Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF TWO AXIS SOLAR TRACKER FOR WATER PUMPING SYSTEM.

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Bachelor of Electronics Engineering Technology with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology with Honours

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2022

DECLARATION

I declare that this project report entitled "Development of Two Axis Solar Tracker for Water Pumping System" 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.

Signature : 

Student Name : WAN NOOR HAZIMAH BINTI WAN MOHAMAD

Date : 27/1/2023

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 Electrical Engineering Technology with Honours.

Signature	:	
Supervisor Name	:	PUAN ROHAINA BINTI JAAFAR
Date	:	27/1/2023

DEDICATION

I want to express my profound appreciation to both of my parents, Wan Mohamad bin Wan Yaacob and Shamsiah binti Mohd Zin, for their love, support, and sacrifices throughout my life. I would never have been able to get to this point without their efforts and support. They are my backbone and always convinced me to continue my studies even though it might be hard for me throughout the journey of my degree. I know you always have faith in me, and your daughter has finally made it. Thank you for the doa and support. I love you umi and abah. I would like to dedicate to my brother, Wan Muhamad Haziq bin Wan Mohamad, who support and counsel me in everything. I'd like to extend a special thank you to my younger brother, Wan Muhamad Hafizuddin and Wan Abdul Hakim and devoted to my sister, Wan Nurul Izzah Faqihah which always advise and cheer me up throughout this Program Sarjana Muda project 1 and 2. Last but not least, I wanna thank me. I wanna thank me for believing in me. I wanna thank me for doing all of this hardwork. I wanna thank me for no days off. I wanna thank me for never give up and being passionate.

ABSTRACT

Renewable energy is very important to human life as humans always rely on energy to supply electricity. Futhermore, renewable energy such as sunlight, wind, rain, water and others is one of energy sources that are continually replenished. This mean that, humans can utilise them as often as they want and are not concerned if the energy is running out. It is unlike fossil fuel, coal, oil or natural gas that if use it to the end, it means it will run out and can not be renewed. Beside, when fossil fuels are used, they release carbon dioxide into the atmosphere, which contributes significantly to global climate change. Hence, solar energy is often significantly more ecologically friendly because humans can get solar energy directly from sunlight. Moreover, solar energy can be used more beneficially by contribute in it solar panels to improve renewable energy consumption. Therefore, the purpose of this project is to develop two axis solar tracker for water pumping system. By using two axis solar tracker it can captured solar rays to generate maximum sunlight and free energy from the solar panel. On top of that, two axis solar tracker is more efficient since it can move the solar panel horizontally and vertically. By implementing solar pumping will reduce the water wastage and helps the consumer for consumption by having water storage tank. Method used are four LDR sensors that is connected to the solar panel. Arduino will send the signal an act as a brain for this system. To manage the panel movement, this project uses two 5 V servo motor. Water level sensor is put in water tank and used to measure the water levels. If it is sensing low water level, 12 V DC water pump will on. For the result, two axis solar traker system for water pumping can successfully implemented. Solar tracking can tracks sunlight efficiently to give energy for water pumping that can be used if necessary by pumping the water via water tank.

