Automatic Solar Panel Cleaner Robot Using IoT

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Abstract. The solar panel operates by allowing light to penetrate solar cells. The more a panel is impacted, the more power it produces. The dust and bird drops are more likely to collect due to the solar windows' upward angles. The mud that is not safe even with air. The same light effect is decreased on the panel, and sensor production is high. The producers and installers of solar panels claim the planned energy figures focused on optimum renewable solar panel efficiency. The radiation's construction on a solar panel will impact the panel's capacity to fulfill the predicted number. It is therefore essential and appropriate to clean the solar panel in order to secure and obtain further electricity. Thus, we build and clean the solar panel, and increase panel capacity, for the automated system.

Keywords: Roller brush, efficiency, cost effective, automatic machine, IoT, PV modules.

1. Introduction
Over the years, solar energy is generally embraced worldwide as non-renewable electricity supplies have significantly declined and raised worry about climate [1]. Solar electricity from all forms of renewable energy has a full capacity as is readily available. Several experts in this area have been drawn to this environmentally friendly and pollution-free application [2]. A wide array of solar power-based technologies is now available on the market [3]. The market is increasingly demanding these solar photovoltaic products because they are available at low prices [4]. Such items include solar lanterns, solar heaters, blowers, network appliances, coolers or fans, laptops, watches and net meters. This pattern is projected to rise steadily in the immediate future by using solar PV cells [5]. It would be one of the most important energy suppliers, even if a small part of this energy is used, particularly if used from other sources in the world [6]. The solar radiation entering the planet's surface is 1016 watts, and the average need for electricity is 1013 watts. That means that if one uses at least 5% of this electricity, one can have the 50 times that the planet wants, 1000 times more resources that one needs [7]. The direct conversion of
solar energy into electricity is achieved utilizing the photovoltaic effect by utilizing solar cells, and various methods to capture and store solar energy, ensuring that vast amounts of solar energy are employed, and PV arrays are installed. [10] However, it is equally necessary for its quality to be maintained. The principal issue is the deposition of dust in PV panels, which inhibit solar energy use by rising solar panel capacity [8]. The project focuses mainly on photovoltaic modules of dirt and dirt accumulation that influence their performance, operations, design and successfully deployed output. Solar panel soiling and dust particles are an obstacle to PV units [9]. Across various areas and varying particle sizes due to local conditions, specific dust forms can be washed. However, owing to the question of usability of panels, washing solar panels are not straightforward. PV modules are found in environments with extreme temperatures such as in desert zones, and it is risky and hard to touch manually, too, to clean the solar panels [11]. With solar panels, the glass may be permanently impaired, and its toughness may also be reduced. Therefore, a program that can clean the panel array automatically is a safer way to create. [12] Since the dust density sensitivity is the main parameter in the PV module’s electrical parameter, the automated cleaning mechanism is needed to extract the dust particle layer from the PV surface to boost performance [13].

2. Literature Review

The internet is the exciting field in which the Wireless Sensor and Actuator Networks (WSAN) and ubiquitous application systems reach. The internet of things (IIOT) [14]. IoT developers have well-defined possibilities, issues, obstacles and the technological requirements for IoT, such as radio frequency identification, sensors, actuators, cell telephones, etc. Specific implementations of the IoT were created. The first fold encompasses the different systems that have so far implemented smart technology. The second fold offers a description of the devices and their requirements [15].

The Solar Panels Farm is usually situated in soil and dust fields, which is suggested in most tropical states. The power generated by the farm may decrease if panels have dust and dirt, which is the principal factor for reducing solar panels’ performances. In general, it can be concluded that the tablets are not properly washed between 1-2 months, with a reduction of approx. 40-50%. Moreover, frequent cleaning of the module would be important to solve this problem and improve power production output.

Moreover, clean the dust, an automated cleaning robot is built that periodically cleans the frames. The system is based on the control circuit, the DC motor; the panels are cleaned by microfiber (bristles). The paper gives one an understanding of how the robot operates and its effect on solar farms' energy output. It also lets us appreciate the issue since solar cells are not washed.

