Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF DUAL AXIS SOLAR TRACKER WITH SURFACE PANEL CLEANING SYSTEM USING ARDUINO

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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DEVELOPMENT OF DUAL AXIS SOLAR TRACKER WITH SURFACE PANEL CLEANING SYSTEM USING ARDUINO

MUHAMMAD SHUKRI BIN SAHARANI

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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Faculty of Electrical and Electronic Engineering Technology

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FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

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Tajuk Projek : Development of Dual Axis Solar Tracker with Surface Panel Cleaning System using Arduino

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Date : 13 / 1 / 2023

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

Signature : ....

Supervisor Name : Ts. ZAIHASRAF BIN ZAKARIA

....

Date : 13 / 1 / 2023

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Signature : ....

Co-Supervisor :

Name (if any)

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Date :

....

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DEDICATION

This project is basically a dedication to myself for being an engineering student and for this being the very first project I have ever undertaken for the purpose of learning and working toward completing this project. It is also enthusiastic to both my mother and my father, who taught me that even the most challenging activity can be successful if it is completed one step at a time and patience is exercised throughout the process. Last but not least, I would like to extend my deepest gratitude to my supervisor, Ts. Zaihasraf Bin Zakaria, as well as to all of my other friends, for serving as tremendous pillars of support for me during the entirety of this endeavor.

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ABSTRACT

Solar energy is quickly becoming a vital source of renewable energy. With solar tracking, it will be feasible to create more energy since the solar panel will be able to maintain a perpendicular profile to the sun's beams. Even if the initial cost of setting up the monitoring system is significant, there have been cheaper alternatives presented throughout time. This project discusses the design and building of a solar tracking system prototype with a dual axis of flexibility. Light Dependent Resistors (LDRs) are used to detect sunlight. An Arduino microcontroller serves as the foundation for the control circuit. The LDRs were configured to detect sunlight before activating the servo to position the solar panel. When opposed to conventional motors, servo motors can retain torque at high speeds. They are also more efficient, with efficiencies ranging from 80% to 90%. The project entails designing and developing a solar panel cleaning system. The primary goal of this design prototype is to clean the solar panel utilising an electrical mechanism while maintaining the efficiency or quality of the solar panel. In reality, due to the frequent dust, the solar panels must be cleaned on a regular basis. If the work is done manually, it will be highly expensive and time consuming. Water sprinklers substance must be utilised in the designed mechanism to ensure cleaning quality.

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ABSTRAK

Tenaga suria dengan cepat menjadi sumber tenaga boleh diperbaharui yang penting. Dengan pengesanan suria, ia boleh dilaksanakan untuk mencipta lebih banyak tenaga memandangkan panel suria akan dapat mengekalkan profil berserenjang dengan pancaran matahari. Walaupun kos awal untuk menyediakan sistem pemantauan adalah besar, terdapat alternatif yang lebih murah yang dibentangkan sepanjang masa. Projek ini membincangkan reka bentuk dan membina prototaip sistem pengesan suria dengan paksi dwi fleksibeliti. Light Dependent Resistors (LDR) digunakan untuk mengesan cahaya matahari. Mikropengawal Arduino berfungsi sebagai asas untuk litar kawalan. LDR telah dikonfigurasikan untuk mengesan cahaya matahari sebelum mengaktifkan servo untuk meletakkan panel solar. Apabila bertentangan dengan motor boleh mengekalkan tork pada kelajuan tinggi. Ia juga lebih cekap, dengan kecekapan antara 80% hingga 90%. Projek ini memerlukan mereka bentuk dan membangunkan sistem pembersihan panel solar. Matlamat utama prototaip reka bentuk ini adalah untuk membersihkan panel solar menggunakan mekanisme elektrik sambil mengekalkan kecekapan atau kualiti panel solar. Pada hakikatnya, disebabkan habuk yang kerap, panel solar mesti dibersihkan secara berkala. Jika kerja dilakukan secara manual, ia akan menjadi sangat mahal dan memakan masa. Bahan pemercik air harus digunakan dalam mekanisme yang direka untuk memastikan kualiti pembersihan.

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LIST OF SYMBOLS

Pm	-	Maximum power in watt
G	-	Irradience
Ac	-	Surface area of solar panel in meter square

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LIST OF ABBREVIATIONS

V	-	Voltage
W	-	Power
A	-	Ampere

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CHAPTER 1

INTRODUCTION

1.1 Background

Renewable radiation is both environmentally friendly and plentiful. The sun's energy is used to create heat, light, and electricity in solar technology. These may be used in both commercial and residential settings. Since traditional energy sources such as petroleum, coal, and natural gas are depleting at an astounding pace, it has become imperative to invest in renewable energy sources that can power the future in a safe and environmentally friendly manner. In terms of potential, the sun is a huge resource. The abundance of the resource does not make harvesting easier. it is difficult due to the array cells' limited efficiency. The bulk of commercially accessible solar cells have efficiencies ranging between 10 and 20 percent. This demonstrates that there is still space for advancement. This research aims to find a solution to improve the efficiency of solar panels. Solar tracking is used. The tracking mechanism moves and adjusts the solar array in order to maximise power production. Other methods involve identifying the causes of losses and devising strategies to alleviate them.

