



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF SOLAR TRACKER USING MICROCONTROLLER TO CONTROL STEPPER MOTOR

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Industrial Electronics) 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's Degree in Electronics Engineering Technology (Industrial Electronics) with Honours. The member of the supervisory is as follow:

.....

ENCIK EFFENDY ONN BIN SIAM

(Project Supervisor)

ABSTRAK

Dalam keadaan yang seba moden ini, tenaga semula jadi sangat diperlukan dalam semua aktiviti manusia. Selain daripada itu, pembangunan yang pesat dalam sesebuah negara juga memerlukan sumber tenaga. Tenaga solar telah mendapat perhatian dalam kehidupan seharian manusia iaitu dalam sector perindustrian, pertanian, pengangkutan dan juga system aplikasi yang berteknologi canggih. Jadi dengan adanya projek ini, sesebuah negara dapat menjimatkan kos pembangunan mereka. Disebabkan Malaysia terletak di garisan khatulistiwa, Malaysia sangat berpotensi untuk memfokuskan tenaga solar ini kerana negara ini menerima pancaran cahaya matahari yang banyak sepanjang tahun. Bagi menjayakan projek ini, pengesan solar paksi tunggal telah dicadangkan iaitu direka bentuk dengan melaksanakan projek yang mampu memutarakan motor stepper berdasarkan keamatan cahaya. Tujuan projek ini dilaksanakan ialah untuk merancang pengesan solar yang akan mengesan maksimum cahaya matahari serta menganalisis maksimum keluaran tenaga (kuasa) dari panel tetap dan panel pengesan solar. Projek ini telah dibahagikan dalam tiga bahagian utama iaitu bahagian masukan (analog), mikrokontroler 18F (mengawal proses) dan keluaran (motor stepper). Mikrokontroler adalah seperti otak yang membaca masukan atau isyarat dari sensor LDR. Di dalam projek ini, lima sensor LDR telah digunakan. Setiap sensor LDR menggunakan litar pembahagi voltan untuk mengukur intensiti cahaya dan kemudian, menentukan arah cahaya yang berserenjang ke permukaan panel solar. Selepas arahan telah dihentikan, PIC akan membuat operasi untuk memutarakan motor stepper berdasarkan intensiti cahaya matahari yang lebih tinggi atau keamatan cahaya yang maksimum. Semua masukan dalam system ini adalah masukan analog iaitu sensor LDR, sensor arus dan litar pembahagi voltan.

ABSTRACT

In this modern state, natural energy is indispensable in all human activities. In addition, rapid development in a country also requires energy sources. This proves that the natural energy need to be produced with much more to meet the development. Additionally, most developed countries use solar energy extensively. Solar energy has been gaining attention in the daily life of the human being in the industrial, agricultural, transporting and advanced technology application systems. So, with this project that have been purpose, a country can save on their development costs. As Malaysia is located on the equatorial line, Malaysia is most likely focus on this solar energy as the country receives plenty of sunshine over the years. To make this project successfully, a single axial solar tracker was purposed designed by implementing a project that have capable of rotating the stepper motor based on light intensity. The purpose of this project is to design a solar tracker that detect the maximum sunlight and to analyze the maximum power output between the fixed position solar panel and movement panel (solar tracker). This project had been divided into three main parts which is input (Analog input), microcontroller (PIC18F) and output (stepper motor). The microcontroller is like a brain that reads the input or signal from the LDR sensor. In this project, five LDR sensors have been used. Each LDR sensor used a voltage divider circuit to measure the intensity of light and then determine the direction of light that perpendicular to the surface of the solar panel. After the instructions have been discontinued, the PIC will make an operation to rotate the stepper motor based on the most higher intensity of sunlight or the maximum light intensity. All input in this system are analog input, which is current sensor and voltage divider circuit.

DEDICATION

I am grateful to the ALLAH SWT for his grace. Within this report I, Siti Khotijah Binti Selamat (B071410653) of UTeM Malacca was successfully completed the report of final year project during two semesters. “Especially for my beloved mother Mrs. Hasuenee Alee and my father Mr Selamat Bin Sardi and my dearest brother Muhammad Maghribi Bin Selamat, who had given me much support, encouragement and advice to complete this project. And do not forget to all dearest fellow friends and UTeM staffs for helping and cheering my day when I lose the direction on doing my project. Thank you so much, I love u all.

