Faculty of Engineering

THE DESIGN OF SOLAR PANEL CLEANER WITH INTERNET OF THINGS (IOT)

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THE DESIGN OF SOLAR PANEL CLEANER WITH INTERNET OF THINGS (IOT)

The Design Of Solar Panel Cleaner With Internet Of Things (Iot)

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ABSTRACT

Every continent in the globe is seeing very rapid and continuous progress in solar power technology, and in the not-too-distant future, practically every nation will be able to look back on a history of the many advantages of becoming solar. However, due to a significant loss in soiling impact, solar panels have a low energy capture efficiency when compared to other renewable energy sources. Consequently, the purpose of this study has been to develop a method that would address this issue with solar panels. An integration of solar panel cleaning system and solar panel monitoring system has been designed and the prototype of the system has been built to improve the performance of the solar panel in absorbing sunlight. A micro controller ESP32 cam has been used as it IoT based for this project. Additionally, an experiment is carried out to make comparison between the efficiency of the solar panel with and without cleaning of the solar panel. The result is revealed that the performance of the solar panels has been improved which shows the practicality and the significance of this project to the industry of the solar energy. Additionally, an experiment is carried out to make comparison between the efficiency of the solar panel with and without cleaning of the solar panel. The result is revealed that the performance of the solar panels has been improved which shows the practicality and the significance of this project to the industry of the solar energy. The most effective brush for the prototype is a microfibre brush. The prototype is effective in boosting the solar panel's performance through cleaning by 15.66% (soil), 56.78% (powder) and 8.03% (sand). A solar panel's performance was affected by temperature. A camera functionality boosts the performance by 16.48% of solar panel cleaning and monitoring.

ABSTRAK

Setiap benua di dunia melihat kemajuan yang sangat pesat dan berterusan dalam teknologi tenaga suria, dan dalam masa yang tidak terlalu lama, hampir setiap negara akan dapat melihat kembali sejarah banyak kelebihan menjadi solar. Walau bagaimanapun, disebabkan oleh kehilangan ketara dalam kesan kekotoran, panel solar mempunyai kecekapan penangkapan tenaga yang rendah jika dibandingkan dengan sumber tenaga boleh diperbaharui yang lain. Oleh itu, tujuan kajian ini adalah untuk membangunkan kaedah yang akan menangani isu ini dengan panel solar. Penyepaduan sistem pembersihan panel solar dan sistem pemantauan panel solar telah direka bentuk dan prototaip sistem telah dibina untuk meningkatkan prestasi panel solar dalam menyerap cahaya matahari. Kamera pengawal mikro ESP32 telah digunakan kerana ia berasaskan IoT untuk projek ini. Selain itu, satu eksperimen dijalankan untuk membuat perbandingan antara kecekapan panel solar dengan dan tanpa pembersihan panel solar. Hasilnya menunjukkan bahawa prestasi panel solar telah dipertingkatkan yang menunjukkan kepraktisan dan kepentingan projek ini kepada industri tenaga solar. Selain itu, satu eksperimen dijalankan untuk membuat perbandingan antara kecekapan panel solar dengan dan tanpa pembersihan panel solar. Hasilnya menunjukkan bahawa prestasi panel solar telah dipertingkatkan yang menunjukkan kepraktisan dan kepentingan projek ini kepada industri tenaga solar. Berus yang paling berkesan untuk prototaip ialah berus mikrofiber. Prototaip ini berkesan dalam meningkatkan prestasi panel solar melalui pembersihan sebanyak 15.66% (tanah), 56.78% (serbuk) dan 8.03% (pasir). Prestasi panel solar dipengaruhi oleh suhu. Fungsi kamera meningkatkan prestasi sebanyak 16.48% daripada pembersihan dan pemantauan panel solar.

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LIST OF ABBREVIATIONS

TW_{avg} - Average Terawatt

GW - Gigawatt

% - Percent

PV - Photovoltaic

CHAPTER 1

INTRODUCTION

1.1 Solar Energy as Renewable Energy Trend

The globe is now very dependent on electricity because of the industrial revolution that has occurred over the past century and the rapid advancement of technology. In this scenario, the need for electricity generation is continuously and steadily rising. However, as non-renewable energy sources will eventually run out if they are constantly used at the current rate, people are beginning to worry about how much fuel is left in the planet. Moreover, the carbon emissions produce from the burning of fossil fuels for electricity, heat and transportation can cause global warming and ultimately climate change. Alternatively, renewable energy was offered as a replacement for fossil fuel. The role of renewable energy in the globe has grown in importance and begun to benefit a substantial portion of society as renewable energy technology advance. The usage of renewable energy is on the rise, and since it is sustainable and clean, it will soon take over the energy industry.

