SOLAR PANEL CLEANING ROBOT

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Abstract - The design and development of a solar panel cleaning system is becoming popular nowadays. The main objective of this design is to clean the solar panel using an electrical mechanism, such that the efficiency or quality of the solar panel is not compromised. As a matter of fact, the gulf region - especially Saudi Arabia- is facing a lot of dust storms so the solar panels need to be cleaned frequently. If the task is performed manually, it will be very costly and time-consuming. A special wiping material shall be used in the conceived mechanism design to ensure the quality of cleaning. This project is about the design and development of a solar panel cleaning bot. Also, if the solar panels are made to be cleaned in a repeated cycle in an automated manner, there comes a situation where these panels will be cleaned even when there is no dust which leads to waste of power. So, this proposed system cleans the panel only when the dust is detected using image processing technique. The main advantage of this solar panel cleaning system is that it operates automatically and remotely in order to maintain high power generation efficiency.

*Key Words***:** Solar panel, cleaning system, dust detection, solar panel cleaning bot, image processing.

1.INTRODUCTION

Globally, there is more than enough solar radiation to meet the demand for solar power systems. The percentage of the sun's rays that reach the surface of the planet is sufficient to meet the world's energy needs 10,000 times over. On average, each square metre of land receives enough sunlight each year to generate 1,700 kWh of electricity. Our planet is greatly impacted by solar panels. The environment can be improved without the need of other polluting power plants, however solar power plants must be cleaned at least once every three days. Generally speaking, it depends on the nation; for instance, in the Middle East, where it must be cleaned daily, it will be highly expensive. There are many methods for cleaning solar panels but, in order to maintain a solar panel's high level of efficiency, our concept is to create a smart solar panel that cleans itself automatically and remotely.

2.PROBLEM STATEMENT

One of the sustainable energy sources is solar energy. Furthermore, it is renewable. Solar water heaters, solar air warmers, and power generating are just a few of its various uses. Both its benefits and drawbacks exist. A few drawbacks are solar power conversion's low efficiency and solar panels' initial purchase and installation costs, which are both significant enough to make one pause. Obviously, a dust-covered plant won't produce at its highest capacity. This dust is caused by a number of factors, including the weather. This dust needs to be cleaned frequently in order to obtain high efficiency.

3.EXISTING SYSTEM

Ecopia's solar cleaning robot cleans the solar panel in a slightly different way. A guiding fence is installed above the solar panels in this setup. The horizontal movement of the guiding railing frame construction is possible over the array of panel surfaces. The robot moves on the railing frame for top-to-bottom movement. Ecopia solar panel cleaning project cleans the surface of the solar array by sweeping its microfiber brushes attached to the head. The system has a battery of its own, which is topped off by a solar cell of its own. This device's ability to store energy enables the system to clean the panels at night. Additionally, internet-based control of the system is possible. One drawback is that the railing cannot completely enclose the area.

Another robotic solar panel cleaning system that employs a support vehicle in addition to the cleaning head and moving trolleys was developed by Sweezey et al. (2009). The cleaning head scrubs the brushes on the panel's surface in a manner similar to the Ecopia and NOMAD systems. DC motors with a voltage of 12 volts are utilised to move the driving system. The upper and lower trolleys can travel in various directions and locations. The system can clean the panels in a square wave pattern thanks to this capability. The system left certain areas undiscovered, which is a drawback.

Wash panel Water and a horizontal brush are used in solar cleaning systems to clean the solar panel. As a horizontal brush is fastened to the system's mobile

assembly. This brush stays in close proximity to the panel. A brush rubs the panel's surface to remove any muck when the assembly of the system moves, and water splatters through water on the panels. The Ecopia system and the Nomad cleaning system are extremely similar. The types of brushes that rotate on the panel's surface are what differ most. A small vehicle carrying brushes travels through the array of the Ecopia system. The solar cleaning robot is moved by a number of pulleys and motors. The solar cleaning robot is moved by a number of pulleys and motors. Nomad system has less motors, belts, and pulleys than Ecopia system does. Only two motors which are used to move the brush horizontally. The brush roll railing is typically located behind the solar panels. The brush rotates in a circular motion around its axis while the assembly moves horizontally. The brush scrapes the panels' surface in a circular motion to get rid of any debris and other obstructions. The entire process is automated, and the intelligence system may be programmed to follow a variety of cleaning regimens and be managed remotely. It operates according to a timetable, thus there may be times when dust collects on the panel.

4.HARDWARE DESCRIPTION

The chassis is the structural component of the robot which contains the drive train and DC motor (BO) Battery Operation. Dc motor converts electrical energy into mechanical energy. DC gear motor is used in robot motor control circuits. The whole assembly is powered by the battery. Zigbee microcontroller is used for controlling movement and transmitting signals. The main advantage of this Zigbee microcontroller is that it is cost friendly when compared with raspberry pi which is used for image processing. There will be a cleaning motor which is used for the movement of the brush and there is a soft sponge which is attached with the cleaning robot. In the ground station, there is an HD camera attached to a pole which is connected to the computer. Dust is detected with image processing techniques using Zigbee microcontroller and is sent to the cleaning bot for automated cleaning. For the software side PyCharm IDE is used.

5.OBJECTIVES AND SCOPE

The main objective of this design is to clean the solar panel using an electrical mechanism, such that the efficiency or quality of the solar panel is not compromised. The criterion of the cleaning system design is its ability to clean panels irrespective of their dimensions. Such a system is considered much simpler than having multiple robots on the same farm working simultaneously.