ABSTRAK

Tenaga boleh diperbaharui amat penting kepada kehidupan manusia kerana manusia sentiasa bergantung kepada tenaga untuk membekalkan tenaga elektrik. Tambahan pula, tenaga boleh diperbaharui seperti cahaya matahari, angin, hujan, air dan lain-lain adalah salah satu sumber tenaga yang sentiasa diisi semula. Ini bermakna, manusia boleh menggunakannya sekerap yang mereka mahu dan tidak bimbang jika tenaga kehabisan. Ia berbeza dengan bahan api fosil, arang batu, minyak atau gas asli yang jika digunakan sehingga habis bermakna ia akan habis dan tidak boleh diperbaharui. Selain itu, apabila bahan api fosil digunakan, ia membebaskan karbon dioksida ke atmosfera, yang menyumbang dengan ketara kepada perubahan iklim global. Oleh itu, tenaga suria selalunya lebih mesra ekologi kerana manusia boleh mendapatkan tenaga suria terus daripada cahaya matahari. Selain itu, tenaga solar boleh digunakan dengan lebih berfaedah dengan menyumbang di dalamnya panel solar untuk meningkatkan penggunaan tenaga boleh diperbaharui. Oleh itu, tujuan projek ini adalah untuk membangunkan penjejak solar dua paksi untuk sistem pengepaman air. Dengan menggunakan penjejak suria dua paksi ia boleh menangkap sinaran suria untuk menjana cahaya matahari maksimum dan tenaga bebas daripada panel suria. Selain itu, penjejak solar dua paksi adalah lebih cekap kerana ia boleh menggerakkan panel solar secara mendatar dan menegak. Dengan melaksanakan pam solar akan mengurangkan pembaziran air dan membantu pengguna untuk kegunaan dengan mempunyai tangki simpanan air. Kaedah yang digunakan ialah empat sensor LDR yang disambungkan ke panel solar. Arduino akan menghantar isyarat bertindak sebagai otak untuk sistem ini. Untuk menguruskan pergerakan panel, projek ini menggunakan dua motor servo 5 V. Sensor aras air dimasukkan ke dalam tangki air dan digunakan untuk mengukur paras air. Jika ia mengesan paras air rendah, pam air 12 V DC akan dihidupkan. Untuk hasilnya, sistem pengesan suria dua paksi untuk pengepaman air dapat dilaksanakan dengan jayanya. Penjejakan solar boleh menjejaki cahaya matahari dengan cekap untuk memberi tenaga untuk mengepam air yang boleh digunakan jika perlu dengan mengepam air melalui tangki air.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Puan Rohaina binti Jaafar for her precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and my panel Encik Mazree bin Ibrahim dan Dr Badril bin Nor Shah for the financial support through this project which enables me to accomplish the project. Not forgetting my fellow friends, Nurul Nabila, Nurul Najihah, Nurul Shazana and Mardhiyah Wahab for the willingness of sharing their thoughts and ideas regarding the project.

My highest appreciation goes to my parents and family members for their love and prayer during the period of my study. An honourable mention also goes to my high school friends for all the motivation and understanding.

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LIST OF SYMBOLS

℃	-	Celcius
Ω	-	Ohm
%	-	Percent
±	-	Plus minus

LIST OF ABBREVIATIONS

V	-	Voltage
mA	-	Miliampere
g	-	Gram
MW	-	MegaWatt
mm	-	Milimeter
cm	-	Centimeter
Mhz	-	Megahertz
µA	-	Microampere
kHz	-	Kilohertz

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CHAPTER 1

INTRODUCTION

1.0 Background

Renewable energy or in other name, clean energy is theoretically a method of generating energy from limitless natural resources. These resources are either limitless or renew at a faster pace than they are consumed. We can generate enough heat and electricity for all of our homes, companies and industry needs by combining these natural resources with sophisticated technology especially in solar energy. Solar power mostly uses photovoltaic cells or solar cells to generate electricity. Malaysia always experiences hot weather. This is actually one of advantages to saving electricity since electricity usage in Malaysia is quite high. Malaysia is curretly one of the region's largest energy consumers per capita, with an average of 4,652 kWh per capita in 2014, more than a third more than the global average of 3,132 kWh [1]. Somehow, Malaysia also has a very high rainfall distribution since Malaysia is close to the equator line. Normally, average rainfall is 2420 mm for peninsular Malaysia and 2630 mm for Sabah and 3830 mm for Sarawak [2].

