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Robot for Automatic Solar Cleaning

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Abstract
Dust particles that accumulate on solar panels obstruct the solar energy from reaching the solar cells, leading to a reduction in overall power generation. If the module is left uncleaned for a month, the power output can decrease by as much as 50%. To ensure the regular cleaning of dust, an automatic cleaning system has been developed to remove dust from the solar panels. This paper reviews the issue and discusses the dust removal method. A robotic cleaning device has been developed that travels the full length of the panel. A PIC microcontroller is used to implement the control system for the robot. The robot has shown favourable results and has proven that such a system is feasible by making robotic cleaning possible, thereby helping the solar panel maintain its efficiency.

Keywords: PIC microcontroller, solar plate, robot.

INTRODUCTION

Since the dawn of humanity, man has increasingly relied on energy for survival and well-being. In the early days, primitive humans primarily sought energy in the form of food, which they obtained by consuming plants or hunting animals. The discovery of fire marked a significant turning point, as energy needs expanded with the use of wood and other biomass for cooking and agricultural purposes. Furthermore, man enhanced his energy utilization by domesticating and training animals for labour. As energy demands grew, humans harnessed wind power for sailing vessels and operating windmills, as well as utilizing the force of flowing water to turn water wheels. Up until this point, it can be accurately stated that the sun was the primary source of energy for humanity, either directly or indirectly, with man relying solely on renewable energy sources. The industrial revolution, initiated by the invention of the steam engine around AD 1700, introduced significant changes, as man began to exploit a new energy source—coal—in substantial amounts.

In modern times, technology has advanced to the point where solar panels are utilized to convert solar energy into electrical energy. Renewable energy sources are now integral to various industries, with numerous solar panels arranged in arrays. Additionally, solar energy has become increasingly important for household applications. However, a challenge associated with solar panel implementation is their maintenance. Various cleaning methods are employed to ensure the efficiency of solar panels. After a year of exposure without cleaning, one facility was cleaned using a pressurized distilled water spray along with brushing, resulting in a 6.9% improvement in energy generation efficiency. Several factors can influence the power efficiency of photovoltaic (PV) panels, including shadows, snow, high temperatures, pollen,

bird droppings, sea salt, dust, and dirt. Among these, dust is the most significant factor, as it can substantially diminish a PV panel's efficiency.

CLEANING METHODS FOR SOLAR PANEL'S

1. Natural Removal Of Dust

The natural elements are harnessed to clear dust, such as wind energy, gravitational force, and the cleansing action of rainwater. The efficacy of this approach is rather limited. It has been noted that the solar cell array can be adjusted to a vertical or slanted position to facilitate dust removal during early morning, late evening, nighttime, and rainy conditions. Nevertheless, rotating a large solar cell array is quite challenging.

2. Mechanical removal of dust

Mechanical methods are employed to remove dust through brushing, blowing, vibrating, and ultrasonic driving. The brushing technique involves cleaning the solar cells with tools resembling brooms or brushes, which are operated by machines designed similarly to windscreen wipers. However, this method is not very effective due to the small size and strong adhesion of the dust particles. Additionally, the harsh working environment of the solar cells complicates machine maintenance. Moreover, the large area of the solar cell array requires a powerful cleaning machine. Finally, the brush may cause damage to the surfaces of the solar cells during the cleaning process. The blowing method, which cleans the solar cells using wind power, is effective but has drawbacks such as low efficiency, high energy consumption, and inadequate maintainability of the blower.

3. Electrostatic removal of dust

When a high potential exists on the surface of the solar panels, both charged and uncharged dust particles are drawn to the panels due to electrostatic forces. Consequently, the dust particles become charged by the solar panels, resulting in them having the same electric charge, which causes repulsion between them. Ultimately, the dust particles will be expelled from the solar panels. However, this technique is not feasible in PV systems due to the impact of rain on the ground.

Aim of the Research

The presence of dust on even one panel decreases its energy generation efficiency. Thus, it is vital to maintain the panel's surface in a clean state. Current cleaning methods for solar panels that rely on human effort are expensive in terms of time, water, and energy consumption. There has been no automation in the cleaning of solar panels, which creates a demand for the development of automatic cleaning machines that can effectively clean and traverse the glass surfaces of the panels. To achieve maximum energy collection, solar panels must be completely cleaned. To address this cleaning mechanism requirement, we have developed a solar panel cleaning bot. This project aims to establish a Solar Panel Cleaning System that can routinely remove the dust that accumulates on its surface and uphold the output of the solar power plant. Our device will improve efficiency by increasing the energy output of solar panels in a rapid and cost-efficient manner. The automation of this system will also reduce the risk of operator injury in high-voltage environments. This bot will clean multiple solar panels in an array, enhancing their efficiency by at least the same amount that rainfall can achieve.

METHODOLOGY

1. Literature survey.
2. Design of model.

3. Material selection.

Fabrication.

