Faculty of Electrical and Electronics Engineering Technology

DEVELOPMENT OF SMART SOLAR TRACKING SYSTEM USING ARDUINO

NASHRAN HAKIMI BIN ZAHILAL

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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A project report submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DEDICATION

To my beloved mother, Nor Masnizah Binti Azman, and my father, Zahilal Bin Talip,

Thank you for supporting me when I continue my studies for bachelor's degree in UTeM.

To my second brother, Nazran Ariff Bin Zahilal,

Thank you for providing your creativity expertise and suggestion for completing this project.

To my brother, Nazhan Shaz Hicham Bin Zahilal, Thank you for your emotional support.

ABSTRACT

Renewable energy, sometimes known as "Green Energy," is a fast-growing source of energy in the worldwide because our nation is situated on the equator, a solar power system is a viable alternative for our country's residents. In addition, this technique is a best efficient method of generating solar power from the sun. The solar panels that are often utilised in Malaysia are movable because the sun's position varies over time-the solar panel's efficiency must be adjusted to ensure that it receives sufficient sunlight to generate minimal energy. As a result, the goal of this project is to make improvements to the current solar panel setup. In the final prototype device, solar panels may be moved around based on the amount of light they get. For the purpose of moving the solar panels, two servo motors and an Arduino are employed. Sensor photoresistor is used to determine the sun's location. It is the major goal of this project to build a 'Solar Tracking System using Arduino'. For optimal power output, this mechanism will help position parallel solar panels into direct sunlight. Data from solar panel voltage generation also be gathered by the system. We will be able to see how solar panels fluctuate over time and come up with strategies to improve solar panel energy efficiency.

ABSTRAK

Tenaga boleh diperbaharui, kadangkala dikenali sebagai "Tenaga Hijau," ialah sumber tenaga yang berkembang pesat di Amerika Syarikat. Oleh kerana negara kita terletak di garisan khatulistiwa, sistem tenaga suria merupakan alternatif yang berdaya maju untuk penduduk negara kita. Selain itu, teknik ini merupakan kaedah yang sangat cekap untuk menjana tenaga suria daripada matahari. Panel solar yang sering digunakan di Malaysia pula adalah boleh alih. Oleh kerana kedudukan matahari berubah mengikut masa, kecekapan panel solar mesti diselaraskan untuk memastikan ia menerima cahaya matahari yang mencukupi untuk menjana tenaga yang minimum.. Hasilnya, matlamat projek ini adalah untuk membuat penambahbaikan pada persediaan panel solar semasa. Dalam peranti terakhir, panel solar mungkin dialihkan berdasarkan jumlah cahaya yang mereka perolehi. Untuk tujuan menggerakkan panel solar, dua motor servo dan Arduino digunakan. Photoresistor sensor digunakan untuk menentukan lokasi matahari. Ia adalah matlamat utama projek ini untuk membina 'Sistem Penjejakan Solar menggunakan Arduino'. Untuk output kuasa yang optimum, mekanisme ini akan membantu meletakkan panel solar selari ke dalam cahaya matahari langsung. Data daripada penjanaan voltan panel solar juga boleh dikumpul oleh sistem. Pelajar akan dapat melihat bagaimana panel solar berubah-ubah dari semasa ke semasa dan menghasilkan strategi untuk meningkatkan kecekapan tenaga panel solar.

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CHAPTER 1

INTRODUCTION

1.1 Background

In the current era, electricity is one of the most essential requirements for human survival. The daily increase in the energy consumption graph is due to the expansion of industries around the nation. Due to this, to achieve a numerous studies have been conducted to find a solution to the paucity of electricity-generating resources issue from investigation and analysis, several forms of energy have been identified.traditional technique and unconventional technique. Some of the sources of energy that it is nonconventional to generate energy from nonrenewable sources like fossil fuels, charcoal, and natural gas, which can be reduced. To overcome such difficulty, The new renewable energy system has been designed. It utilizes the power of nature such as solar, wind, and ocean wave to create power to meet the demand of users.

