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Automatic Solar Panel Cleaning Robot Using Ardino

Prof.Tanuja Hulavale[1], Gurudatta Bodake[2], Rhugved Chougule[3],Rohit Patil[4], Prathmesh Pujari[5]

[1]Asst.Professor Mechanical Engineering Vidya Prasarini Sabha's College of Engineering and Technology ,Lonavala, India

[2345]Student Mechanical Engineering Vidya Prasarini Sabha's College of Engineering and Technology ,Lonavala, India

thulavale1217@gmail.com,gurudatta.bodake@gmail.com, rhugvedchougule@gmail.com,rohitsanjaypatil2001@gmail.com, pujariprathmesh123@gmail.com

ABSTRACT

The solar photo-voltaic modules are generally employed in dusty environments e.g. tropical countries like India. The dust gets accumulated on the 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 designed cleans the module by Ardino control. The main objective is to remove the dust in the photo-voltaic modules to improving the power generating efficiency of the solar power generation system.

Keywords: photo-voltaic modules, ardino, power generation, dust particles

1.INTRODUCTION

As climate change and global warming threaten the future of our planet, it is becoming increasingly crucial to find sustainable ways to fulfill our energy requirements. One of the most efficient ways of moving towards renewable and non-polluting energy sources is to generate electricity using solar panels to harness the sun's energy. Since they have no moving parts, solar panels are one of the most cost-effective and low-maintenance ways of generating.

Despite all their benefits, the efficiency of solar panels can plummet if dust, dirt, and grime are allowed to accumulate. If maximum efficiency in power generation is to be maintained, solar panels need

to be cleaned timely. However, manually cleaning solar panels is hazardous and time-consuming. This Solar Panel Cleaning Robot aims to maintain the efficiency of solar power production by making sure the Sosslar panels are kept clean without putting humans at risk. This robot comes equipped with a roller brush and a water sprayer to clean all dirt and grime from the surface of the panels. The sprayer gets its supply of water through an onboard tank. The rubber caterpillar tracks ensure that this robot can adhere to the slick surface of solar panels. This robot operates remotely and wirelessly.

Along with large-scale industrial applications such as dedicated solar power plants, this robot can also help boost the efficiency of solar panels in smaller applications such as rooftop solar panels in homes and offices.

The innovative solutions to enhance the efficiency of solar energy systems, the development of a solar panel cleaning robot harnesses the power of robotics to address the challenge of maintaining optimal performance in photovoltaic arrays. This research paper explores the intersection of robotics and renewable energy, presenting a novel approach to automated maintenance within the burgeoning field of solar technology. By leveraging robotics, this proposed system offers a sustainable and cost-effective solution to the persistent issue of dust, dirt, and debris accumulation on solar panels, ultimately maximizing energy output and prolonging the lifespan of solar installations. At its core, the solar panel cleaning robot represents a fusion of cutting-edge robotics technology with the imperative for sustainable energy solutions. Through autonomous operation and intelligent cleaning algorithms, this robotic system minimizes the need for manual intervention while ensuring thorough and efficient cleaning of solar panels. This research not only underscores the potential of robotics in revolutionizing renewable energy maintenance but also highlights the significance of interdisciplinary collaboration in driving innovation towards a greener and more sustainable future.

Dust accumulating factors include:

1. Dust properties
2. PV panel composition
3. PV panel orientation
4. Surrounding environment
5. Wind velocity
6. Temperature and humidity

Features of Solar Panel Cleaning Robot:

- Maintains efficiency of solar panels by keeping them clean.
- Remote and wireless operation ensures workers aren’t put in danger
- Roller brush cleans all dust, dirt, grime, and debris.
- Equipped with water sprayer supplied with onboard water tank.
- Compact, portable, and user-friendly design.

2.LITERATURE SURVEY

Following is a list of researchers who has worked in area of solar panel cleaning Robot system:

One of the major issues that people face with the installation and the use of solar panels is the cost that is involved in it. But the cost can be drastically reduced by increasing the efficiency of each solar panel and hence reducing the number of solar panels that needs to be installed. Using less number of solar panels in order to get the required electricity will not only be cost efficient but will also help in having a positive impact on the environment. In order to improve the efficiency of the solar panels, there are two main aspects that need to be considered; the first aspect is the amount of light that falls directly on the solar, and the second aspect is how much of this light energy is capable of using effectively in order to generate power. The issue that is faced with the use of solar panels is the dust that forms over it. Dust on the cells of the solar panels reduces the efficiency of the solar panels to a large extent especially in Saudi Arabia where dust and sand storms are very common. Hence there will be an automated system that will periodically clean the solar panels in order to make sure that they perform at peak performance level. The use of right fabrication and controllers will help in making this project possible.

