



PERFORMANCE ENHANCEMENT OF PHOTOVOLTAIC SOLAR PANEL BY CLEANING ROBOT

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ABSTRACT

One of the biggest problems we have in India is the lack of energy. Approximately 60% to 70% of the nation's energy needs are satisfied by fossil fuels and agricultural leftovers. Energy availability has been a serious issue for both urban and rural households. The sun radiates solar energy, which is a renewable energy source with enormous potential. It's critical to switch from using petroleum-based electric energy to renewable energy. Solar energy applications should be expanded as solar power has emerged as a renewable energy source. Solar photovoltaic modules are typically used in dusty environments, such as those seen in tropical nations like India. Sunlight is blocked from entering the module due to the accumulation of dust on its front surface. It diminishes the module's ability to generate electricity. After a month without cleaning the module, the power output drops by as much as 50%. Through the control of Arduino programming, the cleaning system is designed to clean the module. To increase the power efficiency, dust must be removed from the PV modules.

Keywords: Solar Panel, Robot with Cleaning Brush, Arduino Mega 2560 Uno Microcontroller Board, DC Motors, Node MCU, Motor Driver, Adafruit Software, Arduino IDE.

1. INTRODUCTION

One type of computer system called an embedded system is mainly designed to access, process, store, and control data in various electronics-based devices, among other things. Hardware and software are combined to create embedded systems; the software is often firmware and is integrated into the hardware. The fact that these systems provide the o/p within the time constraints is one of their most crucial features. Embedded systems

facilitate the improvement of efficiency and convenience in work. Thus, embedded systems are widely used in both basic and complicated devices. Sometimes an embedded system is used as a controller to manage a particular function inside of a device. More complex embedded systems may be able to control entire operating systems, but normally they are only meant to perform this function once. Even with their increased complexity, some embedded systems are still capable of performing a wide range of tasks that require minimal processing power. When set to perform a certain function, embedded systems—which are typically not programmable—operate reliably and require no external intervention. On the other hand, certain embedded devices' software may be modified to improve expected functionality

2. LITERATURE REVIEW

1. **In 2016, Prof.V.K.Karra, Shailendra Singh, Prof.J.B.Jawale, Dr.B.P.Patil, Saloni Atre, Punnet Singh [4],**

The efficiency of solar panels is greatly impacted by cleaning and maintenance. An 8-panel array shows a 30%–33% increase in efficiency; as a result, we can see that it will be more useful in solar parks with significantly more cells. Thorough cleaning is very beneficial because even a single panel obstructed by dust can reduce the array's overall performance.

2. **In 2017, N.Rusli, M.N.Abdullah, M.Z.Zulkefli, J.J.Jamian, N.A.Hashim [5],**

An intelligent PV cleaning system was designed to remove impurity deposits on the surface of the PV panels. This system controls the robot's movement using a robotic technique and the appropriate circuit. The primary factor enabling the cleaning robot to function is the sensitivity of the Light Dependent Resistor (LDR), which detects the presence of light.

3. **In 2018, Roopak R,Shajan K.Thomas, Sahad Bin Haris, Shelvin Joseph , Sarrop T S [6] ,** This project makes recommendations for future automation that will lower labour costs and for cleaning recycled water. The goal of the project is to create a smart, completely automated cleaning system that uses less energy and resources.

4. **In 2020, Muhammad Syukri Mohd Saibon, Ili Najaa Aimi Mohd Nordin, Muhamad Faizal Yaakub, Faridah Hanim Mohd Noh,Norain Sahari, Sim Sy Yi,Nori Aira Zambri [7],**

Developed a solar panel cleaning robot using arduino. This research paper describes the development of a solar panel cleaning robot that is fully built. The Arduino platform is used to establish the control algorithm and cleaning protocol. The robot ensures that the designed robot is effective, as evidenced by the 50% increase in output current and the maximum power both before and after cleaning.

5. **In 2020, P.S. Rama Prabha, Kumar, Jayanthi and Somala Rama Kishore [8],**

Proposed an automatic solar panel cleaner robot using IoT. It comprises of battery, Dc motors, motor driver, microcontroller, IR sensor, GSM module. In this system, It is possible to increase the peak power output by 10%–30%. The observation suggests that increased energy usage is caused by dust accumulation on the panel.

Using the easy-to-manage and reasonably priced cleaning technique increases the strength and output of the solar panel. There is less power utilization during this time as well. Finally, the findings demonstrated that the peak power reduction was attained.