6.METHEDOLOGY

The suggested system's fundamental component is the Zigbee microcontroller which is used both in the solar panel cleaning robot and also in the ground station. The bot is also

interfaced with BO motor, Power supply, Chassis, cleaning motor and cleaning materials as shown in Fig 1. In the ground station the camera is fixed on a pole where the entire solar panel is covered by the HD camera which is connected to the pc which is interfaced using Zigbee Microcontroller as shown in Fig 2. The camera captures the entire solar panel and, in each frame, the entire panel is divided into 14 grids for identifying dust in each grid. After detecting dust in these grids, the information containing where the dust is situated is sent to the solar panel cleaning robot using this Zigbee microcontroller. The entire image processing technique used for dust detection is done using Python in PyCharm IDE. After receiving this information, the robot is programmed in a way that it goes to the position where the panel is need to be cleaned and return to its original position.
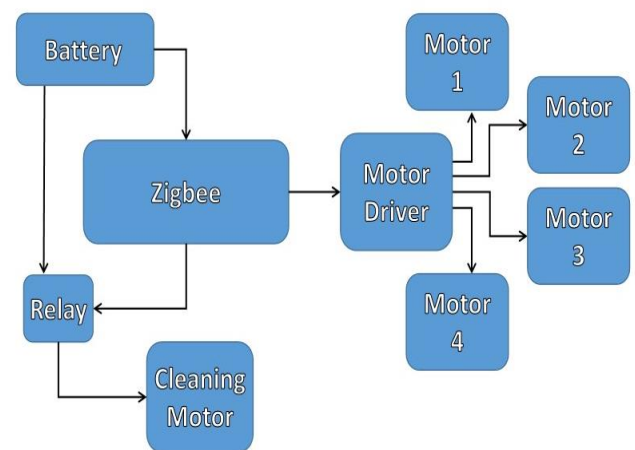

Fig -1: Block Diagram of Solar Panel Cleaning Bot
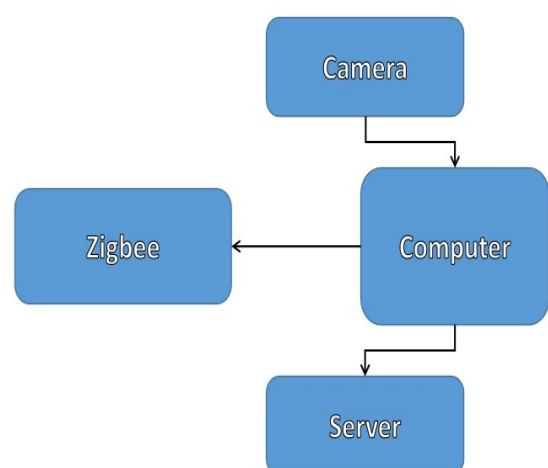

Fig -2: Block Diagram of Ground Station

The entire proposed system reduces the chances of accumulation of dust on solar panels. Since the entire panel is monitored continuously, it improves efficiency of the solar panel. Also, the robot returns to its original position after each

and every cleaning time. The entire system is completely automated which reduces man power cost.

7.RESULT AND DISCUSSION

This method is quite effective in keeping the solar panel clean and dust free which leads to increase in efficiency. Solar panel cleaning includes a lot of manpower and also it is time consuming. The proposed system is fully automated so manpower and cost is reduced. In India, the majority of dust is due to the winds blowing during the north-west monsoon and south-east monsoon. The proposed system will be very useful to clean the solar panels during these monsoon times in an automated manner. The proposed system will have less damage on the solar panel when placed on it. Cleaning materials are selected in such a way that the panel is not damaged in any other way.

Cost effectiveness is preserved because every component utilized is safe for both humans and the environment. As a result, unneeded costs are saved. The panel is continuously monitored which makes the system efficient and free from dust. The system's key benefit is its minimal power consumption, also it eliminates the risk of damage.
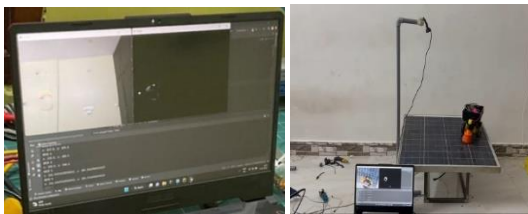

Fig -3: Detection of dust on solar panel

Fig -4: Bot movement and cleaning using roller brush and sponge

Bot shows slight movement fault when placed on a large tilted angle panel due to gravitational pull. The solar panel is perfectly handled by the proposed robot. Environment is not harmed in any way by it. It emits no hazardous radiation of any kind that could cause human mutation. The system is deemed to be wireless as long as only the most basic wiring is used to link the components. The Zigbee module wirelessly sends the information from the ground station to the solar panel cleaning robot.

8.CONCLUSION

As an engineer we have a responsibility to find ways that can help the environment to be better without using the power generation plants that can harm the environment. Solar panel power generation plant is one of it. The proposed solar panel cleaning system is fully automated system. The ground station setup continuously monitors the solar panel. When dust is detected using image processing techniques using Zigbee microcontroller, the exact location is sent to the cleaning robot to go and clean the exact location. The solar panel cleaning robot is programmed in such a way that it returns to its original position after cleaning. Cleaning materials are chosen wisely such that it does not do any harm to the solar panel. It is simple to carry out this plan to safeguard the solar panels and increase its efficiency, and it may be done without endangering people or properties. Additionally, the system's components are not overly expensive, making it highly viable. As a result, this product can be utilized to clean solar panels. It is an easy approach to keep track of the solar panel and concentrates on dust that gets accumulated and affects its efficiency.

9.FUTURE SCOPE

In future the robot can be included with the water tank and other cleaning materials of light weight. Also, high quality cameras can be used in the ground station for better capturing of images in order to identify peculiar dust using image processing techniques.

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