# AUTOMATED POSITIONING SYSTEM OF SOLAR PANEL BASE FOR OPTIMIZED SOLAR ENEGY ABSORPTION

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This report is submitted in partial fulfillment of the requirements of award of Bachelor of Electronic Engineering (Computer Engineering) With Honors

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**UNIVERSTI TEKNIKAL MALAYSIA MELAKA**
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**BORANG PENGESAHAN STATUS LAPORAN**
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# ABSTRACT

"Automated Positioning System of Solar Panel Base for Optimized Solar Energy Absorption" is a device created to follow sun movement accordingly across the sky throughout the day. The design concept is to detect sunlight throughout the day for the sunlight rays to hit directly onto the solar panel with maximum exposure. When the panel has less sun exposure area, the motor will move the base to the direction of maximum sun exposure area. The system will be on standby mode to conserve power usage if the sun does not appear. The microcontroller used is PIC16F84A and is treated as the main component to maneuver the system. The software design implemented the comparison of the sensors and tilt the base with motors directly to maximum sun exposure area.

# ABSTRAK

"Sistem Penentududukan AutomatikTapak Panel Suria Untuk Penyerapan Tenaga Suria Teroptimum" adalah sejenis alat yang dicipta untuk mengikut gerakan matahari dari kewujudannya hingga kesudahan hari. Konsep reka bentuk ini ialah mengesan sinaran matahari supaya tapak panel suria terdedah kepada sinaran matahari yang maksima. Apabila tapak panel suria kurang terdedah pada sinaran matahari, motor akan mengerakkan tapak tersebut ke arah sinaran matahari yang maksima. Tapak juga akan miring ke arah sinaran matahari yang maksima. Sistem ini akan berada dalam keadaan terjaga (standby) jika tiada kehadiran matahari dikesan untuk menjimatkan tenaga yang digunakan. Mikro pengawal yang digunakan, PIC16F84A bertindak sebagai komponen utama untuk megawal pergerakan tapak panel suria. Reka bentuk perisian membuat pembandingan pada kesemua pengesan dan memiringkan tapak panel suria dengan motor tepat ke arah sinaran matahari yang maksima.

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## ABBREVIATION

| | | |
|---|---|---|
| CdS | - | Cadmium Sulfate |
| ECU | - | Electronic Control Unit |
| PIC | - | Programmable Intelligent Computer |
| VDC | - | Voltage Direct Current |
| T&C | - | Test & Commission |
| PSM | - | Projek Sarjana Muda |
| R&D | - | Research & Development |
| OEM | - | Original Equipment Manufacturer |
| LDR | - | Light Diode Resistor |
| LED | - | Light Emitting Diode |
| PIN | - | Personal Identification Number |
| EEPROM | - | Electrically Erasable Programmable Read-Only Memory |
| RAM | - | Random Access Memory |
| ROM | - | Read Only Memory |
| VSM | - | Virtual System Modeling |
| AC | - | Alternating Current |
| DC | - | Direct Current |
| IC | - | Integrated Circuit |
| ADC | - | Analogue to Digital Converter |
| PCB | - | Printed Circuit Board |

# CHAPTER I

# INTRODUCTION

## 1.1 Introduction

A solar tracker is a device for orienting a solar photovoltaic panel or concentrating solar reflector or lens toward the sun. The sun's position in the sky varies both with the seasons (elevation) and time of day as the sun moves across the sky. Solar powered equipment works best when pointed at or near the sun, so a solar tracker can increase the effectiveness of such equipment over any fixed position, at the cost of additional system complexity.

Nowadays, the fixed mounted solar panel will do the jobs, but people will be robbing themselves from free power and maximum efficiency. People do not know that solar panel they used only give them 30-50% of solar energy absorption. To make this device affordable to consumers; this study had been made to improve the positioning system for efficient solar tracker. The success of this project will perhaps give the opportunity for solar panel owners to implement in their system

## 1.2 Objective

Objectives were defined to make sure this project do not deviate from its goals and can be completed within the time frame given.. The objectives of this study are:

**I. To optimize the solar energy absorption by using solar tracking system**

The solar tracker consists of many types, of varying costs, sophistication, and performance. In this study, several types of solar panel were compared: fixed mounted, single axis tracker and dual axis tracker. Compared to a fixed mounted, a single axis tracker increases annual output by approximately 30% and a dual axis tracker an additional 6%. Thus, dual axis positioning system will be presented in this project.