With continuous use of diesel and electricity consumption and also it is an advantage if not using abundant water properly, it will have a negative impact on the environment and people. To not waste these renewable energy sources, by using solar panels, we can invent something new to contribute in many ways to improve renewable energy consumption. So, development of a two axis solar tracking for a water pumping system is an alternative and effective way to track the sun in order to get the most sunlight incidence on the solar panel at any time of day, which will be used to provide energy to the water

pumping system. Hence, a two axis solar tracker is more efficient than a single axis solar tracking. This is because a two axis solar tracker has more flexibility and gives 40% more electricity than single axis solar tracking.

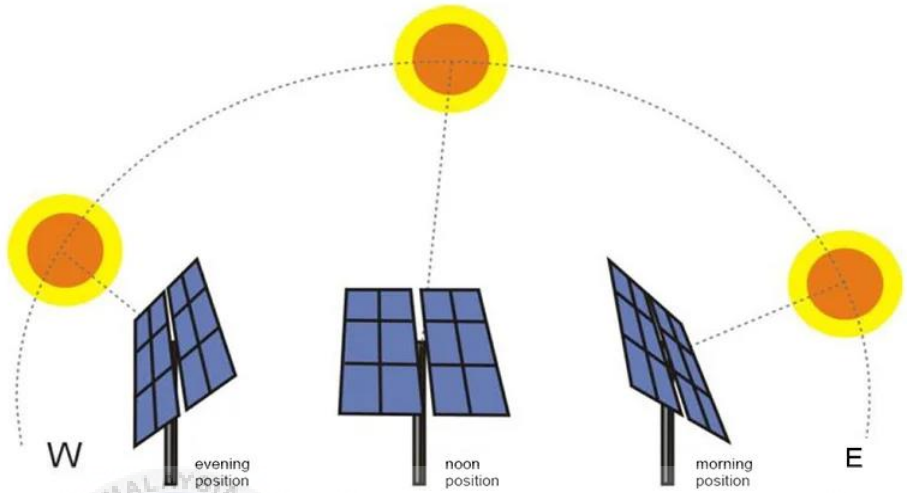

Figure 1.1: Dual Axis Solar Tracker

As we know, solar panels consist of photovoltaic cells that convert energy from the sun to electricity. Direct current (DC) electricity is generated by photovoltaic cells. This DC electricity can be used to charge batteries, which can then be utilised to power direct current equipment. Thus, to improve solar panels in efficient ways, it can be used for two axis solar tracking systems. It consists of polar and axis tracking and also altitude and azimuth tracking. This tracking is changing all the time. In simple words, it goes right, left, up and down. It can track the sun to collect high solar energy. This means that after setting up the tracker, we don't need to update or adjust anything because it will follow the sun wherever it goes. So, it can track from north to south, and east to west. For electricity generation, this method produces the best results.

Moreover, with the electricity produced from two axis solar tracking it can drive a water pumping system directly. People can save water from going to waste by having a storage tank that can measure the water level using a water level sensor. With this, water

will flow according to the level of human consumption. Water is essential for survival, as it is required for drinking, daily domestic tasks, and large-scale applications such as irrigation, construction, and hydropower generation. Water is crucial to the country's development because it is dependent on the quality and amount of water available in their area. So, by using a two axis solar tracker for water pumping systems, people can maintain the usage of water by using a water tank that constantly flows from water supply. Therefore, two axis solar tracker for water pumping systems provides water storage as a basic necessity and it has become so popular especially in the agriculture sector and micro irrigation applications.

To develop two axis solar tracker for water pumping systems to investigate the efficiency of solar tracking and effectiveness on water pumping systems. The major purpose of this project is to track the sun so that the solar panel receives maximum sunlight at all times of the day and can power the water pumping mechanism.

1.1 Problem Statement

The main issue is solar power, which is only accessible in permanent installations. As a result of this problem, the amount of electricity that may be created is limited. Previous solar which is static solar that just does not have any tracks the sun's daily motion which means it can not move at all. Hence, it has no light dependent resistor (LDR). Because the sun's position changes during the day, solar tracking panels in a fixed position may not be able to get enough solar energy to make electricity. Furthermore, the solar panel that is being employed is only one-way. Because of this issue, the amount of power that may be created is limited.

