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Automatic Solar Panel cleaning machine

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ABSTRACT: The growing costs of electricity and concern for the environmental impact of fossil fuels, implementation of eco-friendly energy sources like solar power are rising. The main method for harnessing solar power is with arrays made up of photovoltaic (PV) panels. Accumulation of dust and debris on even one panel in an array reduces their efficiency in energy generation considerably and emphasizes the need to keep the panels' surface as clean as possible. The goal of our project is to create an automated solar panel cleaner that will address the adverse impact of soiling on commercial photovoltaic cells. Specifically, we hoped to create a device that increases the maximum power output of a soiled panel by 10% (recovering the amount of power lost). Furthermore, autonomous cleaning robots are often only economical on a larger scale due to both installation costs and the fact that custom-made parts are needed to fit the plant.

KEYWORDS: Solar, dust, Cleaning, Solar Panel

I. INTRODUCTION

Growing interest in renewable energy has led the solar photovoltaic (PV) industry to expand notably in the last decade. In the year 2014 a staggering 3.03-million gigawatt hours (GWh) of electricity was produced in the European Union covering 3 percent of the total electricity demand. Because Photovoltaic energy is an accessible technology it has become a popular investment for companies as well as for residential users. Consequently, this demand has stimulated the research for increasing the overall output power of PV systems causing laboratories all over the globe to work hard on making the technology both more efficient and cost effective. Solar photovoltaic (PV) industry is expanding worldwide, due to its technological and economic advantages. The PV conversion efficiency ranges from 10 to 13% in commercial level. However, the outdoor installed PV modules efficiency may reduce by 10 to 25%. The reduction in the effectiveness referred to the losses in the inverter, wiring and dust pollution. Any substance spreads in the air includes soil and dust particles (suspended dust), smoke, fog and particulate matters called dust. Dust formed from inorganic and organic substances of terrestrial origin. However cleaning solar panels is not always as straightforward. To begin with, there is the issue of accessibility. Due to the fact that PV panels often are situated on dangerous and difficult to reach places, it might be hard to clean them manually and it takes time to do it safely. Secondly, cleaning a panel only once a year might not have a significant impact on the yearly energy yield for the simple reason that dirt stacks up again in a short period of time making the difference negligible. Especially if you need to contract someone to clean the panel for you, it might just not be economical. However, leaving panels unclean might not be wise either since soiling can lead to permanent damage of the glass limiting the lifespan of the installation.

II. LITERATURE REVIEW

Photovoltaic panel production has increased globally in response to the growing demand for solar energy. This has been the result of an increased awareness of the damage to the environment that using fossil fuel sources has had over the years. Heliotex Technology: Heliotex is an automatic cleaning system that washes and rinses solar panel surfaces. The cleaning system can be programmed whenever it is necessary, depending on the environment. It does not require any further attention except the replacement of the water filter and the occasional refilling of the soap concentrate. It contains a five-gallon reservoir for soap, which does not cause any damage to the solar panels. The Heliotex system sources the water from the residence via a hose or pipe connected to the pump and attached to nozzles on the solar panel surface without causing rubbing. The Heliotex system can be installed for any size or number of solar

panels. Electrostatics cleaning: Electrostatics cleaning technology is named “Harvesting electricity”. This cleaning technology was first developed by scientists to solve the problem of dust deposits on the surfaces of PVs. This technology can also be used in dry dusty areas on Earth. Electrostatic charge material is used on a transparent plastic sheet or glass that covers the solar panels. Sensors monitor dust level and activates the system in to cleaning mode. The dust is shaken off the solar panels when an electrically charged wave breaks over the surface material. This is not a safe way for home owners who are using solar panels because the panel shakes which may loosen its connection to the roof and it could fall down and cause injury. However, it is an effective solution for larger systems elsewhere. The structure of the panels is strong and flexible to avoid breakage that may be caused by shaking. In two minutes this system can remove up to 90% of dust from the surfaces of the PV panels by sending an electrical dust deterring wave which causes the dust to fall off onto the ground. However, this system is not going to remove dust when it gets wet, or if it is in a moist environment. The movement of the wave mechanism requires only a small amount of electricity which makes it a power efficient system however at present; the worldwide usage of the harvesting system is only 4%.

K.A. Moharram, M.S. Abd-Elhady, H.A. Kandil, H. El-Sherif et al. [4], and it includes that in desert regions the dust affects the solar panels to a great extent and also reduces its efficiency, this paper focuses on cleaning the dust in such regions with the help of minimum water and energy. For this a no pressurized water system are used. It was observed that a 14-kW PV power plant was installed in Egypt whose efficiency decreases to 50% after 45 days by using non-pressurized water system, while it remained constant when a mixture of cationic and anionic surfactants was used for cleaning. Thus, using developed systems for cleaning increases efficiency and reduces the amount of water required. Saravanan V. S., Darvekar S. K. [5], Solar Photovoltaic Panels Cleaning Methods A Review—This paper includes various cleaning methods, such as electrostatic cleaning system, super hyperbolic coating methods, mechanical method, microcontroller based automatic cleaning method, self-cleaning Nano dimers and various characteristics of dust particles are discussed in this paper. This paper throws light on various cleaning methods for solar photo volatile panels.