In most nations, the sun generates enormous amounts of energy throughout the year. 3.6x104 TWavg or so of solar energy is accessible at the earth's surface. Only 50 TWavg are being consumed, albeit [1]. The amount of energy produced would be enough to meet the world's energy needs if all the solar energy that the earth's surface emits could be transformed into electrical energy or other kinds of useful energy. In addition, solar energy has the ability to last an infinite amount of time, which is relevant to the longevity of the human species. Solar energy has emerged as a new trend in renewable technology, despite the fact that present technology is unable to collect all of the sunshine that the planet emits. A renewable energy source that has lately gained popularity and been used extensively in most nations is solar energy. This is so that solar panels may be installed in structures ranging in size from roof tops to enormous sun collecting farms. Solar energy production has surpassed 300 GW globally as of late [2] and has a big potential to supply a significant portion of the future world's enormously expanding energy needs.

1.2 Solar Panel Performance Problem

The most accessible form of energy is solar energy, which is radiant energy. It has broad applications in a variety of fields, including agriculture, water heating, and industrial settings where solar panels are used to generate power rather than large generators. The equipment that is used to collect sunlight and turn it into energy is a solar PV panel. While solar panels, which produce an electrical current, enable photons to strike free-floating electrons. Essentially, it is made up of several smaller components called photovoltaic cells. PV cells use solar energy to create electricity. Consequently, a solar PV panel is created by connecting many of cells together. In order to install solar panels and produce effective solar electricity, it is crucial to address issues such airborne particles and shadowing of panels. Therefore, in the instance of rooftop solar PV panels, the panel height would be increased in order to remove shade. Production of electricity might be decreased or even stopped if moisture-containing dust, moss, or airborne particles accumulated on elevated PV panels above. Therefore, given the scenario, routine maintenance of solar PV panels becomes extremely challenging.

Figure 1.1: The Conditions of The Solar (PV) Panel Without Cleaning

1.3 Problem Statment

Solar panels may produce less energy if they become filthy or have some fog on them from time to time. Additionally, because the panels are occasionally put in high places, it might be quite unsafe for the personnel to go up there every three weeks for manual cleaning. Furthermore, it is expensive, particularly if the organization has a lot of panels, which necessitates hiring more staff and incurring higher labour costs. Most solar panel PV cleaning does not use IoT as its base. Some of them are handheld by worker and some of them are controlled by infra-red remote control. With the tropical season of Malaysia, it is much more difficult to maintain the cleanliness of the solar panel. However, with the increase production and usage of solar energy, the number of manpower cannot keep up with it. Hence, come to the automated cleaning system that can cover the time, manpower and cost to maintain the cleanliness of the solar PV panel.

1.4 Objective

1. To design a solar panel cleaning problem with IoT based solution.
2. To construct a prototype that combine solar panel cleaning system with solar panel monitoring system.

1.5 Scope

The focus of this project is to develop a cleaning robot system based on IoT with integrated monitoring system. It is designed to monitor the condition of the solar panel when the temperature is increased or decreased and detect the collection of dusts at the surface of the solar panel. When the conditions are met, the micro controller will notify the user via IoT to clean the solar panel using brush or/and sprinkle water to cool down the temperature of the solar panel to improve the performance of the solar panel.

1.6 Significance of the Project

The dust settles on the solar panels can causes losses of energy on the solar energy industry. Too high of temperature can also decrease the performance of the solar panels which overloaded with too much heat in the system. Hence, the system is made to improve the efficiency of the solar panels in which the solar energy become huge throughout the year as it can make impact on the energy production in the future. This design is created to help the industry by commercialising the product to company of the solar energy industry.

