2: Diagram of link body

Given data:
Material– Aluminum 6606T6.
Properties –

a) Ultimate tensile stress =310MPa,
b) Tensile yield strength =270MPa
c) Link length = 620mm
d) Total Load = 9.81 N.

Bending Moment for link is,

Moment M = F X L
= 9.81 X 620
= 6082.2 N–mm.

Bending moment =Moment of resistance

$$M/I = \sigma/y$$

$$\sigma = \frac{M * y}{I}$$

Where, M=Bending moment (N-mm)
Y= Distance from neutral axis to extreme fibre (mm)
I= Moment of inertia (mm^4).
Assuming, breadth=50 mm and thickness =4 mm

$$I = \frac{50*4^3}{12}$$

$= 266.67\ mm^4$

$$\sigma = \frac{6082.2*2}{266.67}$$

$= 45.61\ N/mm^2$

$$\text{Ultimate strength} = \frac{\text{ultimate tensile stress}}{2}$$

$$= \frac{310}{2}$$

$=155\ N/mm^2$

$$\text{Allowable stress} = \frac{\text{Ultimate strength}}{\text{F.O.S.}}$$

$$= \frac{155}{2}$$

$= 77.2\ N/mm^2$

Hence link will not bend under given loading conditions as 77.2>45.61.
Therefore design is safe.

Design of motor:

Actuators are the drive for the cleaning mechanism. Since we have chosen aluminium material for fabrication, the weight is comparatively less. So the motor should have 1.5 Kg-mm torque to travel on the rails.

Gravity force acting on mechanism = weight X 9.81
=1Kg X 9.81= 9.81 N.

So, we have to generate approximately 10 N forces to move our mechanism.

Available motor torque = 1.5 Kg-cm
=1.5*9.81 N-cm
=14.715 N-cm.

Hence, Force required moving our system is,

Force= Torque/Perpendicular Distance

But, perpendicular distance is the radius of wheel which is 3 cm.

Hence, Force= 14.715/3
= 4.905
= 5 (Approximately taken).

Hence, we have to use 2 motors to drive our system.

VI. ELECTRONIC COMPONENTS

Motor driver- L293D-

Generally, even the simplest robot requires a motor to rotate a wheel or performs particular action. Since motors require more current then the microcontroller pin can typically generate, you need some type of a switch (Transistors, MOSFET, Relay etc.,) which can accept a small current, amplify it and generate a larger current, which further drives a motor. This entire process is done by what is known as a motor driver.

Figure 3: L293D

Motor driver is basically a current amplifier which takes a low-current signal from the microcontroller and gives out a proportionally higher current signal which can control and drive a motor. If your current requirement is not too high and all you need is a single package which does the job of driving a small DC motor in two directions, then all you need is a L293D IC.

The L293 and L293D are quadruple high-current half-H drivers. L293D IC generally comes as a standard 16-pin DIP (dual-in line package). This motor driver IC can simultaneously control two small motors in either direction; forward and reverse with just 4 microcontroller pins.

LDR Sensor-

A light dependent resistor also known as a LDR, photo resistor, photoconductor or photocell, is a resistor whose resistance increases or decreases depending on the amount of light intensity. LDRs (Light Dependent Resistors) are a very useful tool in a light/dark circuits.

Figure 4: LDR sensor

The way an LDR works is that they are made of many semi-conductive materials with high resistance. The reason they have a high resistance is that are very few electrons that are free and able to move because they are held in a crystal lattice and are unable to move. When light falls on the semi conductive material it absorbs the light photons and the energy is transferred to the electrons, which allow them to break free from the crystal lattice and conduct electricity and lower the resistance of the LDR. A light sensor or LDR can be very easily interfaced with an Arduino. The light sensor is connected to the analogue inputs of the Arduino.

Arduino- Single Board Microcontroller-

Arduino is a single-board microcontroller to make using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a boot loader that executes on the microcontroller.

