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# Solar Panel Cleaning robot

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***Abstract :*** *In this project, various studies revolving around how dirt and dust affect the performance of solar panels depending upon different regions, as different areas have different soil compositions and how they are different from one another. A new way of approach to the domestic solar panel cleaning system, researchers have proposed many ways to improve and classify the object and present it in an image in the past. However, there have few projects related to domestic cleaning of solar panels. Due to the inconsistencies in cleaning especially in region where rain is not the most convenient option for cleaning. On continuous using of solar panels, a layer of accumulated dust particles is settled on the surface of solar panels or PV panels which affect the result of decreasing in efficiency by 50 %. By cleaning on regular intervals it decreases this soil loss. Various data have been collected which shows the importance of domestic solar panel cleaning for future generation.*

## I. INTRODUCTION

As the range of applications for solar energy increases, so does the need for improved materials and methods used to harness this power source. There are several factors that affect the efficiency of the collection process. Major influences on overall efficiency include solar cell efficiency, intensity of source radiation and storage techniques. The materials used in solar cell manufacturing limit the efficiency of a solar cell. This makes it particularly difficult to make considerable improvements in the performance of the cell, and hence restricts the efficiency of the overall collection process. Therefore, the most attainable method of improving the performance of solar power collection is to increase the mean intensity of radiation received from the source.

There are three major approaches for maximizing power extraction in medium and large scale systems. They are sun tracking, maximum power point tracking or both. The solar tracker, a device that keeps photo voltaic or photo thermal panel in an optimum position perpendicularly to the solar radiation during daylight hours, can increase the collected energy from the sun by up to 40%. Usually the fixed PV panels cannot follow the sun movement. The single- axis tracker follows the sun's East West movement, while the two-axis tracker follows the sun's changing altitude angle too. Sun tracking systems have been studied with different applications to improve the efficiency of solar systems by adding the tracking equipment to these systems through various methods. A tracking system must be able to follow the sun with a certain degree of accuracy, returns the panel to its original position at the end of the day, and also tracks during cloudy periods.

## II. LITERATURE SURVEY

**Masuda S. et. al,** In this patent paper, inventor has invented a transparent technique for solar PV panel's dust Cleaning on self. The shield is a panel of clear non-conducting (dielectric) material with embedded parallel electrodes. The SPV panel is coated

with a semiconducting film. Electrodes are attached to a single phase AC signal or to a multi- phase AC signal that produces a travelling electromagnetic wave.

**Williams R B. et. al**,In this paper author has worked on a particular downfall of Electrodynamics Screen (EDS) and tried to resolve it by providing an integrated approach. An EDS based systemrequires a high-voltage external power source for its operation, but the EDS can be madeself-sustainable with the power output from the PV cell itself. Author incorporates atransparent EDS with a PV array as its power source to make itself sustainable.

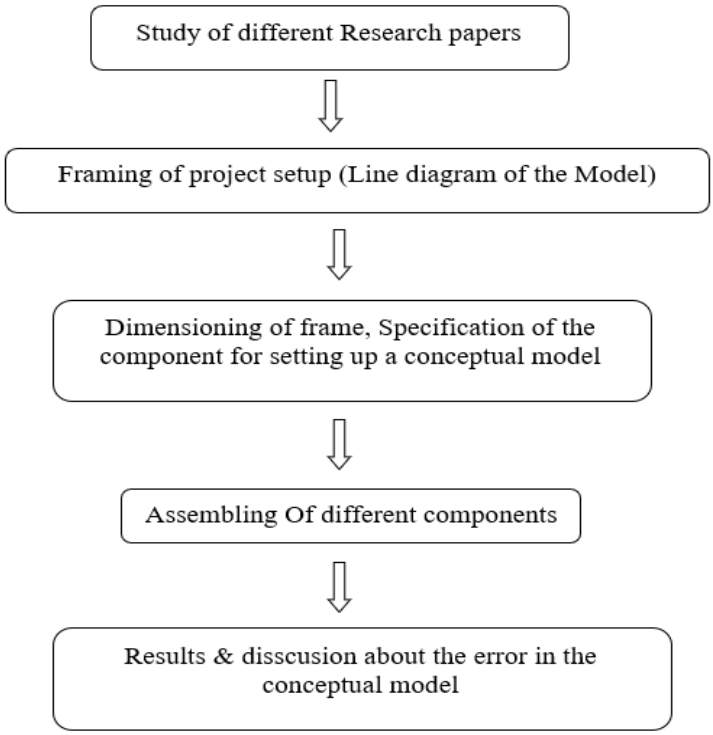
The principal objective of this work is to study the effect of dust and dirt on solar panels and study all aspects of a possible cleaning system which increases the efficiency of solar panels. We studied almost 20 research papers ,daily articles and attended the 13th edition of Renewable Energy India 2019 Expo which helped us to expend our research at different stages. Throughout our whole research; we read several papers from different sources some of the important points are given below.

