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Smart hybrid system for outdoor and indoor application  
(solar tracking system) / Khairurazikin Mukhtar.

“I hereby declare that I have read through this report entitle ‘Smart Hybrid System For Outdoor and Indoor Application (Solar Tracking System)’ and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)”

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Date

: 22 APRIL 2010

**SMART HYBRID SYSTEM FOR OUTDOOR AND INDOOR APPLICATION  
(SOLAR TRACKING SYSTEM)**

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**This report is submitted in partial fulfillment of requirements for the Degree of  
Electrical Engineering (Industrial Power)**

**Faculty of Electrical Engineering**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**UTeM**

**2010**

“I declare that this thesis is my own work except the ideas and summaries which I have clarified their sources.”

Signature

  
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Date

: 22 APRIL 2010

To my beloved mother and father

## ACKNOWLEDGEMENT

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Firstly, thank to Almighty Allah for giving me the strengths and patience in completing this project. Throughout this project, there are some problems and difficulties that are important to me in giving the best of this project. All these troubles had become ease with the help of my supervisor, Mr Hyreil Anuar bin Kasdirin for his many useful comments, suggestions, and guidance since this project is began. I would like to share my gratitude to those who has contributed and help me solve the problem of this project especially to Mr Aminurrashid, Ms Aziah and everyone that has help me. Not forgotten to the technicians that help me with their knowledge and kindness in helping me for this project. Finally, I would like to thank my parents, family and friends for their endless support and encouragement.

## ABSTRACT

This report contain of the design of new innovation and research of solar hybrid system. A list of objectives and scope of study are identified in this report. These systems provide remote power system that integrates two or more power sources. This project deals with two power sources that are power from the sun and AC power supply using intelligent controls to manage the system operation. All systems are designed based on the research work. This particular research aims to develop a product oriented solution for minimising the use of electrical supply at home. Solar tracking system is one of the products and this particular project will be used to collect the sun energy and convert it into electrical power energy and also suitable for consumers that have interests in cutting edge ideas to save money on electricity. Solar tracking system is a combination of light sensors, stepper motor, and solar panel. The combination will help the system to intelligently monitor the amount of sunlight during a day. Light sensors are placed in strategic places to read the amount of sunlight. Stepper motors are placed as well so that it is able to open and close them depending on how much sunlight needed. The analysis has been done once the hardware is completed. The analysis based on the data to increase the efficiency of solar panel and test is carried out for open and short circuit test.

## ABSTRAK

Laporan ini mengandungi pembaharuan dan kajian yang telah dilakukan dalam sistem solar hibrid. Senarai objektif dan skop projek juga telah dikenalpasti dan diisi. Sistem ini menyediakan sistem kawalan dari dua atau lebih sumber kuasa, projek ini menggunakan dua sumber kuasa iaitu kuasa dari matahari dan kuasa dari arus ulang alik. Sistem ini direka agar ia dapat melakukan sendiri segala kawalan. Semua rekaan ini adalah berdasarkan kepada kajian yang telah dilakukan. Kajian ini diketengahkan supaya suatu produk yang dapat menjimatkan penggunaan elektrik dirumah dapat dilakukan. Sistem pengesan solar digunakan agar dapat memindahkan tenaga matahari pada kadar yang tinggi. Projek ini sesuai digunakan untuk pemilik rumah yang berminat untuk menjimatkan penggunaan elektrik lantas menjimatkan wang mereka. Pengesan solar ini menggunakan sepenuhnya system pengesan matahari, pergerakan motor, dan panel dari solar. Melalui penggabungan litar ini, sistem pengawalan dengan sendirinya dapat mengawal kadar cahaya matahari. Pengesan cahaya diletakkan ditempat yang strategik supaya ianya dapat membaca kadar cahaya itu sendiri. Hasil kerja yang telah dilakukan akan disenaraikan di akhir laporan ini berdasarkan kepada analysis yang telah dilakukan berdasarkan kepada beberapa pengujian yang telah dilakukan.