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TABLE OF CONTENT

Abstrak	i
Abstract	li
Dedication	iii
Acknowledgement	iv
Table Of Content	v-vii
List Of Table	viii
List Of Figure	ix-x
List Of Abbreviations, Symbols And Nomenclature	xi
CHAPTER 1:INTRODUCTION	1-4
1.1 Project background	1
1.2 Objective of the project	2
1.3 Project scope	3
1.4 Problem statement	3-4
CHAPTER 2: LITERATURE REVIEW	5-28
2.1 Solar tracker overview	5-6
2.2 The Earth: Rotation and revolution	6-8
2.3 Solar irradiation: Sunlight and the solar constant	8-9
2.4 Sunlight	9-11
2.4.1 Elevation angle	10
2.4.2 Zenith angle	10
2.4.3 Azimuth angle	11
2.5 Types of solar trackers and tracking technologies	11-16
2.5.1 Active tracker	12
2.5.2 Passive tracker	12
2.5.3 Differentiate of different technologies in solar trackers	13
2.5.4 Single axis tracker	13-14
2.5.5 Dual axis tracker	14
2.5.6 Advantages single axis over dual axis of tracker technologies	14-16
2.6 Light dependent resistor theory	16-19
2.6.1 The concept by using two LDRs	17-18
2.6.2 Design of light sensor	18-19
2.7 Stepper motor	19-22
2.7.1 How the stepper motor is controlled	21
2.7.2 Advantages and disadvantages of stepper motor	22
2.8 Crystal	22-23

2.9	Voltage regulation	23-24
2.10	Microcontroller	25-26
2.11	Merits and demerits of solar energy	27
	2.11.1 Merits of solar energy	27
	2.11.2 Demerits of solar energy	27
2.12	Summary of literature review	28
 CHAPTER 3: METHODOLOGY		 29-52
3.1	Project Planning	29-31
3.2	Overview of the project	32
3.3	Project Flowchart	33-36
3.4	Design and development of the project system	37-41
	3.4.1 Software and Hardware Testing	37-38
	3.4.2 Result and analysis from solar panel	38-41
3.5	Software implementation	42
	3.5.1 Simulation in Proteus Software	42-44
	3.5.2 MikroC PRO for PIC Software (Compiler)	44-49
	3.5.2.1 Calculation of battery	45
	3.5.2.2 C Program Development	45-49
3.6	Hardware Model development (Assembly)	50-52
	3.6.1 PCB Development	50
	3.6.2 Hardware Development	51
	3.6.3 Component Testing	51-52
 CHAPTER 4: RESULT AND ANALYSIS		 53-64
4.1	Software and Hardware Testing	53-54
4.2	Result and analysis from solar panel	54-61
	4.2.1 Current and power observation on first day	56-58
	4.2.2 Current and power observation on second day	59-61
4.3	Result Observation	61
4.4	Hardware development result	62
4.5	Discussion	63
 CHAPTER 5: CONCLUSION AND RECOMMENDATION		 65-66
5.1	Conclusion	65-66
5.2	Recommendation	66
 REFERENCES		 67-68
 APPENDICES		 69-74
A	Data Sheet PIC18F	69
B	Motor Driver	71

C	Stepper Motor Wiring Diagram	72
D	LM7805	73
E	Functional Block Diagram of Current Sensor Module	74

LIST OF TABLES

2.1	Table 2.1: Range for sunlight brightness in unit (lux)	10
2.2	Table 2.2: Merits and demerits solar tracker	13
2.3	Table 2.3: Advantage of development solar trackers	14-16
2.4	Table 2.4: Value of resistance based on the light intensity	19
3.1	Gantt Chart for PSM 1	30
3.2	Gantt Chart for PSM 2	31
3.3	Selection of mechanical part	37
3.4	Component and materials name with description	39
3.5	Component and materials name with description	45
4.1	Comparison of Fixed Panel and Single Axis of Solar Trackers Day 1	56
4.2	Comparison of Fixed Panel and Single Axis of Solar Trackers Day 2	59
4.3	Hardware model experimental	62

LIST OF FIGURE

2.1	Solar Panel	6
2.2	The rotation of Earth's	7
2.3	Earth's rotation and revolution	8
2.4	The angle for zenith, azimuth and elevation	11
2.5	LDR Cadmium sulfide (Cds)	18
2.6	LDR and a resistor in voltage divider circuit	19
2.7	Unipolar stepper motor wiring	21
2.8	Bipolar stepper motor wiring	21
2.9	Connection of crystal circuit	23
2.10	Circuit of Voltage Divider	24
2.11	Pin diagram for LM7805	24
2.12	PIC18F45K22 pin configuration	26
3.1	Main Block Diagram	32
3.2	Flowchart of single axis solar trackers	36
3.3	Simulation on Proteus Software	42
3.4	PCB Layout	43
3.5	Top view of 3D Visualizer	43
3.6	Rear view of 3D Visualizer	44
3.7	Software of mikroC PRO for PIC	44
3.8	Process flow of PCB making	50
3.9	Process of making hardware model	51
3.10	Stages of testing component	51
3.11	PIC board	52
3.12	Hardware model design	52
4.1	Input and output of the microcontroller	54
4.2	Panel position at 8.00 AM	55