Sweezey et al. (2009) has produced another kind of robotic solar panel cleaning system which utilizes a support vehicle in addition to the cleaning head and moving trolleys, Similar to NOMAD and Ecopia systems, cleaning head sweeps the brushes on the surface of the panel. To move the drive system, DC motors of 12 volts are used. The upper and lower trolleys are capable to move in different positions and direction. This feature allows the system to clean the panels in square wave pattern.

Nishant Sarode and et al., (2023) presented the efficiency is adversely affected by the accumulation of dust, mist, bird droppings, and snow and therefore it is the need of the hour to have regular cleaning of solar panels. Along with the scheduled cleaning, it is also essential to have appropriate and effective solar panel cleaning. Conventionally, Solar panels are cleaned manually. The disadvantages of manual cleaning are non-uniform cleaning, inaccessibility, damage to panels, risk of human casualties (especially in roof-top panels) and movement difficulties. The labour-hire is also a cumbersome task for PV panel cleaning. The task of PV panel cleaning becomes difficult and costly if labour is hired. These disadvantages can be overcome with the help of an automated robotic cleaning solution. In this paper, we have a comprehensive discussion and review of various technologies developed for this purpose all over the world.

Ks Lalith and et al., (2024) presented the design, development and implementation of a robotic system for cleaning solar panels. The increasing deployment of solar panels worldwide necessitates effective maintenance solutions to ensure optimal performance. Dust, dirt, and other particulates significantly reduce the efficiency of solar panels. Manual cleaning methods are labor-intensive and costly, especially for large-scale installations. The proposed robotic system offers an automated, efficient, and cost-effective solution. This paper details the design considerations, mechanical and electrical components, control systems, and field-testing results of the solar panel cleaning robot.

Dr Bharathesh Patel N. and et al., (2024) 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 favourable result and proved that such a system is viable by making the robotic cleaning possible, thus helping the solar panel to maintain its efficiency. This paper provides an overview of the cleaning aspects of solar panels through a literature review. We first discuss the drawbacks of unwanted deposits on solar panels in terms of energy production and efficiency. Existing cleaning practices and technologies are then presented with an emphasis on factors such as the size of the facility, location, cost, and available resources. Finally, comparative cost– benefit analysis is carried out using decision support tools and taking into account different relevant criteria to support users choose the right cleaning maintenance for their specific solar installation.

2.1 Problem Identification

The dust particles accumulating on the solar panels. The cleaning of dust particles on the solar panel is a panels will prevent the solar energy from reaching the huge problem because it's time-consuming process and solar cells, thereby reducing the overall power requires lot of man power and money. To remove this generation, Power output is reduced as much as by 50%, limitation, robotics can be used as it eliminates human if the module is not cleaned for a month. In order to labour and at the same time more economical and regularly clean the dust, an automatic cleaning system autonomous.

the ground shows that solar panels must be completely cleaned to collect the most energy possible. To answer the need for this cleaning mechanism, our team developed an automatic cleaning system for solar panels. Our device will increase efficiency by increasing the energy output of solar panels in a fast and cheap way. Automation of the system will also reduce the risk of operator injury in high voltage environments. A successful device will clean multiple solar panels and maximize their efficiency with the least amount of rain. We strive for a zero-waste approach to cleaning commercial sized solar panel systems, using minimal water and energy, but requiring little maintenance. The system software periodically clears the row panel

3.Objectives of the Project work

1) Design and fabricate a cleaning robot to maintain efficiency of solar panel which is lost due to environment.

2) To provide an easier solution for cleaning panels plotted on roofs.

3) To minimize wastage of water.

4) Provides safe & soft cleaning.

5) Construct a multifunctional robot

6) To build environment friendly cleaning system.

4. Design consideration

To develop this system & to investigate performance, modeling and mathematical calculations have to develop. Different models of this system have covered in literature. Following are the components from review of literatures:-