The accumulated of dust is responsible for soil loss on solar panels which decreases its efficiency of generation of solar energy. It has to be cleared on regular interval of time for better results. Dust settlement for the most part depends on numerous components like compound properties, size, weight, shape, site, tilt point surface completion, stickiness, wind speed, etc. Dust exposure affects many parameters of SPV; so several attempts have been made to address this issue.

Dust particles are very common in the atmosphere. In some places, it is found settled but at some it is not; for example in National Capital Region (NCR) the dust particles coming from Rajasthan drift towards NCR and causes a dip in the air quality of Delhi also considering the fact that Delhi and NCR region is highly polluted on its own making the are much more polluted. And when it gets settled it may be also settled on solar panels or PV panels and according to studies the layer accumulated dust on the surfaces of solar panels.

## III. METHODOLOGY

### 3.1 Methodology Of Working Process:




### 3.2 Simulation method:

The finite element method (FEM) is used for strain analysis of PV panels, with the simulation process described in Figure 3. Initially, the mechanical properties shown in Table 1 were defined. Subsequently, a physical model of the PV panel was created using ANSYS SpaceClaim. The contact areas between the belt and the surface of the PV panel, as well as between the support bars and the aluminum truss, were also generated. The physical model of the PV panel was then discretized into smaller elements by ANSYS Meshing. The tempered glass sheet, with its simple structure, was meshed using 10 mm-hexahedral elements, while the aluminum frame was meshed using 5 mm-tetrahedral ones. complexity of the aluminum frame compared to the tempered glass. Next, the boundary conditions for fixed support and external load were set according to the parameters mentioned in Table 2. Finally, the solution for directional deformation was defined, and the necessary data was extracted for determining the curvature deformation of the PV panel.

**3.3 System Design:**

In our attempt to design a special purpose machine we have adopted a very a very careful approach, the total design work has been divided into two parts mainly;

- System design
- Mechanical design

System design mainly concerns with the various physical constraints and ergonomics , space requirements, arrangement of various components on the main frame of machine no of controls position of these controls ease of maintenance scope of further improvement ; weight of m/c from ground etc.

In Mechanical design the component in two categories.

- Design parts
- Parts to be purchased.

For design parts detail design is done and dimensions thus obtained are compared to next highest dimension which are readily available in market this simplifies the assembly as well as post production servicing work.

The various tolerance on work are specified in the manufacturing drawings the process charts are prepared & passed on to the manufacturing stage .The parts are to be purchased directly are specified &selected from standard catalogues.

**3.1.1 System selection based on physical constraints:**

While selecting any m/c it must be checked whether it is going to be used in large scale or small scale industry in our care it is to be used in small scale industry so space is a major constrain .The system is to be very compact it can be adjusted to corner of a room. The mechanical design has direct norms with the system design hence the foremost job is to control the physical parameters so that the distinction obtained after mechanical design can be well fitted into that.

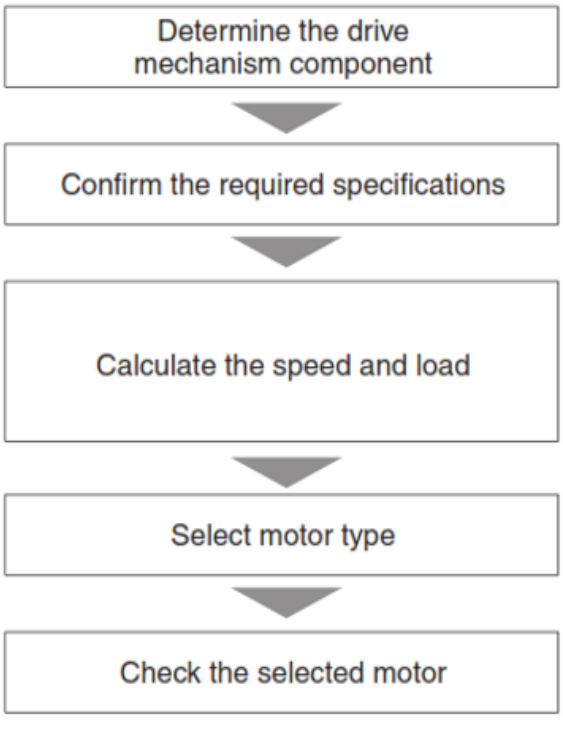
**3.4 Project Methodology For Implementation:**

