Solar Panel Cleaning Robot

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Abstract – One of the renewable energy sources, solar energy, is crucial in supplying the world's rising demand for electrical energy. Researchers have been working on solar panel efficiency, maximizing energy extraction from the sun, control and power electronics in recent years as many countries have developed their energy policies on the basis of solar energy. Solar panels use the energy that the sun provides to create electricity. We can lower installation costs and make it simpler to supply the required peak electrical power by continually extracting the maximum amount of energy from the sun. When muddy rain, snow, or dust are present between the solar panel and the sun, the level of electrical power extraction is lowered. Therefore, maintaining the cleanliness of the solar panels is crucial. A solar panel cleaning robot has been created and put to the test for this purpose.

Index terms - Arduino board, DC Gear Motor, ThingSpeak, Brush.

I. INTRODUCTION

As a result of fossil fuels being used to generate power, such as gas, oil, and coal, which are expensive, scarce, difficult to store, and contribute to global warming, the availability of electrical energy has grown significantly in importance for the development of the country in recent years. The energy obtained from the sun through solar panel is called solar energy. The panel comprises the solar cell. The cell is made of semiconductor material. The electrons will be released from their atoms whenever the sun shines on the cells. The energy will be created as a result of the conductor's particles moving about. Demand for solar energy has risen as a result of solar energy's abundance and lack of pollution. Several locations across the nation have erected significant solar power facilities. Photovoltaic (PV) systems are influenced by dust build up on solar panels. Generally, the cleaning of solar panels with water requires a lot of labor and has been shown to be expensive in large-scale PV systems. Robotics can be utilized to overcome this restriction because it does away with human labor while also being more cost-effective and autonomous. Researchers have demonstrated that the output of solar panels decreases when the sun's angle changes during the day. Power loss will be larger than with solar panels employing solar tracking systems if the solar panel is not tracking the sun. Compared to solar panels using single-axis sunlight tracking systems, those using double-axis sunlight tracking systems produce more power.

II. LITERATURE SURVEY

Chailoet & Pengwang, 2019. Design a robot with various lengths to clean a PV panel. The merits of the system are that it can clean different size of the solar panel as the robot length is 1-meter; extended robot length is done by connecting the robots' using pins. The Robot consists of a brush, sprinkler, wheels, support wheel, photoelectric sensors, DC motor, and aluminium pipe frame. The Robot has three different levels of speed (slow, medium, and high)—a joystick using to control the Robot manually [6].

effectiveness of cleaning the solar panel with a silicon rubber foam brush. The test was collected in 2013 from March till June. The result shows that using this type of brush lead to minimizing the impact of the solar panel's dust [8].

Khadka, Bista, Adhikari, Bista, & Shrestha, 2019. In this paper, the smart solar photovoltaic cleaning system has been designed to clean the surface of a PV panel form unwanted particles. The system is controlled by a microprocessor. There are two types of motors used - stepper motor is selected as the driver for driving the robot cleaner for solar panel cleaning and PMDC (permanent motor magnet direct current) for rotating the brush.

In an autonomous unit, the microprocessor controls the working of the robot depending on the sensors (illuminance sensor (TSL 2561), voltage and current sensor, humidity sensor (DHT11 temperature) and dust sensor (GP2Y1014AU0F) [9].

Akyazı, Şahin, Özsoy, & Algül, 2019. Utilise an Arduino Mega as the microcontroller for a robot that cleans solar panels. The controller directs the robot to clean the PV panel surface vertically and horizontally. To locate the Robot and brush on the PV panel, limit and ultrasonic sensors are employed.

To determine whether the brush is on top or the bottom, two limit sensors are employed. To determine whether the gadget is in the barking position, the third limit sensor is used. Four DC motors are fitted in the robot to regulate its movement in the four directions of up, down, left, and right. The brush is rotated by two 9V DC motors. The brush may be moved up, down, and left to right with the assistance of a unique pallet designed for the device. [10].

Jaradat et al, 2015. To remove undesired particles from the PV panel surface, a robot cleaner has been developed. The system is composed of a robot cleaner and an automated carrier cart, which moves the robot together with the PV panel. In contrast, the robot cleaner cleans the PV panel surface. The cleaner system consists of two brushes, four motors, four wheels, and a controller. The two motors are used to drive the four-wheels and the other two motors are used to drive the two bushes.

