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EFFECTIVE CLEANING OF SOLAR PANEL USING EMBEDDED SYSTEM

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ABSTRACT: The efficiency of solar photovoltaic (SPV) panels depends upon the amount of solar irradiance and spectral content. SPV panels are being widely used because of their economic and environmental merits. The performance of SPV panels gets degraded due to factors like air pollution, bird droppings, dust, snow accumulation, etc. Therefore, it is essential to have regular and proper cleaning of panel. In most of the parts the cleaning is done manually. This type of cleaning is not uniform and it may cause health issues to the workers. This can be solved by fully automated permanent setup solar panel cleaning system with water. It uses soft powerful nylon brushes to clean the panels and has a sprinkler controlled by solenoid valve. In conclusion, it is found that robotic cleaning and heat reduction can help in maintain the solar panel efficiency. In future it can be provided as a permanent cleaning robot at time of installation along with panel frame, dust detection sensor, temperature sensor and camera surveillance, which is centrally connected.

KEYWORDS: Solar Photovoltaic (SVP) panels, Arduino UNO, Panel Cleaning.

INTRODUCTION

With the growing cost of energy and adverse effects of conventional fuels over the environment, implementation of green fuels like solar power is on demand. Solar power is mainly harnessed by solar photovoltaic (SPV) panels. Its efficiency degrades due to accumulation of dust and debris over SPV panels. Dust is the most common factor which decreases the efficiency of such technologies. It acts as an obstruction for the incident light to reach the cells, causing reduced efficiency due to lower power output. Dust accumulation occurs at different rates in different parts of the world depending upon the local wind conditions, panel orientation and nature of dust. Different cleaning methods are currently being used both at industrial as well as domestic level. Labor-based cleaning method for SPV panels is costly, time-consuming and requires technical skill, which also leads to wastage of water and energy and lacks. A system is designed and developed in which power supplies from solar are utilized for cleaning system. Traditionally cleaning system was done manually. The manual cleaning has disadvantages like risk of staff accidents and damage of the panels, movement difficulties, poor maintenance etc. The automatic dust cleaning system of solar panels has taken to overcome the difficulties arise in the traditional cleaning and also produces an effective, non- abrasive cleaning and avoids the irregularities in the productivity due to the deposition of dust. The studies carried out to evaluate the efficiency of solar panel for dust collected on it for one day, one week and a month. The efficiency of solar panel also calculated after cleaning the surface for one day, one week and a month. And finally comparing both the efficiencies it is proved that solar panel efficiency increases considerably. Thus the developed model enhances the solar panel performance. Various source of energy like coal, gas, hydro, nuclear, renewable, diesel and their some of them are going to be exhausted within few years.

REVIEW OF LITERATURE

Electricity of future demands on renewable energy source. Solar energy is one of the most important renewable sources. Solar energy is being utilized to a great extent in the recent times for power generation. So a brief knowledge on solar energy will help us obtain the maximum utilization out of it. It is a clean source of energy. Manual cleaning involves the use of laborers to clean the solar panels.

There must be a team to clean solar panels and the team must be supervised by some personnel. Hence the maintenance cost will be much higher. Moreover, manual cleaning may not be appreciated as there is a huge possibility of imperfect cleaning. This will again lead to efficiency loss. Dust and dirt particles accumulating on PV panels decrease the solar energy reaching the cells, thereby reducing their overall power output. Hence, cleaning the PV panels is a problem of great practical engineering interest in solar PV power generation. So, we are developing the simple and useful dust cleaning device and developed novel architecture of dust cleaning system for PV panel using Arduino. The main motive for this system is developed system for dust cleaning for PV system for maintaining the clean PV panel efficiency.

A Solar Panel Cleaning Robot Design and Application by Algul M. (2019)- They 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.

Water sprinkler based solar panel cleaning system operated by microcontroller interfaced robotic arm by Poonam Chand Sharma –A cleaning of solar panel from either solar or mains supply with the help of water sprinkler based robotic arm is implemented in the system. A software program is also developed for the hardware by using assembly language which is useful for fast program execution. Developed system now has an ability to utilize solar energy for cleaning purposes and prevents energy losses generated by dust accumulation on the panel surface. This strategy is also helpful for economic point of view.

Solar Panel Automated Cleaning (SPAC) System by Shajan K. Thomas - A successful device will clean multiple solar panels in an array and increase their efficiency by at least the same amount that rainfall can. The aim is to provide a non-wasteful approach to cleaning commercial sized solar panel systems by using minimal amounts of water and power while requiring little maintenance. This system will clean a multiple row of panels periodically. Fabrication cost of the final prototype is to be approximately INR 30000.

