

# **Faculty of Electrical and Electronics Engineering Technology**



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**Bachelor of Electronics Engineering Technology (Telecommunications) with Honours** 

## DEVELOPMENT OF SMART SOLAR TRACKING SYSTEM USING ARDUINO

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A project report submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## UNIVERSITI TEKNIKAL MALAYSIA MELAKA

#### DECLARATION

I declare that this project report entitled "Development of Smart Solar Tracking System using Arduino" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



#### APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours.



#### DEDICATION

To my beloved mother, Nor Masnizah Binti Azman, and my father, Zahilal Bin Talip,

Thank you for supporting me when I continue my studies for bachelor's degree in UTeM.

To my second brother, Nazran Ariff Bin Zahilal,



#### ABSTRACT

Renewable energy, sometimes known as "Green Energy," is a fast-growing source of energy in the worldwide because our nation is situated on the equator, a solar power system is a viable alternative for our country's residents. In addition, this technique is a best efficient method of generating solar power from the sun. The solar panels that are often utilised in Malaysia are movable because the sun's position varies over time-the solar panel's efficiency must be adjusted to ensure that it receives sufficient sunlight to generate minimal energy. As a result, the goal of this project is to make improvements to the current solar panel setup. In the final prototype device, solar panels may be moved around based on the amount of light they get. For the purpose of moving the solar panels, two servo motors and an Arduino are employed. Sensor photoresistor is used to determine the sun's location. It is the major goal of this project to build a 'Solar Tracking System using Arduino'. For optimal power output, this mechanism will help position parallel solar panels into direct sunlight. Data from solar panel voltage generation also be gathered by the system. We will be able to see how solar panels fluctuate over time and come up with strategies to improve solar panel energy efficiency.

#### ABSTRAK

Tenaga boleh diperbaharui, kadangkala dikenali sebagai "Tenaga Hijau," ialah sumber tenaga yang berkembang pesat di Amerika Syarikat. Oleh kerana negara kita terletak di garisan khatulistiwa, sistem tenaga suria merupakan alternatif yang berdaya maju untuk penduduk negara kita. Selain itu, teknik ini merupakan kaedah yang sangat cekap untuk menjana tenaga suria daripada matahari. Panel solar yang sering digunakan di Malaysia pula adalah boleh alih. Oleh kerana kedudukan matahari berubah mengikut masa, kecekapan panel solar mesti diselaraskan untuk memastikan ia menerima cahaya matahari yang mencukupi untuk menjana tenaga yang minimum.. Hasilnya, matlamat projek ini adalah untuk membuat penambahbaikan pada persediaan panel solar semasa. Dalam peranti terakhir, panel solar mungkin dialihkan berdasarkan jumlah cahaya yang mereka perolehi. Untuk tujuan menggerakkan panel solar, dua motor servo dan Arduino digunakan. Photoresistor sensor digunakan untuk menentukan lokasi matahari. Ia adalah matlamat utama projek ini untuk membina 'Sistem Penjejakan Solar menggunakan Arduino'. Untuk output kuasa yang optimum, mekanisme ini akan membantu meletakkan panel solar selari ke dalam cahaya matahari langsung. Data daripada penjanaan voltan panel solar juga boleh dikumpul oleh sistem. Pelajar akan dapat melihat bagaimana panel solar berubah-ubah dari semasa ke semasa dan menghasilkan strategi untuk meningkatkan kecekapan tenaga panel solar.

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#### **CHAPTER 1**

#### INTRODUCTION

#### 1.1 Background

In the current era, electricity is one of the most essential requirements for human survival. The daily increase in the energy consumption graph is due to the expansion of industries around the nation. Due to this, to achieve a numerous studies have been conducted to find a solution to the paucity of electricity-generating resources issue from investigation and analysis, several forms of energy have been identified.traditional technique and unconventional technique. Some of the sources of energy that it is nonconventional to generate energy from nonrenewable sources like fossil fuels, charcoal, and natural gas, which can be reduced. To overcome such difficulty, The new renewable energy system has been designed. It utilizes the power of nature such as solar, wind, and ocean wave to create power to meet the demand of users.

Solar panels may be utilised to generate power in Malaysia using renewable resources. Due to its location near the equator, Malaysia gets a great deal of sunlight. As a result, solar energy technology using solar power is quite popular in Malaysia. Over millions of years, the sun has produced billions of watts of energy. Sunlight has no effect on pollutants. Therefore, the sun is a clean source of energy that causes no more pollution to the planet than other energy sources utilised to generate power.[1]

#### **1.2 Problem Statement**

Coal and other forms of fossil fuel are the primary fuels used in the generation of energy in Malaysia. This is due to the fact that Malaysia is one of the prosperous countries that own such an abundance of natural resources. Despite the fact that such resources are very helpful in expanding the Malaysian economy in the manufacturing sector, the effect of their combustion contributes to the pollution of the air around the world. According to an article that was published in the Malaysian daily 'Berita Harian' in August 2018, Miri Sarawak mentioned the reading of the 203-air pollution index (API) as a hazardous consequence caused by open burning. Aside from that, the resources that are consumed are just transitory, and the amount of energy will diminish with time. In order to find a solution to this issue, it is recommended that you make use of renewable energy sources, such as solar energy, because they do not contribute to the pollution of the surrounding ecosystem.[2]

We are all aware that the sun's arc is constantly shifting. In most cases, the solar panel that is currently being used is fixed, and as a result, it is unable to generate energy in an effective manner due to the constant movement of the sun. Therefore, making use of an automated solar tracker is great for increasing the amount of electricity that is generated. According to research published in 2008 by Hossein Mousazadeh and colleagues, two-axes solar tracking is able to capture much more energy than conventionally positioned solar panels. Therefore, the development of a dual-axis automated solar tracking system is a fantastic concept for increasing the amount of electricity that can be produced by a solar panel.[3]

#### **1.3 Project Objective**

The main aim of this project is:

- a) To design and build a prototype solar tracking system using the Arduino.
- b) To develop the voltage changes over time.
- c) To analyze the solar photovoltaic panel perpendicular to the sun in order to make it more efficient in two axis.