When a small portion of a solar panel is occluded by falling rubbish or a film of residue, the performance of the panel reduces dramatically, and rainfall is shown to have little or no cleaning effect. Cleaning the solar panel after it has been installed on the roof of a home, factory, or store is difficult because leftover particles prevent the sun's energy from passing through the panel properly, resulting in a reduction in the panel's ability to generate electricity. Cleaning the surface of the solar panel using a brush and water is the most straightforward, most effective, and most secure approach. The mechanically and

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automatically clean method has been implemented in order to make this process more practicable. In cases when manual cleaning is required, this might be beneficial when the cleaning instrument must be moved to power plant locations, which results in a significant increase in labour costs.

1.2 Problem Statement

A solar tracker is a device that is used in a variety of systems to increase the efficiency with which solar energy is harvested. The challenge that has been presented is the construction of a system that is capable of increasing the generation of electricity by 30 to 40%. The microcontroller is responsible for implementing the control circuit. The control circuit then places the motor, which is responsible for orienting the solar panel in the most efficient manner.

1.3 Project Objective

The major objective of this project is to offer a systematic and practical technique for estimating the system wide distribution network of solar tracker and surface panel cleaning systems with a suitable degree of accuracy. Specifically, the following are the aims of the project:

a) To development of a tracking system that constantly tracing the sun during daytime

b) To development of a tracking system that make best use of the solar array power generation.

c) To create a low-powered, cost-efficient cleaning system that is easy to maintain.

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1.4 Scope of Project

To avoid any uncertainty of this project due to some limitations and constraints, the scope of the project are defined as follows:

a) Solar panel efficiency must be boosted significantly by rotating solar panels continually in the direction of the sun.

b) Make sure the solar panels received water in an efficient manner, and dirt, dust, and other loose particle accumulations were successfully removed by the system.

c) The decision was influenced by the motor's speed, ability to withstand high torque, precision rotation within a restricted angle, and lack of noise.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Adjusting the angle of a photovoltaic array solar panel so that it faces the sun or directing solar reflectors or lenses so that they concentrate on the sun is accomplished using a solar tracker, a mechanical instrument. As the sun travels across the sky, the sun's position in the sky varies with the seasons and the time of day. The sun's location in the sky varies with the seasons and the time of day. When solar-powered equipment is directed directly towards the sun, it performs optimally. As a result, a solar tracker boosts the efficiency of such equipment as compared to equipment in a fixed location at the expense of adding complexity to the system. There are many kinds of trackers available.

It was only with the invention of the photoelectric mechanism and the subsequent development of the solar cell that it became possible to harness usable electricity from the sun. The solar cell is a semiconductor material that transforms visible light into a direct current. It is used to generate electricity. Solar arrays are made up of a sequence of solar cells that are electrically coupled together are used to create direct current (DC) voltage, which may then be used to power a load. As solar panels' efficiency improves, the usage of solar panels is becoming more widespread.

In poor areas where there is no power grid, these devices are often used. The sun's radiation is the source of photovoltaic energy. A photovoltaic cell, or solar cell, is a kind of cell that can convert light into electricity. Photographic cells are non-mechanical devices constructed of silicon alloy that generate electricity. It is important to consider the aspects that influence the efficiency of a solar panel system to increase its performance. Although solar energy has increased in installed capacity, "there are still significant issues about the unpredictability of electricity output" that must be addressed. Because to the deposition of dirt on solar panels, the efficiency of solar panels decreases with time. Every day, the effectiveness of solar panels diminishes because of the accumulation of on the panel's surface, there may be soil, rock, stains, or several particles. Dirt deposition has the potential to obstruct some sunlight and, as a result, degrade solar photovoltaic efficiency by as much as 85 percent in certain cases.

2.2 Related review of solar energy

The term "solar energy" refers to the radiation that is emitted by the sun and is capable of either creating heat, stimulating chemical reactions, or producing electricity. Sunlight strikes Earth with an intensity that dwarfs our current and future energy demands. All future energy needs can be met if this widely dispersed resource is adequately tapped. Because of its limitless supply and lack of environmental impact, solar energy is expected to gain popularity as a renewable energy source in the twenty-first century. When compared to the non-renewable fossil fuels such as crude oil and natural gas, which have limited reserves. Earth receives significantly more energy from sunlight than from any other source, even though sunlight's intensity at the Earth's surface tends to be rather low. Radiation from the distant Sun has a large radial dispersion. More over half the sun's energy is absorbed or scattered by the atmosphere and clouds, resulting in a relatively little additional loss. There is around half visible light and half infrared radiation in the sunlight that reaches Earth, as well as trace amounts of ultraviolet and other electromagnetic radiation.

