



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FACULTY OF ELECTRICAL ENGINEERING

FINAL YEAR PROJECT REPORT

**DESIGN DUAL AXIS SOLAR TRACKER THAT MOVE INDEPENDENTLY IN
X AND Y DIRECTION TO TRACK MAXIMUM ENERGY**

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**DESIGN DUAL AXIS SOLAR TRACKER THAT MOVE INDEPENDENTLY IN
X AND Y DIRECTION TO TRACK MAXIMUM ENERGY**

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**A report submitted in partial fulfilment of the requirement for the degree of
Electrical Engineering (Industrial Power)**

**Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

MAY 2018

I declare that this report “Design Dual Axis Solar Tracker That Move Independently in X and Y Direction to Track Maximum Energy” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature :
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ABSTRACT

As we can see now, the earth becomes hot effect of the global warming. Here we can take an advantage from the effect of the global warming. We can use solar energy as an electrical energy to operate an electrical appliance. The problem that we can see now is most of the solar panel that had been use by a user just only in a static direction. If the solar panel located at east and the sun is located at west, the solar panel cannot be charging. So, the project that wants to develop here is called “Design Solar Tracking System to move independently in X and Y axis to Maximize Energy”. Solar tracking system is the project that used Arduino Uno microcontroller as a brain to control the whole system. The LDR (Light Dependent Resistor) had been used to sense the intensity of light at different angle and sent the data to the microcontroller. This microcontroller will compare the data and rotate a stepper motor to the right direction. The stepper motor will rotate the solar panel based on the highest intensity of light.

ABSTRAK

Seperti yang kita ketahui sekarang, bumi menjadi semakin panas kesan daripada pemanasan bumi. Kita boleh mengambil kelebihan daripada kesan pemanasan bumi yang sedang kita hadapi sekarang. Kita boleh menggunakan matahari untuk menghasilkan tenaga elektrik bagi menggerakkan perkakas elektrik. Tetapi masalah yang dihadapi sekarang ialah solar panel hanya berada dlm keadaan satu arah sahaja (statik). Oleh itu, projek yang hendak dihasilkan di sini dipanggil “Design Solar Tracking System to move independently in X and Y axis to Maximize Energy”. projek ini menggunakan mikropengawal Arduino Uno sebagai otak untuk mengawal keseluruhan projek ini. LDR (Light Dependant Resistor) digunakan sebagai pengesan untuk mengesan keamatan cahaya pada berlainan posisi dan menghantar maklumat ke mikropengawal. Mikropengawal akan membandingkan data tersebut dan menggerakkan motor stepper ke arah keamatan cahaya yang tertinggi.

TABLE OF CONTENT

CHAPTER	TITLE	PAGE
	DECLARATION	2
	DEDICATION	4
	ACKNOWLEDGEMNT	5
	ABSTRACT	6
	TABLE OF CONTENT	8
	LIST OF FIGURES	11
	LIST OF TABLES	13
	LIST OF ABBREVIATIONS	14
	LIST OF APPENDICES	14
CHAPTER 1	INTRODUCTION	
	1.1 Background	13
	1.2 Problem Statement	15
	1.3 Objectives	16
	1.4 Scope	16
CHAPTER 2	LITERATURE REVIEW	
	2.0 Introduction	18
	2.1 Concept of Solar Radiation	19
	2.1.1 Introduction of a Solar Tracking System	19
	2.1.2 Types of Solar Tracker	20

2.1.3.1 Single Axis Tracker	20
2.1.3.2 Dual Axis Tracker	22
2.2 An Overview of Solar Panel	23
2.3 Type of Solar PV Panel	23
2.4 Efficiency of Solar Panel	24
2.5 Working of Photovoltaic	24
2.6 Application of Solar Energy	25
2.7 Previous Project	27
CHAPTER 3	METHODOLOGY
3.1 Overview	28
3.2 Materials	29
3.2.1 Sensors	29
3.2.2 Photovoltaic cells	30
3.2.3 Light Dependant Resistor	30
3.2.4 Light Sensor Design	32
3.2.5 Arduino UNO	33
3.2.6 Servo Motor	35
3.3 Procedure	37
3.3.1 Overall Flow Chart	37
3.3.2 Process of Final Year Project	39
3.4 Experimental Setup	40

CHAPTER 4	RESULT AND DISCUSSION	
	4.1 Introduction	42
	4.2 Connection of Terminal Block	42
	4.3 Attachment of Servo Motor	45
	4.4 Block Configuration of LDR	46
	4.5 Coding	47
	4.6 Schematic Diagram	51
	4.7 Light Dependant Resistor Reading	52
	4.8 Results and Discussion	55
CHAPTER 5	CONCLUSION	
REFERENCES		68
APPENDICES		71

