

# Automatic Solar Panel Cleaning System

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## ABSTRACT

Energy is one of the major issues that the world is facing in India, the supply of energy has been one of the major problems for both urban and rural households. About 60% to 70% of the energy demand of the country is met by fuelwood and agriculture residues. Solar energy is a renewable source of energy, which has a great potential and it is radiated by the sun. Renewable energy is important to replace the using of electric energy generated by petroleum. Solar power has become a source of renewable energy and solar energy application should be enhanced. The solar PV modules are generally employed in dusty environments which are the case tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. The cleaning system has been designed cleans the module by controlling the Arduino programming. To remove the dust in the PV modules to improving the power efficiency.

**Keyword:** Rolling brush, Arduino board, DC Gear motor, Gear wheels.

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## 1. 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.

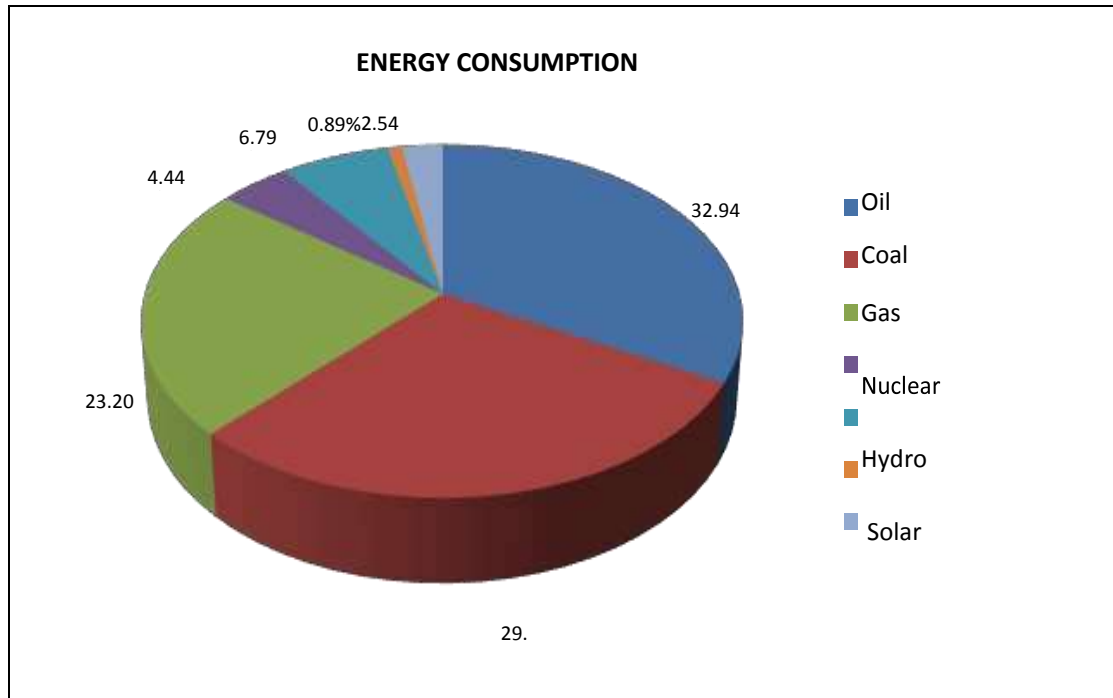


Figure 1. Pie Chart of Energy Consumption

### 1.1. CLEANING METHODS FOR PV PANEL'S

#### 1.1.1. Natural Removal Of Dust

The natural powers are employed to remove the dusts, such as wind power, gravitation and the scour of the rainwater. The effect of this method is not very well. It is seen that the solar cell array can be turned to vertical or oblique position to remove the dusts easily when early morning, late evening, night and a rainy day. However, the rotation of the large solar cell array is very difficult.

#### 1.1.2. Mechanical removal of dust

The mechanical methods remove the dusts by brushing, blowing, Vibrating and ultrasonic driving. The brushing methods clean the solar cell with something like the broom or brush that were driven by the machine was designed just like windscreen-wiper. However, firstly, because of the small size and the strong adhesively of the dusts, the cleaning method is inefficient. Secondly, the abominable working environment of the solar cell makes the maintenance of the machine difficult. Then, due to the large area of the solar cell array, the cleaning machine is powerful. Lastly, the surfaces of the solar cell maybe were damaged by the brush when wiping. The blowing method cleaning the solar cell with wind power is an effective cleaning one except the low efficiency, high energy-consumption and the unsatisfactory maintainability of the blower.

