SELF-CLEANING SOLAR CELL MODULE WITH SUN TRACKING USING MICROCONTROLLER FOR BATTERY CHARGER

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ABSTRACT

Nowadays, the use of electric energy is increasing every day. The source of electric energy is commonly using generator that generate from burning the fossil fuel or coal. The solar energy is now starting to replace old convictional method and become important to our world. Solar energy is solar radiation from sun converting to electric by solar panel for common electric application. Usage of solar energy still small compare to older conventional ways. Energy converted by solar panel is depending on the angle between the positions of the sun and surface of solar panel. Solar energy will receive maximum when surface of solar panel is vertical 90^0 to the position of the sun. Besides that, the efficiency converts solar energy to electric by solar panel surface is depend on the cleanness. The dust is effected the ability of the solar panel to gain the sun irradiation form sun. It is because the dust will block the sunlight though the solar cell in solar panel. This project is design, construct and implement a tracker that has ability to track the sunlight during daylight and have ability self-cleaning. The system is use a microcontroller-based on solar tracking system which will process input data from sensor or instrument and produce output for motor to move the solar panel. As the result, a prototype of self-cleaning solar cell with sun tracking system is operated and able to achieve the objective or goal for this project.

ABSTRAK

Pada masa kini, penggunaan elektrik atau tenaga semakin meningkat. Sumber elektrik atau tenaga biasanya menggunakan penjana motor untuk menjana elektrik daripada membakar bahan api fosil atau arang batu. Kini, tenaga suria mula menggantikan penjana motor untuk menjana elektrik atau tenaga dan menjadi sangat penting kepada dunia kita. Tenaga suria adalah pancaran cahaya daripada matahari ditukar kepada elektrik daripada panel suria untuk aplikasi elektrik biasa. Penggunaan tenaga suria masih kecil berbanding dengan cara-cara konvensional yang lebih tua. Walau bagaimanapun, tenaga ditukar oleh panel suria adalah bergantung kepada sudut antara kedudukan matahari dan permukaan panel suria. Tenaga suria akan menerima maksimum apabila permukaan panel suria adalah menegak 90^0 kepada kedudukan matahari. Selain itu, kecekapan menukar tenaga suria kepada elektrik dengan menggunakan panel suria juga bergantung kepada habuk yang wujud di permukaannya. Habuk boleh menpengaruhi keupayaan panel suria untuk mendapatkan penyinaran cahaya daripda matahari. Ia adalah kerana habuk akan menghalang cahaya matahari kepada sel suria di panel suria. Dalam kes ini, satu projek untuk reka bentuk,dan membina sistem pengesan untuk mengesan cahaya dari pagi hingga malam dan mempunyai keupayaan membersihkan permukaan panel suria. Sistem ini adalah kawalan oleh mikrocontollor. Sistem pengesanan suria yang akan memproses data input dari sensor dan menghasilkan data output kepada motor untuk menggerak panel suria. Sebagai hasilnya, prototaip yang mempunyai keupayaan membersihkan permukaan panel suria dengan sistem pengesanan kedudukan cahaya daripada matahari dikendalikan untuk mencapai objektif atau matlamat untuk projek ini.

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LIST OF ABBREVIATIONS

DC	Direct Current
LDR	Light Dependent Resistor
PIC	Peripheral Interface Controller

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Nowadays, the electricity was important to entire world. It is because the electricity was main source to supply the factory, transportation, communication, commercial building and residential house. Without the electricity will cause many problems in daily life. The entire world now was faced short supplying electric power due to not enough sources to generate electric. Usually source that uses to generate energy or electric is not renewable source such as fossil. Besides that, using fossil will lead to environment destruction to our planet such as global warming. The environment issue was being regarded by most critical problem when using fossil to generate the electricity. Therefore, the goal is to emphasize to obtain the clean energy supplies of the electric energy. Renewable source is now an alternative solution to generate the electric energy for example, sunlight. A free sunlight will produce energy that environmental friendly.

