UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN OF THE SUPPLY GENERATOR FROM SOLAR PANEL BY USING ARDUINO CONTROLLER

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) (Hons). The member of the supervisory is as follow:

……

(Dr. SAHAZATI BINTI MD.ROZALI)

ABSTRACT

This report presents the analysis of Dual-Axis solar tracking system using Arduino Uno. The main objective of this project was to investigate the difference between Single-Axis solar tracker and Dual-Axis solar tracker to determine which is efficiency and reliable. For hardware development, five light dependent resistors (LDR) was used to obtain maximum solar light. Two servo motors was used to actuate the solar panel to get maximum solar light exposing location which was detected by the LDR. As for the software part, the code was built by using C++ programming language and was used to Arduino UNO controller. The performance of the solar tracker was analyzed and compared with the Single-Axis solar tracker and the result showed that the Dual-Axis solar tracker is better than the Single-Axis solar tracker in terms of average voltage, current, power temperature and solar light intensity (illumination). Therefore, the Dual-Axis solar tracker is proven more effective for capturing the maximum sunlight intensity for harvesting process.

DEDICATION

I dedicate this project report to my parents and friends. A special thanks to my father Mr. Manikam Thambusimy and my mother Mrs. Kavitha Kupusamy who both taught me that even when the task seems impossible at first it can be accomplished if it is done one step at a time.

I also devote this work to my friends and people in the societies who have supported me throughout to finish the project. I will always appreciate the help and knowledge shared by my friends and lecturer.

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CHAPTER 1

1.0 Introduction

This chapter briefly explains about project Dual-Axis Solar Tracking System. The objectives, problem statement, and scope is discussed here.

1.1 Background

Recently, the sunlight based energy is one of the sustainable power source that is famous among Malaysian community. Various method of solar tracking system is created by different supplier in different country in order to collect maximum radiation of the sun energy (Azman *et al.*, 2011) (Fayaza *et al.*, 2011). The sun oriented photovoltaic framework is one of the greatest sustainable power sources to create electrical power and the quickest developing innovation for improvising photovoltaic energy transformation effectiveness from accessible sun oriented energy. Sun based tracker will move the solar panel to constantly parallel to the sun. Sun trackers require higher accuracy for recognizing the sun and should maintain the rate angle of 0° parallel to the sun with a specific order to get the greatest energy from the daylight.

1.2 Problem Statement

The solar panel is the primary instrument that is needed to change the radiation of the sun to electrical energy (Processing *et al.*, 2016). Recently, sustainable power source is important since it is an alternative method to overcome the issue of the oil and gases that

have been relatively exhausted (Debnath *et al.*, 2017). The harvest of solar energy is depending on upon the measure of solar radiation on the cell. Fixed static solar panel unable to harvest the solar energy compared with solar trackers because of various position in azimuth and elevation of the sun position at all over the year (Nallathambi *et al.*, 2017). The daylight it either reflected or diffused away when the solar panel is in shallow angle. If the cloud is blocking the solar panel, it will be limit the energy collect time. In addition, the single-axis solar tracker just changes azimuth (level) angle while dual-axis solar tracker changes both azimuth (horizontal) and altitude (vertical) angle (Ray and Tripathi, 2017). Hence, this project propose a double-axis solar tracker in order to create higher power produced.

1.3 Objective

The objective of the project:

a) To design and develop solar tracking system that work in dual axis.
b) To obtain a maximum radiation of sun energy from the designed system.
c) To analyze the voltage, current, power, temperature, and solar light intensity for the active solar tracker system.

1.4 Work Scope

The scopes of this project are;

a) Monocrystalline Silicon Solar Cell is use to harvest the solar energy.
b) Operating system involving microcontroller Arduino Uno.
c) Five Photo resister sensor used to detect the sun orientation and move.

d) Two-servo motor is an actuator that has been used to perform the movement of the solar tracker system.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter present the theoretical part and the past literature on dual-axis solar tracking system. A brief description is given in this chapter regarding to microcontroller used, photovoltaic cell, motor or actuator used and the sensor to detect the position of the sun.

2.1 Solar Panel

A solar panel is an arrangement of solar cells which also known as photovoltaic (PV) cell. Groups of smaller photovoltaic cells spread over a wide area can cooperate to generate and supply electricity in commercial application by converting solar radiation into electrical energy (Zolkapli *et al.*, 2013). Sunlight is an ultimate source of energy that can be used as a renewable energy source. Time of the day, position of the photovoltaic cell and season affect the power output because it depends on the amount of light received by the cell respectively. The more sun light ray that hits the photovoltaic cell, the greater power it produces. Therefore, to get high efficient output from the photovoltaic cell, the cell must should always be parallel to the sun (Al-Naima and Yaghobian, 2010). From the previous research and journal, they have been used several type of photovoltaic cell.