1.7 Expected Outcome

At the end of this project, a solar panel cleaning system integrated with solar panels monitoring system IoT based can be produced.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

Solar energy, generally called solar irradiance, is a form of energy that can be converted into electrical energy via solar energy technology. The most widely used approach for converting solar radiation into electrical energy is the photovoltaic (PV) system. Semiconducting materials that indicate the photovoltaic effect are utilized in photovoltaic (PV) systems to convert irradiance into electrical energy [5]. In terms of global capacity, PV was the third most widely utilized renewable energy source. By 2016, installed PV capacity had crossed 300 gigawatts (GW), contributing to 3% of worldwide power demand, and it continued to expand quickly [6]. Given its significant contribution to the generation of environmentally friendly and clean energy, solar energy is currently getting attention on a global scale. Due to airborne particles and cleanliness, the yield of solar cells is reduced by more than 25% in some parts of the world. The output of solar panels is also reduced by air pollution that can be seen all around them; this impact is not just due to dust that has been dispersed across the PV boards' surfaces [1]. The efficiency of a PV module will decrease because of factors such as the PV module's placement in relation to the sun, temperature, tilt point, shadowing of the PV panel, mounting housetop material, mounting height, sun irradiation, and PV module type [2].

2.2 Soiling Losses

Soiling losses are power losses due by dirt, dust, bird droppings, and other debris that soil the PV panels' surface. For both solar irradiation and these particles, a barrier is created and PV module, which both have a big impact on a PV system's efficiency. Solar panels are almost usually static and placed with the panels pointing upward; this orientation is susceptible to accumulate debris from the surrounding. Therefore, a coating of dust may gradually and continually accrue, affecting the amount of sunlight reaching the solar panels and reducing overall the amount of electricity generated. Manufacturers often assess the performance of their solar panels in a laboratory environment, which overlooks real-world barriers like dust [8]. One of the fairly regular obstructions to PV generation is dust. The thin layer of particles that covers up the solar array is caused by a wide range of external factors, such as wind pollution, harsh weather, vehicular motion, and the deposition of soil, salt, and dirt. As according to sources, only one grams of dust dispersed randomly across a PV panel of 12 cm by 8 cm could affect output power efficiency by 60%. It can be observed in figure 2.1.

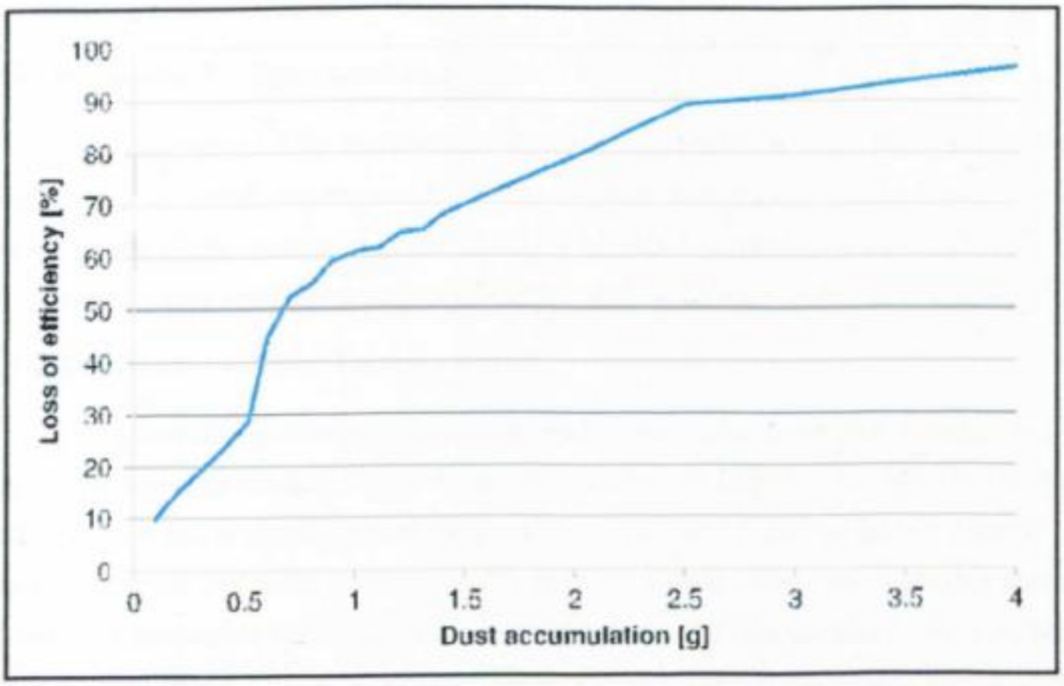

Figure 2.1: Efficiency Decrease of Solar Panel by Dust Accumulation [8]

Over time, dust accumulation accentuates the effect of soiling. In fact, a PV system's overall energy supply on a daily, monthly, and even yearly basis is affected more by bit of dust that covers the solar panels [6].

