UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIGHT TRACKING DEVICE FOR SOLAR PANEL

This report submitted in accordance with requirement of University Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engendering (Robotic and Automation) with Honours.

by

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: **Light Tracking Device for Solar Panel**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirement for degree of Bachelor of Manufacturing Engineering (Robotic and Automation) with Honours. The member of the supervisory comitte is as follow:

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ABSTRACT

Projek Sarjana Muda (PSM) or Final Year Project is an academic research regarding research field that is compulsory for every final year student before being awarded a degree. The goal of PSM is to enhance student's knowledge and capability to completing a task with in academic research regarding to produce a productive and competent engineer. In this paper, a Light Tracking Device for Solar Panel is be fabricated to detect the position of the light with high intensity which can maximize the absorption of sun light by solar panel. The method use to track the light such as by comparing voltages from 4 positions. The movement and the mechanism of the devices had been investigated from the recent inventions and publications. The related equipments and materials were identified. The relevant data that is related to the project was analyzed to know the type of sensor or motor that can be used to move the frames.

ABSTRAK

Projek Sarjana Muda (PSM) atau Projek Tahun Akhir merupakan sebuah kajian akademik yang merangkumi pelbagai bidang kajian yang wajib dilakukan oleh pelajar tahun akhir sebelum dianugerahkan ijazah sarjana muda. Matlamat utama PSM ini adalah untuk menguji pengetahuan dan kebolehan pelajar dalam menyelesaikan tugas-tugas yang diberikan dalam kajian akademik untuk menghasilkan seorang jurutera yang mahir pada masa akan dating. Dalam kajian ini, Alat Pengesan Cahaya untuk Panel Solar, telah dihasilkan untuk mengesan kedudukan atau amplitud yang mempunyai keamatan cahaya yang tinggi agar panel cahaya dapat menyerap tenaga cahaya semaksimum yang boleh. Cara yang digunakan adalah membandingkan voltan daripada 4 posisi. Pergerakan alat dan mekanisma-mekanisma yang diperlukan telah dikaji melalui ciptaan dan terbitan yang terkini. Maklumat yang bersesuaian telah dikenalpasti dan dianalisis supaya dapati membantu pergerakan alat ini.

DEDICATION

I am grateful to all my friends for their support. I would specially like to thank Ajeez, Apis, Adam, Abie and Akam my housemate for their valuable advices. I would like to dedicate this report to my supervisor, Mr. Mohd Hisham Bin Nordin for he is the one who motivated me to complete the Final Year Project.

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A2D	-	Alternate to Direct
AC	-	Alternate Current
ALU	-	Arithmetic Logic Unit
CMOS	-	Complementary Metal–Oxide–Semiconductor
DC	-	Direct Current
DOE	-	Department of Energy
EIA	-	Energy Information Administration
EMF	-	Electromotive Force
I/O	-	Input/Output
IC	-	Integrated Circuit
IEA	-	International Energy Agency
KOH	-	Alkaline Potassium Hydroxide
LPCVD	-	Low Pressure Chemical Vapor Deposition
MCU	-	Microcontroller Unit
MIG	-	Metal Inert Gas
MOSFET	-	Metal Oxide Semiconductor Field Effect Transistor
Ni(OH)2	-	Nickel Hydroxide
Ni-Cd	-	Nickel Cadmium
NiMH	-	Nickel Metal Hydried
N-type	-	Negative type
PC	-	Personal Computer
PLC	-	Programmable Logic Controller
P-type	-	Positive type
PSU	-	Power Supply Unit
PV	-	Photovoltaic
SLA	-	Sealed Lead-Acid
SPI	-	Solar Power Industries Inc,
TIG	-	Tungsten Inert Gas

CHAPTER 1

INTRODUCTION

There are a several types of alternative energy that contribute a lot in our human live such as solar energy, geothermal energy, nuclear energy, hydropower, and others. It is a well-known fact that the sun is one of the enormous and perpetual nuclear reaction that conveys vast amount of energy to earth in the form of electromagnetic radiation. Solar energy can be converted directly or indirectly into other forms of energy, such as heat and electricity. The major drawbacks (problems, or issues to overcome) of solar energy are: (1) the intermittent and variable manner in which it arrives at the earth's surface and, (2) the large area required to collect it at a useful rate (EIA, 2006).

