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# SOLAR PANEL CLEANING ROBOT

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***Abstract*— This work is about the design and development of a solar panel cleaning system. The main object of this design prototype is to clean the solar panel using an electrical mechanism, such that efficiency or quality of solar panel is not compromised. As a matter of fact, gulf region especially Saudi Arabia- are facing a lot of dust storms and the solar panels need to be cleaned frequently. If task is performed manually, it will be very costly and time consuming. Water sprinklers and a special wiping material shall be used in the conceived mechanism design to insure quality of cleaning."**

## I. INTRODUCTION

At present, there is a great interest towards solving the energy problems faced by the world. This has led to research on alternative energy source that would complement the conventional fossil fuel. Solar is a natural energy source. Solar energy is the energy generated by harnessing the power of the solar radiation. It is the cleanest source of energy whose use can contribute to saving exhaustible energy sources. Such systems are based on a solar collector, designed to collect the sun's energy and to convert it into either electrical power or thermal energy.

There is urgency in improving the efficiency of solar power generation. Current solar panels setups take a major power loss when unwanted obstructions cover the surface of the panels. The obstruction turns the shaded cell into a resistor, causing it to heat up and consume extra power. To address this issue, we are going to design one automated solar panel cleaning system which is very easy to implement. So, stop worrying about climbing the roof top every time.If accumulation of dust on the PV panel reduces its transmittance, then results in the reduction of the power output, therefore 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 [2]. After some particular time period density of dust increases to level where power output reduces to the extent which is not able to support its vital functions.

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 is through the manual labor. Apart from being time taking and cumbersome, there is also a risk of damage to the expensive solar panels by the unskilled labor which is involved in this method. The purpose of this project is to develop an automatic self-cleaning mechanism 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.The light intensity is monitored using an LDR sensor. The power supply consists of a step-down transformer 230/12V, which steps down the voltage to 12V AC. This is converted to DC using a bridge rectifier. The ripples are removed using a capacitive filter and it is then regulated to +5V using a voltage regulator 7805 which is required for the operation of microcontroller and other circuits.

It is shown that panel efficiency may be reduced by up to 5% to 10% from build up dust particles alone. Adding in other factors such as falling leaves, bird dropping and water streaking, the

efficiency of these panels can be further reduced to as much as 10 – 30% [1]. Some studies linked about reduction in output. In the case of a commercial installation, this would be a significantly higher cost. For this project, we focused for more of a smaller scale, as in the case of residential use.

## II. LITERATURE SURVEY

Earlier People were not much aware of the renewable sources and conservation of non-renewable sources but later solar panels were developed for the use of renewable sources. Then systems were developed to clean the panel manually.The conventional energy resources consist of Oil, coal, Gas, Nuclear, Hydro and Solar energy.The consumption of these resources is given below in the form of pie chart as shown in figure [3]-July 2018

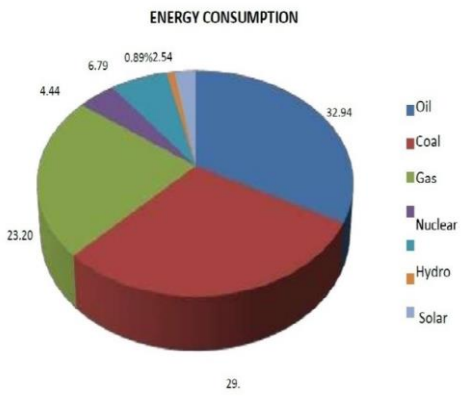



**Fig 1: Pie Chart of Energy Consumption**

India has tremendous scope of generating solar energy. The geographical location of country stands to its benefit for generating solar energy. The reason being India is a tropical country and it receives solar radiation almost throughout the year, which amounts to 3000 hrs. of sunshine. This is equal to more than 5000 trillion kwh. Almost all parts of India receive 4-7 kwh of solar radiation per square meter. This is equivalent to 2300-3200 sunshine hours per year. States like Maharashtra, Punjab, Rajasthan etc. have great potential for tapping solar energy due to their location. Since majority of population lives in rural area, there are much scope for solar energy being promoted in these areas[2]. Use of solar energy can reduce the use of firewood and dung cakes by rural household.

**Fig.2:Manual Cleaning of Solar Panel**

Various technologies being developed around the world for self-cleaning of solar panels are discussed below [3].

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 verydifficult.

2. Removal of dust using Mechanical Methods:

There are different types of methods that are used to clean solar panel. Few of them are mechanical vibration, ultrasonic cleaning, scrubbing and mopping.When brushing is used for cleaning, it is mainly done with the help of brush or scrubber. In these systems a brush is driven by using a machine, which are similar to automobile wipers. But this cleaning method is not that efficient because of the sticky nature and small size of the dust particle. It is

also seen that difficult and harsh working condition of the solar power plant make themaintenance of these machines difficult. Also, the solar power plant is present over a very large area which makes this cleaning method expensive and inefficient.The process of blowing of air on the surface of the solar panel is an effective method but it has some negative features such as low efficiency, huge energy usage and difficulty in maintenance of blower arrangement. Mechanical methods of cleaning also include ultrasonic and vibrating method. The factors that are considered in this process include driving methodologies, amplitude and frequency of vibration. Williams R. Brett has used piezo electric and piezo ceramic actuation methods for making self-cleaning solar panel system. These system work on the above described vibrating method.