In Malaysia, the climate is usually bright sunny day and raining day. The sun radiation in Malaysia is high due to location of Malaysia on earth. The monthly solar radiation is approximately around 400–600 MJ/m2 in Malaysia (Mekhilef et al., 2012). Hence, using sun radiation to generate electric in Malaysia is very useful and suitable. A solar electric system that mostly use in Malaysia is photovoltaic (PV) system. Furthermore, mostly solar panel that install on residential house in Malysia is static solar panel. Static solar panel is not generating high efficiency when converting solar

energy to electric energy. To maximum solar panel to generating electric using the sun radiation, the solar panel must perpendicular to the light source (sunlight). So, a tracker is needed to make the solar panel is follow location of sun. This is because the sun is moving for one location to other location. So that, function of tracker is to make sure that solar panel is always perpendicular with light source to produce maximum electric in a day. Long period use solar panel will cause the existence of dust on the surface of solar panel. Dust will block solar panel to get light source. This will affect the efficiency of the solar panel to generate electric. So, the surface solar panel needs to always clean. The cleaning function is added to solar panel system. So, it can make sure the surface solar panel is always clean.

The innovation value for this project is the added function for the sun tracker which is ability to self-cleaning. The self-cleaning for sun tracker for this project is passed on the concept of the viper car. The self-cleaning is use to clear the dust on the surface of the solar panel. By combine the concept of the viper car into the solar cell with sun tracker, it is able to improve the efficiency for gain maximum solar energy to generate the electric energy.

The solar cell with sun tracker is become common in this world. Besides that, the self-cleaning is already available on the market. Usually existing self-cleaning system is using the mini robot to cleaning the surface of solar panel. So, it is using the electric energy is high and cause the output product to the user is low. Besides that, mini robot moving is slow and block the sunlight may affect the efficiency of solar panel. Second type of self-cleaning system is adding the chemical or addition component to the solar cell. So, the solar cell can using solar energy to clean the dust and it is most effective way to clean the dust but it is expensive. For this project, differentiates itself from existing or matured technology is the addition of self-cleaning ability on the solar panel system with concept of viper car. Besides that, it is cheaper way to cleaning the dust even not effective like other existing self-cleaning system in the market.

1.2 PROBLEM STATEMENT

Mostly the solar panel use in commercial is static at a specific location to gain the sunlight. The problem is a static solar panel only gain the sun irradiation w/m^2 at specific location and direction. Therefore, the solar panel is not fully generating energy from sun radiation for product maximum power. The second problem is long period using solar panel will cause existence of dust on the surface of solar panel. The problem that dust exists on surface solar panel is the solar cell in the solar panel gain the sunlight become low and less effectiveness to generate the energy by solar cell. It is due to the dust block the sunlight through to the solar cell in solar panel.

So, this project is to overcome the problems that occur. The solar tracking systems have ability to detect the position of light source. Furthermore, the self-cleaning ability is added on the solar tracking system can clear out the dust on the surface of the solar panel. Hence, the solar panel able to generate optimum electric energy from sunlight during daily.

1.3 OBJECTIVE OF STUDY

There are the objectives for the project:

- To design and implement the solar system that able to tracking sunlight to gain the optimum of the electric energy that transform from sunlight radiation.
- To design and implement the solar cell module that able to charge the battery for small electric apparatus.
- To design and implement the solar cell module that has ability to clear the dust on surface of solar panel.

1.4 SCOPE OF STUDY

This project is focused to design and develop a solar cell module with sun tracking using microcontroller for battery charger and have ability to clean up the dust on surface of solar panel. Therefore, the project scopes are:

- Use microcontroller (16F877A) to rotate the DC motor.

- Using DC geared motor (SPG30-300K)
- Using light Dependent Resister (LDR) as the sensor to detect the location of the light source
- A solar tracker system which can detect the sunlight during daylight.
- A solar tracker system which can clean the dust on the surface of solar panel.

1.5 THESIS ORGANIZATION

This thesis has contained five chapters. It contains Induction, literature review, methodology, result and discussion, and conclusion and recommendation. For this chapter, it will discuss about introduction of project, problem statement for this project, objective project, project scope, and thesis organization.

Chapter 2 is referring from several journals that related to this project. It will explain about the best of the concept for solar tracking system use on solar panel and the parameter that can cause the efficiency of the solar panel.

Chapter 3 includes the methodology for project. It will explain the procedure, and the way to make sure how the project achieves the project goal on time. Additionally, this chapter also discusses the process flow of the system, electrical circuit design, software design and mechanical design for the project.

Chapter 4 is the result and discussion; it is containing the result for this project. It will explain the sign gain from the light sensor to microcontroller and the output from microcontroller, cooperation voltage value, current value, and power value between static solar system and dual axis tracking solar system.

The last chapter is contained conclusion and recommendation. This chapter is concluding the project and gives a recommendation to improve the project for future time.

