

# **Autonomous Solar Panel Cleaning Robot**

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**Abstract:** *The dust particles accumulating on the solar panels will prevent the solar energy from reaching the solar cells, thereby reducing the overall power generation. Power output is reduced as much as by 50%, if the module is not cleaned for a month. In order to regularly clean the dust, an automatic cleaning system which removes the dust on the solar panel is developed. In this paper, the problem is reviewed and the method for dust removal is discussed. A robot cleaning device is developed and it travels the entire length of the panel. A PIC microcontroller is used to implement robots control system. The robot provided a favorable result and proved that such a system is viable by making the robotic cleaning possible, thus helping the solar panel to maintain its efficiency.*

**Keywords:** Security, net metering, and smart grid

## **I. INTRODUCTION**

After the invention of the solar cell, the solar technology reached the skies by implementing solar panels that use the solar energy to generate electrical energy. Renewable energy is used in all the industries and they use huge solar panels in more numbers in the form of an array. On the other hand it has also started playing a major role in the household usage. Now the problem with the implementation of solar panels is, their maintenance. Different cleaning methods are used to clean the solar panels to maintain their efficiency. After one year of exposure without cleaning, the systems were cleaned using pressurized distilled water spray with brushing for one of the plant that showed 6.9% energy generation efficiency. There are many factors that affect PV panel's 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. Cleaning dirty panels with commercial detergents Ideally, solar panels should be cleaned every few weeks to maintain peak efficiency, which is especially hard to do for large solar panel arrays.

There is a need for an automated cleaning solution to this problem which can service large ground based solar array up to an operating park of 22,000 panels (20,000 Square meters).

## **II. LITERATURE SURVEY**

[1] Mukadam et.al we designed and built an automated self-cleaning solar panel. The panel detects the occurrence of an impediment shading a cell, and actuates a cleaning mechanism that cleans off the impediment and consequently, restores the panel to normal capacity.

[2] Kokila et.al Solar panel has gained its importance in our day-to-day life as a replacement for conventional electricity. The solar panel converts the solar energy into heat or electrical energy. Due to the accumulation of dust on the surface of the solar panel, the incident light is blocked from the sun.

[3] Glasser et.al The solar photovoltaic collection at the Miller Auditorium is a 50 kW DC system that has been depending on five seasonal angle adjustments and no cleaning measures to reach at the mean value of 64.7 MWh annual energy generation from the time of 2012.

[4] Bansal et.al the energy or efficiency produced by solar photovoltaic modules is related with the sun's available irradiance and spectral content, as well as other factors like environmental, climatic, component performance and inherent system



## 2.1 AIM AND OBJECTIVE

- To design a solar panel cleaning robot which can increase the efficiency of solar panels.
- To Increase the use of solar panels.
- To make the cleaning of solar panels simple and automated.
- To minimize human intervention.
- To create an environment friendly cleaning robot

## 2.2 NEED

According to some estimates, working in the Solar industry, is three times more dangerous than being employed in the Windrower sector.

When calculated in relation to the amount of power each industry produces, it's more than ten times more dangerous than nuclear power.

As a result, there are believed to be around 100 to 150 deaths in the worldwide Solar industry each year.

Accumulation of dust on even one panel, reduces their efficiency in energy generation. That is why; the panel's surface should be kept as clean as possible.

Current human-based cleaning methods for Solar panels are costly in terms of time, water and energy usage.

No automation has taken place in cleaning the solar panels, so, there exists a need for developing automatic cleaning machines which can clean and move easily on the glass surface of the panels.

## 2.3 PROBLEM DEFINATION

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. Further this problem has also resulted in huge losses for the solar power plant operators which suffer from reduced power output because of frequent dust storms. Most widely used method of cleaning the solar panels are through the manual labour. Apart from being time taking, there is also a risk of damage to the expensive solar panels by the unskilled labour which is involved in this method. The purpose of this project is to develop an automatic self cleaning robot for cleaning the solar panel so that the process can become more reliable and faster, thus increasing the power output of the solar power plant.