## **1.4** Scope of Project

The scope of this project are as follows:

- a) Develop a mechanism capable of controlling the solar panel's axis of rotation for optimum energy production. The energy gathered during the day is stored in the battery and used at night.
- b) Using a photoresistor sensor to provide a signal to Arduino that modifies the solar panel's orientation in response to sunlight locations.
- c) Using a Voltmeter to measure the voltage of a solar panel and then transfer the results to an Arduino board.
- d) Use Arduino to run a programme that will move all moving parts and collect
   data from sensors.
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#### **CHAPTER 2**

#### LITERATURE REVIEW

#### 2.1 Introduction

A solar power device that converts sunlight into electrical energy is known as a solar cell. Often referred to as solar panels, photovoltaic modules combine photovoltaic modules with solar cells to form photovoltaic modules. All day long, the module's surface tracks the sun using a solar tracking device. During the course of the day, the sun's position changes. A solar tracker may enhance the efficiency of solar-powered equipment in any permanent place, depending on the complexity, costs, and outcomes of the project. Any device that can change its mirror to point in one direction, like a solar tracker, might be considered a kind of tracker. The accuracy of a solar tracker is dependent on the application for which it is being used. Solar cell concentrators, in particular, need a high degree of accuracy in order to transmit concentrated sunlight exactly to the powered device, which is located near the reflector or lens' focal point. Because tracking is essential to concentrator systems, single-axis tracking is a need. It is feasible that many non-concentrating apps may operate without tracking. A system's total output power may be increased as well as its output power at critical system demand periods if tracking is done correctly (often late afternoon in warm climes). Solar panels have had their output boosted in the past. Double-sided panels, improved conversion phases, geometric integration of building panels, and other topics are all part of these investigations. A solar photovoltaic panel generates the maximum energy if it is positioned at a right angle to the sun. As a result, a number of academics have developed a variety of tracking systems for solar panels. As a result, the primary purpose of this project is to build a tracking system for solar panels using Arduino developments.[4]

#### 2.2 Related previous project

#### 2.2.1 Efficient and Low-Cost Arduino based Solar Tracking System

In this study, a dual-axis solar tracker is presented in order to completely use the sun's rays. The LDR input, the Arduino controller, and the servomotor output are the three essential components of the proposed system. A0 to A7 are the analogue pins for the eight LDRs, and the servomotors are linked to the digital pins 9 and 11 of the Arduino. In order to maximise solar intensity, the physical arrangement of the LDRs and their placement on the board is chosen experimentally.

In order to get the most out of the collected solar energy, a dual-axis tracker was developed. The servomotors are controlled by pulse width modulation (PWM), which is generated by the analogue to digital converter (ADC). At 22.50 per degree, the horizontal axis (Axis-1) of the system may travel from 0 to 180 degrees. As servomotors do not support a half-degree, the angles are approximated to the closest value. The servomotor would move the solar panel to the position where the LDR could collect the most light intensity, depending on the intensity. The LDR measurements are obtained every 30 minutes in order to save energy.

The system offers three orientations for the vertical axis (Axi-2): 10, 20 and 30 o. The test site's sun track is used to determine these values. The night mode begins when the readings from all LDRs fall below a particular threshold for a long period of time. When the sun begins to rise, the tracker will return to its starting location (looking east).[5]



Figure 2.2.1: Single and dual axis solar tracking system.

#### 2.2.2 Dual Axis Solar Tracking System using Arduino

The intensity of light is measured using four LDRs (two for azimuth and two for altitude). Analog to digital converter (ADC) and light comparison unit are used to transform the analogue signal from sensors. This output is sent to the Arduino board together with the input instruction. The motor-drive circuit receives its output from the Arduino. The driving circuit links two DC motors, one for vertical movement and the other for horizontal movement. The motor rotates the solar panel in the opposite direction of the sun's rays. Finally, the LCD displays the power output. This project relies heavily on the LDR combo. After sunrise, the panel will be moved back to its original position by a motor, and the process will be repeated. Even more of the solar panel's load is relieved when it is connected to a battery and an inverter. The battery stores and provides the inverter's DC output, which comes from the solar panel. To convert from DC to AC, an inverter was employed. This is followed by the addition of an external load.



Figure 2.2.2: Mechanism of dual axis tracker

An azimuth-altitude dual-axis sun tracker is the underlying concept. The angle formed between a substance and the observer's location is referred to as altitude. Between zero and 90 degrees, it's about the same. Height may alternatively be replaced by the distance to the zenith. Afterwards, azimuth is usually studied from north to east, increasing in direction. While static solar tracking systems have their place, this one is designed to be more efficient than either. Using Arduino UNO, LDRs, a DC motor, an LCD and a solar panel, we were able to achieve this result. To enhance solar tracking based on the sun's position, two-axis solar tracking and automatic solar tracking are provided.[6]

## 2.2.3 Dual Axis Solar Tracking System Using Pic Microcontroller

Solar power production is plagued by a lack of light intensity. To get the most out of a solar panel, it must be positioned vertically and directly in front of the source of light. Solar panels must be able to track the sun's movement throughout the day and year in order to create the optimum amount of electricity. An orthogonal relationship between the light source and the panel may be maintained using a tracking system. Various tracking system designs, such as passive and active systems with one or two axes of freedom, may be found on the market. Different sensors are employed in solar trackers to significantly increase the electric output of a photovoltaic panel. Solar radiation is picked up by the sensors. To maximise the amount of power a photovoltaic solar cell can generate throughout the day, researchers in this study devised a low-cost microcontroller-based solar tracker with two degrees of rotational freedom. A PIC18452 microcontroller drives two DC motors, with data from the sensors (LDR) processed by the microcontroller's inbuilt ADC-analog to digital converter and sent to the motor controller IC-L298N, which then drives the motors in opposite directions. Our project's purpose is to create an active, dual-axis solar tracker with the least amount of inaccuracy possible. A variety of mechanical and electrical alternatives were examined and the best one was selected. We finished the tracking system module and tested it to make sure it worked as expected.[7]

Prototype PIC-controlled solar system that actively monitors the sun to collect maximum power from the array at any time of day is a primary aim. This technology attempts to capture as much sunlight as possible before converting it into useful electrical energy (DC voltage) and storing it in batteries for a variety of purposes. More energy can be harvested from solar tracking systems than can be harvested from fixed panel systems.