Solar panels may be utilised to generate power in Malaysia using renewable resources. Due to its location near the equator, Malaysia gets a great deal of sunlight. As a result, solar energy technology using solar power is quite popular in Malaysia. Over millions of years, the sun has produced billions of watts of energy. Sunlight has no effect on pollutants. Therefore, the sun is a clean source of energy that causes no more pollution to the planet than other energy sources utilised to generate power.[1]

1.2 Problem Statement

Coal and other forms of fossil fuel are the primary fuels used in the generation of energy in Malaysia. This is due to the fact that Malaysia is one of the prosperous countries that own such an abundance of natural resources. Despite the fact that such resources are very helpful in expanding the Malaysian economy in the manufacturing sector, the effect of their combustion contributes to the pollution of the air around the world. According to an article that was published in the Malaysian daily 'Berita Harian' in August 2018, Miri Sarawak mentioned the reading of the 203-air pollution index (API) as a hazardous consequence caused by open burning. Aside from that, the resources that are consumed are just transitory, and the amount of energy will diminish with time. In order to find a solution to this issue, it is recommended that you make use of renewable energy sources, such as solar energy, because they do not contribute to the pollution of the surrounding ecosystem.[2]

We are all aware that the sun's arc is constantly shifting. In most cases, the solar panel that is currently being used is fixed, and as a result, it is unable to generate energy in an effective manner due to the constant movement of the sun. Therefore, making use of an automated solar tracker is great for increasing the amount of electricity that is generated. According to research published in 2008 by Hossein Mousazadeh and colleagues, two-axes solar tracking is able to capture much more energy than conventionally positioned solar panels. Therefore, the development of a dual-axis automated solar tracking system is a fantastic concept for increasing the amount of electricity that can be produced by a solar panel.[3]

1.3 Project Objective

The main aim of this project is:

a) To design and build a prototype solar tracking system using the Arduino.

b) To develop the voltage changes over time.

c) To analyze the solar photovoltaic panel perpendicular to the sun in order to make it more efficient in two axis.

1.4 Scope of Project

The scope of this project are as follows:

a) Develop a mechanism capable of controlling the solar panel's axis of rotation for optimum energy production. The energy gathered during the day is stored in the battery and used at night.

b) Using a photoresistor sensor to provide a signal to Arduino that modifies the solar panel's orientation in response to sunlight locations.

c) Using a Voltmeter to measure the voltage of a solar panel and then transfer the results to an Arduino board.

d) Use Arduino to run a programme that will move all moving parts and collect data from sensors.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A solar power device that converts sunlight into electrical energy is known as a solar cell. Often referred to as solar panels, photovoltaic modules combine photovoltaic modules with solar cells to form photovoltaic modules. All day long, the module's surface tracks the sun using a solar tracking device. During the course of the day, the sun's position changes. A solar tracker may enhance the efficiency of solar-powered equipment in any permanent place, depending on the complexity, costs, and outcomes of the project. Any device that can change its mirror to point in one direction, like a solar tracker, might be considered a kind of tracker. The accuracy of a solar tracker is dependent on the application for which it is being used. Solar cell concentrators, in particular, need a high degree of accuracy in order to transmit concentrated sunlight exactly to the powered device, which is located near the reflector or lens' focal point. Because tracking is essential to concentrator systems, single-axis tracking is a need. It is feasible that many non-concentrating apps may operate without tracking. A system's total output power may be increased as well as its output power at critical system demand periods if tracking is done correctly (often late afternoon in warm climes). Solar panels have had their output boosted in the past. Double-sided panels, improved conversion phases, geometric integration of building panels, and other topics are all part of these investigations. A solar photovoltaic panel generates the maximum energy if it is positioned at a right angle to the sun. As a result, a number of academics have developed a variety of tracking systems for solar panels. As a result, the primary purpose of this project is to build a tracking system for solar panels using Arduino developments.[4]

