

Design and Manufacturing of Solar Panel Cleaning Robot

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Abstract: *With growing costs of electricity and concern for the environmental impact of fossil fuels, implementation of eco-friendly energy sources like solar power are rising. The main method for harnessing solar power is with arrays made up of photovoltaic (PV) panels. 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. The goal of our project is to create an automated solar panel cleaner that will address the adverse impact of soiling on commercial photovoltaic cells. Specifically, we hoped to create a device that increases the maximum power output of a solar panel by 10% (recovering the amount of power lost). Furthermore, autonomous cleaning robots are often only economical on a larger scale due to both installation costs and the fact that custom-made parts are needed to fit the plant.*

Keywords: Solar Panel

I. INTRODUCTION

Growing interest in renewable energy has led the solar photovoltaic (PV) industry to expand notably in the last decade. In the year 2014 a staggering 3.03-million gigawatt hours (GWh) of electricity was produced in the European Union covering 3 percent of the total electricity demand [1]. Because Photovoltaic energy is an accessible technology, it has become a popular investment for companies as well as for residential users. Consequently, this demand has stimulated the research for increasing the overall output power of PV systems causing laboratories all over the globe to work hard on making the technology both more efficient and cost effective.

Solar photovoltaic (PV) industry is expanding worldwide, due to its technological and economic advantages. The PV conversion efficiency ranges from 10 to 13% in commercial level. However, the outdoor installed PV modules efficiency may reduce by 10 to 25%. The reduction in the effectiveness referred to the losses in the inverter, wiring and dust pollution. Any substance spreads in the air includes soil and dust particles (suspended dust), smoke, fog and particulate matters called dust. Dust formed from inorganic and organic substances of terrestrial origin. Dust consists of substances like sand storms, bacteria, factories' smoke, pollen, forest fires and volcanoes vapors. They also include the suspended solid atmospheric particles that remain in the air for long periods. These particles can transfer with wind movements for long distances. The areas characterized by high dust concentration levels suffer from the significant losses due to dust pollution. Many valuable studies confirmed that the airborne dust deposition on the outdoor photovoltaic (PV) modules decrease the transmittance of the cell glazing. Also, it results in a significant degradation of solar conversion efficiency of PV modules. The dust deposition on the outdoor PV studies focused on the glazing transparency performance.

II. OVERVIEW

With significant progress in the field of innovation cleaning solar panels there are many ways of cleaning PV cells, each method has advantages and disadvantages in terms of cost and efficiency, it is possible that the way to be effective but high cost, or less expensive but low efficiency.

III. LITERATURE SURVEY

Every day, the surface of planet earth is blasted with so much solar energy that, if harnessed, 60 seconds worth could power the worlds total energy requirements for one year. The sun is a colossal fusion reactor that has been burning, for more than 4 billion years. In just 1 day, it provides more energy than the current human population would consume in 27 years. By some estimates, the amount of solar reaction striking the earth every 72 hours is equivalent to all energy stored in the planet's coal, oil and natural gas reservoirs. Solar radiation is free and natural recourse, yet converting into an energy source is a relatively new idea.

The devices used in photovoltaic conversion are called solar cells. When solar radiations fall on this devices, it is converted directly into DC electricity. The principal advantages associated with solar cells are that they have no moving parts, required little maintenance and work quite satisfactorily with beam or diffused radiation. Also they are readily adapted.

The use of photovoltaic energy (aka. solar cells) started way back in 1876. William Grylls Adams along with a student of his, Richard Day, discovered that when selenium was exposed to light, it produced electricity. An electricity expert, Werner von Siemens, stated that the discovery was "scientifically of the most far-reaching importance". The selenium cells were not efficient, but it was proved that light, without heat or moving parts, could be converted into electricity.

IV. SYSTEM DESCRIPTION AND DESIGN

Our robot is a water-free robotic cleaning process combines a powerful-soft microfiber brush supposed to remove 99% of dust daily and keeping panels at optimal production rates.

We focus in this robot on decrease power sources used to observe rareness this sources like water, and guarantee work the robot in any location without need water, because the most of PV farm derivate in the desert, and we know the difficult to existence water in this location, and we can say that other aim is facilitation the robot structure and ease to control it.