3. HARDWARE SPECIFICATIONS:

- a. Lead-acid 12 v Battery
- b. Arduino mega 2560 UNO Board
- c. Voltage Sensor
- d. Current Sensor
- e. Node MCU
- f. DC Motor
- g. Motor Driver
- h. Solar Panel
- i. LED

a. Lead-acid Battery:

A battery can be defined as an electrochemical device which can be charged with an electric current and discharged whenever required. A 12V lead-acid battery is used. Lead and sulfuric acid are the two components of a lead-acid battery, which is a rechargeable battery. Sulfuric acid is added to the lead to initiate a controlled chemical reaction. The battery produces electricity as a result of this chemical

b. Arduino Mega 2560 UNO Board:

One of Arduino's standard boards is the Arduino UNO. Here, UNO is the Italian word for "one." The original Arduino software release was known as the UNO. Additionally, it was the first USB board that Arduino has released. It is regarded as a strong board that is utilized for many different kinds of applications. The Arduino UNO board was designed by Arduino.cc. The Arduino UNO is built using the ATmega328P microcontroller.

c. Voltage Sensor:

A device that measures voltage is called a voltage sensor. Voltage sensors are capable of sensing low current levels as well as high voltages. These devices are necessary for many applications, such as power systems and industrial controls [19]. This sensor accepts voltage as its input and can produce analog voltage, current, or audio signals

d. Current Sensor:

A current sensor is a device that measures the current flowing through a wire and produces a signal proportional to that of current. The signal produced can be analog voltage or current or a digital output [22]. There are many different types of sensors, and each kind is suitable for a particular current range and environmental conditions.

e. Node MCU:

An open-source, inexpensive platform that combines Wi-Fi connectivity and a microcontroller unit (MCU) is called the ESP8266 NodeMCU. Based on the ESP8266 Wi-Fi module, it provides an easy approach to prototype without requiring a lot of understanding of hardware and software. It is a great choice for tasks requiring an internet connection because it has built-in Wi-Fi.

f. Motor Driver:

Motor drivers serve as an interface between a motor and a computer or microcontroller. For accurate control of the speed, direction, and torque of motors, motor drivers are essential

g. Solar Panel:

Solar panels, sometimes referred to as "PV panels," are a type of equipment that transforms solar light which is made up of energy particles called "photons" into electricity that may be utilized to power electrical loads [28]. Solar panels are made up of number of smaller components known as photovoltaic cells.

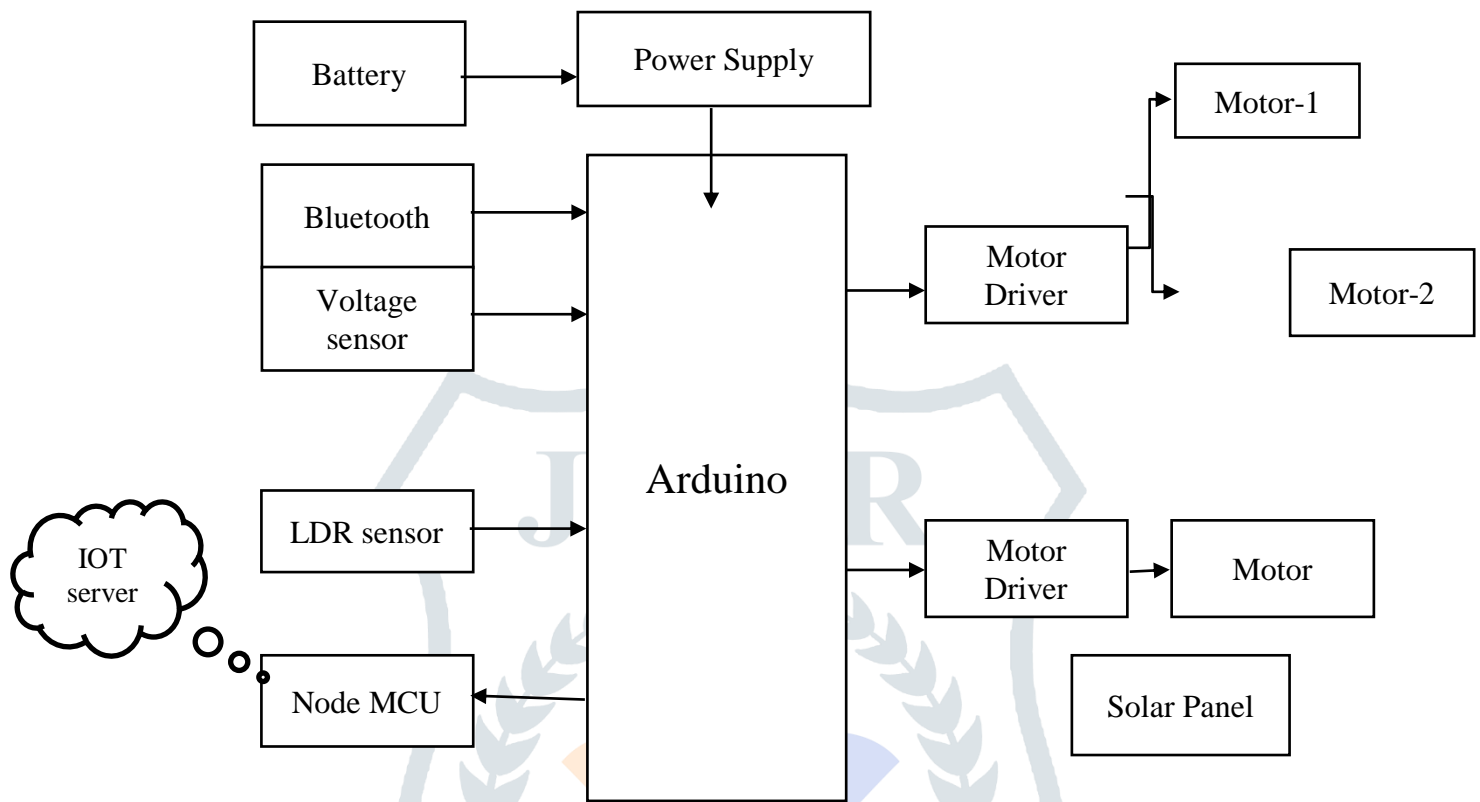
h. Light Emitting Diode (LED):