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**LIST OF ABBREVIATION**

<b>AC</b>	-	<b>Alternating current</b>
<b>DC</b>	-	<b>Direct current</b>
<b>LED</b>	-	<b>Light Emitting Diode</b>
<b>LDR</b>	-	<b>Light Dependent Resistor</b>
<b>PIC</b>	-	<b>Peripheral Integrated Controller</b>
<b>PICC</b>	-	<b>Peripheral Integrated Controller Controller</b>
<b>POT</b>	-	<b>Potentiometer</b>
<b>PV</b>	-	<b>Photovoltaic</b>
<b>SCC</b>	-	<b>Solar Charge Controller</b>
<b>UV</b>	-	<b>Ultra voltaic</b>

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## CHAPTER 1

### INTRODUCTION

In this chapter, the concept of using the solar hybrid system is mainly in concerns and can be considered as a research tool developed to assist with the study of the effects of using solar tracking system. The study of each component used will be considered as part of the development of the solar tracking system. Finally, all systems should be designed for outdoor and indoor application and this chapter will apply some of the concept of overall solar system to analyse what circuit will be used on next chapter

#### 1.1 Background

Solar hybrid system usually used two supplies that connected between them. As shown in Figure 1.0, DC power will be used to supply load using Solar PV array and battery charger. The energy output of the solar array was used to recharge the system battery. Solar Charge Controller was used to ensure the charging process works efficiently and to maximise the life of the battery charger. The solar PV module must be made of crystalline-silicon. The size of the PV array must be in a sense that it will achieve a nominal peak power output as tabulated under solar condition. All the connections for the PV Array should be using solar cable with the following characteristics:

- a) Conductor: Standard tin-plated copper
- b) Cross-linked compounds – prevent deformation of the insulation materials in case of short circuit
- c) UV Protection

Next, to regulate the power flowing from the photovoltaic into a rechargeable battery, the Solar Charge Controller will be used. It featured an easy setup with one potentiometer for the float voltage adjustment.

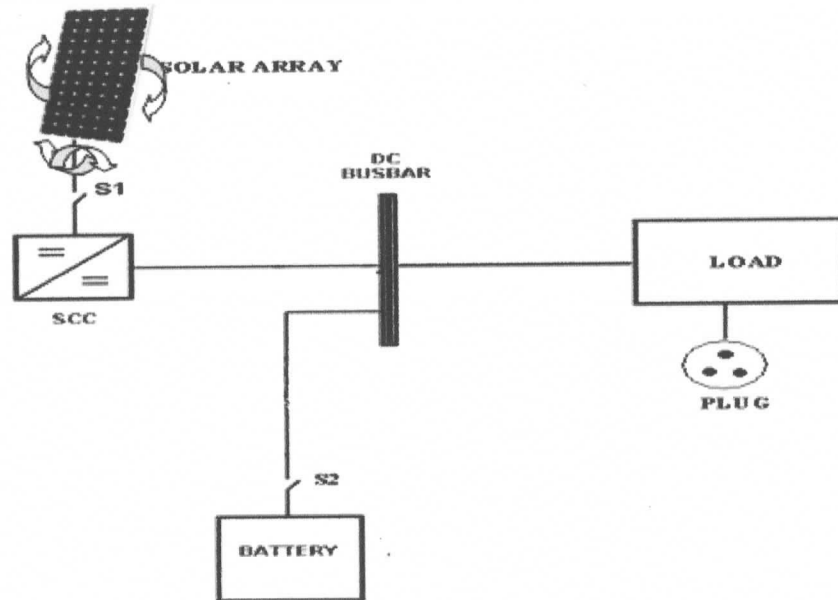


Figure 1.0: Full Diagram for Smart Hybrid system for any application

Producing electricity by using solar PV is a fast growing business. To keep up with the other green energies, the solar cell market has to be as efficient as possible in order not to lose market shares on the global energy marketplace. There are two main ways to make the solar cells more efficient, one is to develop the solar cell material and make the panels even more efficient and another way is to optimise the output by installing the solar panels on a tracking base that follows the sun. Sun tracking systems are necessary in many applications to work appropriately or to improve the efficiency. One of the most important and powerful fields of applications are the renewable energies.

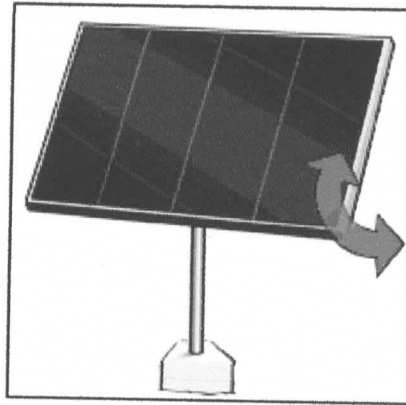


Figure 1.1: Dual Axis Tracking System

The system has adopted two axis control methods which were controlled by motor and by the elevation angle in program. As an example of a simple form as the tracking form was selected in Figure 1.2 for an arrangement method. But this method needs two motors for tracking the sun and the elevation angle of the sun.