CHAPTER 2

LITERATURE REWIEW

2.1 INTRODUCTION

Human has been used fossil fuel to generate electric energy for a long time ago but, the supply of fossil fuel is become limited source for a day to other day. Fossil oil is one – times non-renewable resource. Besides that, the combustion of fossil oil will cause large amount of Carbon dioxide. It will cause large destruction of the environment in earth. For example: Global warming. Therefore, human have been serious threat that use of fossil oil. With development and research from sciences and engineering, clean, green and saving energy has become a famous and hot topical issue for this era. One of the green energy exist nowadays is solar energy. Hence, solar system is become wide use in this world to generate electric energy. However, the solar system is not efficiency to generate energy. Hence, many ways have been develop to increasing the efficiency to generate energy. The most using control system for improve efficiency of solar system is sun tracker system. There are several relevant question are connected and link to my project. There are:

What type of sun tracker existing on this world?

Fixed solar system or moveable solar system which perform well?

Two axis solar system or one axis solar system which performs well?

What are the parameters affects the performance of solar cell?

The question will answer according the research paper, article, journal, or book that I get from ScienceDirect and Google book.

2.2 WHAT TYPE OF SUN TRACKER SYSTEM EXISTING ON THIS WORLD?

Sun tracker system usually divides to two main characteristic. There are active (electrical) solar tracker and passive (mechanical) solar tracker. Sun tracker system that existed is active tracker and passive trackers. (Poulek, and Libra, 1998). In a research article by Mousazadeh et al. (2009), Main component for Passive solar tracker is thermal expansion of a matter (usually Freon) or on shape memory alloys. The active solar trackers are Microprocessor with electro-optical sensor based, date and time based control by PC, auxiliary bifacial solar cell based and a combination of these three systems (Mousazadeh et al., 2009). There are several research paper that been develop and design the passive sun tracker. N, J. G et al. (2004) have developed a simple, efficient smart sun tracking mechanism (SSTM) using SMA actuators. Poulek and Libra (1998) have developed a low-cost single axis passive solar tracker based on a shape memory alloy (SMA) actuators. The following researchers that have been develop the active tracker system. Huang et al. (2011) have design, and build a 1 axis -3 position (1A-3P) sun tracking PV. Abdallah and Nijmeh (2004) have developed a two axes sun tracking system with PLC control. Afarulrazi et al. (2011) have design and develop an automatic solar tracker Robot using Microcontroller. Suwandi (n.d.) has design and implement dual axis sun tracking system with PV Panel as the sensor. Praveen (2012) has design the automatic Dual-axis Solar Tracker using Microcontroller. The figure 2.1 is show the type of sun tracker in this world. For this project, the type of trucker use is microprocessor and electro-optical sensor based active tracker.