The controller subsystem consists of Arduino as a microcontroller and IR sensors. When the robot reaches the end of the PV panel, the sensors are employed to produce a feedback signal for the controller. The test conducted and the result shown depicts that after two passes, the robot can clean more than 80% of the dust [11].

Ronnaronglit, Nawat, and Noppadol Maneerat, 2019. Design a robot for cleaning solar panel. The Robot consists of five DC motors, brush, Mega 2560 Arduino, battery, wheels, ultrasonic sensors, and a relay of 12V. For controlling the movement of the robot, four motors are used to drive the PV panel horizontally and vertically while the last one is used for rotating the brush. Twenty degrees is the maximum slope of the solar panel that the system can be working on to clean the PV panel. At 0 degrees the speed of the robot is 0.70 m/s. For many solar panels, the robot will take a considerable time to clean [12].

III. METHODOLOGY

In the proposed design of solar panel cleaning robot, the robot cleaner is designed using a light weight material such as Aluminium. The robot cleaning system uses a brush element to clean the panels, so that water is not wasted in the process. After the cleaning activity is performed, the robot is relocated to another track of solar panel. This system has a single axis solar tracker's capacity to clean many sun panels in a solar farm., where it is difficult to use manual cleaning. So, using the robot cleaner is more efficient and not costly.

The robot system will accumulate electric power while it is in standby mode. When it is started, the cleaning brush starts to rotate and move down vertically across the panel. When the cleaning of a panel is completed, the cleaning brush will stop rotating and vertically go up and the device then moves horizontally to another panel. This cycle continues until it reaches the end of the solar panel array. Then, the device returns to the parking station and begins to charge. The device gets charged while waiting for the activation command in parking station, which is located at the left side of the panel array.

The robot cleaner is designed to remove the dust and unwanted particles from the PV panel's surface, and the robot can also work without water, cleaning the panel's surface using a brush and water. When the user presses the switch, the DC motor starts rotating the brush, and the water pump spreads the water with the help of the sprinkler on the panel surface.

The robot will not advance. if the output from the IR1 sensor is high. In the code, we can assume that the IR1 output = I and the IR2 output = Z. The IR1 output is given to the Arduino UNO pin 3, while IR2 output is given to the Arduino UNO pin 2. L298N motor driver pin connects to the (4, 5, 6, 7, 8, 9,10, 11) of the Arduino UNO pin. For the forward movement, the value of Z = high and value of I = high. The microcontroller drives a digital signal to the L298N motor drive through the pin (4, 5, 6, 7, 8, 9, 10, 11). The motor will move forward until it reaches the end of the PV panel. Then, the output of the IR1 sensor becomes low. The microcontroller will change the polarity of DC motor through the L298N motor drive1 pin (in1, in2, in3, in4) and L298N motor drive2 pin (in1, in2, in3, in4). We are not using PWM of the L298N because there is no requirement to regulate speed. of the motor. The motor shuts off when the robot moves back to its starting location.

Whenever the LDR's resistor does not change due to the sun's intensity incident on the LDRs sensor, the output generated from the LDR will be zero. Hence, the LDR output gives 0V. So, the input to the Arduino UNO is zero, and the panel does not rotate. When the sun goes west, LDR-A detects the change of the sun's intensity and its electrode resistance decreases. The analogue signal is sent to the Arduino UNO in the pin (A0). The microcontroller will compare the value using the pin's value (A2) of the Arduino UNO and then generate an output signal to the motor drive to control the rotation of the DC motor 1 to the top, right until the sun’s radiation becomes incident to the LDR-A. When the sun goes east, the LDR-B detects the change of the sun’s intensity, and the change of the intensity is sent to the controller through the pin A2, which is analogue value. The microcontroller compares the sensor's outputs and sends the feedback signal to the motor driver L289N through Arduino digital pin (3, 4, 5). Pin-3 connects to the ENA of the L298N, which is the PWM, through which the speed can be controlled. The pin (4, 5) is the H Bridge which reverses the current's flow direction to the DC motor, i.e., forward or reverse by reversing the polarity of the battery of the DC motor to 1.

IV. RESULTS

When the solar panel was dust-covered, the current dropped by roughly 50%. Along with the decline in current, the solar panel's actual power output likewise fell linearly. Then the built robot was used to perform the cleaning. Following the dust-cleaning procedure, the current nearly doubled again. The robot’s design enables it to assist solar panels in producing energy at close to 90% efficiency. The designs for the solar panel cleaning robot are depicted in Figures 1 and 2.