It is essential for the solar panel to monitor the sun's rays that four LDRs (Light Dependent Resistors) be employed in this research. Voltage divider is used to transform the changing value of the LDR (voltage divider) into analogue voltage. The Analog to Digital Convertor (ADC) built in a Microcontroller is used to read the analogue value of LDRs and convert it to digital. Motor Driver (H-bridge) is also linked to the Microcontroller for controlling the direction of the two motors based on LDR measurements. Two LDRs are permanently mounted on the solar panel's axes. The Microcontroller will compare the analogue output **from** the two LDRs to determine if the Motor is CW, CCW, or OFF.[8]



#### Figure 2.2.3: Overall schematic diagram

#### 2.2.4 Automated solar tracking devices are controlled by algorithms.

ASTS may be used to align solar power systems perpendicular to the sun's rays, increasing the amount of energy they can absorb. Transmission mechanical drive subsystems, electric motor control units, and limit switches for solar positioning algorithms are all part of an ASTS's components. This system's primary objective is to generate ST signals that are very accurate and stable while also having a low noise level and being easy to install. An extra 2 percent to 3 percent of the additional power produced by solar electricity should be used by a solar tracker. An evaluation of ASTS building attributes was performed. One of the key differences between ST and ST is that ST precision allows for more effective conversion of solar thermal or electrical energy. Minimum ST accuracy requirements, often defined as the off-tracking angle at which power production goes below 90 degrees, are frequently determined using concentration system acceptance angles. To maximise solar power production, the tracking of the sun must be more exact.[9]

This section gives a classification of the literature on ASTS in order to evaluate different sun tracking methods and Cas. Open-loop, closed-loop, and hybrid-loop systems are all shown in Table 2 according to the ST method. Traditional control methods on–off, PI, and PID are used in 67.55 percent of published publications, with on–off control being the most common. It's also worth noting that just 16.67% of the analysed research projects used a hybridloop method, while 28.95% of the studies utilised an openloop technique. There are a few things to keep in mind while looking at the studies contained in this list: The articles that were examined drew their conclusions and main results directly from the data that was provided. They were, however, not referred to using the same terminology.[10]

# 2.2.5 Low-cost automatic multi-axis solar tracking system for performance improvement in vertical support solar panels using Arduino board.

Photovoltaic and thermal cell surfaces are the primary means of harvesting solar energy, which is environmentally friendly and long-lasting. Simple, inexpensive, and widely available make it one of the fastest-growing clean-energy technologies in the world. Renewable solar power systems have become one of the fastest-growing alternatives to fossil fuels and are increasingly being used in commercial and industrial settings as well. A little percentage of the sun's energy may be captured because of the sun's constantly shifting location and a variety of other important considerations. Sharing an optimization alternative for traditional solar power system installation as applied to LED traffic light systems is the main subject of this study. Solar trackers are a realistic solution to this problem since the sun's constant movement restricts the amount of sunlight that can be absorbed. A significant obstacle to the widespread use of solar trackers has been their prohibitive cost. Solar cell efficiency was considerably enhanced by the introduction of microcontroller-based solar tracking devices utilising Arduino boards. Solar panel efficiency was raised by 23.95% as a result of a multiple-axis servo-motor feedback tracking system established and developed in this research.[11]

Combining hardware components and software control mechanisms, solar trackers are created. Sensors, comparators, a microcontroller circuit, a motor drive circuit, and electric motors compose the system. Stepper motors or servo motors are often used. These are constructed and programmed to move the PV cell-mounted platform.[12] Some of these components are omitted from the Arduino board type described in this research. The system was modelled utilising a power supply device, an Arduino board, a servo-motor, and Light Dependent Resistor's (LDR's) that function as solar light sensors. To accomplish the MPP, the system is automatically steered relative to the sun. Therefore, the solar cells retain their

perpendicular (90-degree) orientation to the sun in the sky while the tracking unit twists towards the perpendicular orientation.[13]



Figure 2.2.5: Tracked and stationary solar panels are compared in terms of the amount of

electricity they produce.

# 2.2.6 IoT-Based Sun Tracker System Prototype: Controlled by Mobile App and Database Monitoring

Because of the rapid development of internet technology and other means of communication, the Internet of Things (IoT) has emerged as a separate academic field of study. Human contact with all internet-connected devices is made easier by a wide range of approaches, including sensor media radio frequency identification, wireless sensor networks, and other intelligent things.

Project intends to build an IoT-based solar cell tracker that is controlled through mobile apps and whose data is accessible over the internet from any location with an Internet connection. This research improved the suggested solar cell tracker system's performance using LDR, DHT11, Voltage, and MPU6050 sensors. An Appinventor is used to build the control system, allowing the gadget to be controlled from a mobile phone. Arduino will be used to connect all sensors, and real-time data may be seen on the Thinger.io website using a Raspberry and a small LCD. An ESP8266 NODE MCU microcontroller is used to connect to a Wi-Fi network. On the basis of this study, dynamic solar cell trackers generate more voltage than static solar cell trackers. With four LDRs on each axis, dual axis sun tracker devices provide an average voltage of 19.40 Volts in bright weather, 18.05 Volts in gloomy weather, and 13.60 Volts in rainy weather.

To power the load, batteries and solar panels operate in tandem. Power is generated throughout the day by photovoltaic modules and saved as kinetic energy in the battery for usage at night. Batteries and photovoltaics can provide electricity even when it's cloudy outside. All of the other functions of the BCU (Battery Control Unit) are intertwined. Microcontroller execution follows the activation of the solar tracking system during the first stages of system setup. Once the panel is installed, engineers may utilise smartphone apps to remotely control its placement. After locating a spot where the solar panels can best absorb sunlight, the gadget will begin collecting solar energy. Maximum energy is converted into electrical energy and stored in the battery, which may also be used to recharge the battery immediately after attaining maximum power (charger).[14]

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Figure 2.2.6: Proposed Model for Solar Tracking: Solar tracker based on the Internet of Things

2.2.7 A Low-Cost Closed-Loop Solar Tracking System Based on the Sun Position

## Algorithm

It is worthwhile to invest in a solar positioning system that can function independently of a strong CPU and the conventional solar positioning algorithm used for positioning. In this study, an 8-bit microcontroller-based dependable two-axis tracking system for real-time solar position monitoring is built using a straightforward, cost-effective algorithm. First, a simulation research was conducted using MATLAB (The MathWorks, Natick, MA) to compare the three most well-known solar position algorithms: SPA, AA, and ENEA. Second, an 8-bit microcontroller implementation of the most practical and somewhat accurate algorithm was built so that its performance could be compared to that of simulation. Finally, an 8-bit microcontroller platform was used to build and construct three distinct tracking systems: a fixed-orientation PV solar panel, a four-light-dependent-resistor-based optical sensor, and an AA algorithm-based dual-axis closed-loop solar tracker. Finally, the efficiency of the dual-axis solar tracker was compared to that of a fixed PV solar panel and an optical solar tracking system. The prototype was tested using simulated results generated in MATLAB and actual data on the location of the sun at various times.

Because of the need for constant power and careful administration, these algorithms are often designed for use with a centralised, microprocessor-based system—not ideal for use in distant locations. Standard techniques, which may provide highly reliable real-time sun position information without significantly raising system cost and removing the necessity of periodic calibration, are computationally intensive and hence challenging to apply in the standalone electronic control system.



Figure 2.2.7 block diagram using optical tracking and proposed sun position algorithm-based

tracking.