Solar energy has been used in many traditional technologies for centuries and has come into widespread use, where other power supplies are absent, such as in remote locations and in space. Solar energy is used for heating water for domestic use, space heating of buildings, drying agricultural products, and generating electrical energy. In the 1830s, the British astronomer John Herschel used a solar collector box to cook food during an expedition to Africa. Now, people are trying to use the sun's energy for lots of things (Dakhel, 2007).

Solar energy is converted directly to electricity. Electricity can be produced directly from solar energy using photovoltaic devices or indirectly from steam generators using solar thermal collectors to heat a working fluid. The energy source is free and the installation can be made anywhere as long as it can receive sunlight. Thus, the solar energy system is an inexpensive energy source and environment friendly (EIA, 2006).

1.2 Problem Statements

A current solar cell system can not perform maximally to absorb the sunlight. When the sun rise from the east, some of the sunlight can not be absorbed by the solar panel installed on the roof or building that is facing to the west permanently. It might also being blocked by the higher buildings around them as well as the clouds.

Besides, most of the solar cell systems are developed as the stand alone type. Therefore, the light can not be absorbed when it is out of the tracking range. Thus, to solve this problem, some controller must be installed to allow the solar panel to move according to the intensity of the light absorbed, whether the type are stand alone or fixed installed on the roofs.

1.3 Objectives

The main objective of this project is to develop an automatically controlled device for a solar panel. Additional objectives of this project are:-

a) To increase the sunlight absorption.
b) To develop a fully functional controller that can be used to control the solar panel movement.
c) To develop smooth movement of the light tracking devices according to the sunlight's intensity.

1.4 Project Scope

In order to develop a working automatically controlled device that can be used to conduct the movement of the solar panel, project scopes are required to assist and guide the development of the project. The scopes for this project are:-

a) To design and develop an electrical circuit to control the solar panel movement using a microcontroller.
b) To design and develop a motor driver circuit with minimum electrical noise effect.
c) To design and fabricate a solid base structure of the light tracking device.

1.5 Benefits of Project

This light tracking device for solar cell is being developed in order to assist the solar panel to move according to the intensity of light absorbed. The benefits of this project are:-

a) Increment in the power produced by the solar cell.
b) Maximization of the sunlight's intensity absorbed in daylight.
c) The utilization of solar power can replace the other power sources.

CHAPTER 2

LITERATURE REVIEW

2.1 Definitions

There are a lot of definitions that being used to describe about the solar cell. Some of them are:-

a) A semiconductor device that converts the energy of sunlight into electric energy. (Crawford, 1990).
b) A machine or device that operates a device that detects or measures electromagnetic radiation by generating a current or a voltage, or both, upon absorption of radiant energy. (IEA, 1999).
c) The devices are made of semiconductors, which convert sunlight directly into electric current. (Aldous, 2008).

According to Corkish (2004), solar cell can be described as semiconductor devices that exploit the photovoltaic effect to directly create electric current and voltage from the collection of photons (quanta of light). They convert sunlight to electricity silently and without moving parts, require little maintenance, and are reliable. They are sold with warranties of up to 30 years, generate no greenhouse gases in operation, and are modular, rapidly deployable, and particularly suited to urban rooftops and facades. While Vallat-Sauvain (2003) said that the solar cells are usually made from silicon, which is the same material used for transistors and integrated circuits.

Brinkworth (2000) told that a solar cell which is also known as a photovoltaic cell is a device which generates electricity directly from visible light by means of the photovoltaic effect. In order to generate useful power, it is necessary to connect a number of cells together to form a solar panel, also known as a photovoltaic module. Otherwise, Williams (1990) defined a solar cells (as the name implies) are designed to convert (at least a portion of) available light into electrical energy. They do this without the use of either chemical reactions or moving parts.