4.3	Panel position at 10.00 AM	55
4.4	Panel position at 12.00 PM	55
4.5	Panel position at 2.00 PM	55
4.6	Panel position at 4.00 PM	56
4.7	Panel position at 6.00 PM	56
4.8	Comparison of current obtained and day time in hour	57
4.9	Comparison of output power over a day on first day	57
4.10	Average power of solar panel on first day	58
4.11	Comparison of current obtained and day time in hour.	59
4.12	Comparison of output power over a day on second day	60
4.13	Average power of solar panel on first day	60

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

PIC	- Peripheral Interface Controller
LDR	- Light Dependent Resister
PV	- Photovoltaic
HSAT	- Horizontal Single Axis Trackers
HTSAT	- Horizontal Single Axis Trackers with Tilted
VSAT	- Vertical Single Axis Trackers
TSAT	- Tilted Single Axis Trackers
PSAT	- Polar Aligned Single Axis Trackers
Cds	- Cadmium Sulfide
MCU	- Microcontroller Unit
AC	- Alternate Current
DC	- Direct Current
IC	- Integrated Circuit
RISC	- Reduce Instruction Set Computer
CISC	- Complex Instruction Set Computer
RAM	- Random Access Memory
CPU	- Central Processing Unit
GND	- Ground
LCD	- Liquid Crystal Display
PVC	- Polyvinyl Chloride
ADC	- Analog Digital Converter

CHAPTER 1

INTRODUCTION

This chapter is discussed clearly about the project background, objective of the project that have been purpose, project scope and problem statement of the project.

1.1 Project background

Fossil energy was nearly exhausted is one of the main problem that had been facing by the world nowadays. This problem is causing because the using of electrical nowadays is very high demand due to the development is increasing rapidly over the world. This is why non-renewable energy such as fuel and coal will run out if the energy continuous using by the users. Due to this big problems, the world scientist and also engineers is busy in searching the renewable energy. The renewable energies that can be determined such as the energy of solar, wind, and hydro. This is because the renewable energy like solar energy was the best solution to reduce this problem. The energy of solar is produced by the sunlight. This energy was helps and also supports all living thing on Earth. Apart from that, the Earth 's was stay in orbit due to the gravitational that pull by the sun. However, the surrounding effect by the power generation was considerable. This is due to the fact modern- day society is uses electricity in huge amounts. The power is always used to generated at the power plants which convert the solar energy to electrical energy. The main benefit in using of solar energy, there is no pollutant create inside the system which process the generating of the electricity. Furthermore, the solar energy facilities will lower the environment impact form the combustion that utilized in fossil fuel power technology.

Solar energy is the energy that more renewable, sustainable and also clean that is in contrast to the gas, oil and coal, and even supporting us to protect our surrounding environment from destruction. Additionally, the solar energy was produced through collecting the sunlight then converts it into electricity power. This can be done by using solar panel, which have large flat panels that made up from many sun cells. Its far most often be utilized in a remote place, although this is becoming more accepted by urban region nicely.

1.2 Objective of the project

1.2.1 To study on the microcontroller (PIC18F) and stepper motor as a controller.

1.2.2 To develop a solar tracker (single axis) that will trace the maximum of the detection of sunlight.

- i. To design and as well implement a project that have capable to rotate a stepper motor based on the intensity of the light.

1.2.3 To analysis the optimum energy output (power) from fixed installation panel and solar tracker panel.

- i. To determine the comparison of the average power gain from fixed installation panel and solar tracker panel.

1.3 Project scope

The scope of this project is to control the rotation of the stepper motor. So, in order to assure the development of this solar tracker be successfully, a well-structured plan must be carried out in this project by searching the detailed concerned. Apart from that, the research must be had careful execution while design and test phase which will transform of the assembly component into a working solar tracker hardware.