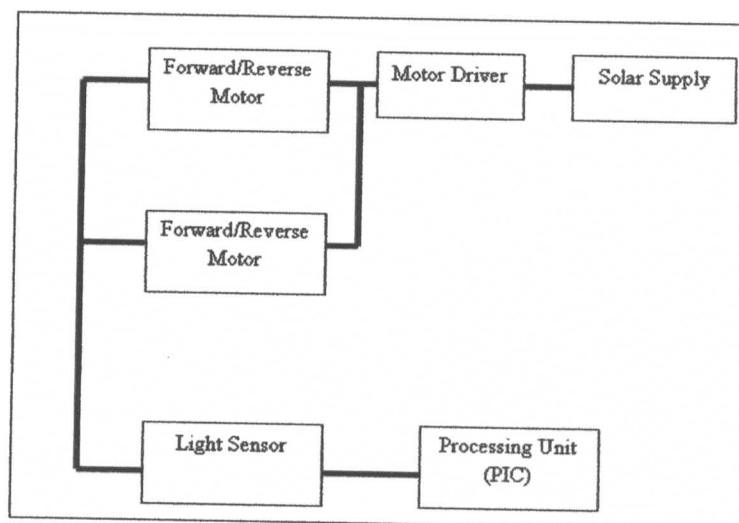


Figure 1.2: Overall Block Diagram for Solar Tracking System

The system was designed to track the sun position as shown in Figure 1.3, the tracking system is comprised of two identical sub-systems, one for each axis, with each sub-system consisting of two adjacent forward/reversed motor separated by a partition of a certain height. In the tracking operation, light sensor used to transmit the signals of the two motor. The



processing unit will then amplified and used as a command signal to drive the collector around the corresponding axis until the sun rays were once again normal to the collector surface.

## **1.2 Problem statement**

Appliances account for about 17% of our household energy consumption, with refrigerators, clothes washers, and clothes dryers at the top of the consumption list and each year, electricity generated by fossil fuels for a single home puts more carbon dioxide into the air than two average cars. As for the road, transportation accounts for 70% of the total oil consumption in Malaysia. The simple problem is that there are simply not enough fossil fuels left to sustain its usage as the foundation of our energy production. Solar hybrid system is one of the choices to reduce this problem. The creation of solar hybrid system can minimise the use of electrical supply at home.

Sun is the basic resource for all solar systems. Knowledge of the quantity and quality of solar energy available at a specific location is important for the design of any solar system. Although the solar isolation is relatively constant outside the earth's atmosphere, local climate influences can cause wide variations in available isolation on the earth surface from site to site. The relative motion of the sun with respect to the earth will allow surfaces with different orientations to intercept different amounts of solar energy. The solar tracking system is the key element to intercepts incoming isolation and then changes it into a useable form of energy that can be applied to meet a specific demand, a new technology area that requires new understandings in order to make captured solar energy as the most practical energy source for the future.

### **1.3 Research Objective**

The aim of this project is to upgrade, design and build a system for solar hybrid that is useful for any application. The specific objectives of this research work are:

1. To investigate the ability of solar panel to support on the whole system that already been designed
2. To build solar tracking system that can be performed to detect the insulation from the sun.
3. To develop appropriate software that make the stepper motor follow certain angle.
4. To integrate stepper motor program with solar tracking system
5. To analyse the difference between using solar tracking system and fixed solar system.

### **1.4 Research Scope**

The solar hybrid system must be able to operate in parallel configuration, where it can be operated in parallel with the solar panel, automatically and without power interruption. The main purpose of developing this system is to increase the ability of the solar to keep on functioning regardless it is in outdoor or indoor environment.

### **1.5 Summary**

This project is designed for outdoor and indoor application. Solar system has to be as efficient as possible in order not to lose market share, one way is by installing solar panel on a tracking base that follow the sun. Tracking system is controlled by motor and by elevation angle in program. The creation of this system can minimise the use of electrical supply at home. Solar must be able to automatically operate and is functional in outdoor and indoor place.