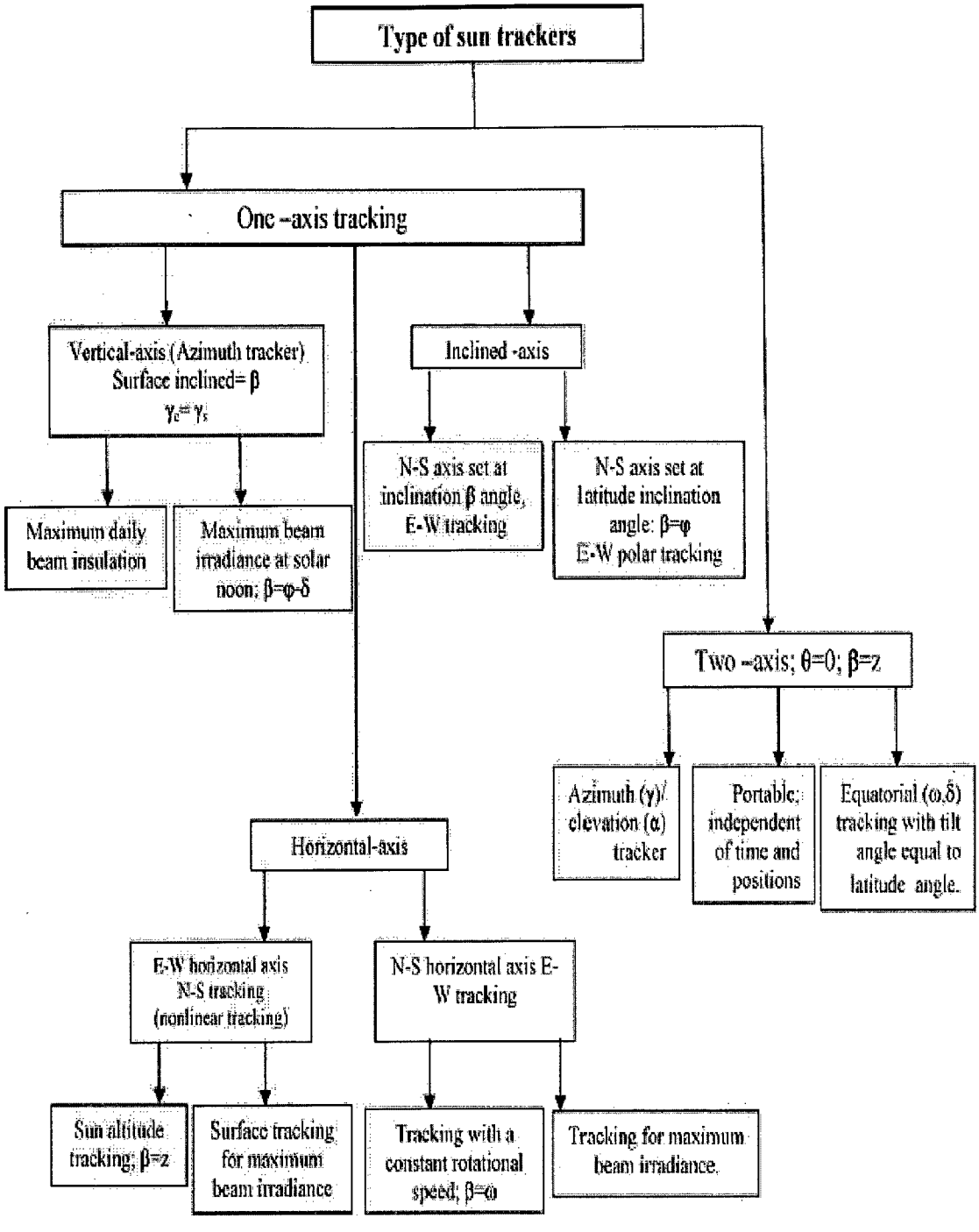

Figure 2.1: Type of sun tracker.

Source: Mousazadeh et al. 2009

2.3 FIXED SOLAR SYSTEM OR MOVEABLE SOLAR SYSTEM WHICH PERFORM WELL?

The fixed solar system is the solar panel is not moving, where moveable solar system is the system that using sun tracker to moving the solar panel to gain maximum efficiency. In a research article by Huang et al. (2011), Monthly-total power generation was increasing between 18.5% and 25.8 % using 1A-3P sun tracking PV. The result for this article is show in figure 2.2. The following five research article attempts to support and demonstrative the hypothesis. In a research article by Abdallah et al. (2004), total daily collection for using two axes tracking surfaces was increasing about 41.34% when compare with the 32^0 tilted fixed surfaces. Table 2.1 is indicates the daily measured solar energy on the two axes tracking system and fixed solar system.

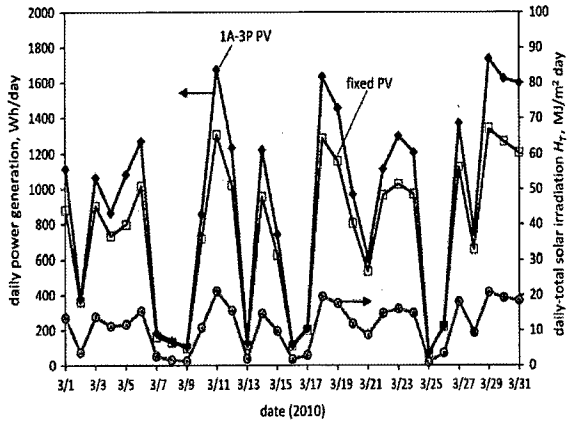

Figure 2.2: Results of 1A-3P tracking PV and fixed PV in March, 2010.

Source: Huang et al. 2011.

Table 2.1: Experimental average daily total solar radiation in MJ/m^2.

Date of day	Two axes tracking	Fixed @ 32 latitude	% Gain
07/05/2001	41.266	27.746	48.73
10/05/2001	27.49	20.73	32.61
11/05/2001	34.534	23.661	45.95
12/05/2001	36.057	26.11	38.09
Average	34.83675	24.56175	41.34

Source: Abdallah et al., 2004

The average power using moveable solar system can increased up to 19.72 percent compare to fixed solar system (Afarulrazi et al., 2011). The result from this article is show in figure 2.3. The efficiency solar system with solar tracking is higher than with fixed angle solar system about 6.7 percent. (Huang et al, 2009). Figure 2.4 is show the result of this research article. In a research paper by Praveen (2012), the results (figure 2.5) indicates that the output power for the dual axis Sun-tracking system that compared with the fixed PV system is overall increase about 30-45%.