Light-emitting diode (LED) is a semiconductor device. When the current flows the led then the light is emitted. Photons are released as a result of the semiconductor's electrons and electron holes recombining. The energy needed for electrons to pass the semiconductor's band gap determines the colour of the light, which is correlated with photon energy. Using multiple semiconductors or covering the semiconductor device with a coating of light-emitting phosphor allows for the production of white light.

4. WORKING PRINCIPLE:

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 remote. The frame carrying this cleaning brush is moved along the length of the solar panel in horizontal direction and vice-versa, which results in mopping action on the solar panel cleaning the panels. This frame is also consisting of DC motors which will produce the rotational motion which is converted into linear motion. This action is also controlled by remote. The shifting of frame from one solar panel row to another solar panel row is done manually. The frame is moved in horizontal direction until the solar panel row ends. All this cleaning actions will consume a time of 80sec for mopping action for cleaning the one solar panel of dimension 1956-990-40(mm). Once one row of the solar panel is cleaned, it moves to another row and hence the cleaning process gets repeats.

Diagram



5. CONCLUSION

A completely functional robot for cleaning solar panels has been developed via this project. It draws attention to how the efficiency of PV systems is impacted by dust, filth, pollen, sea salt, and bird droppings. The performance and efficiency of the solar panels are significantly impacted by dust. Peak power generation can be reduced by as much as 10% to 30%. Dust deposition on the panels was shown to be the cause of power decrease; this can be fixed by employing a robotic cleaning technique. It has enhanced the solar panels' ability to generate power. Some advantages of this approach are low cost, easy maintenance, and reduced power use. Furthermore, this cleaning can also be used to overcome the decrease in peak power generation.

6. REFERENCE

[1] Yekini, Nureni, "Overview of Embedded Systems and it's applications", June 2022

https://www.researchgate.net/publication/361562662_OVERVIEW_OF_EMBEDDED_SYSTEM_ITS_APPLICATION

[2] <https://www.spiceworks.com/tech/tech-general/articles/what-are-embedded-systems/>

[3] <https://iies.in/blog/real-life-applications-of-embedded-systems/>

[4] Muhammad Syukri Mohd Saibon, Ili Najaa Aimi Mohd Nordin, Muhamad Faizal Yaakub, Faridah Hanim Mohd Noh, Norain Sahari, Sim Sy Yi, Nori Aira Zambri, "Development of solar panel cleaning robot using arduino", Volume-19, No.3, September 2020, DOI:10.11591/ijeecs.v19.i3.pp1245-1250

https://www.researchgate.net/publication/344027601_Development_of_solar_panel_cleaning_robot_using_Arduino#:~:text=The%20design%20utilizes%20an%20Arduino,found%20on%20PV%20panel%20surfaces.

[5] P.S. Ramaprabha, R.Kumar, S.Jayanthi, R.Kumar, "Automatic Solar Panel Cleaner Robot Using IoT", IOP publishing, 2020, DOI: 10.1088/1742-6596/1964/6/062084

<https://iopscience.iop.org/article/10.1088/1742-6596/1964/6/062084/pdf>

[6] Md.Shahnewaz Tanvir, Ahmed Yousuf Suhan, Md.Rawshan Habib, Sanim Alam, Abishek Vadher, Koushik Ahmed, Abdelrhman Alrashed, Tahsina Tashrif Shawmee, "Automatic Solar Panel Cleaning System Based on Arduino for Dust Removal", IEEE, April 2021, DOI: 10.1109/ICAIS50930.2021.9395937

<https://ieeexplore.ieee.org/document/9395937>

[7] Mr.Bhupendra Kumar, Achal Ranpise, Yash Salame, Prajwal Gajbhiye, Khushal Manik, Vinay Choudhary, Disha Raut, "Automatic Solar Panel Cleaning System", IRJMETS, Volume-05, Issue-01, January 2023.

[8] M. F. Yaakub, et al., "Prospective study of power generation from natural resources using hybrid system for remote area," Indonesian Journal of Electrical Engineering and Computer Science, vol. 18, no. 2, pp. 642-647, 2020.

[9] S. R. Hunter, et al., "Low-cost anti-soiling coatings for CSP collector mirrors and heliostats," High Low Concentrator Systems for Solar Energy Applications IX, vol. 9175, p. 91750J, 2014.