Monto Mani, Rohit Pillai et al. [6], Research status, challenges and recommendations In areas of most oil reserves the PV panels are adopted due to its growing popularity in recent years. PV module installation depending upon efficiency is related to its geographic location. The PV panels are adjusted in such a way to get maximum sun exposure. Dust is the lesser known factor that influence the efficiency of the PV panel. In this paper research and studies related to the impact of dust on the PV solar panels are discussed.

Manju B Abdul Bari and Pavan C M [7], It includes that the cleaning system designed cleans the module by controlling the Arduino programming. To remove the dust in the PV modules to improving the power efficiency. The dust gets accumulated on the front 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.

B. A. D. J. C. K. Basnayake, W.A.D.M. Jayathilaka, Y.W.R. Amarasinghe, R.A. Attalage, et al. [8], PV efficiency measuring system and smart solar tracking is used on-site to measure power efficiency of panel and other parameters. At a given location while to find solar potential PV efficiency is of great importance. The device mentioned is able to measure PV efficiency, ambient temperature, humidity level, light intensity level and temperature of panel. A 24 V DC supply is required for the operation of device. All the data measured is stored in memory card and is transferred to other devices by using Bluetooth. Atmel Mega 2560 controller was used.

III. PROBLEM STATEMENT AND OBJECTIVE

Problem Statement

Solar panels work by allowing light into the solar cells. The more light that hits a panel, the more power it will generate. Due to the upwards angle of solar panels, they are more prone to bird droppings and a build-up of general dust. Sand, moss and dirt that does not wash off with just rain. This reduces the amount of light hitting the panel and reduces its output. As the projected energy figures claimed by solar panel manufacturers and installers are based on the optimum performance of clean solar panels, this build-up of dirt can adversely affect the panel's ability to meet those projections. Therefore, it is important to clean solar panels in order to protect and maintain your investment. Regular solar panel cleaning will also help you to make the most of the government feed-in tariff.

Objective

- Design a mechanism to detect obstructions on solar panels causing significant loss of power
- Design a cleaning mechanism that runs across the length of the panels
- Improve overall solar panel efficiency

IV. CONSTRUCTION AND MANUFACTURING

MAIN COMPONENTS OF AUTOMATIC PANEL CLEANER

1. DC motor
2. Roller brush
3. Wheels
4. Water sprayer
5. Battery
6. Arduino
7. Relay
8. Motor Driver
9. Solar Panel

DC Motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances.



Figure No. 1: DC Motor

Roller brush



Figure No. 2: Brush

Brush Diameter= 75 mm

Length = 300 mm

Brush material = Soft fibre plastic

Wheels

Specifications:

Wheel Diameter: 70mm.

Wheel Width: 40mm.

Shaft Diameter: 6mm



Figure No. 3: Wheels

Water sprayer

Description

Operating: 3v to 6v DC Power, consumption: 0.4W to 1.5W

Rate of flow: 80 - 120L/hr

Lift: 1.1m MAX.

Type: submersible

Dimension: 45 x 24 x 30 (LxHxB) MM



Figure No. 4: Water Sprayer Pump

Battery

An electric battery has one or more electrochemical cells. The battery converts stored chemical energy into electrical energy. Each battery cell has positive terminal and a negative terminal that is cathode and anode.

The lead acid batteries are used in vehicles and lithium ion batteries are used as portable electronics source. Output: 12 V and 7 amps



Figure No. 5: 12V Battery

Arduino

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package.

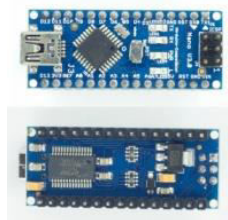


Figure No.6: Arduino

It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

Arduino Nano Expansion Shield

Arduino Nano IO Expansion Shield is specifically designed to facilitate an easy connection between Arduino Nano and many other devices. In essence, it expands the Arduino Nano controller to link those devices in a simple and trouble free manner.

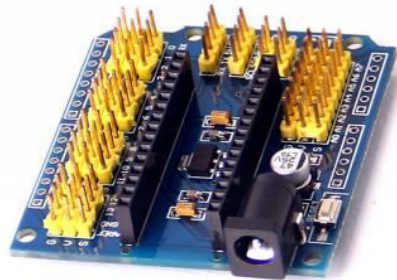


Figure No. 7: Arduino Nano Expansion Shield

Motor Driver

Basically this means using this chip you can use DC motors and power supplies of up to 16 Volts, that some pretty big motors and the chip can supply a maximum current of 600mA per channel.