The cleaning methods of solar panel can be broadly classified into active methods and passive methods.

- Supporting frame: Frame provides strength to the model which makes the project capable of exhibited by the 3D printer, hence the sustaining different weather conditions.
- Guide blocks: Blocks provide path for the motion of the cleaning and also connects the cleaning block to the motor.
- Lead screw: Converts rotation motion of motor into translation motion of the rods for cleaning.
- Rotating cleaning cloth: Micro- fiber cloth attached to a rotating rod which allows it to rotate at a specific speed for cleaning.
- Cleaning block: The middle part of the mechanism which does the primary motion covers the plane of the solar panels. The bottom surface has been integrated with micro-fiber cloth which is quite common in the cleaning of solar panels.

**3.5 Motor Selection:**

This section describes certain items that must be calculated to find the optimum motor for a particular application. Selection procedures and examples are given.




- First, determine certain features of the design, such as drive mechanism, rough dimensions, distances moved, and positioning period.
- Confirm the required specifications for the drive system and equipment (stop accuracy, position holding, speed range, operating voltage, resolution, durability, etc.).
- Calculate the value for load torque, load inertia, speed, etc. at the motor drive shaft of the mechanism. Refer to page 3 for calculating the speed, load torque and load inertia for various mechanisms.
- Select a motor type from AC Motors, Brushless DC Motors or Stepping Motors based on the required specifications.
- Make a final determination of the motor after confirming that the specifications of the selected motor/gearhead satisfy all of the requirements (mechanical strength, acceleration time, acceleration torque etc.).

## IV. Constriction And Working

The 3D design of the robotic unit is shown in Figure 3, which majorly consists of DC motor for translational motion, brushless motor for the rotatory motion of cleaning brush, control circuitry box, power supply solar module. The fabricated prototype is shown in Figure 4 mounted on a demonstration solar module of 40 Watt.

