Improvement of Efficiency of Solar Panel Using Solar Panel Cleaner

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Abstract

A solar panel is an electronic device that provides electricity by converting of solar radiation. But there are a few aspects which reduces the efficiency of panel. Among these aspects, the dust and soiling losses play major role of reducing output power and efficiency. In order to operate panel at optimum efficiency with a no energy loss, the surface of panel need to be dust free. Generally, the dust, dirt reduces the efficiency of panel of around 15 to 18%. In order to compensate these losses there is a need of automation that is automatic solar panel cleaner which will help in cleaning of surface of panel, reduces the labor cost and water utilization, manual analysis and increase the speed of cleaning instead of traditional method.

Keywords- *Cleaning, Solar panels, Brushes, Glass, DC Motor, eco-friendly.*

1. Introduction

Most of the electrical power is generated from non-renewable energy sources especially from fossil fuel but these resources are not in abundant in nature and will be depleted at some time in the future. So there is need of generation of electrical power from the renewable sources. Sun is the only source which is abundant in nature to generate electrical power and solar energy is the promising energy source of the future. In India there are continuous efforts taking place in order to reduce the fossil fuel consumption and increase in renewable energy generation [1]. The electric power is generated with the help of solar panels or photovoltaic module. Installation of solar panel array is becoming more useful all over the globe. Since India is very fortunate country where there is availability of solar energy of about 7.5 KWh/m^2/day, especially talking about west central region, there is 3300 to 3700 hours of bright sunshine are available in year [2]. The generation of power is dependent on the amount of sunlight falling on the surface of panels. Generally the efficiency of multi crystalline PV module is around 16%. But there are a few aspects which reduces the efficiency of panel. Among these aspects, the dust/soiling losses play important role of reducing output power and efficiency. The accumulations of dust on the surface of panels will cover the maximum area of panels which causes the losses and reduction in efficiency of generation of electrical power.

Dust is the fine particles of earth or waste materials which get easily stuck on any flat surface. This fine particles come from various sources .There are various types of dust like concrete dust, wood dust, sand, pollen, mud, etc. These dust, dirt or fine particles of soil accumulate on the solar panels which block the sunlight & thus is the main reason for occurrences of soiling losses. Due to accumulated smut & dust the

production of energy decreases year by year as well as the incoming irradiance to the cell decreases and produces power losses also affects the performance of solar panel. In dry areas, these losses could reach 15%. To handle the panel at highest efficiency with a no energy loss, the surface of panel requirement to be dustless. Usually, the dust, dirt reduces the efficiency of panel [3]-[4]. Also the cloudy conditions or windy atmosphere can reduces the efficiency of panel by 22%-76% [5]. For maximum output we need to keep the array of panel clean with the help of highly controlled process. To manage the losses there is a need of automation that is automatic solar panel cleaner which will help in cleaning of surface of panel, also we need water for cleaning process which will help in improving the efficiency more than 15% [5].Therefore the cleaner must have the capability of cleaning the entire array in fast, no matter the array size. This will remove the entire dust & bird drop over the panels. The system must be simple, robust, and easily energy efficient. By using the automatic solar panel cleaner which will reduces the labor cost, manual analysis as well as increase the speed of cleaning instead of traditional approach.

2. Methodology

The automatic cleaner consists of brushes which are designed such that they should install vertically, rotate with the help of geared dc motor over the surface of a panel and perform the rotatory motion. Both the motor and brush are coupled by aluminum plank and mounted on the linear system. These designs are chosen because of its robustness and easily assemble. On the other hand, the cleaning equipment performs linear motion along the surface of a panel and this motion is done with the help of stepper motor, rubber belt, stainless steel rod, linear bearing with its housing. This coordination issued to avoid the risk of scratches on the glass of a panel.

Due to these scratches it causes the transmission losses. Therefore it is necessary to handle the arrangement sophisticated & thus, both these motion are club together to perform linear as well as rotator motion. So these two motions are operated by motor driver IC to clean the accumulated dust, smut, etc. over the surface of a panel effectively. This system is also applicable to can clean any plane surface and therefore this feature of cleaning equipment makes it widely adaptable as well as versatile.

Brushes: It is a side broom brushes made up of either soft nylon or nylon bristle having an outer circumference of 7 inches and inner hole of 5mm. It is used for cleaning the sticky dust effectively.

Motors: A dc geared motor is easily available in market & it is used to rotate the side broom brushes over the surface of panel. The dc geared motor having a voltage rating of 12v, current rating of 1 amp, and torque of 2kgcm, & speed of 150 rpm. Similarly, a stepper motor having a rating of 6v,1 amp, 1.8 step angle used to provide linear motion along the panel.

Plank: Plank is supportive frame made of aluminum & having length 42 inches and it is used for mounting the DC motor along with brushes.

AVR 8 bit Microcontroller: A microcontroller AT-mega328p having an operating voltage of 5 volt & it is used to operate the electronic component of the circuit like dc motor driver IC, stepper motor and solenoid valve.

Linear Bearings: The linear bearing consist of inner diameter 8mm, outer diameter 15mm, length of 24mm, is used to provide the smooth moment of linear motion along the panel [6].

Nozzle: copper nozzle which gives flat fan spray pattern since it has a V-nozzle at the condescending inlet joined to PVC pipe.

