

Solar Panel Cleaning Using Robotics

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Abstract: The dust particles accumulating on the solar panels (20,000 Square meters). 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. 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 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.

Keywords: Cleaning aspects; solar panels; unwanted deposits; energy production; efficiency existing .

I. INTRODUCTION

Introducing 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.

II. RELATED WORK

- **A Cleaning Robot for Solar Panels:** This paper discusses the design and development of a robot that uses a rotary brush and water spray to clean solar cells. The robot can operate at a surface level of 0–30 degrees Celsius, and the rotary brush can clean 80% of the solar panel.
- **Autonomous solar panel cleaning robot with rubber wheeled:** This robot can clean photovoltaic panels without water, and can move manually or autonomously. It also generates its own energy, and takes in dusty air instead of blowing it out.
- **A Solar Panel Cleaning Robot Design and Application:** This paper discusses the effects of dust build up on PV panels, and suggests a strategy for improving their performance using a slide-cleaning technique.
- **Designing and Manufacturing a Robot for Dry-Cleaning PV Solar Panels:** This robot has a machine vision camera, and a cleaning head with two brushes. The robot's hardware includes a main frame made from aluminium bars, wheels for horizontal and vertical movement, and a motorized trolley that moves along aluminium rods.

III. BENEFITS AND CHALLENGES**A. Benefits:**

- Increased energy production.
- Minimal maintenance.
- Protect panel warranty.
- No personal injury risk.
- Completely green.

B. Challenges:

- High initial investment
- This robotic technology is quite new & hence a lot of R&D (Research & Development) still needs to be done in this sector.

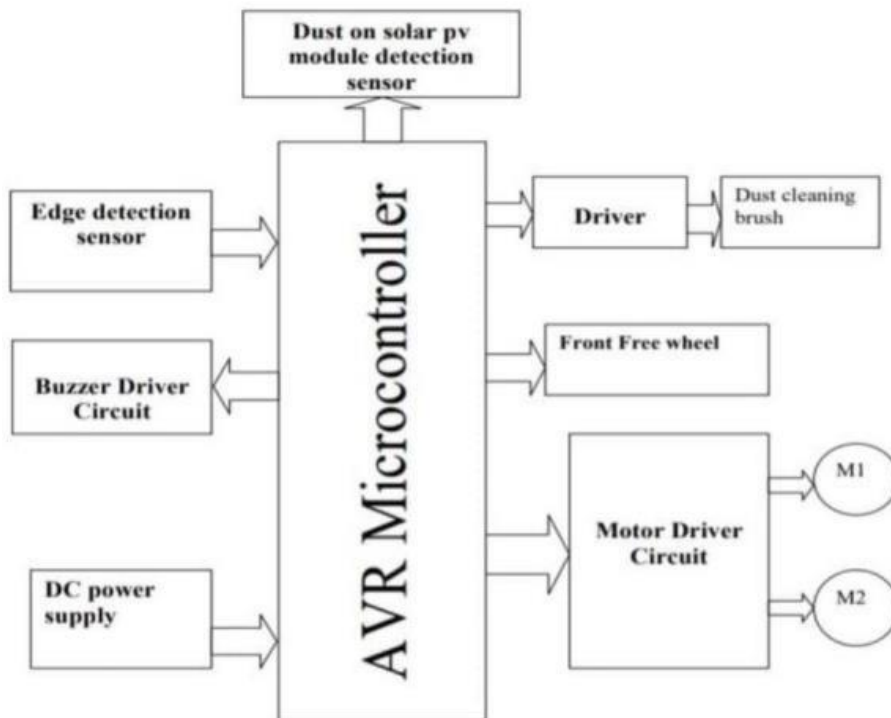
IV. METHODOLOGY

Fig.1

- The methodology for developing a solar panel cleaning robot involves identifying the problem of solar panel maintenance, gathering requirements from stakeholders, conceptualizing design options, and selecting the most feasible concept.
- Detailed design and prototyping follow, leading to integration, testing, and iterative optimization of the robot's performance. Deployment in real-world settings allows for field testing and continuous improvement based on feedback. Documentation and knowledge transfer ensure that the developed solution is sustainable and can be effectively maintained and scaled for broader use.