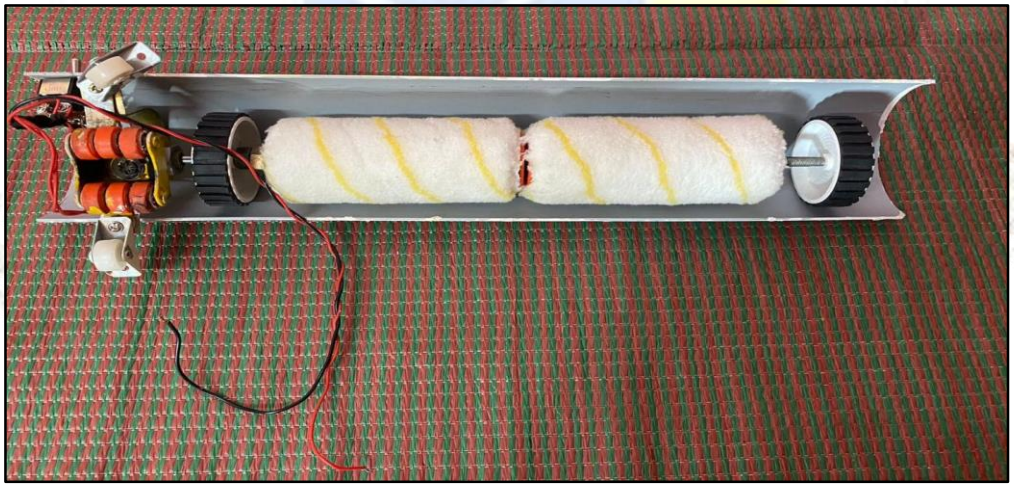

Fig.1 The model of Robot for cleaning solar panels

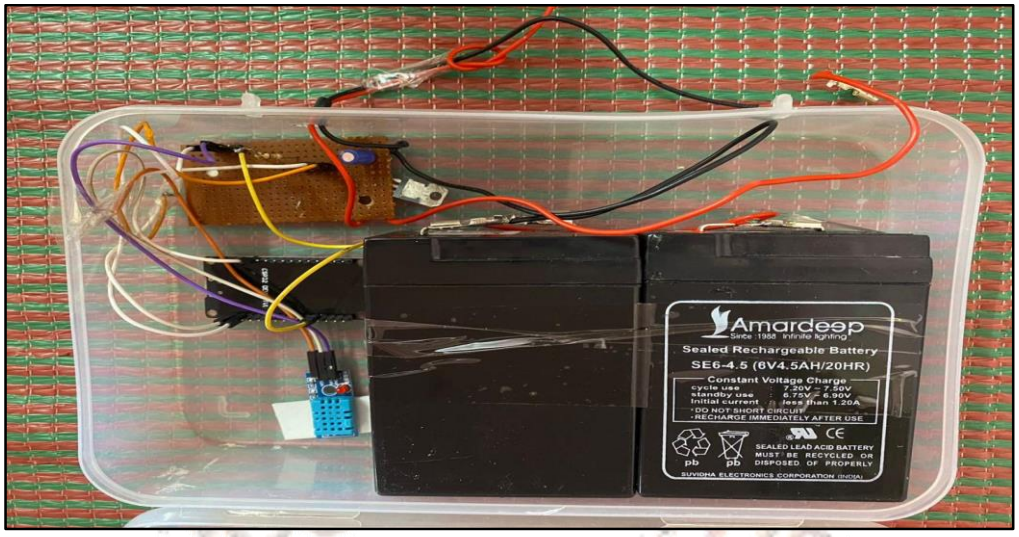

Fig.2 The microcontroller ESP-32 and battery connections

V. CONCLUSIONS

The robot cleaning system is designed and developed to consistently clean the dust particles on the solar panel. The robot cleans the solar panel using a rotary brush. The experimental results show that the efficiency of the panel has improved to 90% by the proposed model, i.e., the robot cleaner designed with light weight material. The entire component used is available in the market and is cheaper compared to other robot cleaners in the market. The robot cleaner could clean the solar panel using wet or dry-cleaning system. Using dry cleaning system would give an advantage to save water. On the other side, using the sun tracking system increases the panel's effectiveness. The robot cleaner can be created once the optimum design has been chosen to guarantee good performance.

VI. REFERENCES

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