In order to address these issues, development of two axis solar tracking is produced since it can track the sun according to its position since it can rotate to 180 degree. Two axis solar tracker also has high efficiency since it can track maximum sunlight on solar panels.

On top of that, by using LDR as a sensor, it can track solar energy. It can be implemented by four LDR sensors since it is two axis solar tracking. Using four LDRs, the solar panel can travel over a double-axis. There will be light whenever one of the LDRs detects the presence of solar energy. It will be easy to build and set up the projects in rural areas throughout the world to generate power on a regular basis. Then, with LDR, a two-axis solar tracker will be able to capture solar energy into electricity, so water will not need more time to fill in the water tank. Thus, solar tracking is required to ensure that the water pump system's precision is maintained.

1.2 Project Objective

There are three main goals of this project :

a) To design a two axis solar tracker for a water pumping sytem for the good purposes by implementing a hardware and software device.

b) To develop a two axis solar tracker system using an LDR sensor.

c) To analyze the output voltage of two axis solar tracker and output volume of water pumping system.

1.3 Scope of Project

This project aims to develop a two axis solar tracker for water pumping systems, the scope of this project will be as follows :

a) The project will be divided into two types of implementation: software and hardware.

b) The system will be developed using the Arduino programming language and Arduino Uno microcontroller as a brain to control all of the project's components is one of the project's goals and include a sensor system and output.

c) Will be able to analysis the output voltage two axis solar tracking using LDR and output volume of water pumping.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Two-axis solar trackers have a lot of benefits for renewable energy. In order to ensure this project's success, a literature review is a must as a guide to assist with problems encountered. There are a few previous discussions, journals, and research papers regarding development of two axis solar trackers for water pumping systems that will be reviewed to get more details.

2.1 Overview

Solar energy may be used to generate heat, chemical processes, and electricity as a substitute for fossil fuels. Solar energy can be categorised into three types : thermal energy from the sun for heating, solar power that is concentrated for electricity, photovoltaics (Solar PV) for electricity. Solar power consists of photovoltaic (PV) panels. Photovoltaic (PV) panels or mirrors that concentrate solar radiation are used in solar technologies to convert sunlight into electrical energy. This energy can be utilised to produce electricity, or it can be stored in batteries or thermal storage. PV cells also can be categorised into three which is monocrystalline silicon, polycrystalline silicon, and thin film are the three types of PV cell technology that now dominate the global market. Based on the efficiency that we can see from three types of PV cells, when compared to the other two kinds of solar cells, monocrystalline solar panels are known to have the best efficiency in conventional test circumstances.

Moreover, a two-axis solar tracker has higher efficiency than a single-axis solar tracker. Since this project uses two-axis solar tracking, it can increase flexibility, allowing for higher energy production on sunny days. Besides, it also has a higher degree of accuracy in pointing directions. Since a water pumping system needs energy from a two-axis solar tracker to pump water from the water supply to the water tank. Efficiency in a project is needed to ensure this project's outcome is successful.

2.1.1 Implementation of Dual Axis Solar Tracking System.

According to a journal by V Mohanapriya, V Manimegalai, V Praveenkumar and P Sakthivel [3]. This paper proposed a method for implementing a dual axis solar tracker using Arduino UNO and LDR. The Arduino Microcontroller, four LDRs, and three stepper motors are used to create the automated solar tracking system based on the Arduino prototype. The machine is operated via a combination of hardware and firmware programming. In hardware manufacturing, four light-based resistors (LDRs) are utilized to catch the most amount of incident light. Three stepper motors are utilised to move the solar panel based on the amount of incident light detected by LDRs. Hence, the benefits of dual axis solar tracking is solar power generation, rather than non-renewable energy sources, is one of the pollution-free and zero-emission processes discussed in this study due to nowadays, CO2 emissions from limited sources of fossil fuels, such as petroleum and coal, contributing to global warming.