#### 2.2.8 Fuzzy logic and PID controller for a single-axis solar tracking system

Since they are easy to implement and work well with both linear and nonlinear systems, proportional integral derivative controllers find widespread usage in manufacturing processes. Fuzzy controllers are most suited to the human decision-making mechanism, combining electronic system functioning with expert judgement. A further benefit of employing the fuzzy controller for a nonlinear system is the mitigation of jittery influences on the system's operation. In this research, two different controllers, one based on proportional integral derivative theory and the other on fuzzy logic, are developed for an Atmel microcontroller-based single-axis solar tracking system and compared. In order to maximise energy production, solar panels are angled toward the direction of the sun's rays and built with the necessary supervisory controllers in mind. Therefore, the goal is to provide the specular reflection of the sun's rays to a solar panel in order to improve the energy collected from solar panels. The two controllers for the planned system have been considered, and the most efficient processing mechanism has been identified.

Fuzzy logic is used for the control of the solar tracking system in this research. The **UNIVERSITITEKNIKAL MALAYSIA MELAKA** control system takes in data from two separate photo resistance sensors. The first step in implementing fuzzy control is to fuzzify the inputs that are being used. To put it another way, the data is classified into membership categories, then translated into a linguistic structure, and finally sent off to the rule processing unit.



Figure 2.2.8 The first LDR and output membership function uisng fuzzy logic

## 2.2.9 Automatic Solar Tracking System Using AT 89852 Microcontroller

The two LDRs send a signal to the microcontroller that causes an action to occur. Since the microcontroller can only accept digital inputs, the analogue signal from the LDRs is transformed to digital using the onboard ADC. The microcontroller determines whether the motor rotates clockwise or anticlockwise based on the signal from the LDR. Suppose it's 10:00 AM in the morning, and the output of the west LDR is higher than that of the east LDR. The DC motor is instructed to spin the panel anticlockwise by a signal sent from the microcontroller. All day long, as the sun progresses westward, the DC motor will be spun anticlockwise to point the panel in that direction. Two relays are controlled by the microcontroller to power the motor. Simply using a microprocessor to power the relays would be impractical, hence dedicated relay drivers are employed. Both clockwise and anticlockwise motor rotation are possible because to how the two relays are wired together. The body of the solar panel is mechanically linked to the motor shaft. Here, a DC motor with limited output is employed for the sake of demonstration. The motor can handle larger power ratings when put to use in real life. Given that DC power is required by all circuits, a DC power source has been built into the system. The relay and DC motor both receive +12 V, but the microcontroller circuit receives +5 V DC.



Figure 2.2.9 The prototype of the Solar Tracking System Using AT 89S52 Microcontroller

#### 2.2.10 Dual Axis Solar Tracking System using 5-LDR sensor

A photovoltaic cell, or sun cell, is analogous to a P-N junction diode. Through the use of the photovoltaic effect, solar energy may be converted into electricity using a photovoltaic cell. All solar panels can be broken down into their smallest component, solar cells. A solar panel is made up of several solar cells linked in series and parallel. Incident light is inversely proportional to the potential of solar tracker and PV technology. How much energy a solar panel generates is dependent on how much sunlight reaches the PV module. When light hits the solar panel at a right angle, it produces the most energy. In practise, this means angling the panels such that they remain perpendicular to the sun all day. The latitude of the area determines the standard angle at which the solar panels are angled. Dual axis tracking systems are superior than single axis tracking systems because they are able to follow the sun's movement both in azimuth and elevation. The panel may be adjusted in any of the four directions thanks to its two tracking motor design. Using a 5-LDR sensor and a PIC microprocessor, two motors may be run at once.



Figure 2.2.10 Graph of output power of tracking PV system

# 2.3 Advantage and disadvantage of previous projects

TITLE	MICROCONTROLLER	ADVANTAGES	DISADVANTAGES
Efficient and Low- Cost Arduino based Solar Tracking System.[15]	ARDUINO UNO R3	The system offers three orientations for the vertical axis (Axi- 2): 10, 20 and 30 o.[16]	Need to replace whole component to make sure the project is work.
Dual Axis Solar Tracking System using Arduino. [17]	Arduino uno R3	Measured using four LDRs (two for azimuth and two for altitude). Analog to digital converter (ADC) and light comparison unit are used to transform the analogue signal from sensors.	May cause failure in the project because of the analog converter will go to maximum voltage.
Dual Axis Solar Tracking System Using Pic Microcontroller. [18]	PIC Microcontroller	Different sensors are employed in solar trackers to significantly increase the electric output of a photovoltaic panel	Project is very expensive.
IoT-Based Sun Tracker System Prototype: Controlled by Mobile App and Database Monitoring. [19]	ESP8266 NODE MCU	Project intends to build an IoT-based solar cell tracker that is controlled through mobile apps and whose data is accessible over the internet from any location with an Internet connection.	The maximum energy and the minimum will cause many failure due to false reading

	movement restricts the amount of sunlight that can be absorbed.	
Arduino Uno R3	Solar tracker	This project cost alot
	controlled by using	of money that can be
1 AV a	used to make the solar	project function This
Ma Ma	panel move into in	project also use
	many axis.	algorithms that really hard to ultilize the solar panel.
كنيكل مليسيا	نيۇم سىتى تىھ	او
RSITI TEKNIKAL M	ALAYSIA MELAK	
PIC Microcontroller	8-bit microcontroller- based dependable two-axis tracking system for real-time solar position monitoring is built using a straightforward, cost- effective algorithm.	This project used a loop solar tracking which is really hard to implement in our eco- system.
	Arduino Uno R3	Arduino Uno R3 Solar tracker controlled by using algorithms that can be used to make the solar panel move into in many axis. PIC Microcontroller B-bit microcontroller- based dependable two-axis tracking system for real-time solar position monitoring is built using a straightforward, cost- effective algorithm.

Fuzzy logic and PID controller for a single-axis solar tracking system. [23]	PID Controller	Using PID controller to control the single axis solar tracker.	This project implement in using fuzzy logic which is really hard and complicated.
Automatic Solar Tracking System Using AT 89S52 Microcontroller. [24]	AT89S52 Microcontroller.	Simply using a microprocessor to power the relays, hence dedicated relay drivers are employed. Both clockwise and anticlockwise motor rotation are possible because to how the two relays are wired together.	The microcontroller can only accept digital inputs, the analogue signal from the LDRs is transformed to digital using the onboard ADC.
Dual Axis Solar Tracking System using 5-LDR sensor. [25]	PIC Microprocessor	Dual axis solar tracking system that can be good further implement in our eco system and used PIC microprocessor.	Use 5 LDR sensor which is unnecessary because only 4 LDR can make the project works perfectly.