3. Removal of dust using Nano-Film:

When the solar panels have a layer of pellucid Nano films capable of self-cleaning, it cleans itself automatically. The Self-Cleaning Nano-Films method mainly use two strategies for cleaning the solar panel, namely Super-Hydrophilic Material or Super – Hydrophobic Materials. These two strategies are explained below.

Super-Hydrophilic Material:

TiO2 is one of the most popular super – Hydrophilic material which has both hydrophilic as well as photocatalytic properties. This method has two stages in its cleaning process. In the first stage, which is a photocatalytic process, the ultraviolet light falls on the TiO2 film and the film reacts with it splitting the organic matters in the dust. Now in the second stage, the hydrophilic nature of the TiO2 diffuses the rainwater on to the surface of the solar panel and rinse the dust. But this method is not that popular because solar power plants are mainly located in the arid region where rainfall is very scarce and erratic in nature.

4. Electrostatic removal of dust:

If there are a high potential on the surface of the solar panels, the charged and uncharged dusts will be attracting to the panels because of the electrostatic forces. Then, the dust particles will be charged by the solar panels finally, so they have the sameelectric 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.

**Fig.3: Roller Mechanism**

Following are some research works on the relevant topics of the project.

In desert regions the dust affects the solar panels to a great extent and also reduces its efficiency, this paper focuses on cleaning the dust in such regions with the help of minimum water and energy. For this a non-pressurized water system are uses. It was observed that a 14-kW PV power plant was installed in Egypt whose efficiency decreases to 50% after 45 days by using non-pressurized water system, while it remained constant when a mixture of cationic and anionic surfactants was used for cleaning. Thus, using developed systems for cleaning increases efficiency and reduces the amount of water required.

Various cleaning methods of solar panel includes electrostatic cleaning system, super hyperbolic coating methods, mechanical method, microcontroller based automatic cleaning method, self-cleaning nanodimers and various characteristics of dust particles are discussed in this paper. This paper throws light on various cleaning methods for solar photo volatile panels.

In areas of most oil reserves the PV panels are adopted due to its growing popularity in recent years. PV module installation depending upon efficiency is related to its geographic location. The PV panels are adjusted in such a way to get maximum sun exposure. Dust is the lesser known factor that influence the efficiency of the PV panel. In this paper research and studies related to the impact of dust on the PV solar panels are discussed.

Automatic Solar Panel Cleaning System includes that the cleaning system designed cleans the module by controlling the Arduino programming[6]. To remove the dust in the PV modules to improving the power efficiency. 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.

PV efficiency measuring system and smart solar tracking is used on-site to measure power efficiency of panel and other parameters. At a given location while to find solar potential PV efficiency is of great importance. The device mentioned is able to measure PV efficiency, ambient temperature, humidity level, light intensity level and temperature of panel. A 24 V DC supply is required for the operation of device. All the data measured is stored in memory card and is transferred to other devices by using Bluetooth. Atmel Mega 2560 controller was used.

## III. BLOCK DIAGRAM

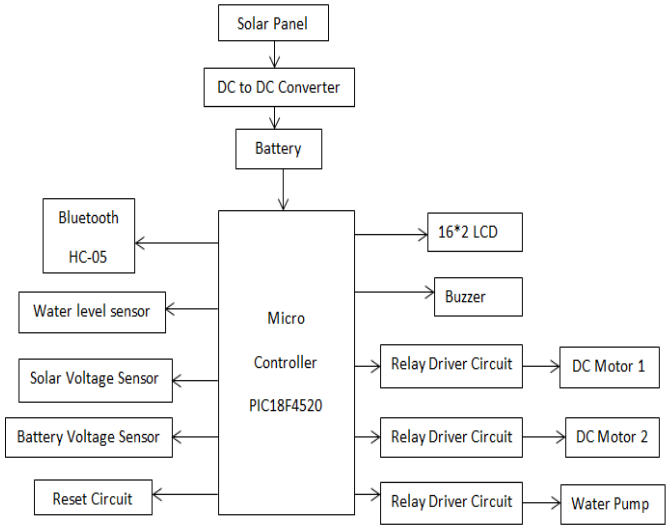
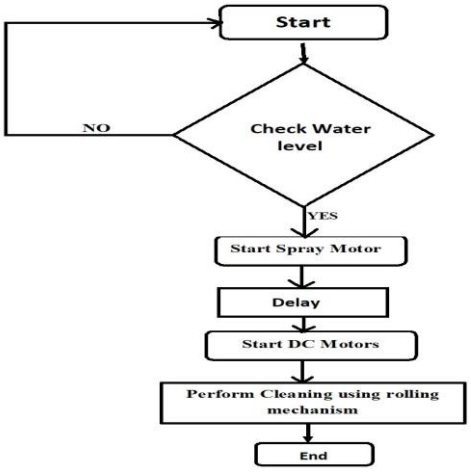