2.2 History

For centuries, the idea of using the sun's heat and light has stimulated human imagination and inventiveness. The ancient Greeks, Romans, and Chinese used passive solar architectural techniques to heat, cool, and provide light to some of their buildings. Pliny the Younger built summer home in northern Italy that incorporated thin sheets of transparent mica as windows in one room. The room got warmer than others and saved on short supplies of wood. To converse firewood, the sixth century, sunrooms on private houses and public building were common that the Justinian Code introduced "sun rights" to ensure access to the sun. (Hoffman, 2000)

Many further solar energy developments and demonstrations took place in the first half of twentieth century and it is continuously year by year. The development of the solar cell stems from the work of the French physicist Antoine-César Becquerel in 1839. Becquerel discovered the photovoltaic effect while experimenting with a solid electrode in an electrolyte solution; he observed that voltage developed when light fell upon the electrode. About 50 years later, Charles Fritts constructed the first true solar cells using junctions formed by coating the semiconductor selenium with an ultra thin, nearly transparent layer of gold. Fritts's devices were very inefficient, transforming less than 1 percent of the absorbed light into electrical energy. (Hoffman, 2000)

By 1927 another metal semiconductor-junction solar cell, in this case made of copper and the semiconductor copper oxide, had been demonstrated. By the 1930s both the selenium cell and the copper oxide cell were being employed in light-sensitive devices, such as photometers, for use in photography. These early solar cells, however, still had energy-conversion efficiencies of less than 1 percent. This impasse was finally overcome with the development of the silicon solar cell by Russell Ohl in 1941. In 1954, three other American researchers, G.L. Pearson, Daryl Chapin, and Calvin Fuller, demonstrated a silicon solar cell capable of 6-percent energy-conversion efficiency when used in direct sunlight. By the late 1980s silicon cells, as well as those made of gallium arsenide, with efficiencies of more than 20 percent had been fabricated. In 1989 a concentrator solar cell, a type of device in which sunlight is concentrated onto the cell surface by means of lenses, achieved an efficiency of 37 percent due to the increased intensity of the collected energy. In general, solar cells of widely varying efficiencies and cost are now available. (Hoffman, 2000)

2.3 Type of Solar Cell

In a traditional solid-state semiconductor such as silicon, a solar cell is made from two doped crystals, one with a slight negative bias (n-type semiconductor), which has extra free electrons, and the other with a slight positive bias (p-type semiconductor), which is lacking free electrons. When placed in contact, some of the electrons in the n-type portion will flow into the p-type to "fill in" the missing electrons, also known as an electron hole. Eventually enough will flow across the boundary to equalize the Fermi levels of the two materials. The result is a region at the interface, the p-n junction, where charge carriers are depleted and/or accumulated on each side of the interface. This transfer of electrons produces a potential barrier, typically 0.6V to 0.7V (Anonymous, 2008).

When placed in the sun, photons in the sunlight can strike the bound electrons in the p-type side of the semiconductor, giving them more energy, a process known technically as photo excitation. In silicon, sunlight can provide enough energy to push an electron out of the lower-energy valence band into the higher-energy conduction band. As the name implies, electrons in the conduction band are free to move about the silicon. When a load is placed across the cell as a whole, these electrons will flow out of the p-type, into the n-type material, lose energy while moving through the external circuit, and then back into the p-type material where they can once again re-combine with the valence-band hole they left behind. In this way, sunlight creates an electrical current. (Tuttle *et al*, 2005)

There are three main types of solar cells commonly used nowadays, which are distinguished by the type of crystal used in them. They are monocrystalline silicon, polycrystalline silicon, and amorphous silicon. (SPI, 2008)

2.3.1 Monocrystalline Silicon

From Figure **2.1,** Monocrystalline Silicon is a monocrystal which is crystalline solid in which the crystal lattice of the entire sample is continuous and unbroken to the edges of the sample, with no grain boundaries. The opposite of a single crystal sample is an amorphous structure where the atomic position is limited to short range order only. In between the two extremes exist polycrystalline and paracrystalline phases, which are made up of a number of smaller crystals known as crystallites. Because of a variety of entropic effects on the microstructure of solids, including the distorting effects of impurities and the mobility of crystallographic defects and dislocations, single crystals of meaningful size are exceedingly rare in nature, and can also be difficult to produce in the laboratory under controlled conditions. One of the many reasons Monocrystalline Silicon is superior to other types of silicon cells are their high efficiencies which are typically around 15%.