Table 2.3 Journal comparison

#### 2.4 Summary

Various A list of advantages and disadvantages of the project is provided at the end of this chapter. Using the methods of previous researchers is considerably more straightforward in our undertaking. As a result, the downsides may be minimised to the greatest extent feasible. The results of previous studies have a positive influence on this project since the right and suitable approach will be implemented while keeping the weak area in mind. As a result of reading their findings, I'd be able to generate decision-making suggestions for appropriate components and room improvement ideas for the system as it pertains to a residential location.



#### **CHAPTER 3**

#### METHODOLOGY

#### 3.1 Introduction

This chapter contains explanations and descriptions of the project's four-part process. The initial step is the development of the project's flowchart. Then, in the subsequent section, an appropriate block diagram for the project is produced. Additionally, the working flow of the project has been depicted. The hardware and materials associated with this project have been discussed. Consequently, the construction of flowcharts will reflect a greater level of comprehension. In addition, the task's materials, and procedure for establishing the circuit association will be discussed. Similarly, the use of programming such as Arduino IDE will be analyzed to develop a solar tracking system based on the microcontroller that used.

#### 3.2 **Project Workflow**

A flowchart visual represents the project management strategy that we are striving to accomplish. For the next project to be successful, it is vital to have a decent flowchart. Numerous methods and data may be used to improve the workflow of a good project. For example, a top and high-efficiency project may improve project stream data, such as multiple journals, studies, and book publication investigations.

اوىيۇبرسىتى تىكنىك





# 3.2.1 Gantt Chart PSM 1

PROJECT ACTIVITIES	STATUS	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14	WEEK 15	WEEK 16
<b>BDP</b> Briefing	E									Μ							S
	А																
Meeting with	E				- 19 m					Ι							Т
Supervisor	А		1	Participant.	SIA.												
Distribution	E		21			10				D							U
of project titles	А	MIL	1			L.P.K											
PSM 1	E					A				В							D
Rubrics	А	Ţ															
Explanation		-															
Project	E	1	λ.					-		R	1						Y
planning	А		<u>B</u> .					<u> </u>	1		-						
Proposal	E		~ A1	No						E							
preparation	А																
Abstract	E	1	- L -				1 and the second second		1	A							W
	А	1	1 YUA		with	1.0		Ren		23	Auto	بر اللي	no.	01			
Literature	E			1.0		0				K	2.	0		/			E
Review	А										+*						
Design	E	1.15	115.71	-DC	1771	TEN	ALL A	LA1	NA AL	AV	CIA.	B S D	AL	A			E
Project	A	U	41 4 1	_rvo		ILL	INIT	ML	MA	LAI	SIA	IAIC		~			
Flowchart	E									S							K
	A									E							
Construct the	E									Μ							
project	A																

## 3.2.2 Gantt Chart PSM 2

PROJECT ACTIVITIES	STATUS	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14	WEEK 15	WEEK 16
Draft	E									М							S
Material List	А																
Meeting with	E									Ι							Т
Supervisor	А																
Test	E			ALAI	SIA					D							U
Hardware	A		Ser 1			4											
Analyse	E	4	2			N.				В							D
Result	A	1				Ve.											
Complete	E	32				Þ				R							Y
Chapter	Δ	- Andrew -											<b>T</b>				
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Discussion	T	- Y.	<u> </u>							17	-		· /				
Complete	E	-	-	_				-	/	E	-						
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for		115	111/1	DC	ITL	TEM	MIR	AL	A M	AV	A12	ME	AR	A .			
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Presentation	Е									S							K
	А									Е							
Submit Final	Е									М							
Report	A																

#### 3.2.3 Flowchart of Overall PSM

The project is being organised such that the deadline can be successfully reached. The flowchart of the project is depicted in Figure 3.2.2 which provides a summary of the activities and the timeframe, is supplied in the appendix.



Figure 3.2.3: Flowchart of Overall PSM

#### **3.3 Data Collection**

Data gathering is the process of gathering all the information necessary to evaluate the project's success. Therefore, the literature review will serve as a guide for data and information collection for the project.

Arduino Mega 2560 will be utilized to store all critical data, including amperes, watts, volts, and kilowatt-hours. A system will be constructed utilizing Arduino Mega 2560 and SDM meter, and all other required components to gather the necessary data.

The creation of this project used all the information obtained from various sources. In addition, reviewing previous initiatives may help you understand more about the project, its purpose, strategy, and outcomes so that you can make more informed judgments.



Figure 3.4.1: Project system block diagram

The LDRs are used to get analogue input values for the sun tracking system. Analog readings from the sensors are converted to digital signals on the Arduino UNO R3 microcontroller through an included Analog to Digital converter. Solar panel orientation is adjusted to the point of greatest light intensity by driving the servo motor with a digital PWM

pulse. There are four distinct locations where LDR may be found: top-left, bottom-left, bottomright.

#### 3.5 Hardware Specification.

Numerous hardware components were used in this project to get the desired outcome. In this project, Arduino Mega 2560, Solar Cell, Stepper Motor, Motor Driver, LDR Sensors, and any kind of load to be monitored, including a light bulb and an iron box, were used as hardware components. The hardware implementation comprises of the pin configuration, function, and interfaces with the Arduino Mega 2560, without which the project cannot be completed successfully. The hardware implementation is required for the device to function as intended.

#### 3.5.1 Arduino Uno R3

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). Digital input/output ports may be used to output PWM signals, whereas analogue input ports can be used to receive analogue signals. One of the features of this device is a 16-MHz ceramic resonator, as well as six analogue inputs. A USB cable, an AC-to-DC converter, and a battery are all included to get you started with the microcontroller. Unlike earlier boards, the Uno does not make use of the USB-to-serial driver chip from FTDI. Thus, the Atmega16U2 (Atmega8U2 up to version R2) is utilised instead of the Atmega8U2 as a USB to serial converter.



Fig 3.2 Arduino Uno R3

#### 3.5.2 Solar Cell

An essential component of every photovoltaic system is the solar cell. The size of each cell may range from 0.5 inches to 4 inches. Only 1 or 2 watts of power may be generated by a single cell, which is insufficient for the majority of household equipment. Photovoltaic arrays efficiency is directly tied to the amount of light they receive.

The quantity of solar energy that the array receives and, thus, its effectiveness, are greatly influenced by weather conditions such as clouds and fog. Between 10% and 20% of PV modules are effective.



Figure 3.5.2 Solar cell

#### 3.5.3 Stepper Motor

AC, DC, Servo, and Stepper motors are just a few of the various varieties. Discrete step motion is achieved using stepper motors, which are DC motors. Phases are groupings of coils that are arranged in a certain order. The motor will spin one step at a time if each phase is turned on sequentially. Stepping controlled by a computer allows for very accurate placement and/or speed control. Consequently, stepper motors are often used in precise motion control systems.