2.2 Related previous project

2.2.1 Efficient and Low-Cost Arduino based Solar Tracking System

In this study, a dual-axis solar tracker is presented in order to completely use the sun's rays. The LDR input, the Arduino controller, and the servomotor output are the three essential components of the proposed system. A0 to A7 are the analogue pins for the eight LDRs, and the servomotors are linked to the digital pins 9 and 11 of the Arduino. In order to maximise solar intensity, the physical arrangement of the LDRs and their placement on the board is chosen experimentally.

In order to get the most out of the collected solar energy, a dual-axis tracker was developed. The servomotors are controlled by pulse width modulation (PWM), which is generated by the analogue to digital converter (ADC). At 22.5o per degree, the horizontal axis (Axis-1) of the system may travel from 0 to 180 degrees. As servomotors do not support a half-degree, the angles are approximated to the closest value. The servomotor would move the solar panel to the position where the LDR could collect the most light intensity, depending on the intensity. The LDR measurements are obtained every 30 minutes in order to save energy.

The system offers three orientations for the vertical axis (Axi-2): 10, 20 and 30 o. The test site's sun track is used to determine these values. The night mode begins when the readings from all LDRs fall below a particular threshold for a long period of time. When the sun begins to rise, the tracker will return to its starting location (looking east).[5]

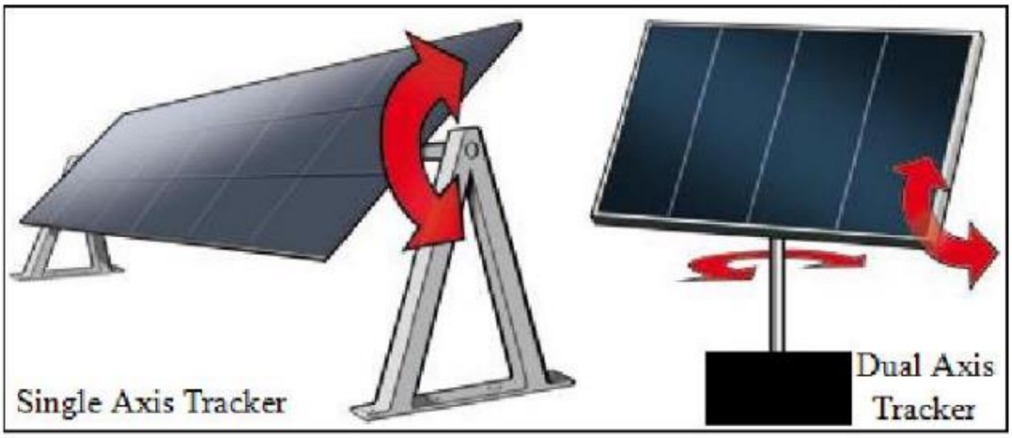

Figure 2.2.1: Single and dual axis solar tracking system.

2.2.2 Dual Axis Solar Tracking System using Arduino

The intensity of light is measured using four LDRs (two for azimuth and two for altitude). Analog to digital converter (ADC) and light comparison unit are used to transform the analogue signal from sensors. This output is sent to the Arduino board together with the input instruction. The motor-drive circuit receives its output from the Arduino. The driving circuit links two DC motors, one for vertical movement and the other for horizontal movement. The motor rotates the solar panel in the opposite direction of the sun’s rays. Finally, the LCD displays the power output. This project relies heavily on the LDR combo. After sunrise, the panel will be moved back to its original position by a motor, and the process will be repeated. Even more of the solar panel’s load is relieved when it is connected to a battery and an inverter. The battery stores and provides the inverter’s DC output, which comes from the solar panel. To convert from DC to AC, an inverter was employed. This is followed by the addition of an external load.