A Review on Solar Panel Cleaning Robot using IoT by Reeka Narang - This paper highlights the effect of dust, dirt, pollen, sea salt, and bird droppings on the PV systems' efficiency. Dust has a major impact on the efficiency and performance of the solar panels. The reduction in the peak power generation can be up to 10 to 30%. Power reduction was observed due to dust accumulation on the panels and this can be improved by using robotic cleaning method. has increased Power generation capacity of the solar panels. Easy maintenance, low cost and less power usage are few advantages of this process.

Increasing the efficiency of Solar Panels using Autonomous Cleaning Robot by Ananthi. K This paper provides the necessity of cleaning solar panels for increasing the efficiency is demonstrated and model and working of new proposed machine with high efficiency and low cost is discussed. In future this cost effective cleaning robot can be developed with devices like dust sensors and camera to check the deposition rate based on that cleaning process can be carried out and also it can be made to be controlled by remote which enable this as a user friendly.

This review discusses effects of various parameters on the solar Photo Voltaic panel, and various cleaning systems that is developed and being used in present days. The key points of the topics discussed are.

1. Environmental factors like temperature, humidity, solar irradiance affect efficiency of solar panel.
    - It is seen from the studies that for increase of 18.5 degree Celsius, the power is reduced by 5W.
    - Humidity is another factor where due to humid environment, only 55-60% of solar energy can be utilized with the decrement of 10-15%

2. Atmospheric dust and dust deposition on solar PV both reduce efficiency of solar panel. Experimentally it is seen that efficiency of the solar panel decreases by 30-40% for indoor set up with constant illumination whereas there is loss of 4-5% for outdoor set up with natural lightening condition. Opaque objects like moss tremendously decrease efficiency of solar panel by 80%.
3. Most of the cleaning system require human interface to clean efficiently, and use high pressure water to spray on surface thus requiring high power to operate.

PROPOSED SYSTEM

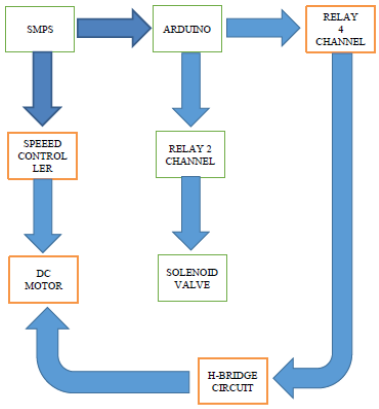


Fig. 1 Flow diagram of proposed system

The proposed solar panel cleaning robot moves with a guide way and movable support on the solar panel and sprinkle water in the required area of the panel with the help of a pump. Its operation is controlled by a microcontroller. The robot rolls along the guide way of each array with the help of wheels. The wheels are made to rotate at 500 rpm which is driven by a motor. The driving motors are connected to the motor driver circuit which is in turn controlled by the microcontroller board. The microcontroller board plays a vital role in automating and controlling the solar panel cleaning robot. The action performed by the robot is linear motion in the forward and backward directions. These actions are fed into the microcontroller board with the help of a suitable program. The water is sprayed through the mist nozzles from the water container with high pressure created by the solenoid valve. Tracks and guide ways provide the necessary support and transport of the system. The robot is elevated to the same height as that of the solar panels and is placed on the support which is at the same inclination as that of the solar panels.

SYSTEM REQUIREMENTS

ARDUINO UNO: The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.[4] It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.

SOLENOID VALVE: 12V DC Electric Solenoid Water Air Valve Switch (Normally Closed) Controls the flow of fluid and act as a valve between high-pressure water or any fluid! This liquid valve would make a great addition to your robotic gardening project. There are two ½" (Nominal NPT) outlets. Normally, the valve is closed. When 12Vdc is applied to the two terminals, the valve opens and water can push through. The valve works with solenoid coil which operates electronically with DC 12-volt supply. As it is normally closed assembly, it opens the flow of liquid as soon as power ON and stops/blocks the flow when the supply voltage removed.

DC MOTOR: This Permanent Magnet DC Motor is suitable for small and medium CNC machines and for replacement of stepper motors to DC servos which provides high speed and accuracy. This motor with drive can replace a stepper motor upto NEMA 34 size where high speeds are required. Motor runs on 12V to 24V DC and gives upto 6000 RPM on 24V. This motor may be directly coupled with ball screw linear system with a coupler. Reduction is possible with external timing belt and pulley system. The Motor is a Industrial grade motor with replaceable carbon brushes, hardened shaft and skewed armature for reduction of cogging effect.