Energy is one of the biggest challenges the world faces in India, as power supplies for both the urban and rural households have been one of the major problems. Fuelwood and crop residues reach about 60-70% of the country’s electricity demand. Solar energy is a green energy plant of tremendous capacity and sunlight. The usage of electricity produced by petroleum is significant in replacing renewable energy. Solar power has been a sustainable fuel, and the use of solar energy will be improved. For sandy climates like Africa, tropical countries typically use solar photovoltaic panels. On the front surface of the module, the dust builds up and blocks the light incident. It that the ability of the module to produce electricity. If the module is not washed for a month, the power production will be 50%. By manipulating Arduino programming, the cleaning device has been built to clean the board. The dust in PV modules is to be eliminated to increase energy efficiency.

The PV solar modules are usually used in tropical countries like India. The deposition of dust and debris in panels decreases the solar energy to the cells and lowers their overall power efficiency. If the module is not washed for a month, the power production will be 50%. Cleaning of panels in solar photovoltaic systems is, therefore, a question of strong practical engineering importance. This paper explores the issue and addresses strategies for extracting dust. A self-cleaning device is built to detect the dust on the solar panel and automatically clean up the battery for routine dust cleaning. This automated
device helps to sustain the solar company's overall production. A system has been developed for the cleaning of the PV units, including sliding brushes. Regarding everyday power production, in contrast to the dust-accumulated PV package, this automated cleaning device offers approximately 30% more energy efficiency.

The proposed photovoltaic modules are commonly used in dusty conditions in tropical countries such as India. On the front surface of the module, the dust builds up and blocks the light incident. It that the ability of the module to produce electricity. If the module is not washed for a month, the power production will be 50%. A self-cleaning device is built to detect the dust on the solar panel and automatically clean up the battery for routine dust cleaning. The automated cleaning machine introduced today provides around 30% more power in everyday energy production than the PV module accumulated with dust. Figure 1 represents the system architecture.

3. System Architecture

![System Architecture Diagram]

Figure 1: Design of the system

The above diagram shows the system's design, which constitutes IR sensors, GSM modem, motor driver, and DC motors. All these above-mentioned sensor modules are connected to a controller externally driven by a battery.

4. Needs of Automatic Panel Cleaner

Because the cost of electricity is growing and fossil fuels have an environmental impact, environmentally friendly energy sources are needed. The key form of solar electricity is used primarily by the reflection of sun rays on solar panels. Dust deposition on a single panel reduces their energy output. Therefore, the surface of the panel must be kept clear. Present work-based solar panel cleaning processes are expensive in terms of time, water and energy usage and are deficient in automation. Therefore, we will create an automated cleaner that can quickly travel onto the panel glass surface to increase performance.
5. Proposed System

We are using 5 DC motor; two motors are moving operation and another two motors for support. At last DC motor are attached to the brush for cleaning the solar panel. Two IR sensors are connected in opposite directions to find the end of the solar panel. This system two ways to operate one is manual mode; another one is automatic mode. In automatic mode, the system moves forward and reverse automatically with an IR sensor and motor. The controller receives the signal from IR 1 the system move in the forward direction and receives the signal from IR 2 the system move in the backward direction. The system starts the Operation then the brush motor rotates continuously. This system connected through the cloud so we can operate the system anywhere world. GSM modem via system connects the cloud.

6. Results

IR sensor and motor are connected to the controller, and the robot setup is made, and all the tested are conducted, and the proposed output is verified. Figure 2 shows the system hardware and IoT control screen of the system. This system via a solar panel is cleaned, so generated output is high and reduces power loss.

![Figure 2: Image of the system Hardware and IoT control Screen](image)

The solar panel performance at 380C has given radiation as 1000 W / m2 despite the solar panel and producer's stable condition. Around 12.44 IST we get scores of 23V and 2.07amp as we find the Sunrays are approximately perpendicular to the solar panel. Thus we can quantify the energy (VI), which equals 47.61W, by multiplying irradiation and location, more sole power can be measured. Solar Panel area = 0.23368 m2 of L*B (active region). So solar power=1000 * 0.23368=233.68W and output of the solar panel improved a percentage after the dust was swept through by our system. Our system can be powered by a battery that can be recharged and the output of the panel can, therefore not be decreased in any way.