**II. To provide consumer more efficient way to off-grid**

The term off the grid or off-grid refers to living in a self-sufficient manner without reliance on one or more public utilities like electrical power. The best way to off-grid is to use natural resources such as water (river and waterfall), wind and sun energy. Most of the ways to off-grid is expensive example like the solar panel. It is expensive but affordable and most of consumers do not optimize solar panel usage. This project optimized the solar panel usage by using the system that allowed solar panel to maximize sun exposure throughout the day. Therefore the device gained the utmost electrical power. The power collected by two fixed mounted type showed about the same power collected by one positioning mounted type. Thus, device efficiencies increase.

**III. To implement knowledge of assembly language by using an appropriate software**

An assembly language is a low-level language for programming computers. It implements a symbolic representation of the numeric machine codes and other constants needed to program a particular CPU architecture. This representation is usually defined by the hardware manufacturer, and is based on abbreviations called mnemonics that help the programmer remember individual instructions, registers and memory. An assembly language is specific to certain physical or virtual computer architecture (as opposed to most high-level languages like C or C++ language, which are usually portable).

Assembly languages were developed in the 1950s, when they were referred to as second generation programming languages. They eliminated much of the error-prone and time-consuming first-generation programming needed with the earliest computers, freeing the programmer from tedium such as remembering numeric codes and calculating addresses. They were once widely used for all sorts of programming. However, by the 1980s, their use had largely been supplanted by high-level languages, in the search for improved programming productivity. Today, assembly language is used primarily for direct hardware manipulation, access to specialized processor instructions, or to address critical performance issues. Typical uses are device drivers, low-level embedded systems, and real-time systems. Thus by learning assembly language, its expand knowledge and the flow of programming is easier to understand.

**IV. Propose to be implemented in national solar-power industry and hopefully in mass production for general use**

Solar–power technology is not widely implemented in Malaysia, even though Malaysia is one of the hottest countries due to its geographically located near the equator. Even so, there are a few national companies like Super Solar

(M) Sdn. Bhd., Nakaei (M) Sdn. Bhd. and SM Solar Malaysia Sdn. Bhd. that are already approved at international level. The solar tracker in market nowadays is expensive and is not affordable by consumers and this project is the solution as it only cost about a quarter of the market solar panel price. Unfortunately, this objective cannot be achieved as the project does not function properly.

## 1.3 Scope of Work

The Solar Tracker would follow the sun across the sky in order to maximize solar input throughout the day. The solar panel base will be operated by stepper motor and DC Motor with sensors to determine the position of the sun. The system tilted in varied degree according to the sun position horizontally in different seasons and places. The system will face east for the next day by detection of sensor mounted on the back of solar panel.

The research project will mainly focus on developing solar tracker positioning system for solar panel and horizontal tilt by using PIC Microchip microcontroller to maneuver the system. Literature survey was done on sun positioning throughout the year based on the latitude of the device location. The scope is one of parameter defined which supports the project objective. This project scope divides to three elements:

### I. Limitation

The project will mainly focus on development of positioning the sun tracker and will not consist of solar panel development. The sun tilt North-South degree is limited to 90 degree tilt each side to make sure the device in stable condition.

**II. Efficiency**

The sensors used will allow the panel to follow the sun accordingly. Their sensitivities are set according to specification of device location (mostly on the roof top). Stepper motor will be used to increase sun tilt precision between North and South. Microcontroller PIC16F84A is used to control the stepper motor.

**III. Low Cost**

The least amount of components are used to reduce the cost but keeps the quality to make the device more durable

## 1.4 Problem Statement

World economy today is unstable. The instability causes the increase in living cost for most people. Paying utility bills is a burden as electricity and water are basic needs of everybody. The best way to get away from dependency on public utilities is to doing off-grid. Going off-grid is becoming an increasingly popular choice (mostly in European countries) for people looking to reduce their daily burden, self-sufficient dependency and avoid reliance on typical public power source. The most common way to do so is by using the sun and the wind to provide power. This study is focus to solar energy.

Common solar panel in market is of the fixed type. To optimize the solar energy, more solar panels are used, which is expensive. A single solar panel with output power of 100W cost about RM 2000 – 5000. To be more efficient, solar tracker is recommended. A solar tracker is a device for orienting a solar photovoltaic panel or concentrating solar reflector or lens, toward the sun. There are several types of solar tracker. The common consumer type is of a fixed mounted type.

The fixed mounted type does not track the sun, it is located on a fixed position with the panel facing the sun in average degree for low efficient exposure. To achieve better efficiency, some user manually changes the location twice a year. It is usually located on the roof top.