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2.2.1 Related review of solar panel

PVs are virtually usually built in the same fundamental way: To generate 100 to almost 450 watts, a loop is formed by connecting anywhere from 36 to 96 rectilinear silicon cells. To link the smaller silver conductor wires in each cell to larger bus bars in the panel junction box, the current flows via crystalline silicone cells. The fingers and bus bar are made of silver and copper, respectively.. The cell string is laminated between two layers of EVA (ethylene vinyl acetate) foil and is protected on both sides by tempered glass and a PVF (polyvinyl fluoride) cover [1].

2.2.1.1 Related review performance of monocrystalline and polycrystalline solar panels

Monocrystalline silicon cells are made in special ovens from monocrystalline silicon cylindrical bars. They're made by cutting the bars into tiny pellet shapes (300 mm thick). Their conversion efficiency of solar light to electricity is roughly 15%, however they have a high production cost. Silicon blocks generated by melting pieces of pure silicon in specific molds are used to make polycrystalline silicon cells. Atoms do not assemble into a single crystal throughout this procedure. The efficiency with which they convert sunlight into power is around 13% [2]. Figures 2.1 and 2.2 demonstrate how solar radiation intensity and cell temperature impact the performance of a photovoltaic panel.

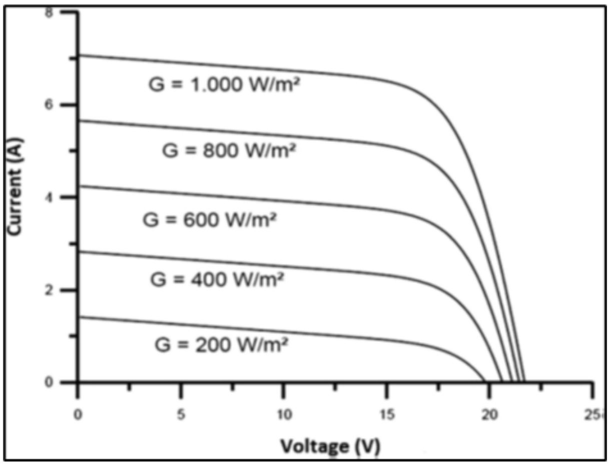

Figure 2.1Solar radiation fluctuation affects a PV system's characteristic curve [2].

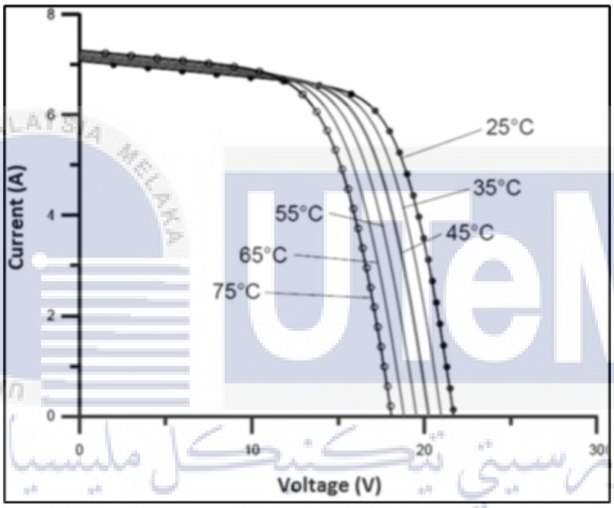

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Figure 2.2 Temperature effect on PV system's characteristic curve [2].

2.3 Related review of photo sensor

Electrical components used to detect the presence or quantity of light are known as light dependent resistors (LDRs) or photoresistors (photoresistors). It is important to note that LDRs are distinct from other kinds of resistors used in various electronic systems, including carbon film resistors, metal oxide film resistors, metal film resistors, and others. They're made to be sensitive to light and to alter resistance as a consequence.

A sensor gathers signals and turns them into electrical signals that may then be utilized by electronic equipment. Light dependent resistors (LDRs) are employed in the circuit to detect changes in the position of the sun. To use the photocell, connect it beside a resistor in series Consequently, the output at the junction is controlled by the two resistances of a voltage divider. The microcontroller's analogue input pin receives the value. [3].

2.4 Related review types of solar trackers and tracking technologies

There are a number of different types of solar tracking systems in use today.

2.4.1 Active tracker

ASTS are devices that may change the orientation of solar power systems in order to maximize energy intake by orienting the systems perpendicular to sun rays. ASTS typically incorporate components such as sun sensors and solar position algorithms as well as control units as well as limit switches are included in the transmission mechanical drive subsystems [4].

The objectives of the ASTS are to realize high accuracy ST, resistance to shocks, high stability, gentle control signals, and ease of implementation.

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2.4.2 Passive solar tracking

Passive tracking systems rely on the differential thermal expansion of materials like refrigerants, bimetallic strips, and shape memory alloys. Typically, the mechanism consists of two opposing actuators. When the actuators are illuminated differently, unbalanced forces occur, causing the device to be orientated in such a manner that equal illumination and force balance are restored. Active trackers are more effective; however, these passive trackers are less expensive and less complex than the active trackers. In addition, given that they are thermally activated devices, variations in the temperature of the surrounding environment have the potential to affect how they function. [5].