7. Conclusion

The results of dust phenomenon were examined with falling leaves, pollen, lowering of birds. The dust influences the performance and strength of the solar panel significantly. The peak power output can be raised by up to 10-30%. The observation indicates that energy consumption due to dust collected in the
panel is enhanced. The solar panel's strength and output are increased by utilizing the cleaning process, which is simple to manage and affordable. For this phase too, power usage is smaller. The results showed finally that the peak power reduction was achieved. In future, the program for the system will be generated to be better, such as to store details about its height, position and contour as it cleanses every solar panel surface. Instead of individual batteries, we can use solar panel electricity. For full wireless service, we can even connect the device.

Reference

[1]. Wagner, E., Twesme, E.N. and Hidalgo, C., Solarex Corp, 1992. Solar panel. U.S. Patent 5,164,020.
[2]. Werner, E., Feldmeier, G., Scherer, H., Strelow, M. and Woeber, A., Tyco Electronics AMP GmbH, 2006. Connecting box for a solar panel and solar panel. US Patent 7,097,516.
[3]. Ullman, S.A., 2002. Roof support system for a solar panel. US Patent 6,360,491.
[4]. Cinnamon B, inventor; Andalay Solar Inc, assignee. Mounting system for a solar panel. United States patent US 7,987,641. 2011 Aug 2.
[5]. Baer SC, inventor; Zomeworks Corp, assignee. Lightweight solar panel support. United States patent US 4,832,001. 1989 May 23.
[6]. Benghanem M. Optimization of tilt angle for solar panel: Case study for Madinah, Saudi Arabia. Applied Energy. 2011 Apr 1;88(4):1427-33.
[7]. Sreega R, Nithyananthan K, Nandhini B. Design and development of automated solar panel cleaner and cooler. Int. J. Electr. Electron. Eng. 2017;9:186-97.
[8]. Sinha, A. and Preet, A., 2017. Automatic Solar Tracker with Pre-Installed Panel Cleaner.
[9]. Mortimer K, Ndamala CB, Naunje AW, Malava J, Katundu C, Weston W, Havens D, Pope D, Bruce NG, Nyirenda M, Wang D. A cleaner burning biomass-fuelled cookstove intervention to prevent pneumonia in children under 5 years old in rural Malawi (the Cooking and Pneumonia Study): a cluster randomized controlled trial. The Lancet. 2017 Jan 14;389(10065):167-75.
[10]. Khadka N, Adhikari B, Bista A, Shrestha A. Solar Panel Cleaner Technology: A Review. InProceedings of the 5th International Conference on Developments in Renewable Energy Technology (ICDRET’18), Kathmandu University, Nepal 2018 Mar (pp. 29-31).
[11]. Gagan Parmar, Sagar Lakhani, Manju K. Chattopadhyay "An IOT based low-cost air quality monitoring system" in RISE 2017.
[12]. Dongyun Wang, Chenglong Jiang, Yongping Dan “Design of air quality monitoring system using internet of things” in SKIMA,2016.
[13]. Chen Xiaojun, Liuxianpeng, Xu Peng “IOT-Based air quality monitoring and forecasting system” in ICCCS,2015.
[14]. Marinov, Marin Berov, Dimitar Iliev, Todor Stoyanov Djamiykov, Ivan Vladimirov Rachov, and Katya Konstantinova Asparuhova. "Portable Air Purifier with Air Quality Monitoring Sensor." In 2019 IEEE XXVIII International Scientific Conference Electronics (ET), pp. 1-4. IEEE, 2019.
[15]. Shelestov, Andrii, Andrii Kolotii, Mykola Lavreniuk, Kyrylo Medyanovskyi, Vladimir Vasiliev, Tatjana Bulanaya, and Igor Gomilko. “Air quality monitoring in urban areas using in-situ and satellite data within Era-planet project.” In IGARSS 2018-2018 IEEE International Geoscience and Remote Sensing Symposium, pp. 1668-1671. IEEE, 2018.