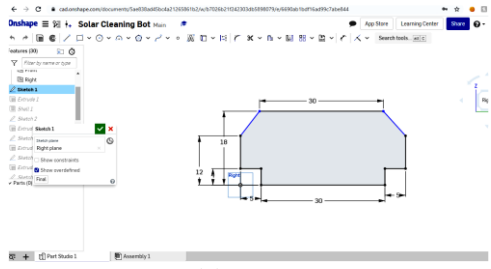
NYLON BRUSH: Solar Panel Cleaning brushes are used to gently clean panel surfaces and remove difficult to remove dirt, grim and bird droppings. These solar panel cleaning brush are purpose built for cleaning solar panel surfaces and ensures that there are no scratches or other damages on the surface of panels, with repeated scrubbing over a period of time. Solar Brushes are made of Nylon Bristles, gives smooth and effective cleaning on panel, which protect from getting scratches on panel. Nylon brush can clean the Solar panels easily. You can easily and safely clean the solar panels and can avoid stepping on panels or structure without taking any risk.

MOTOR CONTROLLER: This is Universal DC9-60V 10A Motor Controller with PWM Speed Control Switch. This motor controller supports DC Motors from 9V to 60V. Electric motor cannot be used. The input voltage should be equal to the rated voltage of the motor.

SMPS: is an electronic circuit that converts power using switching devices that are turned on and off at high frequencies, and storage components such as inductors or capacitors to supply power when the switching device is in its non-conduction state.

ARDUINO PROGRAMMING: Arduino programs are written in the Arduino Integrated Development Environment (IDE). Arduino IDE is a special software running on your system that allows you to write sketches (synonym for program in Arduino language) for different Arduino boards. The Arduino programming language is based on a very simple hardware programming language called processing, which is similar to the C language. After the sketch is written in the Arduino IDE, it should be uploaded on the Arduino board for execution. The first step in programming the Arduino board is downloading and installing the Arduino IDE. The open source Arduino IDE runs on Windows, Mac OS X, and Linux.

DESIGN AND PROCEDURE



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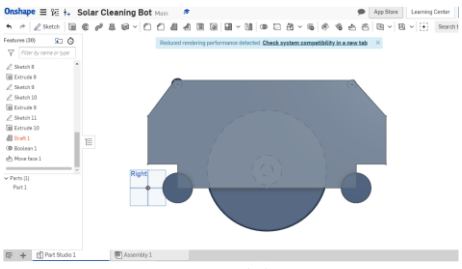

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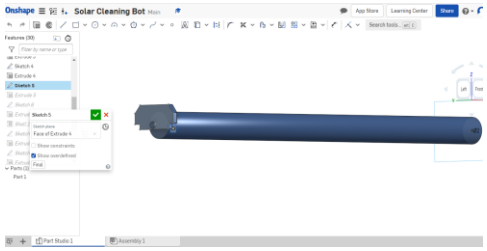

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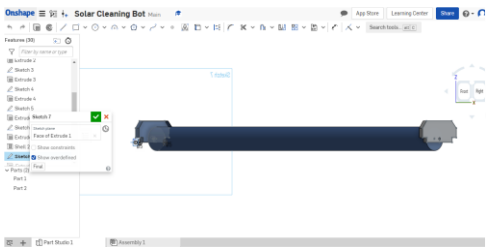

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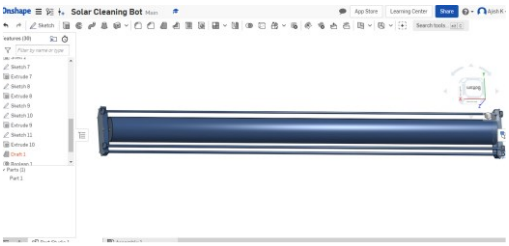

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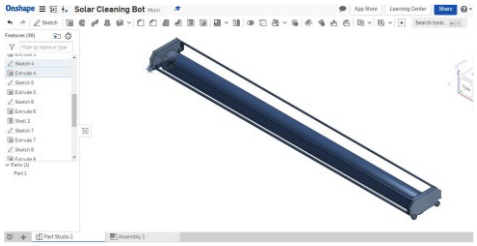

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CONCLUSION

Dust accumulation on PV panels can significantly reduce their power output. While the Geographic region is solar-energy rich, the desert conditions are quite dusty threatening the PV systems power generation potential. The robotic system proposed by us provides a simple way to tackle this challenge effectively. Although promising results will be obtained. Here we are going to set a new benchmark by using latest technology and replacing the conventional methods of cleaning the solar panels. We are saving water, time and money. In general, the technique used by other method explain above total cost of solar panel maintenance goes around 5% of total plant cost annually but cleaning done
by robot reduced it by 2%. The robot of this kind can clean the solar farm as and when require very easily without man power thus saving the cost and wastage of water.

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