The overview of this project is shown Figure 2.1 and Figure 2.2 is that when the program starts, it declares variables for each component set and states variables to the predefined i/o port patterns for the input and output ports. Next, it makes the microcontroller read the values that got from the light dependent sensors and conduct the appropriate actions, then it will look for outputs on the LDR, read the analogue values, and analyse the data for solar panel placement. After that, check the voltages of the fixed in the design setup and tilt

the machine accordingly. Examine the voltage differences between LDR sensors, then through circumstances, if the voltage is higher on the left, the panel will spin clockwise and if the voltage doesn't change significantly, the location stays the same and also if the voltage on the right side of the LDR is higher, the panel will be rotated anticlockwise.

Figure 2.1: Flowchart of Implementation of Dual Axis Solar Tracking System.

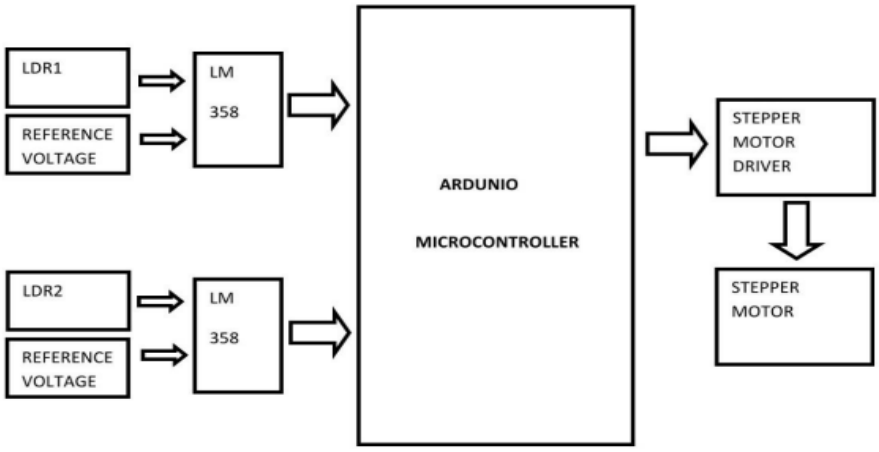

Figure 2.2: Blockdiagram of Implementation of Dual Axis Solar Tracking System.

2.1.2 Solar Tracking for Automatic Irrigation System.

According to a journal by S. Muralidhar, T.M. Chandrashekharaiah, Saleemasb Doddamamani on May 31, 2019 [4]. It is explaining about the components used to detect sunlight using LDRs, then use the stepper motor to adjust the solar panel such that it receives the most sunlight, Arduino software, servomotor, temperature sensor, soil moisture sensor, water pump, LCD Panel, and Arduino UNO microcontroller (IDE)

Next, it is also describe about the irrigation pump in this automatic irrigation with solar tracking system is powered by solar energy, and the circuit includes sensors that detect whether the soil is dry or moist. The automated watering system will be controlled by an Arduino UNO microcontroller. The system's sensor will detect the amount of moisture in the soil and send a signal to the microcontroller unit controlling the pump. The comparator receives the signal from the sensor and processes it using the saved software on the microcontroller. The pump is turned off when the soil is damp and on when the soil is dry.

Figure 2.3: Components of Automatic Irrigation System.

2.1.3 Solar Tracking and Automated Water Pumping System.

The journal was published by S Sushruthi Pai, Yashaswini Y Acharya, Vibha K P on 2019 [5]. This journal discussed a single axis solar tracking system that collects the maximum amount of energy from the sun rays and stores it in a battery for future use in developing an automated water pumping system that saves water and reduces manpower. Then, researchers also explained based on Figure 2.4 that it consists of 2 parts which is solar tracking and water pumping system.