4.1 System Description

In this project, the cleaning of the dust materials accumulated and formed on the PV panel surface will be facilitated. Control of the device will be provided by microprocessor which is explained detaily in software section. Designed device completes the cleaning process automatically with limit and distance sensors. It will be able to charge the battery in the parking station so that it will be ready for the next washing process without any extra effort. In the movement system, pulley pallet system which is specially designed for the PV panel provide a smooth transition from the gaps between the PV panels. Thanks to this pallet system, there is no need for any additional rail system for PV panels that results in reducing both material and labor costs. Aluminum sigma profiles used as frame and rail system provide the advantage of lightness to the device. The parts used in connections of metarials are filament and the designs are produced with 3D printer. By reduced weight and cost of the designed SPCR system, cheap, lightweight, automatic and low maintenance cleaning will be obtained.

4.2 System Design

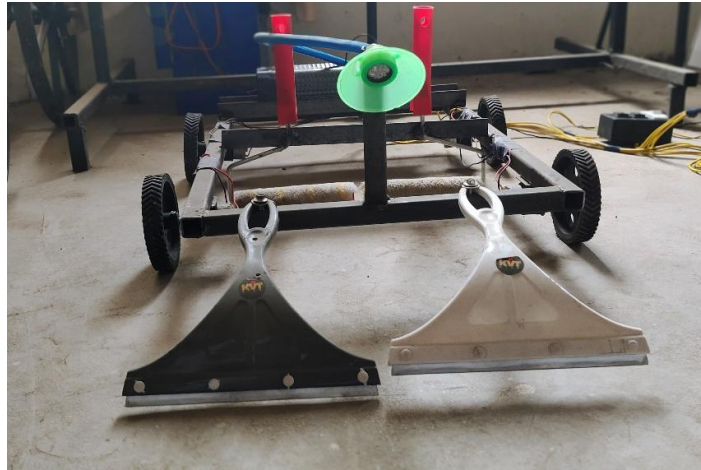
The design of the robot is a rolling brushes connected to a body that traverses vertically along the frame and the frame will move horizontally along the array, the device would not use water and would not need to be connected to any source of water.

4.3 Robot Body Design

Mildsteel square with dimensions of 0.3m contains two microfabric brushes that move vertically from the top toward the bottom to guarantee that the dust gets swept towards the bottom and not just transported sideways. There will be two strokes (top to bottom, bottom to top) to make sure that dust swept perfectly.

V. FUTURE SCOPE OF PROJECT

- Wireless transmission: the movement of the tool which is done by PLC can be done wireless by using radio frequency which will reduce the cost involved in installing the system and also the complexity in maintaining the system will be reduced.
- Wireless monitoring: the present system which is monitored by SCADA through interfacing with PLC by wiring can also be done wireless.
- Replacing the rack and pinion mechanism with other type of mechanism like track system for bigger power plants.
- Interfacing with VFD (variable-frequency drive) drives for optimizing the power consumed by the system.
- Using LDR sensor, it helps to sense amount of dust on panel and cleans the module automatically.



Real project model

VI. ADVANTAGES

- Increases efficiency of solar plate.
- Sometime dust or other particles remains long time on a solar panel, so it damages the aluminium strip of solar plate. So we avoid these damages by this system.
- Increases the gain as much as 5 to 30% in output from your solar panels.
- Eliminate build-up of dirt and debris and potential damage to solar panels.
- Automatic self-cleaning mechanism that can be attached to solar panels and operated without human operation.
- Minimise the cost of cleaning as compared to manual.
- Remote control is possible.
- The entire plant can be handled by using single PLC system.

VII. DISADVANTAGES

- “Wiper Blade” which consists of an rubber band would need to be changed.
- Needs to be scaled for a larger project (ex: increase the torque of the motor).
- .Skilled labour is required to handle the system.

VIII. CONCLUSION

The main conclusions can be summarized as: The losses of the output power of the fixed solar panel at a tilt angle(35) is about 25% of the rated yield and can be higher depending on the dust form. The dirt and bird drop make a hotspot in the panel, and it can make temporary fail in the panel. Dry cleaning can' not remove all the dirt on the surface of the solar panel, but it is able to remove the outer layers of the dust. Cleaning solar panel with water increases the cleaning efficiency

by removing majority of the dirt deposited on the panel. No external powers are required as the self- cleaning system takes its power from the battery of the solar panel. This device is made up of lightweight material, so the power consumed is low. Comparing the costs of cleaning by Manual operation and Automatic operation the cost for automatic cleaning is proved to be more economic and significantly less cumbersome particularly in systems having large number of solar panels. Also frequent periodic cleaning ensures that the solar panel works with a good transmittance consistently at all times

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