1.4 Problem statement

As we can realize, there numerous issues that have been occur within the solar tracker that have been set up in fixed position. This will cause the power of solar panel that have been installation in fixed position became low. So, the major problem in this issues is solar panel in fixed position only can overcome a low power. However, the other problem is the cost to install multiple solar panel in many position angle will cause incredible high priced. This is because a family will use an awful lot of power in daily life. This is why they want to install multiple panel to get sufficient power for daily activities. Apart from that, the solar tracker that in fixed position installation cannot aim the intensity light of solar directly due to the movement of Earth which is constant because the Earth is not only rotates on its axis. The power was produced is in low result by using fixed installation due to the Earth that revolves around the sun at the same time its rotates on its axis. To overcome this problem, a single axis solar tracker will purpose to collect the maximum of output power it should produce. The Sun was moved from east to west, so the installation of the solar tracker need to install on the movement of the Sun. The solar panel can generate high output power compare to fixed installation. This is because to get maximum of output power, the intensity of the sunlight need to be concentrated on the surface of the solar panel. So, this solar tracker project can detect the sun movement in 180 degree of the rotation by using stepper motor. This project will overcome the problem of fixed position installation of solar tracker due to its output power. The main function of this solar tracker that have been purpose is to follow the higher intensity of the

light where to get the most output power. Indirectly, this project will reduce the amount of cost of buying multiple solar panel for installation. Moreover, this project will help the user to reduce time in changing the position of solar panel to make sure that the surface of solar panel is concentrated to the sunlight. In addition, the user just using one solar panel to generate enough power by using this project.

CHAPTER 2

LITERATURE REVIEW

This chapter will discuss on approximately of the literature overview and then explain in detailed about the development of solar tracking system, the history of solar panel and overview on the type of solar tracker. In addition, this part also involves the materials that studied and which is relevant to the study. In order to develop this project, it is required to go through a few of research which is related the idea of project that have been purpose. The research will be focusing on hardware and software which to development this solar tracker. The hardware part is included the mechanical part that is need to design in functional prototype. There is a brief on overview of the method used for tracking system and how the system tracks the apparent movement of the sun based on the increasing of power on solar panel. As whole in this chapter is about the basic knowledge on making solar tracking system.

2.1 Solar tracker overview

Solar tracking system is a device that act as detector which used to detect the position of the most sunlight that will perpendicular to the surface of the solar panel. The sun location within the sky will varying with time of day. This is because the Sun is move throughout of the sky. The power of the solar panel device will work excellent when the surface of solar panel is pointed to the sunlight. Consequently, the development of the solar tracker is in affordable price. However, the price to increase the efficiency of fixed position solar tracker is expensive due to the price of additional multiple solar panel that

need to add to the system. The solar panel converts visible light into direct current because it is semiconductor fabric. If the solar arrays are increased, the efficiencies of solar panel became higher. The photovoltaic energy is which is acquired from the Sun power. A photovoltaic cellular is generally referred to as a solar panel which is the technology that used for conversion of solar energy direct to the electrical power. The photovoltaic cellular is made from silicon alloy which is a non-mechanical device (Algarin, 2016). The cell is the basic construction from block photovoltaic arrangement and a single cell can vary in range 0.5 inches to 4 inches across. Furthermore, a cell only can produce one or two watts which give not enough power for most appliances. So, the performance of the photovoltaic cell system is based on the intensity of sunlight. However, the bad weather like clouds or thick fog indirectly affect the amount of solar power that received by the arrays of photovoltaic which decreased its performance (Kumar, 2013).



Figure 2.1: Solar Panel

2.2 The Earth: Rotation and revolution

As we know, Earth have two motion which is the rotation and revolution. Earth is one planet of the sun which is revolves around the sun and the Earth also rotates round on its own axis. Its rotates on its own axis which is from west to east. Apart from that, the

Earth axis is an imaginary line which is pass via northern and southern of the Earth poles. The Earth rotation is complete in around 24 hours. The movement was accountable that is incidences of day and night on Earth. However, the 24 hours is term of solar day, while the actual period that sidereal is only 23 hours and 56 minutes. So, the difference is four minutes which is due to the reality the Earth's position is maintains in changing the reference of the Earth indirect to the Sun.

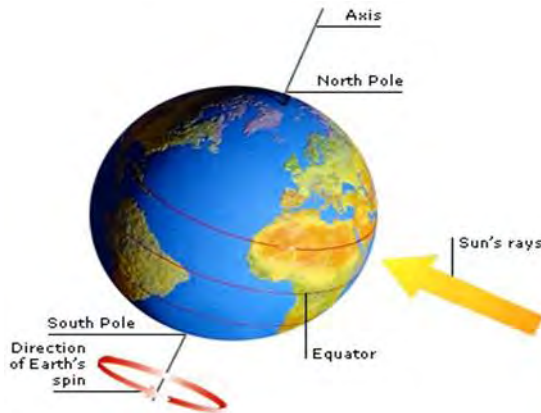


Figure 2.2: The rotation of Earth's

Meanwhile, the another motion which is revolution is the motion of the Earth that is spherical to the Sun. its additionally occurs which is from west to the east that takes a period of 365 days or 1 year. The Earth have an elliptical orbit. So, because the Earth in an elliptical orbit the gap in between the Earth and the Sun is in continuous inconstant. The elliptical is referred by the apparent annual track of the sun that through the fixed star within celestial sphere. The angle that made by Earth's axis is sixty-six and five degrees direct to the elliptical aircraft. The Earth attains four critical position which the position is reference to the sun because of the angle (Antonio Luque Lopez, 2007).

