

Design and Development of Automatic Solar Panel Cleaning System

^{#1}Mr.Shubham S. Shelke, ^{#2}Mr. Abhilash W.Paranjape, ^{#3}Mr.Bajrang V. Shinde,
^{#4}Mr. Syed Sufyaanuddin, ^{#5}Dr. Anil Sahu

¹hubhamshlk@gmail.com



^{#12345}Department Of Mechanical Engineering
G.H.Raisoni College of Engineering, Pune.

ABSTRACT

Electricity plays a key role now in our daily lives but the energy sources to electric power has been used in abundance and so researchers were compelled to find an alternate source of power leading to the discovery of solar energy. Solar energy is inexhaustible and eco -friendly and can be converted into electricity. using photovoltaic panels. These panels can be used in a fixed form or used in a solar tracking system for single axis as well as for dual axis their efficiency is lowered if the panels become dirty since dirt blocks the intensity of the rays and thus lowering the electric output from the panels .Thus maintaining this condition is the most demanding task and thus requires frequent cleaning. The project of solar panel cleaning ensures fast and effective cleaning in least possible space and cost , more over system being portable can also be used in mobile applications also. The project work will include desgn development and analysis of the above said system using Unigraphix for solid modelling and Ansys workbench for analysis. The perofrmance evaluation of the system and its effectiveness over the existing system will be done by carrying out test and trial o n a scaled prototype for a panel of 2 watt power.

Keyword: Solar Panel, Solar energy, cleaning .

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I. INTRODUCTION

The sun emits energy at an extremely large rate hence there is abundant availability of solar energy in the nature. If all solar energy could be converted into usable forms, it would be more enough to supply the world's energy demand. However, this is not possible because of conditions in the atmosphere such as effect of clouds, dust and temperature. Solar energy can be converted to more usable energy forms through solar panel. There is unprecedented interest in renewable energy, particularly solar energy, which provides electricity without giving rise to any carbon dioxide emission. Of the many alternatives, photovoltaic method of extracting power from solar energy have been considered has promising toward meeting the continuously increasing demand for energy . The efficiency of solar panel is limited due natural conditions so it is very much essential to take care of parameters like dust, humidity and temperature. In this regard the work has been taken up to study the efficiency of solar panel with and without dust collected on it.

The developed project includes design and to implementation of microcontroller based dust cleaning

system. The main aim of the project is provide automatic dust cleaning mechanism for solar panel. Traditionally cleaning system was done manually. The manual cleaning has disadvantages like risk of staff accidents and damage of the panels, movement difficulties, poor maintenance etc. The automatic dust cleaning system of solar panels has taken to overcome the difficulties arise in the traditional cleaning and also produces an effective, non-abrasive cleaning and avoids the irregularities in the productivity due to the deposition of dust .

The studies carried out to evaluate the efficiency of solar panel for dust collected on it for one day, one week and a month. The efficiency of solar panel also calculated after cleaning the surface for one day, one week and a month. And finally comparing both the efficiencies it is proved that solar panel efficiency increases considerably. Thus the developed model enhances the solar panel performance. Various source of energy like coal, gas, hydro, nuclear, renewable, diesel and their some of them are going to be exhausted within few years. To get the most from solar panels, you need to point them in the direction that captures the most sun. But there are a number of variables in figuring

out the best direction. This page is designed to help you find the best placement for your solar panels in your situation. This advice applies to any type of panel that gets energy from the sun; photovoltaic, solar hot water, etc. We assume that the panel is fixed, or has a tilt that can be adjusted seasonally. (Panels that track the movement of the sun throughout the day can receive 10% (in winter) to 40% (in summer) more energy than fixed panels. This page doesn't discuss tracking panels.) Solar panels should always face true south if you are in the northern hemisphere, or true north if you are in the southern hemisphere. True north is not the same as magnetic north. If you are using a compass to orient your panels, you need to correct for the difference, which varies from place to place. Search the web for "magnetic declination" to find the correction for your location. The next question is, at what angle from horizontal should the panels be tilted? Books and articles on solar energy often give the advice that the tilt should be equal to your latitude, plus 15 degrees in winter, or minus 15 degrees in summer. It turns out that you can do better than this - about 4% better.

II. LITERATURE REVIEW

2.1 Serbot Swiss Innovations; Gekko Solar August 2013. Gekko Solar is developed for mobile deployment onto Solar PV panels as shown in fig. It is having a cleaning capacity of 400 m² /hr. Thorough cleaning using rotating brush and demineralized water. Its movement is based on feet, with vacuum technology, which are rotating on two trapezoid-shaped geared belt drives, enabling the robot to astonishing flexible movement in every chosen direction. It can be radio controlled with a joystick from a distance of 300m. Vacuum based feet movement which requires air pressure of 8 bar. It is able to clean inclined panels upto 45 deg.