## CHAPTER 2

### LITERATURE REVIEW

There seems to be a compromise within the energy scientific community that major countries should begin setting a path for renewable energy in order to provide 20% of their domestic energy by 2020 around the world. This has far broader and bolder benefits than what people realise. First, it can set any country onto a steady, dependable course to energy independent while advancing the new economy of wind, solar, and waste conversion to energy, and at the same time capitalising on the recent advances in fuel cell technologies. Second, it can create distributed centres of energy generation with high quality, dependable, rate-stable electricity that will attract new businesses who need very reliable power. A great motivation for building a solar energy system knows that the solar designer is doing their part of moving our world towards a more sustainable energy future. [1]

Solar panels are the field of technology and research related to the application of solar energy system by converting solar energy (sunlight, including ultra violet radiation) directly into electricity. Due to the growing demand for clean sources of energy, the manufacture of solar cells and solar panel arrays has expanded dramatically in recent years. Solar panel production has been doubling every 2 years, increasing by an average of 48 percent each year since 2002, making it the world's fastest-growing energy technology. At the end of 2008, the cumulative global solar panel installations reached 15,200 megawatts, a 94% annual increase. Roughly 90% of this generating capacity consists of grid-tied electrical systems. [2]

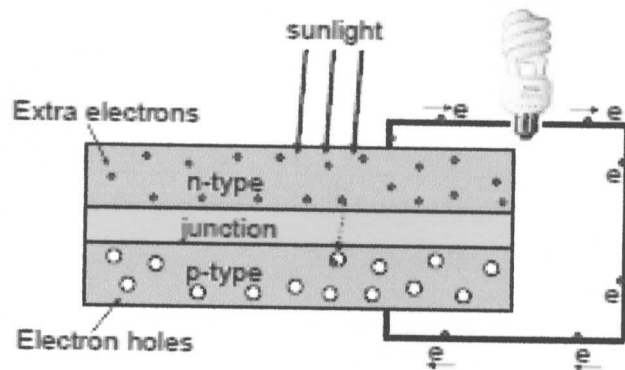


Figure 2.0: Cross section of Solar panel cell

The solar panel material is typically made out of specially treated silica semiconductor material. The cells generate electricity whenever photons (sunlight) strike the solar panel material and move loosely-held electrons. Solar energy systems work any time the sun is shining, but more electricity will be produced when the sun's rays are brighter and strike the solar electric cells directly (perpendicular to the solar electric cell surface). As shown on Figure 2.0, a solar electric module (also known as a 'panel') is made up of many solar panel cells that are wired together in a series to achieve the desired voltage. The thin wires on the front of the module pick up the free electrons from the solar panel. [2] [10]

For most part, a solar panel that is properly installed and adequately sized will not require much. However, for those times of marginal sun or very large power requirements, it is important to understand the relationship between battery charge level, the amount of charge that they are receiving, and the power being withdrawn from the system. To make this relationship clear, a design of the basic operation of a solar energy electric power system must be understood. Solar panels generate free power from the sun by converting sunlight to electricity with no moving parts, zero emissions, and no maintenance. The perfect situation for a Solar Power energy system is a small remote location where it is not practical or is too expensive to have regular utility company power connected. [13] [6]

Progress of technology of the solar panel is achieved rapidly by development of semiconductor. Also, price of solar cell is descending continuously. Therefore, solar panel

system is a very important alternative energy and is increasing constantly. There are three methods to increase the efficiency of solar panel system. The methods will increase the efficiency of system itself, increasing efficiency of solar panel cell and increase the use of solar energy by tracking the solar path. Nowadays, efficiency of solar cell has been developed to approximately 24%. However, increasing the efficiency of solar panel will also increase the cost of generation unit cost. Therefore more cost needed to develop the system. Currently, there are many efforts to develop the solar tracking system. [1] [11] [4]

The abundance of solar energy throughout the year in Malaysia due to the geographic location provides strong reason for the implementation of an efficient solar energy system. Studies show that solar panels constitute a large portion (57%) of the total cost to install solar energy system. As the solar panels are relatively expensive, much research work has been conducted to improve the utilisation of solar energy. Physically, the power supplied by the panels depend on many extrinsic factors, such as insulation levels (incident of solar radiation), temperature and load condition. To ensure the economical viability of this energy system, the development of an adaptive system that always obtains the maximum power from these solar panels is essential. The average solar energy intercepted by the conventional solar panels, during the course of the day, is not always maximised. This is due to the static placement of the panel which limits their area of exposure from the sun. [5] [8]

