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A Prototype for IOT based Solar Panel Cleaning Mechanism

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ABSTRACT

The adoption of green energy sources like solar power continues to rise due to price hikes for electricity and have implications about the environmental effects of fossil fuels. Natural occurrences, such as the build-up of dust on installed photovoltaic panels' surfaces, tend to lower their electrical output, which in turn lowers their efficiency. Cleaning products are hence essential for increasing solar panels' effectiveness. Cleaning panels by hand is pricey and ineffective. A prototype of solar panel cleansing mechanism has been presented in this paper and the enhanced output power after its implementation has been recorded. This strategy seeks to increase the effectiveness of by removing any kind of dust on solar cells. The proposed work includes a cloud server that uses the internet of things (IoT) to provide global live status monitoring. It can be entirely automated by the assistance of robotics and the Internet of Things. A mechanised cleaning system is more effective and uses less water. The unit can function both directly and electronically owing to sensors, microcontrollers, and other components.

Keywords: *Servo Motors; Electrostatic Cleaning; Guide Rails; Micro-particles; Foam wiper; Jet spray.*

1.0 Introduction

Making the shift to renewable energy sources has become necessary due to the rising global energy demand, the effects of climate change, and the limited availability of conventional energy sources. Considering its size, abundance, and environmental friendliness, solar energy has been regarded as the finest alternative. Due to ongoing attempts to address the issue of intermittency, lower the cost of solar systems, and implement novel government initiatives that promote their usage, solar energy's impact on the worldwide mix of energy sources has been rising. Solar energy can be used effectively to generate electricity for a range of uses, including domestic, commercial reasons, and industrial ones [1]. The necessary supply of electrical power may be delivered without harming the ecosystem or people's health because there are no harmful gases discharged throughout the procedure for converting energy. Dust on the solar panel is primarily made up of industrial and urban goods. SiO_2, Al_2O_3, Fe_2O_3, Ca Mg $(CO_3)_2$, Ca $(OH)_2$, CaO and $CaCO_3$ are some sorts of dust particles found on the solar panel [2]. Dust buildup on solar panel surfaces has a substantial influence on the equipment's efficiency. Dry locations have been reported to reduce system effectiveness by about 50% and result in power losses of about 15%. However, not all countries use solar energy, and most are still working to integrate alternative forms of energy with conventional urban thermal power plants. Even while solar energy and heat sources have many applications and are widely available, some situations prevent their full usage.

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The low solar energy rate of conversion into electrical energy is one of the key issues preventing solar power plants from being widely used [3]. However, there is a significant barrier to the construction of solar power plants: the issue of surface contamination caused by rainfall and climatic events, as well as a low coefficient of performance. Temperature, irradiance, dirt, and shadowing are examples of environmental elements that have an impact on a solar PV system's effectiveness. PV system efficiency can also be impacted by system component losses. The degradation of PV panels, meanwhile, is one of the most significant issues with PV power plants built in deserts. In areas with a lot of rain, the panels' dust buildup is immediately cleansed by rainwater, and the output power loss is tolerably minimal [4]. Due to the stirred-up dust, panels installed in deserts suffer severe degradation, and a plant's output power degrades over time if it isn't cleaned. Cloudy circumstances hinder absorbance and can lower the panels' efficiency by 22% to 76% [5]. With the aid of a tightly controlled technique, it's essential to maintain the panels and in turn the arrays clean for optimal production.