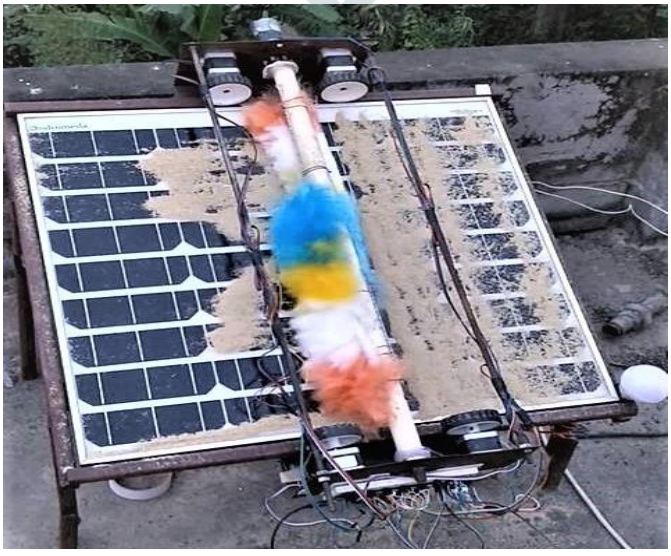


**Figure: From research paper Robotic Unit: Fabricated Prototype**

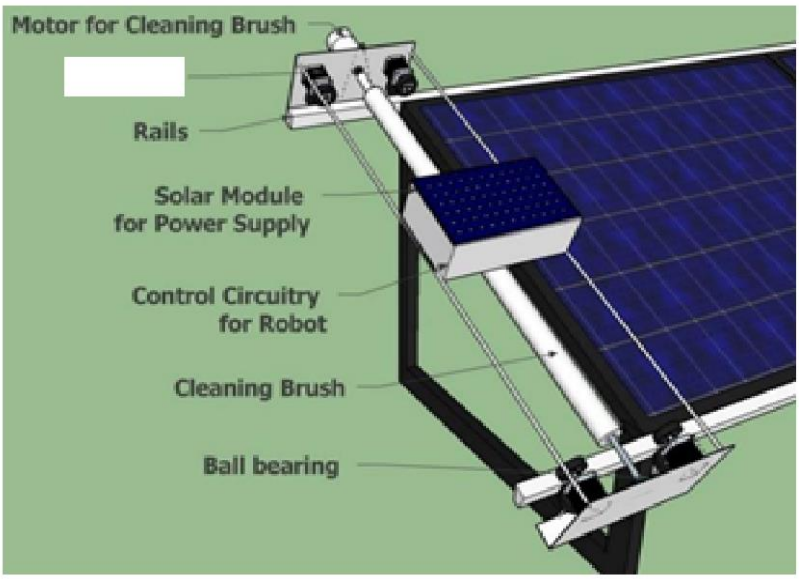
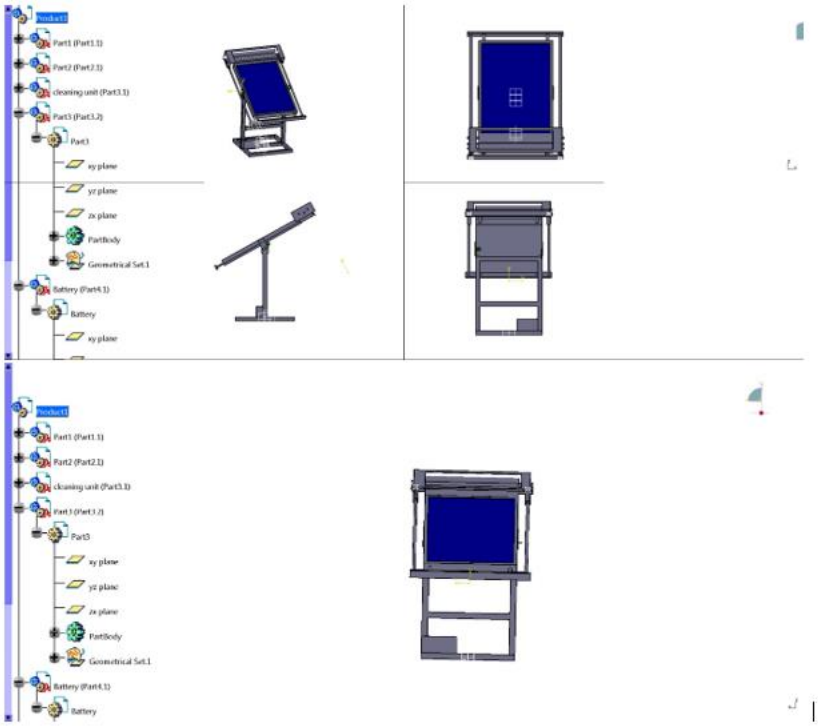