Figure 3.5.3: servo motor

## 3.5.4 Motor Driver

This is a professional two-phase stepper motor driver. It is capable of regulating speed and direction. With six DIP switches, the microstep and output current of the driver may be adjusted. In conclusion, there are seven distinct micro step kind and eight distinct current control type. In addition, optocoupler isolation at high speed is applied to all signal terminals, enhancing the device's resistance to high-frequency interference.

The stepper motor driver has the following features:

- 8 types of current control
- 7 kinds of microstep adjustment
- The interfaces use high-speed optocoupler isolation
- Heat reduction via automatic semi-flow
- Big cooling surface
- Input reversal protection
- Protection against overheating, excessive current and short-circuit



Figure 3.5.4: . TB-6600 stepper motor driver

### 3.5.5 LDR Sensors

The fixed resistor and the light-dependent resistor make up the lighting sensor (LDR). You cannot connect the LDR voltage directly to your controller's supply voltage of 5V. LDR voltage is read using the voltage divider technique, as shown in Figure 1. A comparison of the voltage difference between two LDRs is made since the motor cannot be operated continuously throughout the day. When the voltage differential between two LDRs is higher, the solar tracking system is intended to spin in either CW or CCW orientations. Voltage differences higher than or equal to sensitivity cause motors to turn in the desired direction.



To get the necessary output voltage signals, the above circuit utilises a 4.7k complementary resistor.

#### **3.6** Software Specification

#### 3.6.1 Arduino IDE

There are menus and a toolbar with buttons in the Arduino integrated development environment (often referred to as the Arduino Software) for basic activities like text editing and message areas (IDE). With the hardware component connected, it can communicate and upload data.

Arduino is a free and open-source platform for creating electronic projects. It is necessary to utilise an IDE (Integrated Development Environment) on your computer to programme the Arduino board. This enables you to programme the Arduino board directly from your computer.

The Arduino platform is becoming more popular, and with good cause, among those who are just beginning their careers in the area of electronics. In contrast to prior programmable circuit boards, the Arduino may be updated over a USB connection, rather than by using a separate piece of hardware that is referred to as a programmer. Additional advantages include of a programming language that is less difficult to learn and a simpler version of the Arduino integrated development environment (IDE). To summarise, Arduino is a platform that provides a standard form factor for microcontrollers. This simplifies the functionality of the microcontrollers, making it easy to understand how to use them and getting started.



Fig 3.6.1 Arduino IDE

## 3.6.2 Proteus 8 Professional

Electronic circuits may be simulated, designed, and drawn using Proteus. Using Proteus, we can also create two-dimensional circuit designs. Using simply a home computer and this engineering program, we may create and simulate various electrical and electronic circuits. Moreover, the design of circuits on Proteus requires less time than their actual fabrication. In software simulation, the probability of errors such as loose connections, which require a significant amount of time to identify in a physical circuit, is reduced.

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Fig 3.6.2 Proteus Design Suite 8.1.1

## 3.7 Project Implementation

In the proposed system, a single axis solar tracking system is used with an Arduinobased changeable and compactable system. Motor driver and stepper motor are used to rotate solar panel to lighting location utilising data from the two LDR sensors. The voltage sensor is a voltage divider mechanism. Using a battery to store the solar panel's energy, the battery may then be utilised to power the loads.

The LDR sensor, microprocessor, and stepper motor are all components of the control systems. The microcontroller receives data from the LDR, which senses sunlight and transmits it. The signal from LDR sensors is used by the microcontroller to operate TB-6600 motor drivers, which in turn drive the stepper motor. To maximise electricity, the solar panel follows the sun's path. The charge controller regulates the voltage that the battery receives from the charger.

#### **3.7.1** Flowchart of the System



Figure 3.7.1 : Flowchart of the system

The header files, variables, input/output pins, and other components are regarded to be initialised first. Afterwards, LDR are read. The LDR and sensitivity of the two devices are compared. The direction pin on Arduino is HIGH if the difference between the sensors is larger than the sensitivity setting. In the CW direction, the motor spins. The Arduino's direction pin is LOW, and the motor spins in the opposite direction of the Arduino.

## 3.8 Summary

In conclusion, the solar system using Arduino may be constructed provided all hardware and software are properly linked and meet the requirements. Any errors pertaining to the project will be resolved so that the goals may be met. Chapter 4 will detail the data collecting and analysis procedures.



#### **CHAPTER 4**

#### RESULTS

#### 4.1 Introduction

This chapter explains the results obtained from the project that was implemented. This chapter is important in order to prove whether all objectives of project that stated in chapter one are fulfil or not. It also focuses mostly on the outcomes of the pre-processing, picture classification, distribution and conclusion.

#### 4.2 Result & Analysis

#### 4.2.1 Experimental Setup, Sensors, and Information Gathering System

#### Multimeter

In order to compute and assess all relevant factors in order to acquire data from our project's solar tracking solar panel. In order to evaluate the efficiency of our systems, we need to. Our lab technician helped us collect data using a multimeter for this reason. Our project involves using a multimeter to measure the voltage output by the solar panels at various times during the day. The voltage was initially measured while the sun was perpendicular to the panel. When the solar panel was following the sun, the voltage was measured for a second time. All day long, we kept on with this routine. After calculating the power input using, we now know the output power, or the power being generated. Both of these calculations were then used to determine the system's efficiency.



Figure 4.1 shows the multimeter that used to measure the voltage, current and power

Time (hrs)	Voltage (V)	Current (Ma)	Power watt(W)
9 am	5.5	0.11	0.605
10 am	9 >	0.19	1.71
12 pm	12.5	0.28	3.5
1 pm	14	0.32	4.49
3 pm	م المسب	0.26	2.86 ويوم
5 pm UNIV	ERSITI TEKNIKA	L MAL012SIA ME	LAKA 0.72

## 4.2.2 Performance of Solar Panel without Tracking

Table 4.1 Table of voltage, current and power watt recorded time by time without tracking.

## 4.2.3 Performance of Solar Panel with Tracking

Time (hrs)	Voltage (V)	Current (Ma)	Power watt(W)
9 am	12.2	0.23	2.8
10 am	13.5	0.25	3.4
12 pm	14	0.3	4.2
1 pm	15	0.3	4.5

3 pm	13	0.26	3.38
5 pm	7	0.2	1.4

Table 4.2 Table of voltage, current and power watt recorded time by time with tracking.