**FIG.2.1 BLOCK DIAGRAM**

The above block diagram consists of a solar panel which we have used to clean automatically using cleaning mechanism. It consists of one bracket which is mounted on side of solar panel array having pulley system. It converts rotational motion into translational motion with required torque. The cleaning mechanism has one brush mounted just above the surface of panel which slides with particular speed in linear direction.Spray motor is used to supply water which used to perform cleaning using relay driver circuit

## IV. FLOW CHART



## V. ADVANTAGES

- Every Automated cleaning system thus do not require any man power.
- Reduces threat to human life.
- Maximum power is harnessed throughout the year due to clean panel surface.
- Cost of production is low.
- Working principle is quite easy.
- Portable.
- It is easy to construct.
- Low maintenance.

## VI. APPLICATIONS

- All solar panel-based applications can be cleaned like Solar panels onspace crafts, solar panels in home appliances, solar panels in industries etc.
- It can be used to clean the exterior glass of the buildings by changing some assembly.
- It can be used to clean floor with some modifications.

## VII. RESULTS

The reduction of output power is reducing after cleaning of solar panel by water spray with using rubber wiper. The dirt, speck of particles or bird drop are the reasons of losses power. Another technique is dry cleaning cannot completely remove all dirt and other particles from solar panel, it`s only remove upper layer. In this system no external power is required, system uses rechargeable battery and also battery is recharge directly from solar panel. This system is made up of light weight- long lasting material, so the cost and power consumption is less compare to other system. Water is down the temperature of solar plate during the cleaning process, it`s also increase the ration of power generation.


In the beginning we have displayed the message **"WELCOME TO SOLAR PANEL CLEANING ROBOT"** on LCD. After that it displays "Solar Voltage, Battery Voltage and Efficiency of solar panel" before cleaning the solar panels. After cleaning it again displays increased efficiency, battery voltage and solar voltage.

## VIII. CONCLUSION

Existing automated cleaners mainly focus on large arrays and in general are not suitable for installing on smaller arraysnamely residential solar plants. Our systemrequires less space than a commercialarray also it is easy to install, therefore our idea serves as a huge advantage for those smaller sites.As we know

prevention is better than curing thus the cleaning action prevents the primary accumulating surfacedust on the solar panel before it becomes too sticky to remove. As a result, we can increase the efficiency of solar panel bykeeping the surface of panel clean and dust free using same renewable source of solar energy.

## IX. REFERENCES

I. B.A.D.J.C.K.Basnayake,W.A.D.M.Jayathilaka,Y.W.R.Amarasinghe,R.A.Attalage, "*Smart Solar Tracking and On-Site Photovoltaic Efficiency Measurement System*", July- 2016.

II. Dr. G. Prasanthi ME, Ph.D., T.Jayamadhuri, *"Effects Of Dust On The Performance Of Solar Panel And Improving The Performance By Using Arm Controller And Gear Motor Based Cleaning Method.",*2015.

III. Babu K , Dinesh Kumar p ,Kamala Priya S, Kathirvel P "*Solar Panel Cleaning Robot",* International Journal Of Innovative Science and Research Technology, Volume 3, Issue 3, March Dabhi Chirag and Gandhi Mayank,*"Design and Development of Solar Panel Cleaning Machine",* Scientific Journal of Impact Factor (SJIF):4.72,Issue SIEICON-2017,April-2017.

*IV.* Addanki Mark, Bhupathi Raju Dheeraj Varma, Chandra Sekhar Reddy Kanala, *"Design and Development of Solar Panel Cleaning System",* International Journal Of All Research Education & Scientific Methods , Volume 9, Issue 5, May 2021.

*V.* Manju B Abdul Bari and Pavan C M, *"Automatic Solar Panel Cleaning System"*, International Journal Of Advance In Scientific Research and Engineering (IJASRE), Volume 8,July- 2018.

*VI.* K.A. Moharram , M.S. Abd-Elhady, H.A. Kandil , H. El-Sherifet.al., *"Influence of cleaning using water and surfactants on the performance of photovoltaic panels",* volume 68 April-2013.

VII. MontoMani, RohitPillaiet.al., "*Impact of dust on solar photovoltaic (PV) performance: Research status, challenges and recommendations*",Volume 14(9), December-2010.

VIII. Rutvij P. Kulkarni, Mandar A. Kadam, Tushar T. Shinde, Nitin B. Sonone , Prof. Atul D. Atalkar, "*Automatic solar panel cleaning system"*,IJARES Journal,April 2018,pp.1173-1181.