1. The first frame is fixed. It is made of mild steel.
2. The second frame is movable frame, it is made of aluminum. Moving in horizontal direction
3. The third frame is brush moving in vertical direction.
4. The above frames are controlled by Arduino programming.
5. Arduino is micro-controller device in which the program is been dumped into it, and through the help of this micro-controller the aluminium frame moves

ILLUSTRATION OF SOLAR PANEL CLEANING DEVICE

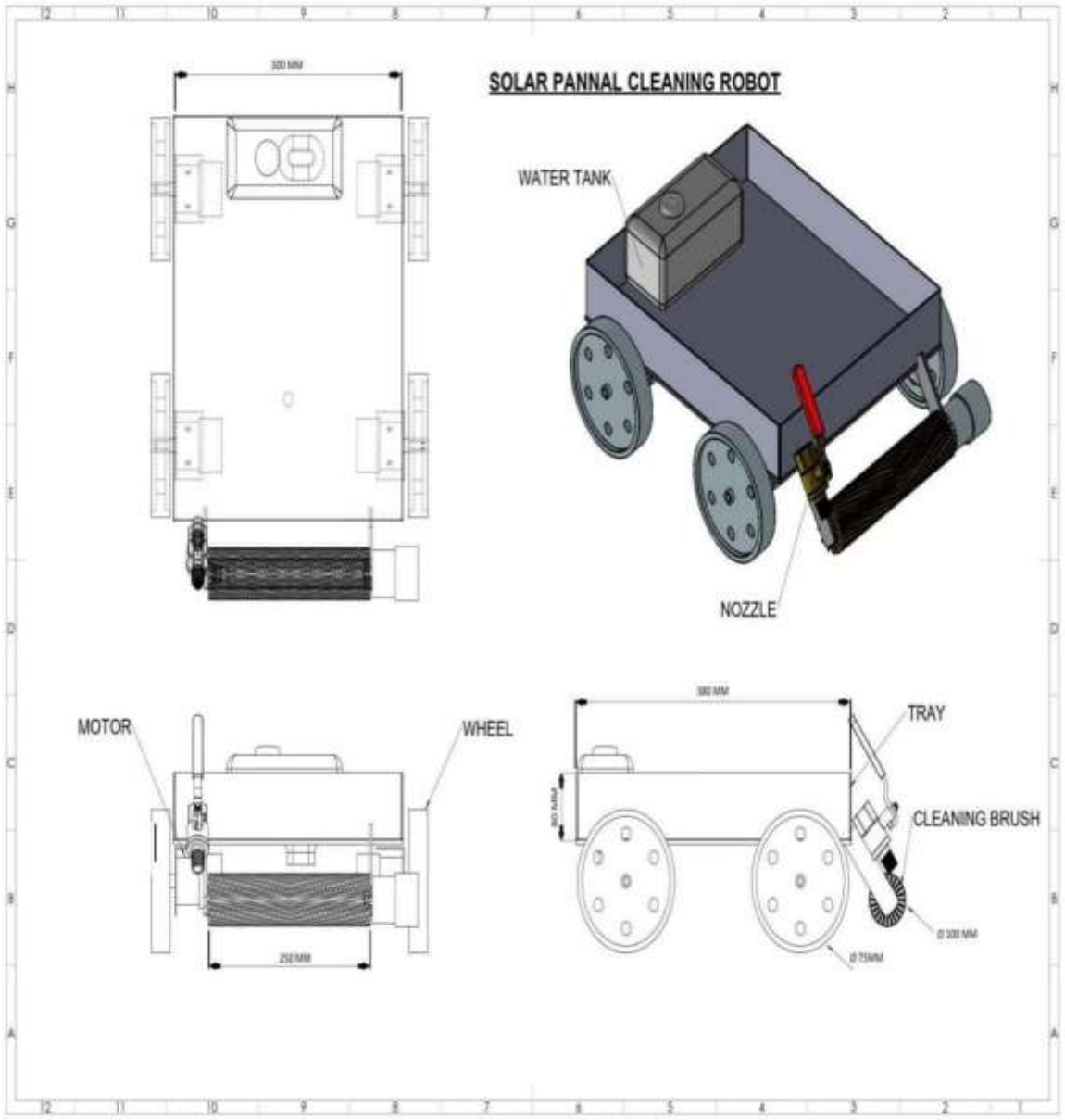
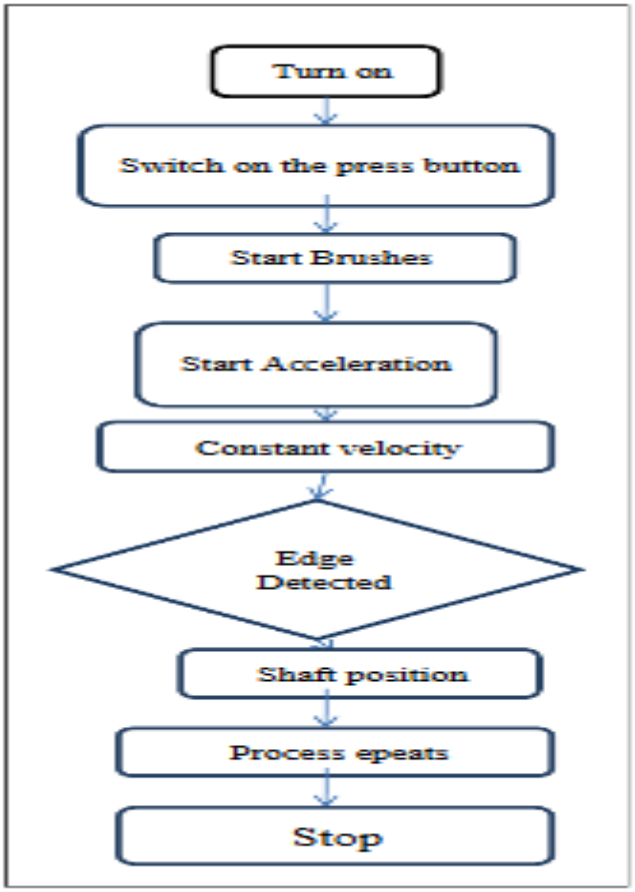