2.2 Serbot Innovations; Gekko Solar Farm August 2013. Gekko Solar Farm is developed for the cleaning of large field solar farms. It is having a cleaning capacity of 2900 m² /hr. thorough cleaning using multiple rotating brushes and demineralized water. Its movement is based on feet, with vacuum technology, which are 22 rotating on two trapezoid-shaped geared belt drives, enabling the robot to astonishing flexible movement in every chosen direction. It can be radio controlled with a joystick from a distance of 300m. Vacuum based feet movement which requires air pressure of 8 bar. It is able to clean inclined panels up to 30 deg.

2.3 Tuff fab; Nano Clear: SPV Panel Glass Coating Solution August 2013 It is available as a solution which is easy to apply. Once applied it makes the glass surface Non-stick, easy to clean and look new for years. User no longer needs to use harsh chemicals and scrub clean your glass any more. Just a wash with clean water or mild detergent and a wipe with a soft towel will clean the panels. In this method cleaning has to be done, only advantage is cleaning process would be easy.

2.4 Mazumder; Designed flexible electrostatics screen to protect the solar cell on Martian explorer based on travel-wave field technology. Based on the study of feasibility,

both technical and financial, I propose a robotic system that moves on the surface of the solar panel and cleans the surface with the help of a brush. Since the surface of the solar panel is not horizontal but tilted suction method is used for creating the grip on the panel. In suction method, a vacuum pump and a suction cup is used. Vacuum pump sucks air out of the cup and suction cup grips the wall due to external pressure. A semi-independent Wall Climbing with Scanning Type Suction Cup was created and tried by Tomoaki Yano, Tomohiro Suwa, Masato Muraxami. The robot was connected with the gears on the ground through the electric power cables. Experimental results showed that the robot was able to walk on walls, clear steps, and stick on cracks and crevices with high effectiveness. As accumulation of dust on the PV panel reduces its transmittance which results in the reduction of the power output, thus resulting in loss of power generation. This particular problem is also responsible for the short life span of many interplanetary exploration missions such as Mars Exploration Mission of Curiosity Rover as the power output from their solar panel reduces over time because of the accumulation of dust. At a point of time density of dust increases to level where power output declines to the extent which is not able to support its vital functions.

III. METHODOLOGY

In this paper, the effects of accumulated dust on the performance of the solar panels are investigated by referring the results obtained by experimentation in dusty atmosphere of different levels. Also, an auto cleaning system is employed to work as the auto cleaner which is equipped on the tilted solar panel is proposed. The design of the auto cleaning system will have flexibility in order fix on different sizes of flat solar panels. In accordance with the dimensions of the tilted plate panel, the system consists of brushes driven by DC-motors through a threaded rod system. The movement of the brushes is controlled by signal generated by a microcontroller in accordance with the dust sensor which produce a rotational motion which is converted into linear motion through rod. The electrical power which is needed to drive the DC motor is supplied from the battery.

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.

IV. DESIGN

The main component of our machine is as follows

- Driving motor
- Wipers
- Battery
- Limit switch
- Circuit box

- Bearing
- Wheels
- Solar cell

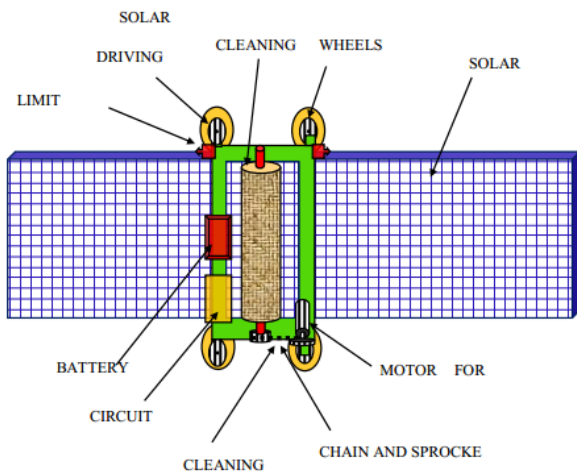


Figure1 : Construction

V. CONCLUSION

The Main Conclusion can be summarized as the losses of power of fixed solar panel or at tilt angle of 35 degree 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 temporarily fail panel. Dry Cleaning cannot remove all the dirt on the surface of solar panel. But if it is able to remove the outer layer of the dust, cleaning solar panels with water increases cleaning efficiency by removing the majority of the dirt deposited on the panel. No external power is required as a self-cleaning system. It powers from the battery of the solar panel. This device is made up of lightweight material, so the power consumed is low as compared to manual cleaning of the solar panel. Due to automatic operation, the cost of automatic proves to be economic and significantly less cumbersome. Particularly in systems having a large number of solar panels, work with transmittance is consistent all the time. The solar panel cleaning system is designed taking into consideration all the design parameters according to ASME.

The CAD Model Design was then fabricated and test and trial were conducted accordingly :-

1. The Rack and Pinion Design worked as it was designed to do.
2. The Linear rack and pinion was working smoothly and was able to achieve forward and backward motion.
3. The cleaning action of brush was good. It was able to clean the dust but it failed to scratch tough stain.
4. The sticky dust is required to be cleaned by using jet of water and mopping action of brush.
5. Water drainage mechanism needs to be adopted in order to save water and recycle it.

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