LIST OF FIGURES

1.1	Types of Solar Radiation	14
2.1	Horizontal Single Axis Solar Tracking System	21
2.2	Vertical Single Axis Solar Tracking System	21
2.3	Dual Axis Solar Tracker	22
2.4	Module of Array	25
2.5	Construction and urban planning	26
2.6	Agriculture and agriculture	26
2.7	Heating, cooling and ventilation	26

3.1	Sensors	29
3.2	Photovoltaic cells	30
3.3	Sensors block scheme	31
3.4	LDR Sensor	31
3.5	Cross Configuration of Photoresistor Frame	32
3.6	The input circuit that employs a voltage divider	33
3.7	Voltage Divider Formula	33
3.8	Arduino UNO R3 Microcontroller Board Diagram	34
3.9	Arduino UNO Uno Microcontroller Board	34
3.10	Servo Motor	35
3.11	Cross Configuration of Photoresistor Frame	36
3.12	Inner Part Servo Motor	36
3.13	Servo Motor Connected Arduino	37
3.13	Measurement of Voltage	40
3.14	Measurement of Photoresistor	41
4.1	Conceptual Terminal Connection 1	42
4.2	Conceptual Terminal Connection 2	43
4.3	Conceptual Terminal Connection 3	43
4.4	Conceptual Terminal Connection 4	44
4.5	Conceptual Terminal Connection 5	44
4.6	Servo Motor Connection	45
4.7	Design of LDR Diagram	46
4.8	LDR Prototype	46
4.9	Draft Project Prototype	47
4.10	Coding 1	48
4.11	Coding 2	49
4.12	Coding 3	49
4.13	Coding 4	50

4.14	Schematic Diagram	51
4.15	LDR diagram	52
4.16	Voltage Divider	53
4.17	Actual LDR Resistance Variation Graph	52
4.18	Measured LDR Resistance Variation Graph	55
4.19	Graph current 11 th April 2018	56
4.20	Graph voltage 11 th April 2018	56
4.21	Graph current 18 th April 2018	57
4.22	Graph voltage 18 th April 2018	57
4.21	Graph current 25 ^h April 2018	58
4.22	Graph voltage 25 th April 2018	58
4.23	Bar chart of power 11 th April 2018	59
4.24	Bar chart of power 18 th April 2018	60
4.25	Bar chart of power 25 ^h April 2018	60
4.26	Bar chart of power gained 11 th April 2018	61
4.27	Bar chart of power gained 18 ^h April 2018	62
4.28	Bar chart of power gained 25 th April 2018	62

LIST OF TABLES

2.7	Comparison of Previous and Current Project	27
4.7	Measured Photo Resistor	53

LIST OF ABBREVIATIONS

I/O	-	Input Output
RAM	-	Random Access Memory
ROM	-	Read Only Memory
PROM	-	Programmable Read Only Memory
EPROM	-	Erasable Programmable Read Only Memory
IC	-	Integrated Circuit
R	-	Resistor
LED	-	Light Emitter Diode
K	-	kilo
V	-	volt
mA	-	mili ampere
LDR	-	Light Dependant Resistor
PCB	-	Printed Circuit Board

LIST OF APPENDICES

A	Current, Voltage, and Power Measured	71
B	Arduino Code to Servo Motor	74
C	Statistic of Average of Solar Radiation in Malaysia	78
D	Statistic of Renewable Energy	79
E	World Energy Consumption	80
F	Usage of Fixed and Solar Tracking Installation	81

CHAPTER 1

INTRODUCTION

1.0 Background

Exponential growth of population and economic development has put an impact on our world which raised consumption in these few years. Our world nowadays, yearly there will be rapid growth of industrial society mainly caused by fossil fuels energy such as nuclear energy, coal energy, natural gas and etc.

Renewable energy sources such as electric power have overtaken as main role to fulfill the needs of electric energy. The extinction of fossil fuel resources are been expected to ends within the next hundred years from now onwards. Basically, renewable energy that produced naturally through environment surroundings are mainly will keep going to replenished one day. Sources that keep continuous renewed constantly are biomass, wind, sunlight, water, geothermal and heat. In terms of renewable energy, solar energy is listed as the highest energy to get the most efficient energy to produce electricity generation .It is mainly chosen as the primary energy resources in warm climate country in our world.