- **Design Drawing**

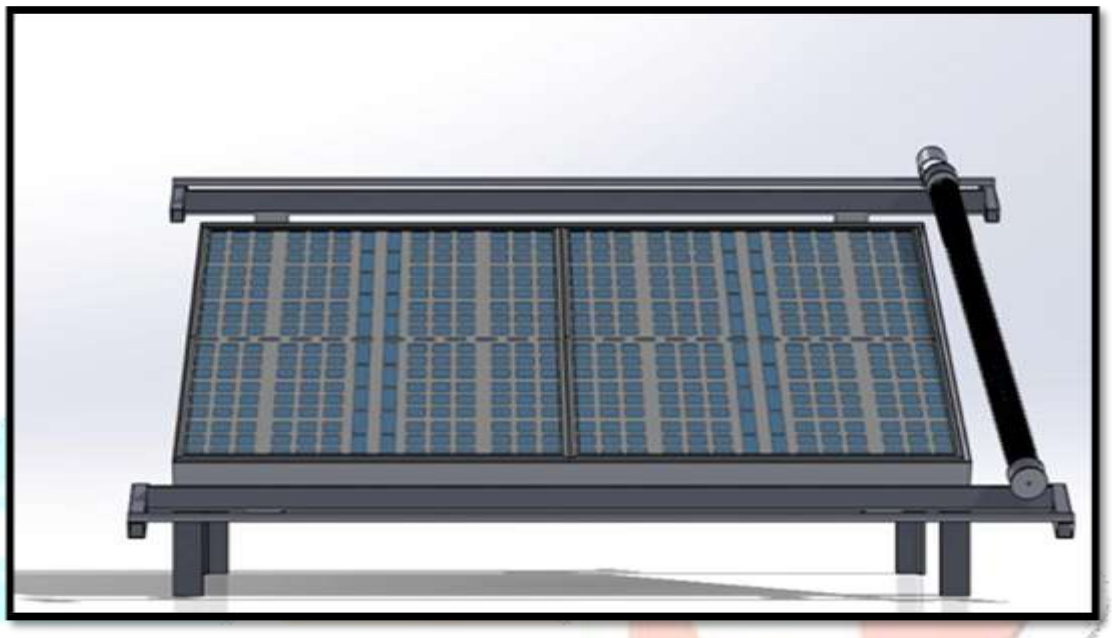

Fig 4.1: Solar Panel Cleaning machine

This proposed system consists of solar panel cleaning machine. The solar panel cleaner robot makes use of a rolling brush with motor along with DC motors to achieve vehicle motion using chain and sprocket. The robotic vehicle is built over a metal chassis with a controller circuitry operated wired remote(DPDT Switch) .

A remote controller is used to wired transmit control movement data to the robotic vehicle. The controller receives the data and operates the wheel motors in desired directions to achieve the desired movement. The front brush is fixed to the main chassis front and operated by a geared DC motor. The system thus allows for easy solar panel cleaning using wired control.

5. Manufacturing process

1. Measurement of the material required dimension
2. Cutting operation as per dimension
3. Machining operation on required parts
4. Drilling and tapping the material as per dimension
5. Welding the material as per dimension
6. Grinding the project welding joints:

6.Costing

Raw material cost:-It includes the material in the form of the Material supplied by the "Steel authority of India limited" and 'Indian aluminum co.,' as the round bars, angles, square rods, plates along with the strip material form. We have to search for the suitable available material as per the requirement of designed safe values. We have searched the material as follows:-Hence the cost of the raw material is as follows:-

Sr. No.	Name of the Part	Cost
1	Solar Panel	1500
2	DC Motors	1000
3	Brush	600
4	Shaft	1000
5	Chain and sprocket	200
6	DPDT Switch	200
7	Power Supply	1000
8	Screws & Bolts	200
9	Supporting Frame	1500
	Total	7200/-

Advantages

- Our device will increase efficiency by increasing the energy output of solar panels in a fast and cheap way.
- Automation of the system will also reduce the risk of operator injury in high voltage environments.
- A successful device will clean multiple solar panels and maximize their efficiency with the least amount of rain.
- We strive for a zero-waste approach to cleaning commercial sized solar panel systems, using minimal water and energy, but requiring little maintenance.
- The system software periodically clears the row panel.

Disadvantages

- Initial investment is more
- Periodic maintenance.

Conclusion

The Solar Panel Cleaning System project aimed to provide a better solution for maintaining solar efficiency. The main objective was to develop a machine that can clean a solar panel through a proper control system. This project involved developing a prototype to tap into a new and growing market. The project team encountered many obstacles along the way. Designing the control system required learning and its interaction with the electrical components. Using soldering boards to implement the designed

circuit, hardware wiring, motor driver shield, and machinery were new experiences. Despite these challenges, the project achieved the desired design with the planned control and mechanism. The DC motors were controlled by both drivers to manage speed and direction. The roller cleaned the panel. Additionally, control code for the DC motors and the water pump was written and implemented in the system. However, the prototype was not completed due to the challenges and limitations mentioned earlier