2.0 Solar Panel Cleaning Methods

The efficiency of the solar panels, which are directly subjected to weather conditions, relies on the amount of solar radiation they encounter. The solar panel's efficiency of conversion will be decreased as a result of the assimilation of dust and other particles. This makes it possible to regularly clean the panels [6]. Various [7] researchers have compiled various cleaning techniques from the literature and assessed their benefits and drawbacks. The most popular and extensively explored approach throughout the research literature is the cleaning robot. The most typical and established way of cleaning is using a brush and water. Robotic automation of cleaning has also proven to be useful. However, manual cleaning is challenging in the harsh desert environment, water and its delivery to the locations where the power plants are located are prohibitively costly, and potential worker earnings are uncertain. Masuda et al. [8] suggested the electrostatic travelling wave as another cleaning technology, and it is still being developed today. It is an automated cleaning method that uses a remarkably small amount of power and doesn't depend on supplies or mechanical moving parts. The present methods for cleaning surfaces are pricy, time-consuming, inefficient, and may damage collectors' surfaces. To maintain optimal reflective behaviour and power production, a built-in cleaning system retains the solar collector pristine while it is in use [9]. In order to reduce and ultimately remove the impact of dirt and soiling on solar system performance, the goal of this inquiry is to design and build an automated cleaning system for a solar-based collector.

There are four further subcategories of autonomous mechanised solar panel cleaning systems or robot systems: mobile robot system, tethered robot system, rail robot system, and mobile manipulator with ground vehicles. Two rails are located on opposite side of the panel and make up the rail system, also referred to as the fixed system [10]. If the cleaning brush is horizontal (side rails) or vertical (top and bottom rails) relies on the clean-up process. For solar panel setups that use uninterrupted panels, this technique works well. By analysing the movement of solar panel cleaning robots that are effective in Thailand, wireless joystick, sensor sonar employing gear motor, and ARDUINO microcontroller are used in this research to build and create the solar panel cleansing robots. In order to enhance the cleaning process, the bot will wipe down a solar cell utilising a rotational brush and water spray. This study developed and assembled a drive system for a robot that can be installed on solar energy panels on inclined and slippery surfaces [11]. The robot features sensors and encoders that allow it to accurately control its movements, pausing at panel borders and

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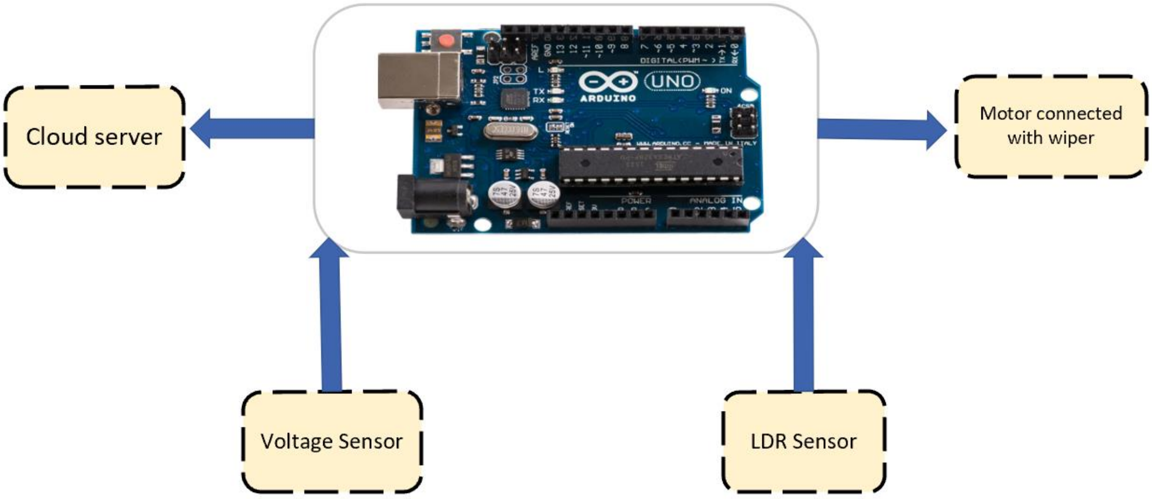
navigating through panel gaps. Four omnidirectional wheels, which may either roll normally like an axle or roll laterally utilising the rollers, were used to propel the robot.