These LDRs are attached to the solar panel's two ends. The Arduino will determine the direction of rotation of the stepper motor based on the intensity of light falling on the LDR. The panel is attached to the stepper motor. As a result, the Arduino regulates the rotation of both the stepper motor and the solar panel. The water pumping system, which is the second half of the project, is made up of water level sensors, a DC motor, and a battery. The water level sensor is used to monitor and control the tank's water level. Solar energy is captured and stored in a battery. The absorbed energy is subsequently delivered to the pump's motor, which drives it.

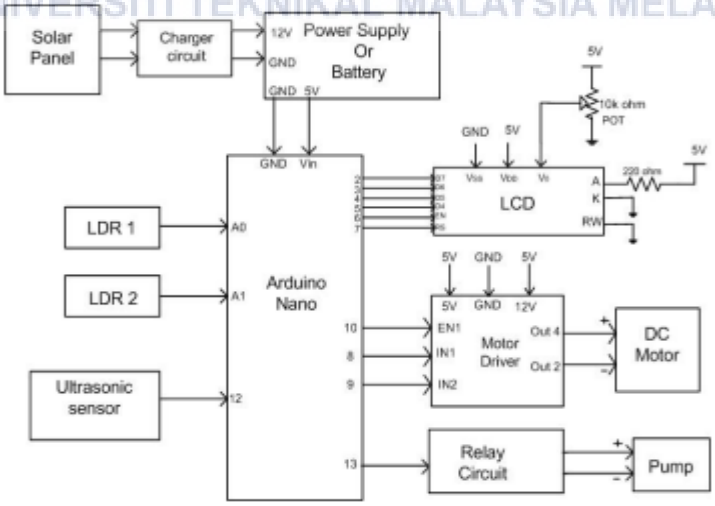

Figure 2.4: Block diagram of Solar Tracking and Automated Water Pumping System.

According to figure 2.5, 2.6 and 2.7 the design of single axis solar tracking and automated water pumping system was successfully implemented by the researchers. Moreover, an automated water pumping system was built, which detects the water level in the tank and automatically switches on and off the pump based on the water level detected then sends the message through LCD to display, which was programmed using an Arduino Uno.

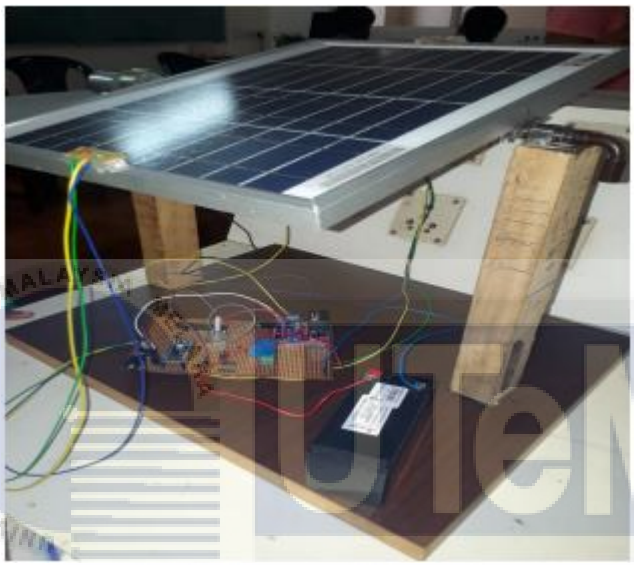

Figure 2.5: Design of Solar Tracking System

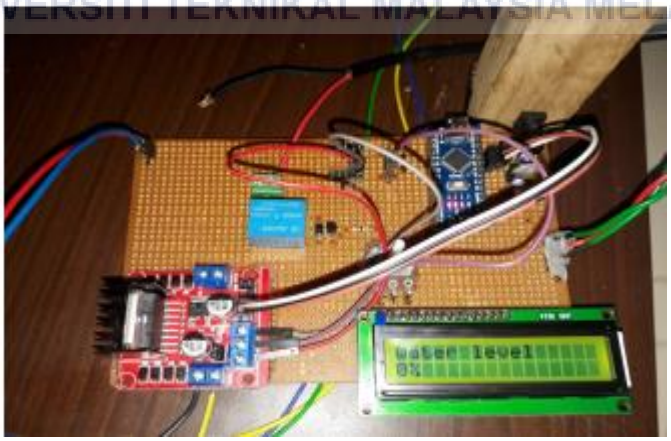

Figure 2.6: Design of connection Solar Tracking and Automated Water Pumping System.