#### 1.1.3. Electrostatic removal of dust

If there are a high potential on the surface of the solar panels, the charged and uncharged dusts will be attract to the panels because of the electrostatic forces. Then, the dust particles will be charged by the solar panels finally, so they have the same electric charge and the electrostatic forces between them are repulsion. At last, the dust particles will float away the solar panels. However, this strategy cannot be used in PV system, because of the effecting of the rain on earth.

## 2. OBJECTIVE

- To clean the solar panel effectively.
- To make the system automated using Arduino.
- To avoid the manual work.
- To avoid dust associated problems on solar panels.
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## 3. COMPONENTS USED

1. Mild steel frame.

2. Aluminum channel.
3. Aluminum L frames.
4. Running lengths (Rack).
5. Gear wheels.
6. Rubber wheels.
7. DC gear motors.
8. Rolling brush.
9. Arduino board.
10. Driver boards

#### 4. METHODOLOGY

- Literature survey.
- Design of model.
- Material selection.
- Fabrication.
  - i. The first frame is fixed. It is made of mild steel.
  - ii. The second frame is movable frame, it is made of aluminum. Moving in horizontal direction
  - iii. The third frame is brush moving in vertical direction.
  - iv. The above frames are controlled by Arduino programming.
  - v. Arduino is micro-controller device in which the program is been dumped into it, and through the help of this micro-controller the aluminum frame moves.

#### 5. 2-D DIAGRAM OF SOLAR PANEL CLEANER

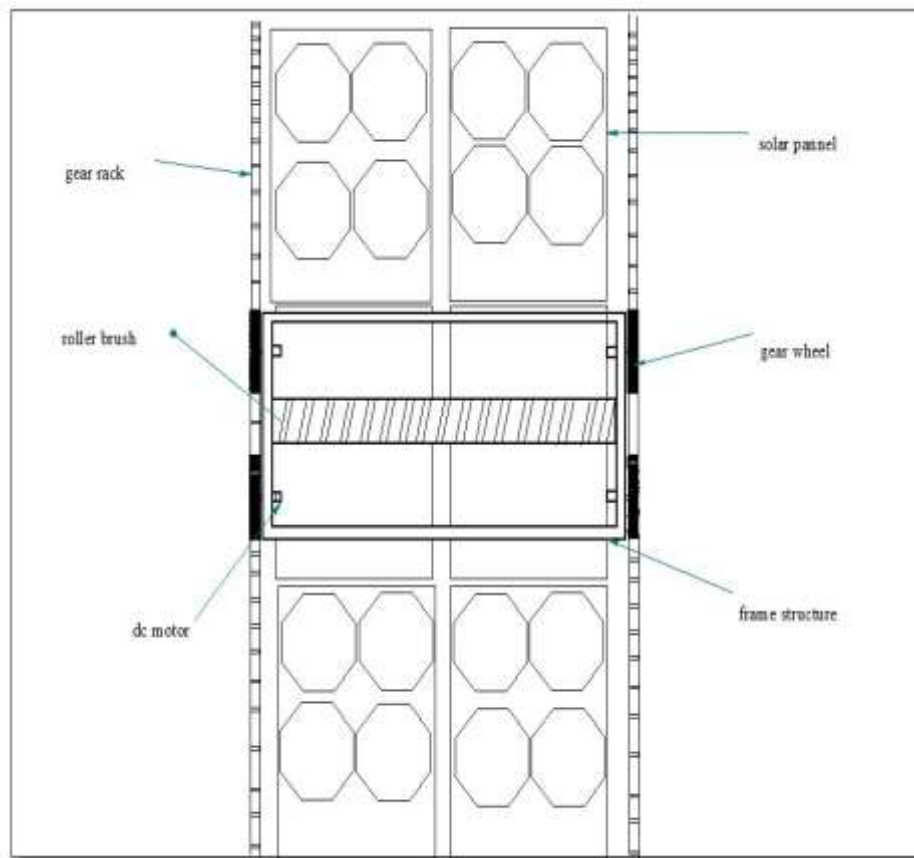
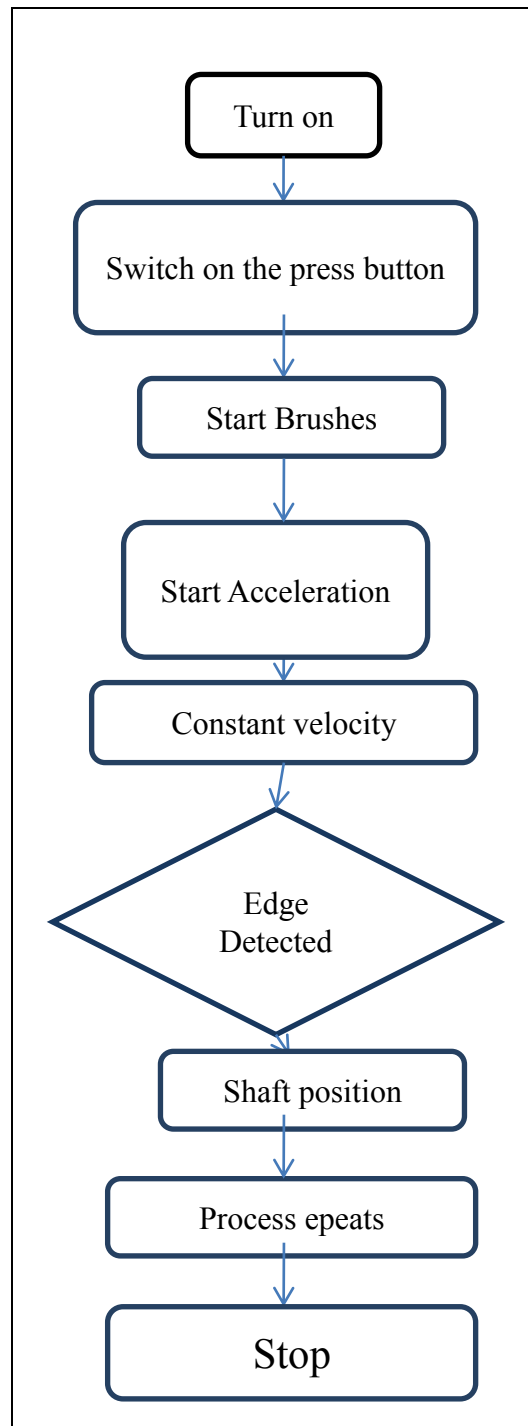