Solar panels without tracking produce an average of 2.134 watts of electricity, whereas solar panels with tracking produce an average of 3.18 watts of power.

Without including the energy used by the motor, the efficiency has increased by 41.64 percent. As a result, the suggested dual axis tracking system provides an efficient mechanism to link solar energy, ensuring that energy consumption exceeds that of a stationary solar panel.

Our research proposes a hardware design and implementation for sun-tracking solar panels. Our findings demonstrate that using a solar tracking device improves solar panel performance. The minimal cost is guaranteed by the fully automated sun tracking solar panel. Accordingly, it is a dual-axis system that provides maximum efficiency and may be attained gradually. Only around 30% to 40% of the solar energy that hits a solar panel is converted into usable electricity. To maintain a steady output, you need an automated system that can keep the solar panels in motion. For this reason, a test version of the sun-tracking system was developed. Until the sun is directly overhead, the system will keep the panel pointing forward automatically.



Figure 4.2.3 Testing using 5w 12V solar panel



Figure 4.2.3 shows the component that used to measure the voltage, current and power

# 4.2.4 Instrumentation, Sensors, and Data Acquisition Network Powered by Photovaltaic Solar Panel Array Outputs

LDRs on both the solar tracker and the stationary panel provided the data needed for the project. The data was collected over the course of two days, documented, and tallied. The light intensity that hit the LDRs would determine their outputs. Using digital pins 0 and 1, as well as a USB connection, Arduino can communicate with a computer through a serial connection. Therefore, if these features are utilised, digital input and output can occur on pins 0 and 1. The NodeMcu board may be communicated with using the Arduino environment's built-in serial monitor. In order to compile the data, a programme was built that polled the LDRs once each hour.

Time (hrs)	Photovoltaic array outputs (V)
0600	08.25
0700	08.95
0800	09.52
0900	09.89
1000	ALAYSIA 44
1100	10.76
1200	11.00
1300	10.82
1400	اونيةم سيت تيكنيكا مليسا
1500	10.32
1600 UNIV	ERSITI TEKNIKAL MAL10.08 A MELAKA
1700	09.26
1800	08.34

Table 4.3 Photovoltaic array outputs for bright sunny day

At certain intervals, take a reading from both LDRs and write down their values. LDRs are able to accurately detect light intensity, making them a reliable indicator of the power that reaches the solar panel's surface. The brightness of the sun's rays is related to the amount of energy harvested by the solar panels.

Time (hrs)	LDR 1	LDR 2
0600	1.478	1.487
0700	2.803	2.838
0800	3.204	3.995
0900	3.970	3.995
1000	4.213	4.174
1100	4.500	4.576
1200	4.990	4.990
1300	4.888	4.990
1400	4.976	4.982
1500	4.941	4.862
1600	4.874	4.756
1700	3.974	3.984
1800	2.898	2.745
	Table 4.2.3 LDR outputs for bri	ght sunny day

## 4.3 Data Analysis/ERSITI TEKNIKAL MALAYSIA MELAKA

The tables make it clear that the brightest part of the day is in the middle of the day, with maximum values being reached between 1200 and 1400 hours. This corresponds to the time when the sun is directly overhead. The intensity of the sunlight is lower in the morning and in the late evening, thus the values that are acquired during these times are lower than those that are obtained during the day. When the sun goes down, the tracking system is turned off in order to conserve electricity. The next morning, it is turned back on again.

It is anticipated that the values of the LDRs will be rather close for the panel that was outfitted with the tracking system. This is due to the fact that an error is issued anytime they are in different places, which makes it possible for it to move. When the values are equal, which indicates that the LDRs are being exposed to the same amount of sunshine, the motion of the panel comes to a stop. The values change depending on the fixed panel since the fixed panel is in a predetermined location. As a consequence, the LDRs do not always face the sun at the same angle the vast majority of the time. This is not the case during the middle of the day, though, when they are both almost perpendicular to the sun. The days in which there is the least amount of cloud cover are the ones that have the highest light intensity, and as a result, the outputs of the LDRs will be at their maximum. On overcast days, the values acquired by the tracking system and the fixed system do not differ by a significant amount from one another due to the fact that the intensity of the light remains relatively constant. The differences, if any, are not significant. When the weather is clear, the tracking system performs at its peak level. It will be able to harness a significant portion of the sun's kinetic energy, which will then be transformed into usable energy. It is self-evident that the tracking system would have a higher power output than the fixed system when it comes to the power output of the solar panels, as compared to the power output of the stationary system. This is due to the fact that the amount of light available affects the amount of electricity that can be generated by solar panels. When there is a greater amount of available light, the solar panel will produce a greater amount of usable electricity.

#### 4.4 Summary

The solar rays are tracked more by the Single Axis Solar Tracker than by a fixed solar panel. In general, a variable elevation solar tracker can produce up to 20% more power per year than a fixed installation. Researchers looked at the effect of one-axis east-west tracking on solar radiation received by a PV panel compared to a permanent installation. To maximise output power, the system must be able to track and follow the sun's intensity. Aside from that, a low-speed DC geared motor was utilised to ignore the motor speed parameter, allowing the system to focus solely on tracking solar intensity.



Figure 4.4: Complete setup of Automatic Solar Tracker System

#### **CHAPTER 5**

#### CONCLUSION

#### 5.1 Conclusion

In today's highly productive world, energy is the bedrock upon which our entire society rests. Although it's true that energy can't be made or destroyed, such response could imply that it can be stored in some way. This project has strived to uncover the road to such objectivity in an effort to make such a goal credible. It's only logical that as human use of energy increases, we'll eventually run out of access to certain resources on Earth. Sun, in which, the tallest source, spiked over for ages right from the birth of the whole universe, through which life has been conceived, is the fundamental and mother source of all energy. In light of the most elementary issues involved in storing this kind of energy, the project has been untangled. Burning various materials to create non-solar energy involves the release of a great deal of pollution, which is slowly but surely poisoning the environment and the atmosphere. In today's lightning-fast, information-rich global environment, where instantaneous access to every facet of life is a prerequisite for acute comfortability, the daily challenge of coming up with something novel and original provides the impetus that serves as the ultimate source behind all the effort put forth. In this respect, it would be more worthwhile to show that commercialization has expanded so far in the pursuit of money and power that we are somehow present in the pool of severe ignorance of the world's resources scarcity, which has resulted in the wounding of the entire planet. This project presents the eye to open the corridors of minimising the amount of pollution in storing energy culled out from the Sun and also to make the pace of advancement revved around healing the planet, which is the basic cultivation with which the hour clock is calling.