Figure 2.7: Design of Solar Tracking and Automated Water Pumping System.

2.1.4 Solar PV Powered Water Pumping System- a review.

This journal by Shrey Verma, Shubham Mishra, Subhankar Chowdhury, Ambar Gaur, Subhashree Mohapatra, Archana Soni and Puneet Verma on 30 August, 2020 [6]. This journal review of solar water pumping systems focuses on the many configurations of the water pumping system and the numerous types of motors and pumps used for various purposes.

Based on their studies, a solar powered water pumping system can be installed with DC coupled, AC coupled and AC coupled with battery back up as shown in figure 2.8, 2.9 and 2.10. Researchers discussed that the generated energy is predominantly in DC and the pump is mostly in AC, the inverter must convert the output energy to AC before it can power the pump. Hence, DC motors are popular because they do not require an inverter or controller to convert the DC output of a PV array and may be used directly by the motor. For big applications (above 9 hp), DC motors are more efficient than AC motors, which require an inverter to convert the PV array output from DC to AC. On top of that, researchers also mentioned that type of motor used in solar power water pumping systems and type of pump such as DC shunt motor, switched reluctance motor and induction motor usually used in centrifugal pumps while brushless dc motor used in helical rotor pump.

Besides, the researchers also reviewed the accuracy of the pump head selection is important in determining the solar power water pump system overall efficiency. The pump head, often known as the discharge head, is a measurement of the pump's power. The higher the pump head, the more pressure the pump can generate.