Solar technology is also one of the fastest growing renewable energy since its source is always continuous, cheap in price, pollution free and friendly environmental. Solar radiation is basically act as a solar energy that beam radiation to solar PV panel for a period of time that is called as solar irradiation. There are three different combinations for solar radiation which are diffused, direct and reflected radiation that will be displayed in Figure 1.1. The main problem and limitation for solar energy is when there are certain condition occurred. One of it is

caused by weather which can be wet or cloudy that causes the solar PV panel to absorb less sun radiation which unable to produce electricity on its maximum.

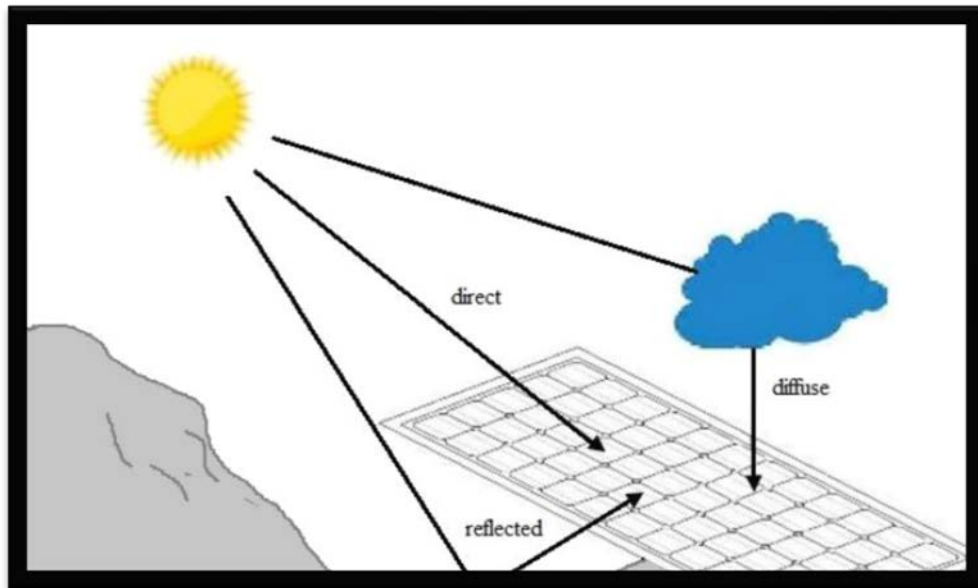


Figure 1.1 Types of solar radiation

Moreover, the problem occurred on solar photovoltaic is of its low efficiency. This is a problem to generate maximum output power absorbed by the sunlight. The solution for this, research have been made by researches that the only solution to be carried out is by increasing the efficiency output power by implement solar tracking system. It's been widely used now in our world technologies nowadays. It works as to align the solar PV panel to be perpendicular to the position of the sun radiation. There are elements that merged together to create and design this solar tracking system which are electric, electronics, and mechanics.

Thus, by implementing the tracking system for solar PV, the solar energy efficiency can be increased and improved. This system can help to increase the efficiency output power to get the maximum result.

1.1 Problem Statement

In our world, not all countries have big resources such as oil and gas to generate and produce electricity. It is been assumed that one day, the fossil fuel will extinct when its been overused. Renewable energy is well known to this world as its continuous sources that will keep reproduced. Consumers frequently use solar energy as a renewable energy to charge small devices and portable appliances for their daily usage.

Nowadays, strength efficiency to generate solar energy power is low. However, lack of accuracy and efficiency is a major problem as well with the incensement of operation energy consumption. In order to solve this issue, solar tracking system has been recognized in our world. Generally, the solar tracker act as device that will orient and move the solar PV panel to be aligned with the sun position. It will as well reduce the angle between lines to force the solar PV panel to be perpendicular with the sun radiation. When there is a change of solar irradiance intensity, the solar PV panel will automatically change its direction.

Solar tracking system is more costly to be produced because it doesn't need a big area of perimeter to produce and generate power compared to other big generation system. There are basically two types of solar tracking system which are fixed tracking system and dynamic tracking system. Dynamic solar tracker categorized as passive and active tracker. The active tracker is much more reliability because of its capability to produce higher efficiency compared to the passive tracker that have to depend on the weather. Dynamic solar tracker much more preferred to be used

Active tracker adapted to sense the light intensity by using sensor such as light dependent resistor (LDR) .Then, the other will be the photo diode constructed to the motor to align the position of the solar PV panel. Basically, dual axis trackers will be more accurate. However, the design of dual axis tracker is much more complex in terms of its circuit as it involved electronic parts which are sensors, microcontrollers, servo motors, resistors and etc.