The Solar Panel Cleaning System project aimed to bring a better solution for maintaining solar efficiency. The main scope was to develop a machine that can clean a solar panel by a proper control system. This project is a developed prototype to expand on a new and increasing market The project team hit many obstacles along the way. Our goal was to build an automatic solar panel cleaning system which is efficient to clean various solar panels with the help of automatic robot cleaning system which have minimum contact with solar panel and does not make any disturbance in case of assembling and disassembling the solar panels. With the scope of improvement, the project is done to fulfil all the current demands of solar power plant. The main objective of dust, sand, and cost of labour for cleaning solar plant as it is difficult to clean the solar power plant by few persons. With this solar panel cleaning system percentage reduction in time required for cleaning was observed to be % and reduction in labour cost as compared to other method was 70% It has solved the problem of traditional way of cleaning by human. Since the capital cost is essential factor while cleaning for solar panel. This system has very least capital cost as compared to other type of cleaner and principal advantages of having automated and easy to control. By undergoing all the discussion and undergoing factors associated with automated solar panel cleaning system, this will be proven to be a great boon for the Indian solar panel power plant.

Future Scope

We have tried to make a working model of solar planning mechanism such that it will be budget friendly. For working towards this purpose, we have not included automation in it as it will require more electronics and software part. But we can use artificial intelligence and automation for further advancement in our model to make it better than the current model. We have used rack and pinion mechanism in our system. In case of extreme dusty environment, blockage may arise in the free movement of the pinion on the rack due to accumulation of dust. Here we can use roller mechanism instead of rack and pinion which is made of metal. It would require more power supply and battery with high torque but it is worth using because it will allow smooth functioning of cleaning even in harsh environment.

- Increase the grip of the wheels, change the wheels type.
- Write a program for automatic on/off roller and water pump.
- Increase the battery capacity and performance.

References

1. Nishant Sarode, Paras Ghugal, Shivam Yadav, Samiksha Dantule and Praful Nandankar, “A

Comprehensive Review on Solar Panel Cleaning Robot Technologies", Advances in Material Science and Manufacturing Engineering, 2023

2. Ks Lalith, Aman Raj, Jayesh Nikam and Professor Sheetal Mali, "Robot for Cleaning Solar Panels", international Journal of Scientific Research & Engineering Trends Volume 10, Issue 3, 2024, Pp:244-226
3. Aman Viroja, Rahul Vashi, Prof. Bhavesh Patel, Prof. Chintan K. Patel and Prof. Rohit Sahu, "Design and Development of Solar Panel Cleaning Machine", International Journal of Creative Research Thoughts, Volume 8, Issue 6, 2020 , Pp: 38-42
4. Dr Bharathesh Patel N., Naithanya Y., Anusha N. L., Bhanushree K., and Rakshitha S., "Solar Panel Cleaning Using Robotics", International Advanced Research Journal in Science, Engineering and Technology, Vol. 11, Issue 5, 2024, Pp:473-477
5. Sambhaji S. Shankar, Mayur B. Bande, Swapnil A. Gore, Prof. Manmohan O. Sharma and Prof. A. V. Harkut, "Literature Review on Solar Panel Cleaning System", International Journal of Research in Advent Technology, Special Issue, Convergence 2019,
6. Aniket Mali, Purvil Jain, Vaibhav Futane, Harshal Jadhav and Prof. Ashish Devshette, "Design & Fabrication of Water Optimized - Solar Panel Cleaning Robot", International Journal for Research in Applied Science & Engineering Technology, Volume 12, Issue VI, 2024, PP:210-220
7. 1. Sharvari Nikesh Ghate , Karan Rajendra Sali , Avinash Suresh prasad Yadav , Namita Sandeep Neman, Jagdish Chahande, "Design and fabrication of Automatic Solar Panel Cleaning System", International journal of machine tool and manufacture. ISSN(Online): 2319-8753 ISSN (Print): 2347-6710
8. Gargi Ashtaputre, Amol Bhoi, "Artificial Intelligence Based Solar Panel Cleaning Robot" e-ISSN: 2278-2834,p- ISSN: 2278-8735
9. B. Shrihariprasath and Vimalathithan Rathinasabapathy, "A smart IoT system for monitoring solar PV power conditioning unit", Futuristic Trends in Research and Innovation for Social Welfare (Startup Conclave), World Conference on IEEE, 2016
10. Aslan Gholami, Ali Akbar Alemrajabi, Ahmad Saboonchi, "Experimental study of self-cleaning property of titanium dioxide and Nanospray coatings in solar applications" paper published in sciencedirect.com ,2017