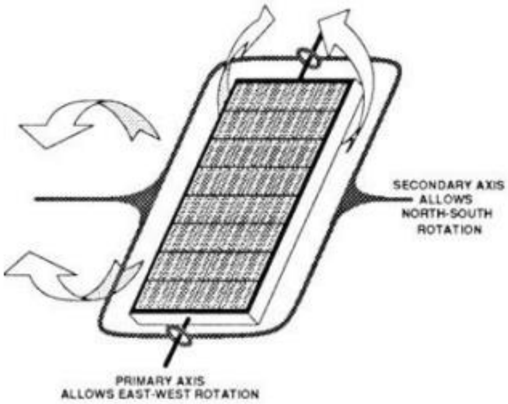

Figure 2.2.2: Mechanism of dual axis tracker

An azimuth-altitude dual-axis sun tracker is the underlying concept. The angle formed between a substance and the observer's location is referred to as altitude. Between zero and 90 degrees, it's about the same. Height may alternatively be replaced by the distance to the zenith. Afterwards, azimuth is usually studied from north to east, increasing in direction. While static solar tracking systems have their place, this one is designed to be more efficient than either. Using Arduino UNO, LDRs, a DC motor, an LCD and a solar panel, we were able to achieve this result. To enhance solar tracking based on the sun's position, two-axis solar tracking and automatic solar tracking are provided.[6]

2.2.3 Dual Axis Solar Tracking System Using Pic Microcontroller

Solar power production is plagued by a lack of light intensity. To get the most out of a solar panel, it must be positioned vertically and directly in front of the source of light. Solar panels must be able to track the sun's movement throughout the day and year in order to create the optimum amount of electricity. An orthogonal relationship between the light source and the panel may be maintained using a tracking system. Various tracking system designs, such as passive and active systems with one or two axes of freedom, may be found on the market. Different sensors are employed in solar trackers to significantly increase the electric output of a photovoltaic panel. Solar radiation is picked up by the sensors. To maximise the amount of power a photovoltaic solar cell can generate throughout the day, researchers in this study devised a low-cost microcontroller-based solar tracker with two degrees of rotational freedom. A PIC18452 microcontroller drives two DC motors, with data from the sensors (LDR) processed by the microcontroller’s inbuilt ADC-analog to digital converter and sent to the motor controller IC-L298N, which then drives the motors in opposite directions. Our project’s purpose is to create an active, dual-axis solar tracker with the least amount of inaccuracy possible. A variety of mechanical and electrical alternatives were examined and the best one was selected. We finished the tracking system module and tested it to make sure it worked as expected.[7]

Prototype PIC-controlled solar system that actively monitors the sun to collect maximum power from the array at any time of day is a primary aim. This technology attempts to capture as much sunlight as possible before converting it into useful electrical energy (DC voltage) and storing it in batteries for a variety of purposes. More energy can be harvested from solar tracking systems than can be harvested from fixed panel systems.

It is essential for the solar panel to monitor the sun’s rays that four LDRs (Light Dependent Resistors) be employed in this research. Voltage divider is used to transform the changing value of the LDR (voltage divider) into analogue voltage. The Analog to Digital Convertor (ADC) built in a Microcontroller is used to read the analogue value of LDRs and convert it to digital. Motor Driver (H-bridge) is also linked to the Microcontroller for controlling the direction of the two motors based on LDR measurements. Two LDRs are permanently mounted on the solar panel’s axes. The Microcontroller will compare the analogue output **from** the two LDRs to determine if the Motor is CW, CCW, or OFF.[8]