Therefore, the main problem that needs to be solved is to find solution to lessen the energy consumption and how to increase the efficiency power of dual solar tracker by improving its hardware system.

1.2 Objective

In order to utilize a great solar power system, a solar tracker is very important in terms of its effectiveness. Thus, this project has three main objectives as follows:

1. To design dual axis solar tracker that move independently in X and Y axis direction
2. To implement system in terms of hardware and software of the solar tracking system by aligning the solar panel in the direction of the sun throughout the day by tracking maximum energy

1.3 Scope

One of the scopes of this project is to create and design an intelligent method using solar tracking system. This system will measure the strength of light intensity by using four LDR sensors that will be placed on the top of the solar PV panel to get the best sun radiation. The tracking system will move its surface of the solar PV panel to orient and align with the incoming sunlight beam. There will be two DC servo motor used in this system as the motors will rotate in certain direction. The motors will move into their desired position movement and angles based on the signal transmitted controlled by microcontroller which is Arduino.

For this project, there are two criteria been considered which are the software and hardware part that need to be developed in this project. The major part of this project is more focusing on the hardware development which are the microcontroller Arduino, servo motor , LDR light sensors, servo motors and solar tracker mechanism that to be

used on the solar tracker. The microcontroller which is Arduino function as the best microcontroller as it meets the best criteria for this project as in terms of its effectiveness. The effectiveness are based on the power consumption, the adaptation of its signal to the sensor, number of output and input, speed and etc.

The input system works when the LDR sensors operated to detect and identify the light intensity of sunlight. It is mainly based on its sensitivity, position and accuracy. The motor drivers which are the servo motors are been used in the project of its capability to direct the position and control the solar tracker to move accordingly to the sunlight. Servo motor is used because of its great torque that able to rotate the solar PV panel in a smooth rotational, low cost and less power consumption needed to operate this system. The mechanism of solar tracker is created and designed to meet the objective which is a system that able to track solar energy.

Lastly, programmers are developed in this system which are based on the microcontroller Arduino. This is to help the system to meet the desired output which are the position and direction of solar PV panel. The fuzzy coding is intended to produce the best controller to control the accuracy, precision and movement of the solar tracker system. The Arduino which is written in C++ language is been operated and executed in this project.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Our global world now facing with extinction of oil and fossil fuels which is a serious threat to our world. This affects the Earth resources causing deterioration of atmosphere environment and global warming. Rapid growth of population and economic crisis leads to energy saving and protection for environment in our world.

Regeneration energy also known as green energy has been enlarged bigger attention. Green energy can be recycled repetitive and can be used every time such as water, wind power, biomass, sea waves, tides and solar energy. Among this green energy, solar energy is the main dominant resource that can be used to produce power. A good energy source prospect for industrial continuous processes needs to be:

- More or less constant energy throughout the year;
- Highly reliable and needs little maintenance;
- Low cost to construct and operate;
- Virtually green environmental and landscape friendly;
- Modular flexible in size and applications;

2.1 Concept of Solar Radiation

Theoretically, solar radiation is beamed when it is produced by the sun. There are two type of solar radiation which is direct radiation and diffuse radiation. Direct radiation occurs when the solar hit directly to the solar PV panel .By means, around 90% of the solar been carried by diffuses energy radiation .In other word, diffuse radiation is when the solar been scattered caused by weather , wet environment , cloudy and etc. It is mainly caused when the solar energy flash towards a cloud before had been beamed into solar PV panel. The energy radiation is the main incident radiation that has been replicated by our earth. This radiation is called as global radiation on a solar PV panel [1].

2.1.1 Introduction of a Solar Tracking System

Generally, solar tracking system is a appliance device that used for positioning a photovoltaic panel pointing the sun to minimalize the angle incident in between of sun and surface of solar panel throughout the day. It has the best performance when it is pointed straight to the sun as the value of efficiency of the output power is the maximum. Thus, it wills causes complexity and add cost to this project which is a negative side to the project.

The amount of intensity of solar radiation is decreased when the system rotates mechanically towards to face the sun and getting the highest intensity of solar radiation. One of the benefits is that it can help to maximize the effectiveness of the power from the solar energy. Then, the disadvantage will be the operation energy consumption will be high when the system is operated which causing the system to be hard to yield more output than expected. [2].

Fundamentally, a well-organized solar tracking have to function at its maximum to generate maximum output power with low energy consumption at the same time. Mostly of the PV installation located in Malaysia are basely individual systems. The grid connected PV taking place with some test installation recently. In

2002, Prototype Solar House been constructed in Kuala Lumpur as a part of Research and development of Grant Scheme (IGS) [3].