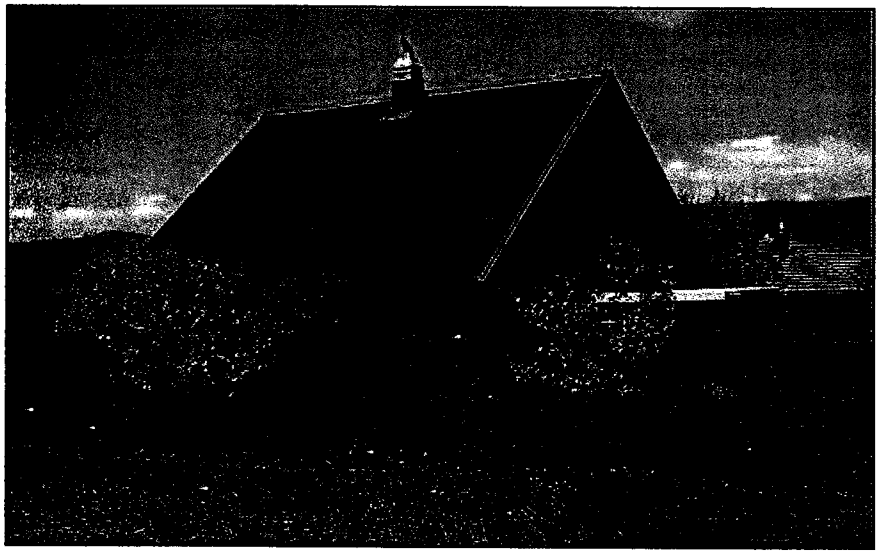

**Figure 1.1 Fixed Mounted Solar Panel**

Polar trackers have one axis aligned to be roughly parallel to the axis of rotation of the earth around the north and south poles, hence the name polar. The polar axis should be angled towards due north, and the angle between this axis and the vertical should be equal to the latitude location of the device.

**Figure 1.2 Single-Axis Solar Tracker**

Although the solar tracker will do an efficient solar tracking, it still cannot optimize the solar absorption. This project addresses the optimization issue. There is already a product in the market but the price is still expensive. This project provide a cheaper solution.

## 1.5 Methodology

The methodology for this project can be simplified into six (6) body parts:

### I. Literature Review and Research.

The literature reviews consist of studies of various project parameters. The main study is about solar tracker positioning system. The sun azimuth studies are the focus of this study. The study of stepper motor and DC motor helps in the construction of the circuit. The studies of the sensor with filter consolidate the project to be durable. The research conducted to determine the effective circuit with the minimum budget.

## II. Hardware

The hardware parts assembled on a breadboard according to software's diagram and test the circuit in real-time situation. The circuit implemented on the printed circuit board (PCB) after the circuit operates according to specification. Due to time and space constrains, etching process was chosen to save the time and space (faster process and smaller circuit design).

## III. Software

The circuit was developed and simulated in the MPLAB software used for coding manipulation. After debugging produce no error, the source code was loaded into Proteus software to test the program functionality.

## IV. Integration

The Proteus software provides the integration with the hardware part. The circuit design use the assembly language of PIC16F84A and the virtual hardware is run in the Proteus simulator. This will check the system functionality.

## V. Result Analysis

The gatherings of data are done and analysis performed to verify project objectives. The analysis involves the software and hardware characteristic after implementation.

**VI. Report Writing**

Report writing consists of all steps from the beginning of this project to last action of project completion. The requirement and format for report writing has been standardized as in faculty report writing reference.

## 1.6 Report Structure

The structure of the report builds on five (5) chapters. Each chapter details the core of the title and has continuity between each other. The following is the description of each chapter.

Chapter one is a simplified introduction that consists of several sub chapters that literally overview about this project. This includes introduction, objectives, problem statement, scope of work and lastly methodology used to accomplish this study.

Chapter two discusses the literature done during the project. Review starts from sun positioning and azimuth, solar absorption, microcontroller and components used.

In addition, chapter three discusses the methodology used throughout this study. Methodology starts with explanation of project block diagram and flow chart of the project. The hardware and software part will then be explained.

The fourth chapter concludes all the findings, problems and result of the project in the aspect of software, hardware, simulation and result.

All conclusions in project findings, analysis project achieve and future research will be concluded in the last chapter. The knowledge and contribution to the university, faculty and own self through the research conduct will be mentioned.

# CHAPTER II

# LITERATURE

## 2.1 Background Study

Every project that needs to be accomplished must go through the literature review. Literature review is a body of text that aims to review the critical points of current knowledge on a particular topic. The literature review will keep track of the project and thus power up the method of any theory that used within the project. This literature then provides a concept of work body relate to project completeness. Thus, the perspective of project, R&D and objectives of project will not be deviate from project goals. So, this chapter will reveal the literature survey on solar absorption, sun positioning and azimuth that had been analyzed especially about the main components that will use in this project which are microcontroller, stepper and DC motor and component used. Also the software to design the circuit will be discussed.

This sub-topic discuss about the literature review that had been done during the PSM 1. The following sub topic will discuss about the idea for early start to the last end of this project.