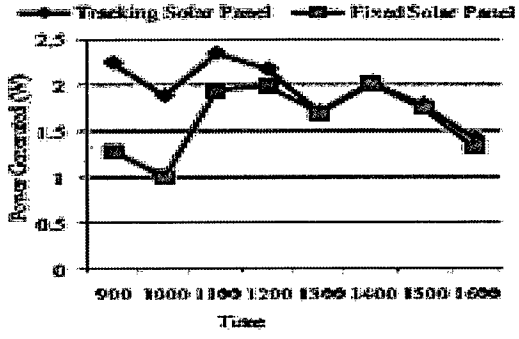

Figure 2.3: Tracking solar panel versus fixed solar panel.

Source: Afarulrazi, A. B., et al., 2011.

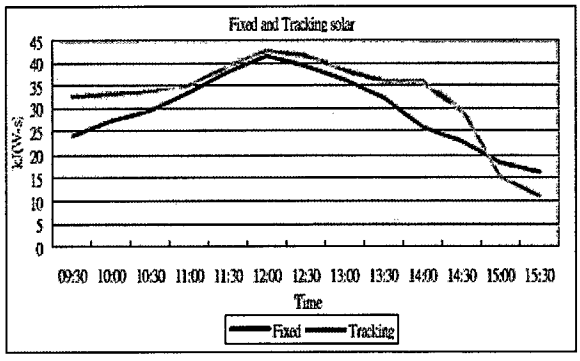

Figure 2.4: Power generation comparison of fixed angle type and tracking systems.

Source: Huang, Y. J., et al, 2009.

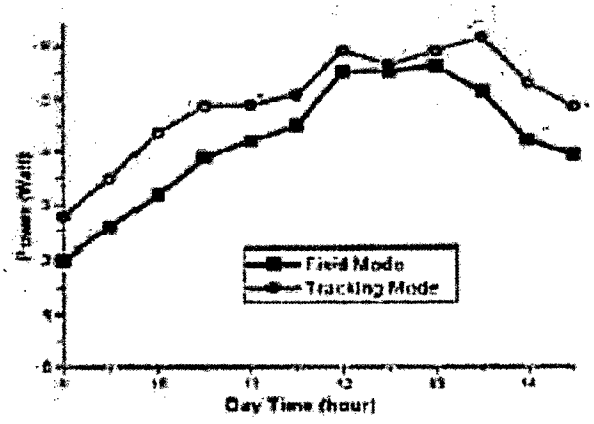

Figure 2.5: Variation of cell power with day time.

Source: Praveen, C., 2012

2.4 TWO AXIS SOLAR TRACKER SYSTEM OR ONE AXIS SOLAR TRACKER SYSTEM WHICH PERFORMS WELL?

In a research article by Taylor et al. (2010), the vertical-axis tracker is receives 18%, tilted (horizontal) –axis is receives 11%, and two axis is receives 30% more annual solar radiation than the fixed-tilt system. Besides that, a research article by Abdallah et al. (2004), The results indicate that the north–south, vertical, east–west tracking, and two axes tracking were increases in daily measured solar energy up to 19.7%, 23.3% ,24.5%,and 41.34% as compared with the fixed surface inclined 32_ to the south respective. Both of the researcher is show the two-axis sun tracker is more efficient that one axis solar tracker system. There are two of research article is given the result of the efficiency one axis solar tracker system. Chin et al. (2011) was show the efficiency using one axis tracker system is 20%. Afarulrazi et al (2011) show that the average power compares to static solar system is increased up to 19.27 percent. For the result for two research article, we can conclude that the improvement of efficiency using one-axis sun tracker is almost 20%. So, both of the research article is support the research article by Taylor (2010), and Abdallah et al. (2004). One of the research articles is show the efficiency when using two-axis sun tracker. In a research article by Praveen (2012), overall increase of output power for the dual axis Sun-tracking system compared to the fixed PV system is about 30-45%. But, one of the research article by

Huang et al. (2011), the 1A-3P tracking PV generates electricity about 30-45% than the fixed PV.