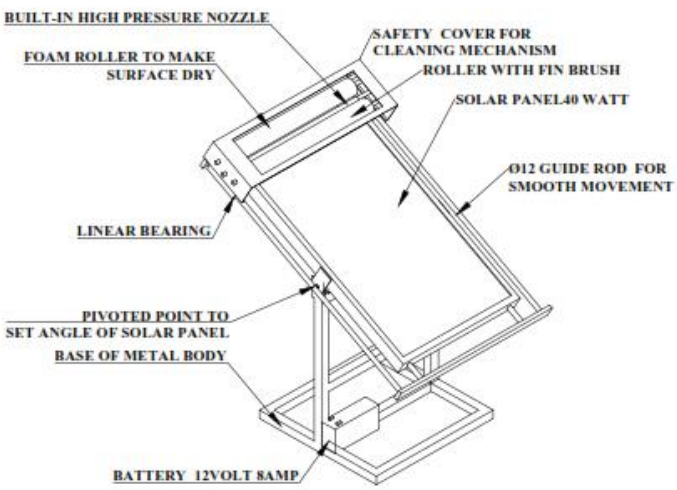

**Figure: Robotic Unit: 3D Model**

### 4.1 EXPERIMENTAL WORKING

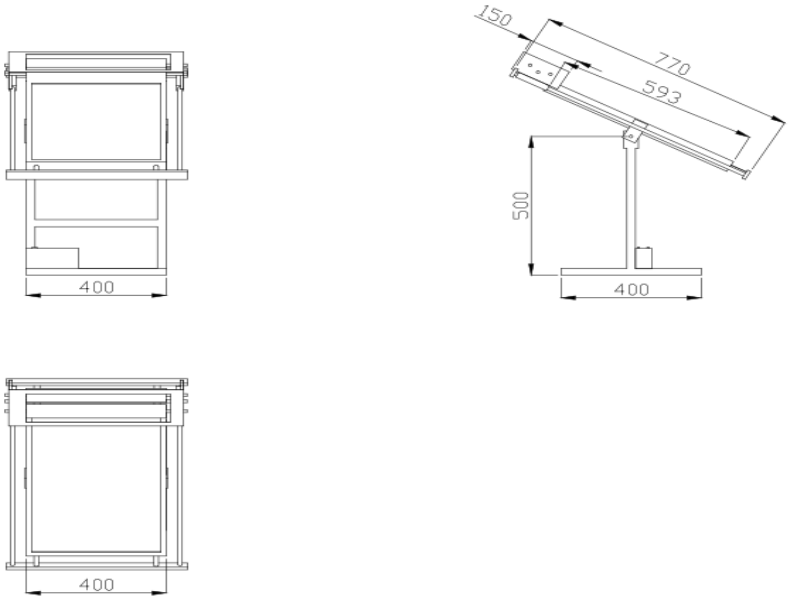
#### 4.1.1 Automatic Cleaning

The prototype of an autonomous unit is intended to generate a "time to clean" signal when the performance of the solar farm degrades below the specified limit. An experimental set up is done to develop a regression model by collecting data from two different scenarios: a totally clean and completely covered dusty panel. The developed regression model is single switch operated such that it detects the worst condition when the panel needs cleaning action.

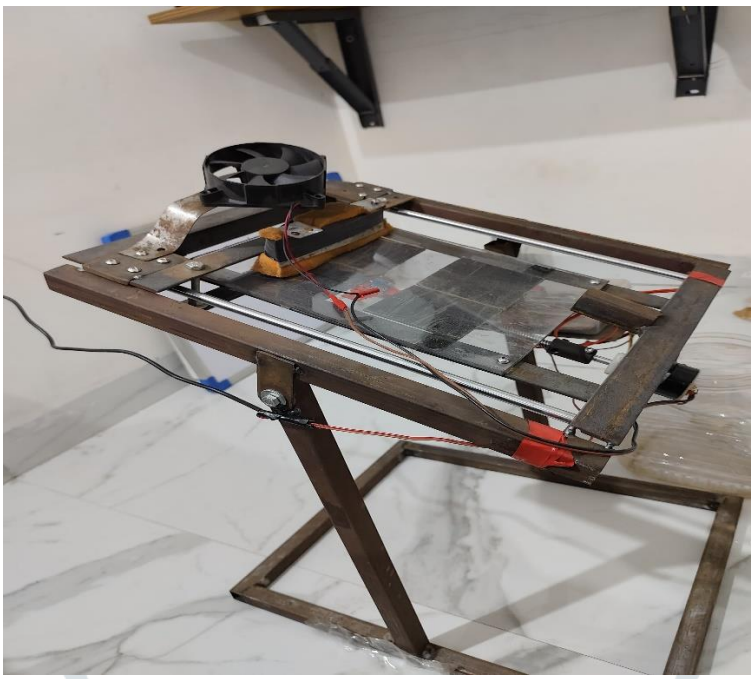





**3D model drafted in AutoCAD**



## V. RESULT



## VI. CONCLUSIONS

Existing automated cleaners mainly focus on large arrays and in general are unsuitable for installing on smaller arrays namely residential roofs. For those with limited space this means that a smaller array only needs to be installed, hence our idea serves as a huge advantage for those smaller sites. Our system can be installed for roof top solar panels. The solar panel cleaning system was first designed taking into consideration the design parameters. Our model was tested and the following observations were made. The rack and pinion mechanism work as it was designed to do.

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