Fig: 2. - Solar panel cleaning robot

WORKING METHODOLOGY

Fig.2. working flow chart



The carrier robot, together with the cleaning robot, moves towards the solar panel and ceases its movement by detecting the solar panel. The carrier robot then communicates a signal to the cleaning robot. Upon receiving this signal, the cleaning robot travels the entire length of the solar panel in both forward and backward directions, cleaning the panel for the specified duration. After the cleaning is finished, it returns to the carrier robot. The carrier robot then advances to the next panel, and the procedure is repeated.

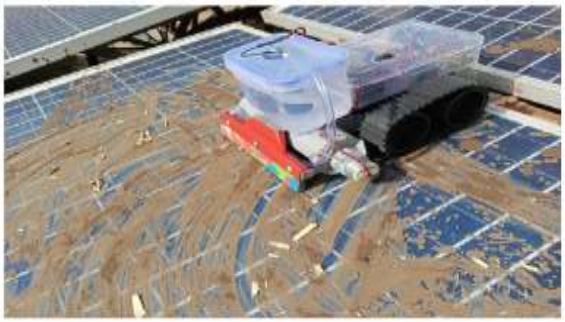


Fig-3 Cleaning Processing Start of the Solar Panel

Fig-4 after Cleaning Processing of the Solar Panel

FACTORS DETERMINING THE CHOICE OF MATERIALS

The various factors that influence the selection of materials are discussed below.

1. Properties:

The chosen material must have the essential properties for the intended application. The requirements that need to be met can include weight, surface finish, rigidity, resistance to environmental damage from chemicals, service life, reliability, etc.

The following four principal types of properties of materials significantly impact their selection:

a. Physical
b. Mechanical
c. From a manufacturing perspective
d. Chemical

The various physical properties involved include melting point, thermal conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, and magnetic properties, among others.

The mechanical properties relevant to this discussion include tensile strength, compressive strength, shear strength, bending strength, torsional strength, buckling load, fatigue resistance, impact resistance, elastic limit, endurance limit, modulus of elasticity, hardness, wear resistance, and sliding properties.

The properties from a manufacturing perspective include:

1. Cast ability
2. Weldability
3. Surface properties
4. Shrinkage
5. Deep drawing, etc.

2. Manufacturing considerations:

At times, the need for the lowest manufacturing cost or the surface qualities achievable through suitable coating materials may necessitate the use of specialized materials.

3. Required Quality:

This influences the manufacturing process and ultimately the choice of material. For instance, it would not be advisable to cast a small number of components that could be fabricated more economically through welding or hand forging of steel.

4. Material Availability:

Certain materials may be limited or in short supply, making it essential for the designer to select an alternative material that, while not a perfect substitute, can fulfill the design requirements. The delivery timelines for materials and the product should also be considered.

5. Cost:
As with any other issue, the cost of materials plays a crucial role in the selection process.

RESULTS AND CONCLUSION

This project emphasizes the impact of dust, dirt, pollen, sea salt, and bird excrement on the efficiency of photovoltaic (PV) systems. Dust significantly affects the efficiency and performance of solar panels. The peak power generation can decrease by as much as 10 to 30%. A reduction in power output was noted due to dust accumulation on the panels, which can be mitigated through the implementation of a robotic cleaning method. This approach has enhanced the power generation capacity of the solar panels. Some advantages of this method include easy maintenance, low cost, and reduced power consumption. Ultimately, the decline in peak power generation can also be addressed by utilizing this cleaning system. The device is lightweight, as it is primarily constructed from aluminium. When comparing the costs of manual cleaning versus automatic cleaning, the latter has been shown to be more economical and considerably less labor- intensive, especially in systems with a large number of solar panels. Regular and periodic cleaning ensures that the solar panels operate consistently with good transmittance at all times.

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