#### 5.2 Future Work Recommendations

The "Automatic Solar Tracking System" project is the precise embodiment of how the future dilemma will be resolved. In both its financial prowess and its general ease of use, this system is a true innovator. In the thick of things, where pollution smothers progress everywhere it's produced, this device's efficiency is a breath of fresh air, helping to clear the air so that only progress and development can thrive.



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## APPENDICES

# Appendix A: Project Gantt Chart Bachelor

**Degree Project 1** 

PROJECT ACTIVITIES	STATUS	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14	WEEK 15	WEEK 16
BDP Briefing	E									Μ							S
	А		-	ALA	YSIA												
Meeting with	E		A. 2			As.				Ι							Т
Supervisor	А		Z			100											
Distribution	E		¥.			Z				D							U
of project	А	2				S											
titles		ш									-						
PSM 1	E									B							D
Rubrics	А		A									-11					
Explanation			Oh.			a											
Project	E		192							R							Y
planning	A			"Nn													
Proposal	E			1					-	E							
preparation	A		10				6			-	- 19						
Abstract	E		274	~ ~~	Audohudha	~~ (		~~~~		A	( 5)	- V	~ ?~	21			W
	A			-	1.0	~		- 14									
Literature	E									K							E
Review	A	U	NIV	ERS	SITI	TE	(NI)	(AL	MA	LAY	'SIA	ME	LA	KA_			
Design	E																E
Project	A																
Flowchart	E									S							K
	A									E							
Construct the	E									M							
project	A																

E – Estimated, A – Actual-All project activities that have been estimated are in line with the actual timeline plan.

# Appendix B:

# **Project Gantt Chart Bachelor Degree Project 2**

PROJECT ACTIVITIES	STATUS	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14	WEEK 15	WEEK 16
Draft	Е									М							S
Material List	А																
Meeting with	Е			1. 1. D.	V Gr					Ι							Т
Supervisor	А		1	مستعر	- SA												
Test	E		14			No.				D							U
Hardware	А		3			1.4											
Analyse	E	3				2				B							D
Result	А	Ш				4											
Complete Chapter	E	-								R			VI				Y
4:Result and	А	Y	es.										V/				
Complete	E		×44	1.00						E							
Chapter	Δ			NA.													
5:Conclusion	2 X		1.1	(			1		1								
Submit draft	Е		N	0 4	and a	0		Ru	-	Α	in	اللب	naw				W
report	А			-		0		-		-	5.	0	10	1			
Prepare	E									K	+*						E
Project Poster	А		NUNZ	E D C	171	TEL	ZNI	CAL	34.0	L AN	ALO I	D.0.E	1. 6.1	10			
Preparation	E	0	NIV	E PAG			VINIT	<b>WAL</b>	INIM	LAI	SIA	IVIE	LAI	1.94			E
for presentation	А																
Presentation	Е									S							K
	А									E							
Submit Final	E									М							
Report	А																

E – Estimated, A – Actual - All project activities that have been estimated are in line with the actual timeline plan.

```
#include <Servo.h>
 1
 2
      #define SERVOPINH
 3
                             5
      #define SERVOPINV
 4
                             6
 5
      #define dtime
 6
                          50
      #define tol
 7
                       50
 8
      Servo horizontal;
 9
      int servoh = 90;
10
11
      int servohLimitHigh = 175;
12
      int servohLimitLow = 5;
13
14
      Servo vertical;
15
16
      int servov = 90;
17
      int servovLimitHigh = 180;
18
      int servovLimitLow = 90;
19
20
      const int ldrlt = A0;
21
      and a state of the second
~~
     const int idrit = A0;
21
     const int ldrrt = A1;
22
23
     const int ldrld = A2;
     const int ldrrd = A3;
24
25
26
    UNID SETUD (TI TEKNIKAL MALAYSIA MELAKA
27
28
     {
29
       Serial.begin(115200);
       horizontal.attach(SERVOPINH);
30
      vertical.attach(SERVOPINV);
31
      horizontal.write(servoh);
32
33
      vertical.write(servov);
34
      delay(100);
35
36
       for(int i=servovLimitLow;i<servovLimitHigh;i+=2)</pre>
37
       { vertical.write(i);
38
39
        delay(30);
40
       }
      vertical.write((servovLimitLow + servovLimitHigh)/2);
41
```

```
41
      vertical.write((servovLimitLow + servovLimitHign)/2);
42
      delay(100);
43
      for(int i=0;i<180;i+=2)</pre>
44
45
         horizontal.write(i);
       {
        delay(30);
46
47
       }
      horizontal.write((servohLimitHigh + servohLimitLow)/2);
48
49
50
51
    }
52
    void loop()
53
54
    {
55
      int lt = analogRead(ldrlt);
      int rt = analogRead(ldrrt);
56
      int ld = analogRead(ldrld);
57
      int rd = analogRead(ldrrd);
58
59
60
<u>c</u> 4
          int avt =
                       (1t + rt)
62
                                     / 2;
                       (1d + rd) / 2;
63
          int avd =
64
          int avl =
                       (1t + 1d)
                                        2;
                                     1
65
          int avr =
                        (rt
                            + rd)
                                        2;
66
          int
               dvert = avt
                                  avd;
67
          int dhoriz = avl - avr;
68
69
70
          Serial.print(lt);
          Serial Print MALAYSIA MELAKA
71
          Serial.print(rt);
72
          Serial.print(",");
73
74
          Serial.print(ld);
          Serial.print(",");
75
          Serial.print(rd);
76
          Serial.print ("
                                             ");
77
                                       I
78
79
          Serial.print(avt);
          Serial.print(",");
80
          Serial.print(avd);
81
```

```
Serial.print(avl);
 83
         Serial.print(",");
 84
         Serial.print(avr);
 85
                            ");
         Serial.print(",
 86
         Serial.print(dtime);
 87
         Serial.print(",
 88
                            ");
         Serial.println(tol);
 89
 90
 91
 92
         if (-1*tol > dvert || dvert > tol)
 93
        ł
         if (avt > avd)
 94
 95
         {
           servov = ++servov;
 96
            if (servov > servovLimitHigh)
 97
 98
            {
             servov = servovLimitHigh;
 99
100
            }
101
         else if (avt < avd)
102
103
104
           servov= - servov:
 120
            1
 121
            servoh = servohLimitLow;
 122
            }
          YIN
 123
          else if (avl < avr)
 124
 125
          ş
            servoh = ++servoh;
 126
                (servoh > servohLimitHigh)
 127
             if
 128
             servoh = servohLimitHigh;
 129
 130
             }
 131
          }
          else if (avl = avr)
 132
 133
          {
            // nothing
 134
 135
          ł
 136
          horizontal.write(servoh);
 137
          }
          delay(dtime);
 138
 139
        }
 140
 141
```