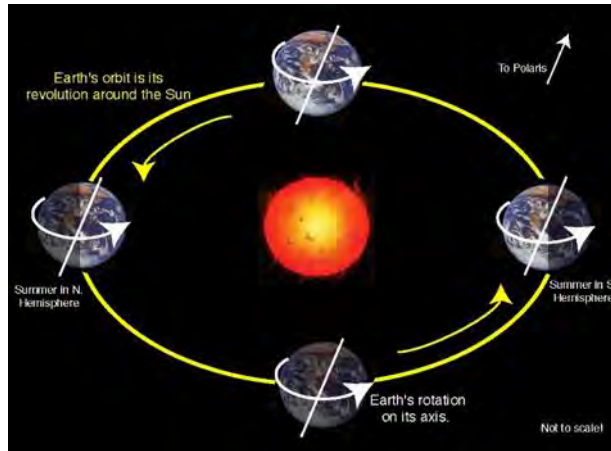


Figure 2.3: Earth's rotation and revolution

2.3 Solar irradiation: Sunlight and the solar constant

The solar grants energy by way of the electromagnetic radiation. There is solar that are fusion which results from the intense temperature and strain of the core of the solar. Protons get converted into helium atoms at six hundred million tons per second. Due to the output of the method has lower strength than the protons that commenced, so fusion gives upward push to masses of power in form of gamma rays which might be absorbed by using particles inside the sun and then they re-emitted. The whole electricity of the solar may be expected by way of the law of Stefan and Boltzmann.

$$P=4\pi r^2 \sigma \epsilon T^4 W \text{ (Dutta, 1990)}$$

T is the temperature which is set **580K** and at the same time as r is the radius of the solar that's **695800 km** and σ is the Boltzmann steady that is **$1.3806488 \times 10^{-23} \text{ m}^2 \text{ kg s}^{-2} \text{ k}^{-1}$** . The emissivity of the floor is denoted by using ϵ . That is because of Einstein's famous law which is **$E=mc^2$** about thousands and thousands of tons of depend are transformed to energy each second. The sun strength is irradiated to the Earth is **5.1024 Joules** in keeping with year. That is ten thousand instances the existing worldwide electricity intake in step with 12 months. The Sun radiation from the solar is received in three approaches that is direct, diffuse and reflected. Direct radiation is likewise referred to as beam radiation and

is the solar radiation which is travels on a straight line from the sun to the surface of the Earth. Whilst diffuse radiation is the description of the sunlight which has been scattered by using debris and molecules inside the surroundings but nonetheless manage to reach the Earth's floor. The diffuse radiation has no definite path, not like direct versions. Finally, meditated radiation became defined daylight which has been reflected off from non-atmospheric surfaces just like the ground (Cooke, 2011).

2.4 Sunlight

Photometry empowers us which to decide the measure of light emitted by the Sun as far as brilliance saw by the human eye. In photometry, a glow work is utilized for the brilliant power at every wavelength that give an alternate weight to a specific wavelength that models human splendor affectability. Photometric estimations started as ahead of schedule as the finish of the eighteenth century bringing about a wide range of units of estimation, some of which can't be changed over inferable from the relative importance of shine. Be that as it may, the brilliant motion (or lux) is ordinarily utilized and is the measure of the apparent energy of light. Its unit, the lumen, is briefly characterized as the glowing motion of light created by a light source the produces one candela of iridescent power over a strong point of one Steradian. The candela is the SI unit of radiant force and it is the power discharged by a light source in a specific bearing, weighted by an iridescence work while a Steradian is the SI unit for a strong edge; the two dimensional edge in three dimensional space that a question subtends at a point. One lux is proportionate to one lumen for each square meter; $1 \text{ lx} = 1 \text{ lm.m} = 1 \text{ cd.sr.m} (1)$ i.e a transition of 10 lumen, focused over a territory of 1 square meter, illuminates that zone with illuminance of ten lux (Dutta, 1990). Daylight have go in between 400 Lux and roughly 130000 Lux, as condensed in the table underneath.