Solar panel that are available in the market were different by their efficiency, price and temperature were:

a. Monocrystalline (Mono-Si)
b. Polycrystalline (Poly-Si)
c. Thin Film (TFSC)

Based on website from (Mathias Aarre Maehlum, 2017) mentions the advantages and the disadvantages of the solar panel.

2.1.1 Monocrystalline

Figure 2.1: Monocrystalline Silicon Solar Cell

Monocrystalline solar cells as shown in Figure 2.1 made out of crystalline silicon bars, which are tube-shaped. To enhance performance and lower expenses of a single monocrystalline solar cell, four edges was remove of the tube-shaped bars to make silicon wafers, which is the thing that gives monocrystalline photovoltaic panels.

Advantages:

- Monocrystalline sun based boards have the most elevated effectiveness rates since they finished out of the highest-grade silicon. The capability of monocrystalline sun based boards are commonly 15-20%.
- Monocrystalline silicon sun powered boards are effective. Since these sun based board's harvest the maximum power produces, they likewise need minimal measure of room contrasted with some other sorts. Monocrystalline sun powered boards create up to four times the measure of power as thin-film sun powered boards.
- Monocrystalline photovoltaic survive the highest. Most of solar panel producers put a 25-year guarantee on their monocrystalline sun oriented boards.
- Have a tendency to perform greater to similarly valued polycrystalline sun based boards at low-light conditions.

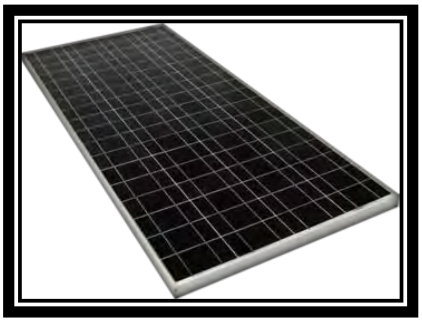
Disadvantages:

- The assembling of this sort of boards is more complex and in this way the cost is significantly higher compared with thin film sun oriented PV modules or polycrystalline sun oriented boards.
- In the event that you live in a region that gets a great deal of snow fall and dust, installing monocrystalline boards may not be the best decision. On the off chance that they are secured by overwhelming snow, the delicate sun powered cells can be harmed and the entire circuit can break down..

- The Czochralski procedure is too utilized to deliver monocrystalline silicon. It brings about large cylinder shaped bars. Four sides removed of the bars to make silicon wafers. A lot of the first silicon end up as waste.
- Monocrystalline sun based boards have a tendency to be more effective in warm climate. Execution endures as temperature goes up, yet less so than polycrystalline sunlight based boards.

2.1.2 Polycrystalline Silicon Solar Cell

Figure 2.2: Polycrystalline Silicon Solar Cell



Polycrystalline panel as shown in figure 2.2 are some of bits unadulterated or pure crystalline comprises of silicon offcuts, which is formed using a block. It will not be proficient when singular precious crystals are not adjusted together and there is a misfortune in the joints between it. Nonetheless, in low light, the cells work better to light at all points because of misalignment.

Advantages:

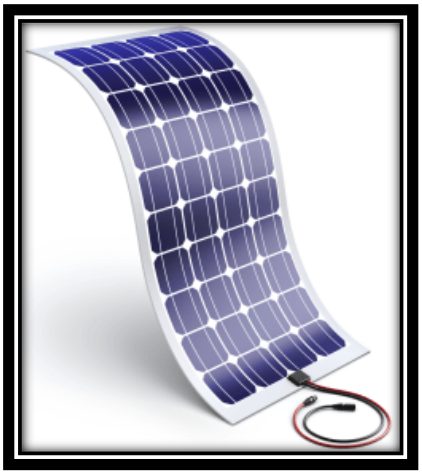
- The procedure used to make polycrystalline silicon is less troublesome and cost less. The measure of waste silicon less diverged from monocrystalline.
- Polycrystalline sunlight based boards have a tendency to have somewhat bring down warmth resistance than monocrystalline sun oriented boards. This actually implies they perform marginally more terrible than monocrystalline sun oriented boards in high temperatures. Heat can influence the performance of sun powered boards and shorter their life lifespans. In any case, this impact is minor, and most property holders don't have to consider.

Disadvantages:

- The efficiency of polycrystalline-based sunlight based boards is normally 13-16%. Due to bring down silicon pureness, polycrystalline solar panel not exactly as effective as monocrystalline photovoltaic.
- Lesser space proficiency. For the most part need to cover a greater surface to yield the same electrical power from as would with a sun powered board made of monocrystalline silicon. Although, this does not mean each monocrystalline solar panel perform better than those based on polycrystalline silicon.
- Monocrystalline and thin-film sun oriented boards have a tendency to be all the more visually pleasing since they have a uniform look contrasted with the dotted blue shade of polycrystalline silicon.