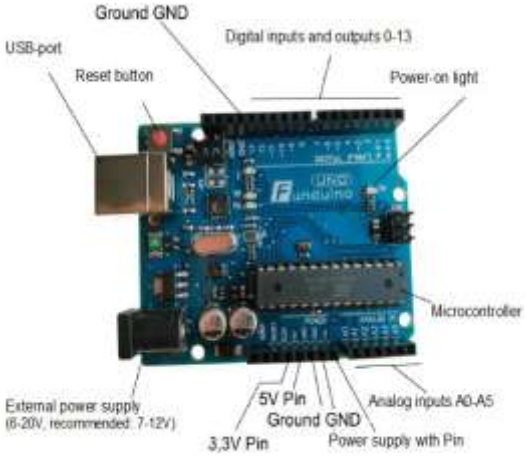

Figure 5: Arduino board

Hardware Specifications –

1. Microcontroller: ATmega328
2. Operating Voltage: 5V
3. Input Voltage (recommended):7-12V
4. Input Voltage (limits): 6- 20V
5. Digital I/O Pins: 14 (of which 6 provide PWM output)
6. Analog Input Pins: 6
7. DC Current per I/O Pin: 40 mA
8. DC Current for 3.3V Pin: 50 mA
9. Flash Memory: 32 KB (ATmega328)
10. SRAM: 2 KB (ATmega328)
11. EEPROM: 1 KB (ATmega328)
12. Clock Speed: 16 MHz

Batteries-

Batteries give supply for a motor and Arduino. Motor gets 12v supply from Lithium- Ion rechargeable battery mounted on the central body and Arduino gets supply from a 9v battery.

Figure 6: Batteries

VII. EXPERIMENTAL ANALYSIS

First, we manufactured the cleaning system mechanism and mounted it on the solar panel. Then, we kept whole system in sunlight. Readings are taken day by day in a fixed time span. The readings are taken with the help of Luxmeter (to measure intensity) and Multimeter (to measure voltage).

At the day 6, we set the 18.6 volt reading as a reference with the help of potentiometer. At day 6, the cleaning system starts as the voltage falls below 18.6 volt.

Power calculations:

V_m= 21.6 Volt

I_m= 2.691 Amp

Therefore, $P_m = V_m \times I_m$ = 21.6 X 2.35

= 50.90 W for ideal conditions.

Hence, when dust is deposited on surface of panel, we take our trials. We get 18.6 volt, loss of 3 volt.

Power loss is 3 X 2.35 = 7.285 watt per unit

Hence, for 1000 solar panel= 7.285 X 1000 = 7285 watt.

VIII. ADVANTAGES

1. Minimum consumption of water.
2. Performance area is more.
3. Power consumption is less.
4. No requirement of climb on roofs.

IX. CONCLUSION

A sun reserves large power in people's life, along with the fossil fuel exhausted and unfriendly to environment how to utilize solar power is more important in the further. That is mainly reason why this thesis researches this topic. Through the experiment people can get more clearly observe which elements has more affect for solar panel. This project highlights the effect of dust, dirt, pollen, sea salt, and bird droppings on the PV system's efficiency.

Dust causes efficiency degradation of a PV panel by attenuating the incoming solar irradiance, reducing the surface transmittance, introducing partial shading effect and efficiency degradation is proportional to dust deposition. The reduction in the peak power generated can be from 18-20%. The dust must be removed from the surface of solar PV panel in order to ensure highest performance. The output losses of solar panel are considerable due to dust cannot be neglected. So, it is necessary to develop a dust cleaning system in order to reduce the losses and increase the efficiency of solar panel.

So, we finally developed an automated system which is able to clean dust with help of sensors. And the losses occurred by the dust is fully eliminated. Actually, there are many benefits from such a project. First, economic benefit, where there is no more money will be paid to a cleaning agency. Second, it is time saving, where there is no time will be spent to clean those solar panels because the system is fully automated. Besides that, frequently cleaning will ensure that the solar panel works with a good transmittance. Finally, safety and health of workers is achieved on sites. Since these system is capable of working in hazardous environments. Thus the safety and health of workers is ensured, thereby reducing expenditures on health and medicines.

Figure 6: Actual wor kingsystem

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