2.5 WHAT ARE THE PARAMETERS AFFECTS THE PERFORMANCE OF SOLAR CELL?

In a research paper by Sulaiman et al., (2011), performance of solar PV panel can effect by the dust. The peak power that generate by solar panel can be reduce up to 18% (Table 2.2). The following research article is support this hypothesis. In a research paper by Ibrahim, A. (2011), Short circuit current, Isc and open circuit voltage, Voc of the solar cell when under deposited dust through field exposure were decreased 2.78% and 0.863% respectively. Besides that, this research article is also given other parameter which is shadow. Short circuit current Isc is more decreased in a high percent than open loop voltage Voc for the solar cell under shadow, so the other solar cell parameters will be decreased (Ibrahim, 2011). The other effect of the solar cell is heat. According to Suwandi (n.d.), the cooling system could reduce 10 ^{0}C to 20^{o}C depending on the temperature difference between PV cell and the surrounding (Table 2.3).

Table 2.2: The peck power of each condition.

Condition	Peak power (W)		
	255 W/m²	301 W/m²	340 W/m²
No plastic	4.25	4.12	3.62
Clean plastic	4.25	3.75	3.16
Mud	3.48	3.43	3.49
Talcum	3.55	3.22	1.73

Source: Sulaiman, S. A., et al., 2011.

Table 2.3: Comparison is between cooling system and non-cooling system.

	TEMP 1	V_{OC} 1	TEMP 2	V_{OC} 1
COOLING SYSTEM	43°C	2.12v	50°C	*NA*
NON COOLING SYSTEM	53°C	1.90v	70°C	1.80V

Source: Suwandi, F. W., n.d..

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will explain the flow work or the method for the project to achieve the objective. Besides that, this chapter explains the process flow for sun tracking system and self-cleaning system. Additionally, this chapter briefly explains the basic theory of some important component using in this project. Furthermore, this chapter also explains the hardware development, electrical circuit development, and software development.

3.2 PROJECT FLOWCHART

This project is dividing several steps to design, construct the prototype of self-clearing solar cell module with sun tracking system. Flow of the project to archive the objective or goal of study is show in figure 3.1.

Firstly, the mechanical structure or part is designed. This is making sure that the design of the mechanical part is suitable and able to support the system for a long time.

Next, simulate and design for the electrical circuit for the project. Electrical circuit is simulated and design by using development software (ISIS Proteus).

Next, design the program for microcontroller use in this project. The software development is use to design and create the program for this project is MicroC.

Next, construct and test the electrical circuit for this project. All electronic components use in this project is taken from laboratory and buy direct from electric shop.

After that, install the program to microcontroller. To install the program to microcontroller is need development software. The development software is PICkit2. It will take the Hex file to install in the microcontroller.

Next, the mechanical structure is constructed and test for this project. it used to make sure that the mechanical structure that produce is same to the design drawing.

Next, combine the mechanical structure, and electrical structure to final the prototype for this project.

Lastly, testing and improve the prototype. It is to make sure the prototype can work and able to achieve the target.

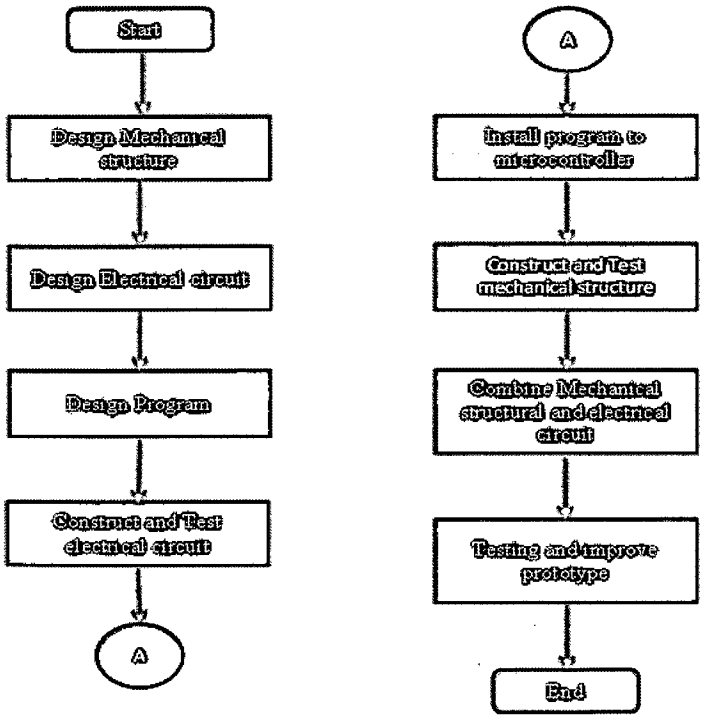

Figure 3.1: Flowchart of the project.