2.1.3 Thin-Film Solar Cell (TFSC)

Figure 2.3: Thin-film Solar Cell



Thin-film solar cell also known as thin-film photovoltaic cell (TFPV). The produced is by saving one or a few high coatings of photovoltaic material onto a substrate is the fundamental core. Thin-film demonstrate models have achieved efficiencies between 7-13% and generation modules work at around 9%. The varied kind of thin-film sun powered cell can be classified by which photovoltaic material is kept onto the substrate:

a) Armorphous silicon (a-Si).

b) Cadmium telluride (CdTe)

c) Copper indium gallium selenide (CIS/CIGS).

d) Organic photovoltaic cell (OPC).

Advantages:

- Mass-production is simple. This makes them and possibly less expensive to produce than crystalline-based sun powered cells.
- Their homogenous appearance influences them to look all the more engaging.
- Can be made adaptable, which opens up numerous new potential applications.
- High temperatures and shading have less effect on sun powered board execution.
- Space is not an issue, thin-film solar panels can generate electricity.

Disadvantages:

- Thin-film sun based boards when all said in done not extremely helpful for in most residential circumstances. They are modest, yet they likewise require a great deal of space. Monocrystalline sunlight based boards create up to four times the measure of power as thin-film sun based boards for a similar measure of room.
- Low space-effectiveness likewise implies that the expenses of PV-equipment (e.g. support structures and cables) will increase.
- Thin-film sun oriented boards have a tendency to corrupt speedier than monocrystalline and polycrystalline sun based boards, which is the reason they normally accompany a shorter warranty.

2.2 Microcontroller

Microcontroller is imperative in a control framework to control the stream procedure. Each one of the parts need to interface with this microcontroller for the working procedure. The framework is for running and process the strategy in this controller. A portion of the journal are say the important of the controller. The controller that have been used in the previous research are PIC16F84A microcontroller (Barsoum, 2009), PIC16F877A microcontroller (Mallick *et al.*, 2014),(Sreejith, Rajesh and Unni, 2016) and (Beltán, González and García-Beltran, 2007). (Leedy and Garcia, 2014) has use PIC18F4550 and (Alboteanu, Ravigan and Novac, 2014) for PIC18F4520. ATmega2560 (Suria and Idris, 2016), ATMEGA32 (Al-Naima and Yaghobian, 2010), ATMEGA328 (Zakariah, Jamian and Yunus, 2016) and (Mereddy and Sadula, 2015). ATMEGA328P (Sreejith, Rajesh and Unni, 2016). ATMEGA8 (Bharath and Kanakasabapathy, 2016) and (Ray and Tripathi, 2017). Arduino UNO by (Chhoton, 2017), (Reddy, Chakraborti and Das, 2017), (Liu, 2015), (Othman *et al.*, 2013), (Zakariah, Jamian and Yunus, 2016), (Zolkapli *et al.*, 2013) and (Kaur *et al.*, 2017). Programming Logic Controller (PLC) (Karthik *et al.*, 2016), (Ahmad, Shafie and Ab Kadir, 2012) and (Alboteanu, Ravigan and Novac, 2014).

(Karthik *et al.*, 2016) in a journal titled "Automatic Solar Tracking System using DELTA PLC" shows that the tracking is done by programmed light intensity of the panel with the help of LDR sensors and magnetic reed switches. It controls the speed and direction of the dc gear motor attached to the solar panel through mechanical structure and gear arrangement by programming in PLC (Karthik *et al.*, 2016).

(Othman *et al.*, 2013) in the journal titled "Performance Analysis of Dual-axis Solar Tracking System" uses solar tracker that controlled by Arduino UNO. Hardware and software of Arduino are easy to use and it is open-source electronics prototyping platform that is flexible. C Programming languages are used in the Arduino software. An Arduino can received input from a variety of sensors that connected to the analog of Arduino and projects that used Arduino can operate independently or communicate with software on a computer.

(Oo and Hlaing, 2010) in a journal titled "Microcontroller-Based Two-Axis Solar Tracking System", study a solar tracker that control by PIC 16F84A. PIC 16F84A microcontroller is use to interface with two-axis solar tacker system using a programming language and it is the main controller entire circuit. PIC16F84A can decode write commands and adapt it to electrical signals.

(Cristaldi *et al.*, 2014) in journal "An Improved Model-Based Maximum Power Point Tracker for Photovoltaic Panel" have study about the using model –based (MB) MPPT give batter performant that is because the system is easy to maintain an accurate model of the single PV panel (Cristaldi *et al.*, 2014).

2.2.1 Arduino Uno Microcontroller

Figure 2.4: Arduino UNO

Arduino Uno is a device that can detect analog signal and respond as digital signal. It is a direct microcontroller board that easy to write programming for the board. Arduino activities can speak with computers or can remain solitary and it used to take input from different sensors, controlling a different of motor and other physical output.

Advantages;

- Basic and clear programming condition.
- A USB interface, the board connects straight to USB port on PC.
- Open source and extensible programming and equipment.

Disadvantages;

- Arduino library essentials to be improve to make it easier to resolve the problems.