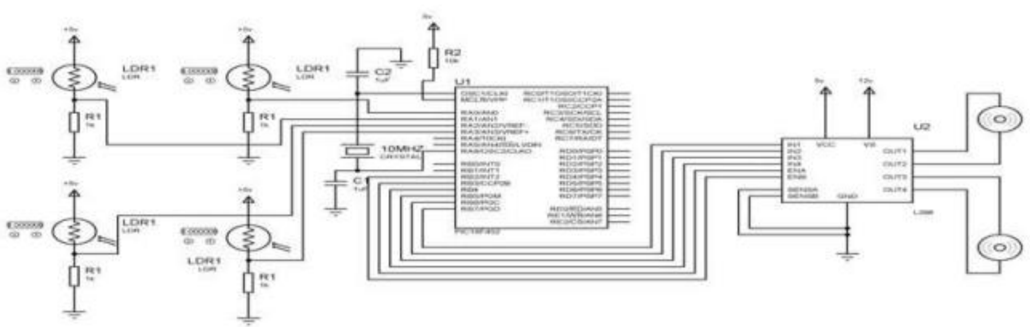

Figure 2.2.3: Overall schematic diagram

2.2.4 Automated solar tracking devices are controlled by algorithms.

ASTS may be used to align solar power systems perpendicular to the sun's rays, increasing the amount of energy they can absorb. Transmission mechanical drive subsystems, electric motor control units, and limit switches for solar positioning algorithms are all part of an ASTS's components. This system's primary objective is to generate ST signals that are very accurate and stable while also having a low noise level and being easy to install. An extra 2 percent to 3 percent of the additional power produced by solar electricity should be used by a solar tracker. An evaluation of ASTS building attributes was performed. One of the key differences between ST and ST is that ST precision allows for more effective conversion of solar thermal or electrical energy. Minimum ST accuracy requirements, often defined as the off-tracking angle at which power production goes below 90 degrees, are frequently determined using concentration system acceptance angles. To maximise solar power production, the tracking of the sun must be more exact.[9]

This section gives a classification of the literature on ASTS in order to evaluate different sun tracking methods and Cas. Open-loop, closed-loop, and hybrid-loop systems are all shown in Table 2 according to the ST method. Traditional control methods on–off, PI, and PID are used in 67.55 percent of published publications, with on–off control being the most common. It's also worth noting that just 16.67% of the analysed research projects used a hybridloop method, while 28.95% of the studies utilised an openloop technique. There are a few things to keep in mind while looking at the studies contained in this list: The articles that were examined drew their conclusions and main results directly from the data that was provided. They were, however, not referred to using the same terminology.[10]

2.2.5 Low-cost automatic multi-axis solar tracking system for performance improvement in vertical support solar panels using Arduino board.

Photovoltaic and thermal cell surfaces are the primary means of harvesting solar energy, which is environmentally friendly and long-lasting. Simple, inexpensive, and widely available make it one of the fastest-growing clean-energy technologies in the world. Renewable solar power systems have become one of the fastest-growing alternatives to fossil fuels and are increasingly being used in commercial and industrial settings as well. A little percentage of the sun's energy may be captured because of the sun's constantly shifting location and a variety of other important considerations. Sharing an optimization alternative for traditional solar power system installation as applied to LED traffic light systems is the main subject of this study. Solar trackers are a realistic solution to this problem since the sun's constant movement restricts the amount of sunlight that can be absorbed. A significant obstacle to the widespread use of solar trackers has been their prohibitive cost. Solar cell efficiency was considerably enhanced by the introduction of microcontroller-based solar tracking devices utilising Arduino boards. Solar panel efficiency was raised by 23.95% as a result of a multiple-axis servo-motor feedback tracking system established and developed in this research.[11]

Combining hardware components and software control mechanisms, solar trackers are created. Sensors, comparators, a microcontroller circuit, a motor drive circuit, and electric motors compose the system. Stepper motors or servo motors are often used. These are constructed and programmed to move the PV cell-mounted platform.[12] Some of these components are omitted from the Arduino board type described in this research. The system was modelled utilising a power supply device, an Arduino board, a servo-motor, and Light Dependent Resistor's (LDR's) that function as solar light sensors. To accomplish the MPP, the system is automatically steered relative to the sun. Therefore, the solar cells retain their