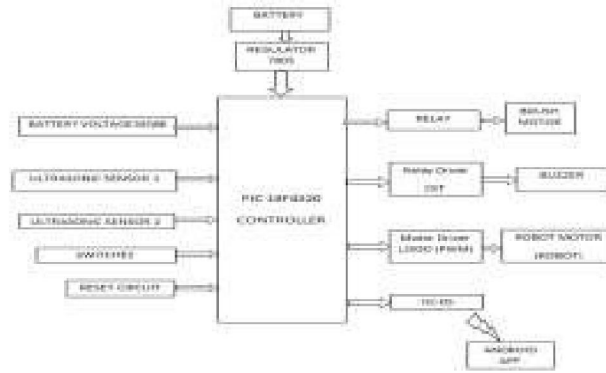
## III. WORKING

The proposed solar panel cleaning robot is used to remove the dirt and dust deposited on the solar panel thus helping the solar panel to absorb the maximum quantity of energy.

The proposed system consists of two main parts, the first is the cleaning robot and the second is the carrier robot. the carrier robot acts as a carrier that carries a cleaning robot by moving from one panel to another. the cleaning robot travels along with the carrier robot, covering the entire length of the panel. The brush which is attached to the cleaning robot takes away the dirt and dust from the panel. the robot is programmed with a microcontroller and Arduino which controls its operations and its movement from one panel to the other panel. the main criterion of the cleaning system design is its ability to clean multiple panels in a solar farm using a single robot. such a system is considerably much

simpler than having multiple robots in the same farm working simultaneously. In practice, cleaning of solar panels should be frequently done which makes the process more laborious and expensive.

### 3.1 System Diagram



Hardware and Software Tools :

#### Hardware tools:

- PIC 18F4520 microcontroller
- Rechargeable battery
- Motor driver IC
- Ultrasonic Sensor
- Bluetooth module
- Relay driver circuit
- DC motor

#### Software Tool:

- PCB wizard for PCB designing
- Protel SE99 for Circuit designing
- MPLAB IDE software
- EMBEDDED "C" language

#### Project Plan/Schedule (Gantt chart)



#### Applications

- Applicable for floor cleaning system
- Glass Surface/ Roof Cleaning System

**ADVANTAGES :-**

- Increased Energy Production
- Minimal Maintenance
- Protect Panel Warranty
- No Personal Injury Risk
- Completely Green

**IV. FUTURE SCOPE**

The device that is developed, reduces the number of workers needed to clean the arrays significantly. Further development could be done to optimize the system to be smaller, lighter and easier to assemble in higher volumes and to become more user- friendly. The next focus will be on diversifying the robot's functionality by including auto inspection, communication and self-diagnostic features.

The installation of a thermal camera module that will allow for inspection of the panels since the cleaning head is in direct contact with every individual panel. Cold spots just under the glass surface will indicate a section of panel that remains un- cleaned and will prompt the cleaner to make another pass if needed. Solar panel energy can be used instead of using individual battery. Wireless cameras can be also attached for perfect wireless operation

**V. CONCLUSION**

This project highlights the effect of dust, dirt, pollen, sea salt, and bird droppings on the PV systems' efficiency. Dust has a major impact on the efficiency and performance of the solar panels. The reduction in the peak power generation can be up to 10 to 30%. Power reduction was observed due to dust accumulation on the panels and this can be improved by using robotic cleaning method. It has increased Power generation capacity of the solar panels. Easy maintenance, low cost and less power usage are few advantages of this process. Finally, the reduction in the peak power generation can also be overcome by using this cleaning system. The device is lightweight because most of its material is made of aluminium.

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 with large number of solar panels. Frequent and periodical cleaning ensures that the solar panels work consistently with a good transmittance at all times

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