It is magnificent meanwhile in a normal residential area, house dissimilar of grid-connected roof installation with not the same photovoltaic generators (polycrystalline, monocrystalline, amorphous silicon; mounting, integration and roof tiles) have been constructed with highlighting on architecture and thermal features. [4].By allowing the evaluation of relevant operation parameters for PV systems, the installation is much more dependable and reliable with greater efficiency. There are as well certain aspects that been used related with grid connected system of PV in Malaysia.

2.1.2 Types of Solar Tracker

In order to get the maximum efficiency of output power, position of solar PV and sun must be both perpendicular in alignment .Nowadays, there are many different types of tracking system that can be used which are different in terms of its rate, accuracy, reliability and etc. The design of the solar tracker must be selected accordingly to make sure the tracking system can be constructed with great results at the end by getting high output power.

2.1.3.1 Single Axis Tracker

This tracker consists of one degree of freedom. It operates as an axis as the movement of single axis can be either on 2 directions which are horizontal and vertical axis. The movement of this system is variable upon the technology adapted on the tracker as well the prototype mounted on it. Each country in tropical region such as Malaysia is set up as horizontal type tracker as the sun usually has the lowest point of getting the high solar intensity.

A single axis tracker normally moves in a plane. It will alternatively move and rotate in either two positions which are horizontally and vertically. It is less difficult to control this tracker and the price of built this is quite low and affordable. [5].The problem is the efficiency of getting much solar irradiance is not enough and low for the solar tracker system. Figure 2.1 and Figure 2.2 displays the types of solar single axis tracker.

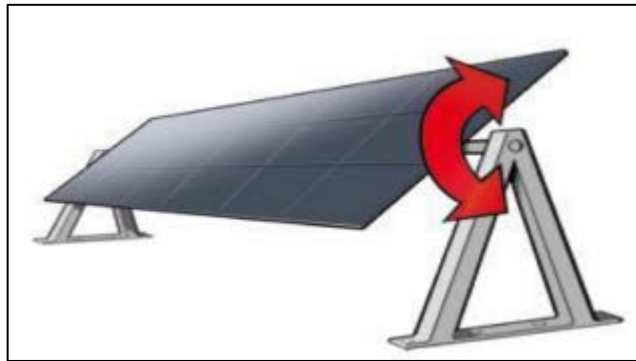


Figure 2.1 Horizontal Single Axis Solar Tracking System



Figure 2.2 Vertical Single Axis Solar Tracking System

2.1.3.2 Dual Axis Tracker

By using DOF, a dual axis tracker will rotate freely which can be horizontal and vertical axes. It will rotate in a form of vertical axis which is from east to west or west to east. The horizontal axis will then move from north to south or south to north. The movement will depend on its location of the sun. Dual axis will give much more greater performance and accuracy compared to single axis tracker. The sun position will be flashed to solar PV panel which the controller of the signal will be controlled by a microcontroller.

The sensors are placed on the top of PV panel will help to get as much as rate of current and voltage to be absorbed by the sun. [22]. A dual axis tracker normally will increase the output power by 40-50% compared to single axis tracker which will be much lower [6]. Figure 2.3 displays the example of tracker which has two degree of freedom.



Figure 2.3 Dual Axis Solar Tracker

2.2 An Overview of Solar PV panel

A solar PV panel is a solar module or as known as photovoltaic panel (PV). Photovoltaic cells are assembled by a PV panel. PV solar panels help to absorb great amount of total surface of solar energy .A greater photovoltaic system can help to generate higher supply of electric for commercial purpose and residential area. The output power can be ranged in between of minimum range of 0 to 100 watts and for the maximum range between 0 to 320 watts. [7].

The effectiveness of the solar PV panel will help to identify the total region places of area If many solar panel are been used in an array, there will e more power that can be harvested.. [24].

2.3 Type of Solar PV Panel

Generally, the are many types of solar PV panel which will be listed as:

- i. Poly-crystalline (p-Si)
- ii. Mono-crystalline (m-Si)
- iii. Amorphous Silicon (a-Si)
- iv. Ribbon Silicon
- v. Chalcogenide films of Cu (CIS)

The parameters on a solar cell will keep changing if the light intensity changes as well. This is due to exposure of open circuit voltage, efficiency, effect of series resistances and short circuit current. [8]. Therefore, changes of ups and downs effects the total power of output from the solar panel.