The solar tracking system is the key element in a solar energy system. It is also the latest technology that requires new understandings in order to make captured solar energy a viable energy source for the future. The design and implementation of the tracking system and the positioning control circuits are carried out to understand the overall system requirement. Tracking systems try to collect the largest amount of solar radiation and convert it into usable form of electrical energy (DC voltage) and store this energy into batteries for different types of applications. The solar tracking systems can collect up to 50% more energy than what a fixed panel system collects. Therefore, the proposed system is easy to implement and efficient. [3] [13] [9]

Flat-plate thermal solar tracking system are the most commonly used type of solar tracker. Their construction and operations are simple. A large plate of blackened material is oriented in such a manner that the solar energy that falls on the plate is absorbed and converted to thermal energy thereby heating the plate. Tubes or ducting are provided to remove heat from the plate, transferring it to a liquid or gas, and carrying it away to the load. One transparent plate is often placed in front of the absorber plate to reduce heat loss to the atmosphere. Likewise, opaque insulation is placed around the backside of the absorber plate for the same purpose. Operating temperatures up to 125°C are typical. [14]

As it has been studied, the solar panels are devices that convert sunlight to electricity, and they reach its maximum efficiency if they carry out sun track. The developing of solar tracking system have enabled of many solar thermal and solar panel systems for a diverse variety of applications. Compared to their traditional fixed-position counterparts, solar systems which track the changes in the sun trajectory over the course of the day collect a far greater amount of solar energy, and therefore generate a significantly higher output power. This review provides us with a handy guide to understand the overall of the project that is needed to be done. With a limited time to conduct research, review of the literature can give an overview for student that can keep them up to date with the project. This review provides a solid background for a research paper investigation. Comprehensive knowledge of the literature of the field is essential to most research papers. [7]

### **Summary**

A motivation of building the project is part of moving this world towards more sustainable and reliable energy in future. Solar system usually very expensive and this project is one of the methods for researcher to reduce the cost to build solar system. Design of basic operation must be understood to cooperate with charge that receiving and the power being withdrawn from the system. There are many efforts to develop solar tracking system to reduce the cost of generation unit. The design and implementation are carried out to understand the overall system requirement.

## CHAPTER 3

### RESEARCH METHODOLOGY

Throughout this research to design a solar tracking system device, that need to be solved in stages. This research also dealt with the used of some measurement tool that need to be designed and other way, a tool that already been developed for analysis the data all through the project. Figure 3.0 gives the information regarding process involved in the research. The idea on how to do this research is described as below:-

#### 3.1 Project phase

##### 1. First Phase

Project Focus: research focus on project overview, project objective and literature review that define what solar hybrid system is and how to improve the system. At this point, solar hybrid system must be clearly understood.

##### 2. Second Phase

Project Design: At this phase, component that are needed to be used are already chosen, the circuit will finally be analysed. The calculation to sizing panel is done and the program appropriate to run the motor is tested.

##### 3. Third phase

Product Search: Searching for all components need to be done to develop a project. The main component is used on the design is solar panel and the stepper motor.

4. **Fourth phase**

**Product Fabrication:** Structure has been designed to achieve the objectives of this project. Making hardware is the most important part before this project can be presented to panel.

5. **Fifth phase**

**Result Analysis:** Analysis will be performed when the hardware and software already complete. Analysis performed includes open circuit test to measure voltage of panel and short circuit test used to measure current of panel. This test is done based on appropriate table which has been supervised by the project supervisor.

6. **Final phase**

**Making Report:** The report is done based on the work that has been done for the project

### **3.2 Tool for Analysis result**

1. **Complete Structure**

Before analysis can be started, hardware already completed for testing.

2. **Clamp meter**

Tool is used to measure the value for Short circuit current and open circuit voltage.

3. **Sensor**

Light Dependent resistor (LDR) is used as a sensor to detect the sun brightness

4. **Motor**

Stepper motor is used so the angle for each position can be calculated

5. **External stepper motor**

External stepper motor used as a supply for the motor to energized