Solenoid valve: solenoid valve having one inlet and one outlet and operate at a input voltage of 12volt to control as well as minimize the flow of water.

Brackets: T shape brackets are made of cast iron and having a height of 3 inches, base of 1 inch & centre bore of 8mm. T shaped bracket are used for rod mounting and U shaped bracket has same specification as T shape brackets and it is used for belt fitting.

Solar panel stand: solar panel stand is used for giving inclined support to solar panel. Stand having length 42 inches and width 32.2 inches, front height 6 inches and back height 16 inches. It is made up of cast iron [6].

Solar panel: A poly crystalline solar panel having a peak voltage 18.1 V and peak current 2.89 Amp, peak power is 50Wp. The open circuit voltage (V_{oc}) is 21.9 Volts and short circuit current (I_{sc}) is 3.06 Amps. Module efficiency is 16.2% and fill factor of 77.8%.

3. Flowchart

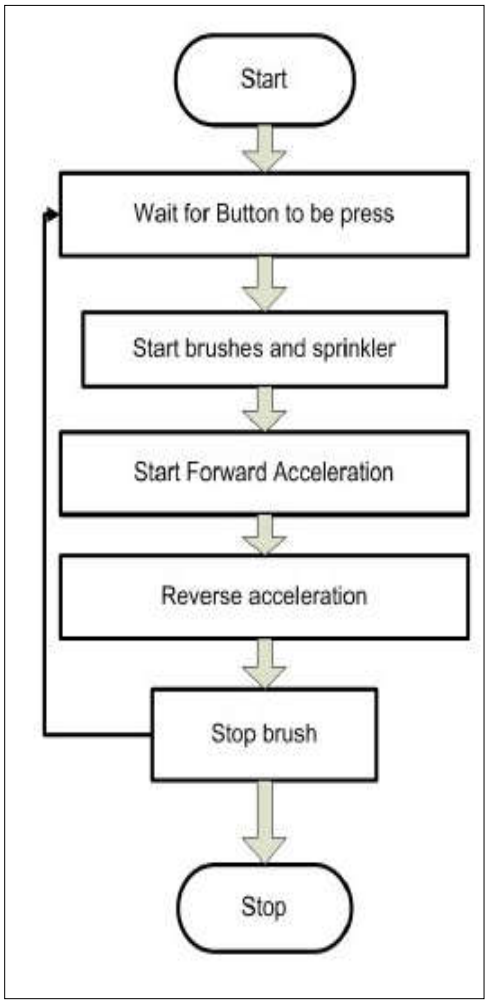

Figure 1. Flowchart of Program.

Following equation shows the efficiency of solar panel,

$$n = \frac{Vp \times Ip}{Ps \times A} \times 100$$

Where,

I_p is the electrical current of the solar PV panel

V_p is the voltage of the solar panel

P_s is the power of the incident solar radiation (W/m^2)

A is the module area in m^2.

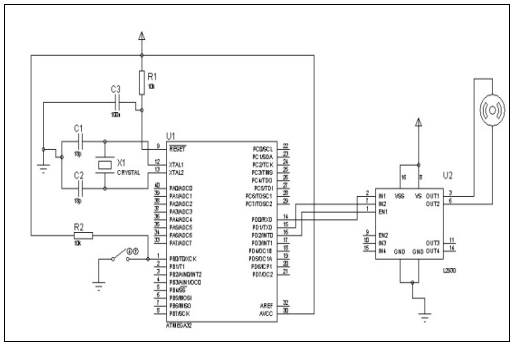

Figure 2. Control circuit of geared dc and stepper motor

4. Load Calculation

Stepper motor-12 watt (2 quantity*6V*1Amp)
DC motor-12 Watt (3 quantity*12V * 1Amp)
Electronic circuit- 2.5 Watt
Total power - 50.5watt.
System voltage or battery voltage -12volts
Energy consumed by the load-50.5Whr (0.0505 KWhr).

5. Applications

- In this prototype automatic solar panel cleaner is used which will eliminate the requirement of man power.
- Due to the use of solenoid valve, the reduction of water consumption takes place.
- This technique is more convenient, effective and cheaper than traditional method.
- This automatic cleaner is also applicable to use to clean the any type of flat surface such as glass, blackboard, etc. Therefore it is versatile and has wide application in future.

6. Conclusion

Cleaning and maintenance is extremely important aspect regarding solar panel efficiency. The solar panel surface is cleaned by using the cleaning equipment. Therefore, losses are reduced by cleaning the surface of solar panel. The cleaning equipment is eco friendly and robust as well as durable. The presence of dust, smut and bird dropping affects the performance of solar panel to a greater value. Because

the dust on the surface of photovoltaic 6 module decreases and produces power losses up to 15% in dry areas. And in another study, the reduction in the peak power generated can be up to 18% (in a normal area). Therefore the variation in a decrease in the efficiency of PV module depends on the geographic location and its orientation. To run the PV module at optimum efficiency we need to clean the surface of the solar panel at regular interval for that there is need of automation. So the robotic system proposed in this paper is a simple way to troubleshoot this problem. The further development aims at optimizing the system to be smaller, lighter, robust, reliable & improving its overall intelligence.

7. Prototype

Figure 3. Top View of Running Prototype

8. Acknowledgement

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