Figure 1: Components of an IOT based Solar Panel Cleansing Model



The drone's potential to glide in a straight path across the solar panel's outer layer and hover from a single solar panel to the next is one of its key features. The quantity of dirt can be measured by attaching a sensor to the glass in front of a solar cell and shining an LED over it [12]. The measurement is made by contrasting the transmission loss of the glass with that of a pane of unobstructed sample glass. "DUSST," which stands for Detector Unit for Soiling Spectral Transmittance, is the name of the technique. The panels are cleaned autonomously by a robot in this situation, and their motion is made possible by gear motors that are controlled manually over the internet. Limited cash was expended on labour, which had a noticeable fiscal impact for the nation. The robot is made for cleaning solar panels that are on the water. A controller is used to control the valve as well as to restrict and enable the movement of water. The Arduino controls the wiping motor to remove the dust from the panel if the voltage drops as a result of dust particles accumulating there [13]. To further improve efficiency, it can be executed by cleansing the solar panel with a water or chemical-based mixture. The Wi-Fi module collects data, which the Internet of Things (IoT) then stores in the cloud. The complete setup was controlled by an Arduino Uno R3 microcontroller. The convenience and programming simplicity of this microcontroller made it feasible to easily establish communication between the computer and the engine [14]. However, because of their high price, using Arduino series controllers with a huge-scale cleaning system is not feasible.

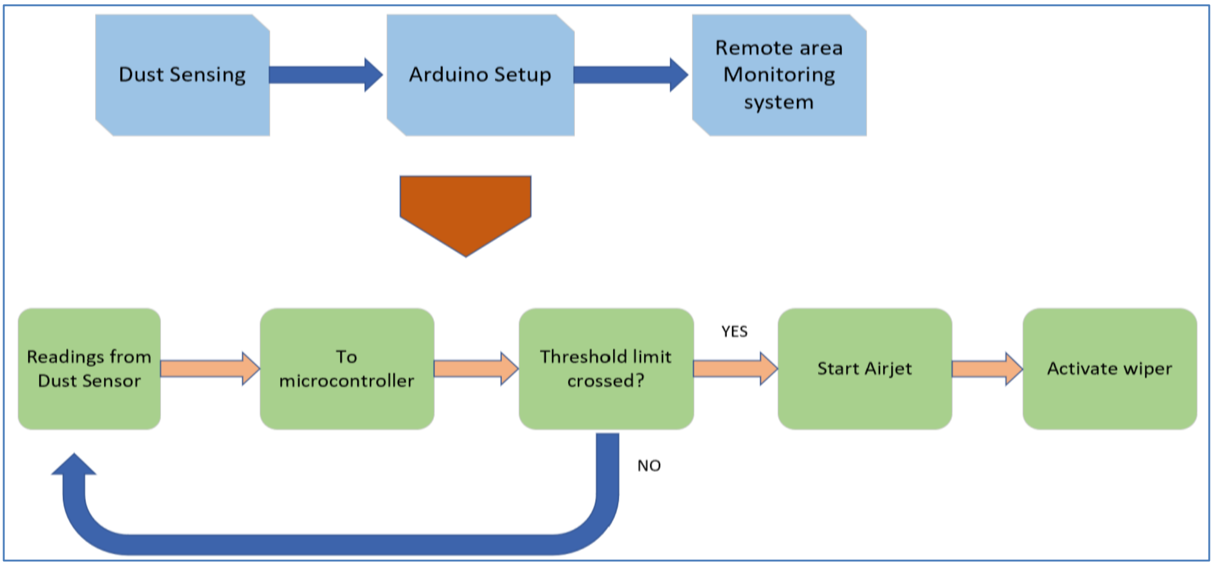
The dust sensor will be used to identify any debris affecting power generation and is going to switch ON the water pump in order to avoid the indicated reason. The dust sensor picks up the light that dust in the air reflects. When the sensor is switched ON, the IR light highlights the dust particles in the surrounding air. It is made up of an IR (Infrared) LED and a Phototransistor. As a result, a signal of scattered light is produced [15]. This signal of scattered light is picked up by the light detector phototransistor. The response of the light detector system is amplified by the multiple signal amplifier circuit. A signal that consists of amplified light is subsequently utilised to calculate the amount of dust in the air. In accordance with the amount of dust or smoke in the atmosphere, the optical dust sensor produces an analogue voltage signal on the Vo pin. The quantity of diffused light measured by the light detector circuits determines the size of the resultant voltage.