Figure 2. Top view of solar panel cleaner

## 6. WORKING PRINCIPLE



**Figure 3. Flowchart Of Cleaning System**

1. In accordance with the dimensions of the flat plate panel the solar panel cleaning system consists of brush driven by DC motors and actions of brushes is controlled by signal generated by Arduino.
2. The frame carrying this cleaning brush is moved along the length of the solar panel in vertical direction of 11ft and vice-versa, which results in mopping action on the solar panel cleaning the panels. This frame is also consists of DC motors which will produced the rotational motion which is converted into linear motion through rack system. This action is also controlled by signal generated by Arduino.
3. The shifting of frame from one solar panel array to another solar panel array is also carried out using gear motors.
4. The frame is shifted in horizontal direction of 9ft cleaning 3 sets of solar panel arrays.

5. All this cleaning actions will consume a time of 300sec for mopping action for both movements of cleaning system in horizontal direction and vertical directions.
6. Once one array of the solar panel is cleaned, it moves to another array and hence the cleaning process gets repeats.

### 6.1 Cleaner Installed On Solar Panel



Figure 4 : Solar cleaning model

### 7. ADVANTAGES

- Cost of production is low
- No need to purchase heavy machinery
- Reduces threat to human life
- Manual assistance is not required
- Working principle is quiet easy.
- Portable.
- Autonomous self-cleaning mechanism that can be attached to solar panels and operated without human operation.
- It is easy to construct, low cost and low maintenance.

### 8. DISADVANTAGES

- Rolling brush which consists of electrostatic cloth would need to change.
- Needs to be scaled for a larger project (ex: increase in the torque of the motor)
- System is not powered by photovoltaic cells instead it consumes electric power for its necessary actions which leads to additional cost for power.
- Ineffective for sticky dust and cannot clean the dust at the corners.
- The sticky dust need to be removes using hard brush or through mopping action.

### 9. FUTURE WORK

- In this project there is a great scope to modify it in different ways like increasing its operation by using surface vacuum cleaners and spray of waters.
- This can be modified by sensors.
- In this project electric supply has been used through power supply, this can be modified by using solar panel for power supply.
- Silicon brushes can be used where it gives max life of cleaning.
- Arduino programs can be replaced by better and variety of micro-controllers.
- It can also be controlled by using remote controllers for necessary cleaning actions.
- Rack system can be replaced by belt drives.
- Even though our project worked perfectly and was functioning as initially planned, there are still a lot of improvements that can be made to make it more effectively in cleaning.

## 10. CONCLUSION

- 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.
- The linear actuator system worked very nicely and was able to achieve the required design parameter.
- The cleaning action of the brush was good but it failed to scrub the dust which was sticky in nature.
- The sticky dust needs to be remove using hard brush or through mopping action.  
So as we know prevention is better than curing as a result the cleaning action prevents the primary accumulating surface dust on the solar panel before it becomes to sticky to remove.

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