2.3 The Need of IoT based Solar Panel Cleaning System

Renewable energy sources are necessary since fossil fuels have an impact on the environment and power costs are expanding. The main source of solar power is the sun's rays reflected from off solar panels. The energy output of a single panel is significantly reduced by dust accumulation. As a logical consequence, the panel's surface must remain clean and free of debris. The current methods for cleaning solar panels at work are inefficient in terms of automation and costly in terms of time, water, and energy use. In order to achieve better performance, an automatic cleaner that can swiftly move over the panel glass surface is designed based on IoT. The benefit gained from this project are an automated or manually controlled robot that can clean every part and corner of the solar PV panels.

2.4 The Need of Solar Panel Monitoring System

Solar monitoring systems are designed to detect and alert users to solar panel problems so that they may be properly addressed before the system is deemed dysfunctional. Solar monitoring systems are a significant aspect of a solar energy system as it verifies that the solar equipment is functioning effectively and to its complete capability. As for monitoring criteria, the main aspects to look out for are the temperature, dust and rain detector. Temperature rises have a detrimental impact on the efficiency of solar panels. When tested at a temperature of about 25 degrees C (STC), or 77 degrees F, photovoltaic modules' output efficiency could be dropped by 10–25% due to the heat, depending on where they are installed. The solar panel's output current grows exponentially as its temperature rises, while its voltage output decreases linearly. In actuality, the voltage drop is so predictable that temperature can be monitored properly using it (11).

2.5 Review on Solar Panel Cleaning System

It is difficult to maintain solar panels once they are installed on a roof or in a far-off solar farm. Currently, a few cleaning methods, such as the traditional process of brushing off dust, coating processes, and robotic cleaning machines, may be used to clean solar panels. This procedure has been automated since using water and hand brushes to clean industrial solar arrays necessitates a considerable amount of time, effort, and money. A sensor and controller-based autonomous unit and a water or waterless cleaning mechanism unit make up an automated cleaning system for photovoltaic panels. Robotic, heliotex, electrostatic, coating cleaning, vibrating cleaning, and forced-air cleaning are some of the ways for cleaning solar panels that may be used to remove dirt.

2.5.1 Manual Cleaning

The most conventional method of cleaning a solar panel is by hand. Additionally, it offers the lowest initial equipment investment cost. It does, however, involve a lot of labour.

Manual cleaning becomes difficult and tiresome for some panels which are positioned in hard-to-reach or isolated areas, such a roof top or desert. Additionally, cleaning solar panels daily or weekly makes them more effective, which makes the repeated and exhausting labour even worse.

2.5.2 Type of Brush

Since the brush is a key element in the cleaning system, choosing the right kind is crucial when cleaning panels. The brush that is used ought to be durable and strong and able to remove any dirt off panels without damaging the surface. Scratches are apparent or opaque markings on the panel that decrease the solar panel's efficiency. Various brushes with standard designs include spiral, roller, wiper, and spinning brushes.

Figure 2.2: Spiral Brush and Roller Brush

2.5.3 SOLARBRUSH Solar Cell Cleaning Robot

Since the brush is a key element in the cleaning system, choosing the right kind is crucial when cleaning panels. The brush that is used ought to be durable and strong and able to remove any dirt off panels without damaging the surface. Scratches are apparent or opaque markings on the panel that decrease the solar panel's efficiency. Various brushes with fairly standard designs include spiral, roller, wiper, and spinning brushes. There are 5 electric motors that provide power for the cleaning robot, 2 of which serve as horizontal drives along the row of solar panels, while the other two electric motors serve as vertical drives (ascending and descending movement), and the remaining motors rotate the microfiber cleaning system's parts to maintain stability during the robot's smooth up and down motion. In order to prevent the robot's shadow, which has an impact on power production, cleaning usually takes place in an area of 54 square feet for 30 seconds at a time. Work begins at sunset.

Figure 2.3: SOLARBRUSH Cleaning Robot