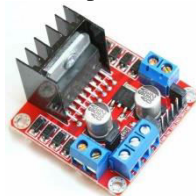


Figure No. 8: Driver

Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Solar Panel

Photovoltaic panel converts solar energy directly into electrical energy. This electrical energy is given to the charge controller. In a Photovoltaic panel, cells are soldered together to produce a 36 cell string (or longer). This string is laminated between toughened glass on the top and an electrical back contact. The string consists of four layers: antireflective coating, contact grid, p-n junction.



Figure No. 9: Solar Panel

BLOCK DIAGRAM OF AUTOMATIC SOLAR PANEL CLEANING MACHINE

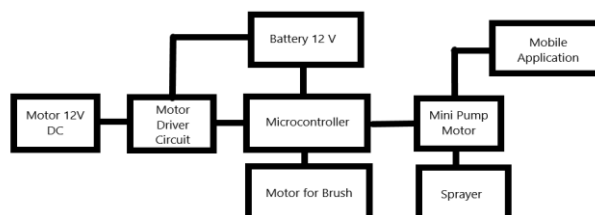


Figure No. 10: Block diagram

1. In accordance with the dimensions of the flat plate panel the solar panel cleaning system consists of brush driven by DC motors and actions of brushes is controlled by signal generated by Arduino.
2. The frame carrying this cleaning brush is moved along the length of the solar panel in vertical direction of 2ft and vice-versa, which results in mopping action on the solar panel cleaning the panels. This frame is also consists of DC motors which will produced the rotational motion which is converted into linear motion through track system. This action is also controlled by signal generated by Arduino.
3. The shifting of frame from one solar panel array to another solar panel array is also carried out using gear motors.
4. All this cleaning actions will consume a time of 30 sec for mopping action for both movements of cleaning system

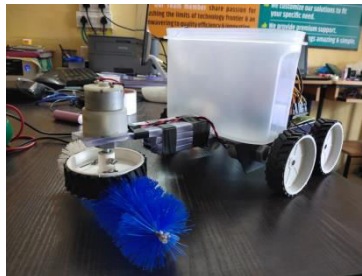


Figure No. 11: Solar cleaning machine

V. ADVANTAGES, LIMITATIONS AND APPLICATIONS

ADVANTAGES

- The surface of PV panel remains clean always.
- It gives better efficiency comparing with general systems
- By using adjustable timer, user can clean the panel as per convenience.
- No man power is required for cleaning.

DISADVANTAGES

- Consumption of water.
- Initial Cost is High

VI. CONCLUSION

The losses of the output power of the fixed solar panel can be higher depending on the dust form. The dirt and bird drop make a hot spot in the panel, and it can make temporary fail in the panel. Dry cleaning can't remove all the dirt on the surface of solar panel, but it is able to remove the outer layers of the dust. Cleaning solar panel with water increases cleaning efficiency by removing majority of the dirt deposited on the panel. Comparing the costs of cleaning by manual operation and automatic operation the costs of automatic cleaning is proved to be more economic and significantly less difficult particularly in systems having large number of solar panels. Also frequent periodic cleaning ensures that the solar panel works with a good consistency at all times.

REFERENCES

- 1) SCCC701 Engineering Development Paper
- 2) Microcontroller Based Automatic Cleaning of Solar Panel
- 3) International Journal of Latest Trends in Engineering and Technology (IJLTET)/ Vol. 5 Issue 4 July 2015/ ISSN: 2278-621X
- 4) K.A. Moharram , M.S. Abd-Elhady, H.A. Kandil , H. El-Sherifet, "Influence of cleaning using water and surfactants on the performance of photovoltaic panels", Energy Conversion and Management 68:266-272
- 5) Saravanan V. S., Darvekar S. K. —Solar Photovoltaic Panels Cleaning Methods A Review, International Journal of Pure and Applied Mathematics 118(24):1-17
- 6) Monto Mani, Rohit Pillai, "Impact of dust on solar photovoltaic (PV) performance: Research status, challenges and recommendations", Renewable and Sustainable Energy Reviews 14(9):3124-3131



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| DOI:10.15680/IJIRSET.2023.1206016 |

- 7) Manju B, Abdul Bari and Pavan C M, “Automatic Solar Panel Cleaning System”, International Journal of Advances in Scientific Research and Engineering, E-ISSN : 2454-8006, Volume 4, Issue 7 July -2018
- 8) B.A.D.J.C.K. Basnayake, W.A.D.M. Jayathilaka, Y.W.R. Amarasinghe, R.A.Attalage, “Smart Solar Tracking and On-Site Photovoltaic Efficiency Measurement System”,IEEE,2016. 4) ShahriarBazyari, Reza Keypour, Shahrokh Farhangi, Amir Ghaedi, Khashayar Bazyari, “A Study on the Effects of Solar Tracking Systems on the Performance of Photovoltaic Power Plants”, Journal of Power and Energy Engineering,2014.



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