Design and Implementation of Roof Top Solar Panel Cleaner Robot Using IoT

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Abstract: Fuel is one of the main challenges which the world faces in current situation; water shortage for urban and rural households has been one of the major problems too. Fuel wood and crop residues meet about 60 to 70 percent of the country's electricity demand. Solar energy is a green energy source with an immense potential & light from the sun. The use of electric energy generated by petroleum is important for renewable energy. Solar energy has become a clean energy option and the deployment of solar energy needs to be strengthened. For dusty climates, tropical nations such as India typically use Solar PV panels. On the front side of the frame the dust accumulates and filters the light from the sun. It reduces the ability of the module to produce electricity. If the device is not cleaned for one month, the power output is reduced by 50%. The cleaning device cleans the module via the PIC programming interface. To eliminate the dust in the panel for energy efficiency enhancement.

Keywords: Solar panel, Controller, Cleaning robot, IoT, PV panels.

1. Introduction
The solar sweeping system has become extremely relevant, since there's been more solar farms installed [1]. The power produced depending on the light intensity emitted by the semiconductor [2]. It has been recorded that a 4-gram sediment layer per square meter reduced the transition of solar power by 40 per cent [3]. There are currently many cleansings process forms which are extensively used in solar array cleaning [4]. Automated panel washing is a great investment because manual washing on the rooftop is inefficient [5]. We built an automated cleaning robot in this research by focussing on designing an operating system using omni wheels [6]. The omni wheel can travel in both directions freely & makes multi-directional movement introduced to a flat surface [7]. The omni wheels have thus been used in several implementations to provide versatility in the rotational movement of robots, rather than gradually spinning robots [8]. It will reduce excessive cleaning time for solar panel cleaning and result in more effective cleaning [9]. And in the following pages we would likely to see the block diagram of the proposed system, Components used, Results and discussions and finally conclusions. The references are very useful to design the above proposed system [10].

2. Proposed System
As shown in Figure 1, our proposed system block diagram constitutes of Controller, IR sensors, Motor driver circuit and Motors. The suggested system can be switched from the user mobile based on his or
her requirements. Whenever the user feels his solar panel is dusty or covered by dirt particles once can switch on the prototype from his or her mobile phone [11].

![Block diagram of the proposed system](image)

**Figure 1:** Block diagram of the proposed system

This proposed system consists of three motors one is connected to the cleaning brush of the prototype and other two motors are used for moving the prototype across the solar panels. So, whenever the user switches the prototype the motors which is used to move the prototype starts rotating in one direction thereby carrying the cleaning prototype to one end when it reaches the end of the solar panel IR which is kept at the other end detects the prototype and commands the controller to alter the direction of the motor [12]. So, IR is the significant module which is used for this cleaning operation.

3. **Hardware Components**

3.1. **DC Motors**

![DC motor](image)

**Figure 2:** DC motor

A DC motor shown in Figure 2 is a grade of rotary power motors that transform direct power into mechanical power. The main types of magnetic fields depend upon the forces generated.

*Classifications of DC motors:*
- Permanent Magnet DC motors.
- Series DC motors.
- Shunt motors.
- Compound motors.

3.2. **IR Sensors**

An infrared sensor is an electronic tool used to detect certain properties of the environment. It does so by the release or measurement of infrared radiation. [13] Furthermore infrared sensors can quantify
& detect the heat generated from an entity. IR sensor board is shown in Figure 3 and its working is explained in Figure 4.

![Image of IR sensor](image1.png)

**Figure 3:** Shows the image of a IR sensor

![Diagram of IR sensor working](image2.png)

**Figure 4:** Shows the working of the IR sensor

### 3.3. Microcontroller

A single chip microcomputer produced from a VLSI output is a microcontroller (μC or UC). Often known as the embedded controller is a micro controller [14]. Today, a number of different kinds of micro-controllers of different size are available on the market including 4bit, 8bit, 64bit & 128bit. Figure 5 shows the dual line package of the microcontroller used in the application.

![Microcontroller](image3.png)

**Figure 5:** Microcontroller

### 4. Results and Discussion

The robot's stability was measured at 0°, 3°, 5°, 8° and 10° angles in a bent solar frame [15]. The robot is approximately 30 cm forward and backward in our measuring environments at the edge of the solar panel. The robot's velocity changes according to the battery conditions. The pace was also not just though the wheels slipped during the testing conditions. Table 1 shows the tested values of the roof cleaning robot. We can clearly see the average time for the robot to reach the ends of the solar panels getting varied based on the condition of the battery. As the IR sensor is the main reason for the prototype for switching the motors rotation. Hence the proposed robot is more desirable for solar panel cleaning operations. The overall hardware is shown in Figure 5.
Figure 6: Hardware Implementation of the Solar Cleaner

Table 1:

| Solar panel angle(degrees) | Panel Length(cm) | Average time(ms) | Battery Condition |
|----------------------------|------------------|------------------|-------------------|
| 0                          | 30               | 0.2              | Fully Charged     |
| 3                          | 30               | 0.3              | Fully Charged     |
| 5                          | 30               | 0.6              | Fully Charged     |
| 8                          | 30               | 0.9              | Fully Charged     |
| 10                         | 30               | 1.5              | Fully Charged     |
| 0                          | 30               | 1.5              | Low Charge        |
| 3                          | 30               | 1.8              | Low Charge        |
| 5                          | 30               | 2.25             | Low Charge        |
| 8                          | 30               | 2.6              | Low Charge        |
| 10                         | 30               | 3                | Low Charge        |

5. Conclusion
By developing a new driving device with a controller and other dc motors, we have built a solar panel robot for improving cleaning speed and retaining effective robot control. In our initial tests the robot will travel over a 10o angle surface at speeds of approximately 1.5 m/s. And if the robot is attached to a 60 cm long panel it would take almost twice the time which 3m/s. Furthermore, by using strong-friction material for rotating wheels, we are designing the solar cleaning robot to reduce slip. To order to increase the battery life for extended use, the weight of a robot must be reduced. In addition, further attention should be given to the lightweight cleaning brush configuration for this device.

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