V. MATERIALS NEEDED

C. Hardware description:

SL NO	Hardware	Quantity
1	AVR Microcontroller Development Board (Arduino Board)	1
2	Dust on solar PV module detection sensor (IR or ultrasonic sensor)	1
3	Edge detection sensor (IR sensor)	1
4	DC Power Supply (Rechargeable battery)	1
5	Driver circuit (Relay Circuit Board)	1
6	Motor Driver Switch Board (4 channel relay)	1
7	DC Motor	4
8	Buzzer or Alert device	1
9	Dust cleaning brush	1
10	Water pump	1
11	Roller	1
12	Solar PV Module	1

Table.1

D. Software description:

SL NO	Software
1	Arduino Software
2	Embedded C

Table.2

VI. RESULTS AND DISCUSSION

- Solar panel cleaning robots provide an efficient and cost-effective solution for maintaining the performance of solar panel arrays.
- They help reduce manual labour, improve energy production, and ensure the longevity of the panels by keeping them clean and free from obstructions.
- Undesirable deposits on solar panels can have negative effects on energy production and efficiency.

- This article presents existing cleaning practices and technologies, with an emphasis on factors such as facility size, location, cost, and available resources.
- The importance of cleaning solar panels to optimize their energy production and efficiency.
- As a conclusion, we presented a microcontroller based SPCR system which is cost and lightweight effective.
- The proposed system reduces the effect of dusting on the output power of the PV panels.
- This system is designed in short time period and also, the tests are likewise. However, more testing of the device will be done to ensure the reliability.
- As future aspects, we want to make some improvements on our project.
- Some of these developments are to provide shortest cleaning time, minimum water and electricity storage requirements.
- The cleaning time can be reduced by changing brush type. Also, for the next version of the device, a light deduction circuit will be included to the system for day and night deduction.



Fig.1

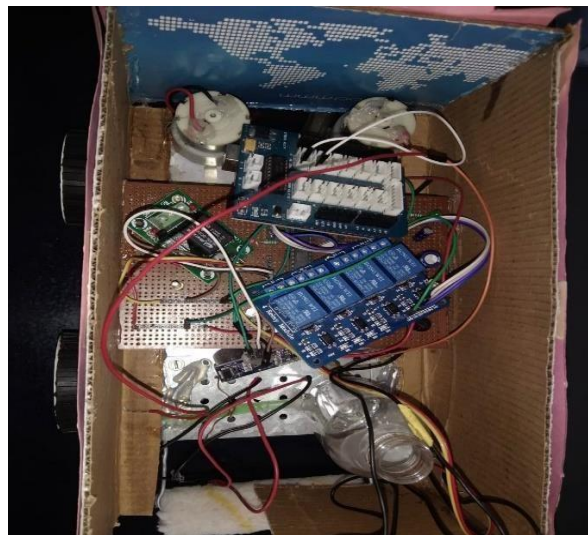


Fig.2

VII. CONCLUSIONS

Autonomous Robot for dust cleaning on solar pv module is designed and implemented using embedded technology. The AVR microcontroller is used as heart of the project for building autonomous robot for detecting and cleaning dust on the solar pv module. The edge detection sensor is used to detect edges of the Solar pv module and embedded C code is written using ATMEGA-328 IC. This IC is reprogrammable in the feature we can enhance it more application on the same development board. This research focuses on mechanical approaches encompassing module vibration, air and water jets, and combinations of these. Here, we discuss the overall cleaning design philosophy and approach, systems design, and how multiple cleaning configurations can be realized within the overall PV module. Results indicate that in this project we are building a prototype autonomous robot for cleaning solar pv module.

In addition, dust cleaning brush optimized for cleaning dust on solar pv module with autonomous robot. Now days renewable energy is booming in the world every one going to use the solar pv module for different domain application. So we need to keep the solar pv module with good working condition for absorbing more sunlight and producing more energy we need keep it without dust on the panel. The proposed system uses embedded technology for building a small prototype autonomous robots used as heart of the project and embedded C code is written using ATMEL-328 IC.

VIII. 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.

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