Additionally, the amount of light that scatters is inversely related to the quantity of airborne dust particles. Less power is produced when there are more dust particles present, and vice versa. The two-step cleaning processes used in the envisioned solar panel cleansing method. Initially a ventilation fan does its utmost to clean the panel's exterior of any contaminants. As dirt, four main types of sands are employed. Then gently swipe with a wiper constructed from soft clothing. As a result, the system can be cleaned without the need of water. This function prevents the solar panel from being damaged. This study proposes a gadget that may be programmed to wipe down solar panels [16]. The suggested research project makes use of the Internet of Things, and the framework is managed by a microcontroller and an Android device. The technology is flexible, so it may be utilised everywhere. Through the use of the solar panel that is linked to it, the battery can be recharged in this. Utilising an Android app to control reduces the need for human labour. In addition to its inexpensive price, minimal power use, and integrated Wi-Fi capabilities, the ESP8266 is a great option for IoT projects. The Arduino IDE makes it simple to programme, making it a suitable choice for newcomers. Its compact size makes it adaptable and enables its integration into a variety of devices. It can be employed as a Wi-Fi module for other microcontrollers or as an isolated microcontroller. The Arduino IDE is used to create the programme. The configuration's upload speed is set at 9600, and the setup ID is connected to the ESP8266 board's COM5 port. As a microcontroller, Node MCU is employed. It is a platform for developing open-source software and hardware. Here, an ESP-8266 Wi-Fi module is employed. Programming is carried out in a very basic language.

3.0 Working of the Proposed Model

The "the initial stage" involves applying compressed air to the panel with the use of nozzles in order to clear away sand and other large particles that have gathered there.

Figure 2: Steps Involved in Solar Panel Cleaning Mechanism



A coating of implausible humidity that could currently be existing over the panel surface in the early hours of the morning is likewise dried away by the air. A compact on-board D.C.

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compressor that is simple to find in a store can be used. The cleaning structure moves in tandem the panel on guidance rails that are installed beneath it. After sufficiently cleansing the panel with an air jet spray, the "next stage" is commenced. Backtracking towards its initial place of origin, the machine now starts to move [17]. For this stage, a low density, pliable foam roller is utilized. Sand and dust that remain clung to the panel's exterior are removed by the roller. After that, the 'last stage' starts. The compressor is reactivated and the air jet is once more sprinkled to eliminate the particulates that the polyurethane foam roller had applied to the outermost surface layer.

4.0 Results and Discussion

After employing cleaning mechanism the output power from the solar power was recorded and a gradual hike in the output power has been observed.

Table 1: Table Depicting the Change in Output Power after Employing Cleaning Mechanism

Date	10 May, 23	11 May, 23	12 May, 23	13 May, 23
Output power without cleaning mechanism (Kwh)	8.1	7.2	6.6	7.6
Output power after cleaning (Kwh)	13.4	12.6	11.6	12.4

5.0 Conclusion

The efficiency of the solar panels, which are directly subjected to weather conditions, relies on the amount of solar radiation they encounter. The solar panel's efficiency of conversion will be decreased as a result of the assimilation of dust and other particles. This makes it possible to regularly clean the panels. Different cleaning techniques with their benefits and drawbacks are assessed. The most popular and extensively explored approach throughout the research literature is the cleaning robot. A prototype of solar panel cleansing mechanism has been presented in this paper and the enhanced output power after its implementation has been recorded.

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