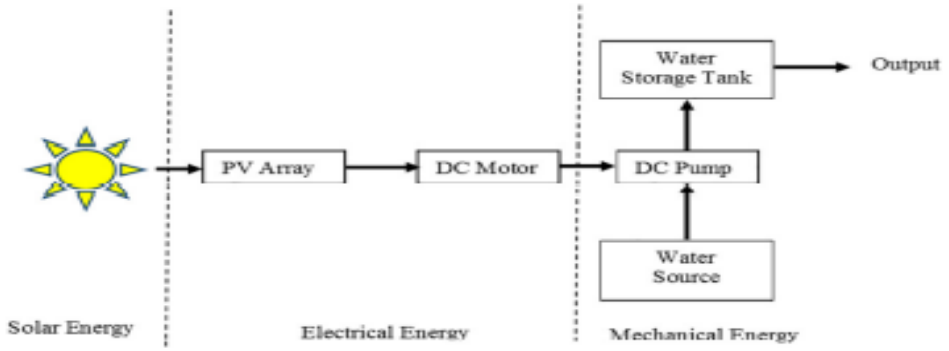

Figure 2.8: Solar Power Water Pumping System with DC-Coupled

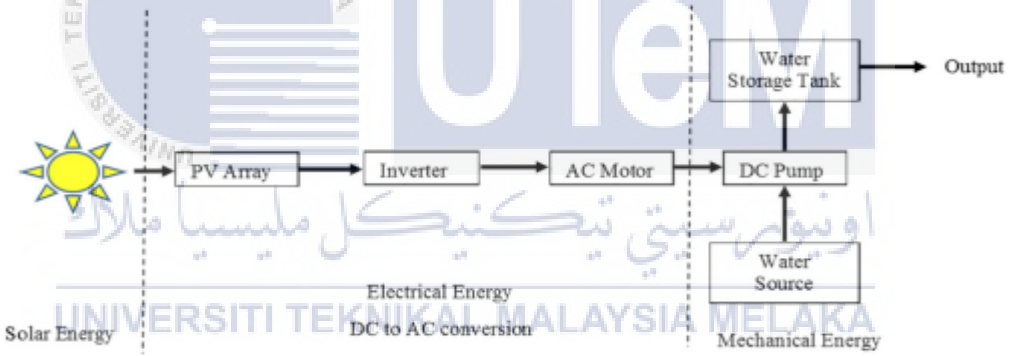

Figure 2.9: Solar Power Water Pumping System with AC-Coupled

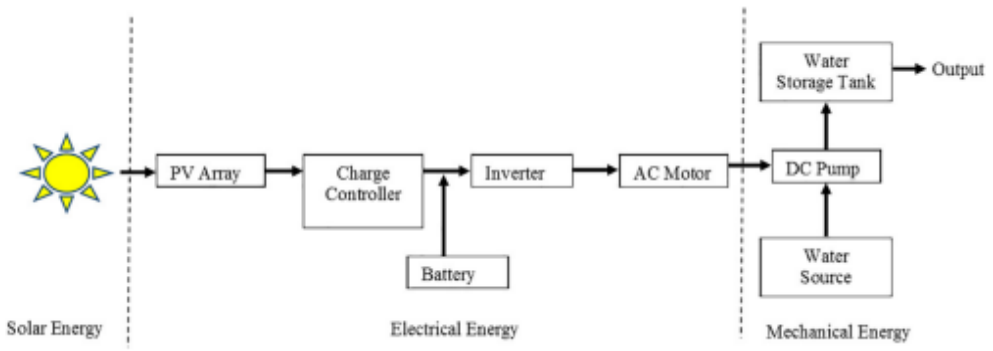

Figure 2.10: Solar Power Water Pumping System with AC-Coupled and battery backup

2.1.5 Comparison of Efficiencies of Solar Trackers System with Static Panel Single Axis Tracking System and Dual Axis Tracking System with Fixed Amount.

On 2013, Dhanabal.R, Bharathi, Ranjitha.R, Ponni.A, Deepthi.S and Mageshkannan.P [7] proposed this research to compare efficiencies of solar in fixed form and solar trackers between single axis solar tracker and dual axis solar tracker. The researchers discussed that in a fixed form, their efficiency is low since the panels are oriented at a specific angle. However, in a tracking system, the panel is made to move along a single or dual axis. A single axis system that uses two LDRs positioned on both sides of the panel in which the panel is moved from east to west with respect to the sun, is more efficient than fixed panels.

Moreover, a dual-axis system that uses four LDRs, two motors and a controller. Each of the four LDRs is positioned in a different direction. Based on Figure 2.11 shows dual axis tracker that explains one pair of sensors and one motor are used to tilt the tracker in the east-west direction of the sun, while the second set of sensors and another motor are used to tilt the tracker in the north-south direction of the sun. The controller detects the LDR signal and instructs the motor to rotate the panel in the desired direction. This means it can allow the panel to rotate in all four directions in response to the sun.

The researchers also concluded that dual axis systems have outperformed both fixed panels and single-axis systems in terms of efficiency. This is because based on the experiment that made by researchers from 8 am to evening 6 pm for every one hour, according to the measurements, the dual axis tracker's efficiency is 81.68 percent higher than that of a fixed panel, whereas the single axis tracker's efficiency is only 32.17 percent higher than that of a fixed panel.

This journal also proposed a recommendation that adding a mirror or concave lens to the top of the screen may boost the dual-axis solar tracking system’s performance even

further. Because a large amount of sunlight is focussed on the panel and a large amount of power is created, using a lens or mirror boosts the tracker's efficiency. It also has the potential to minimise the size of the solar cell necessary to generate big amounts of energy. It has a high optical efficiency as well.

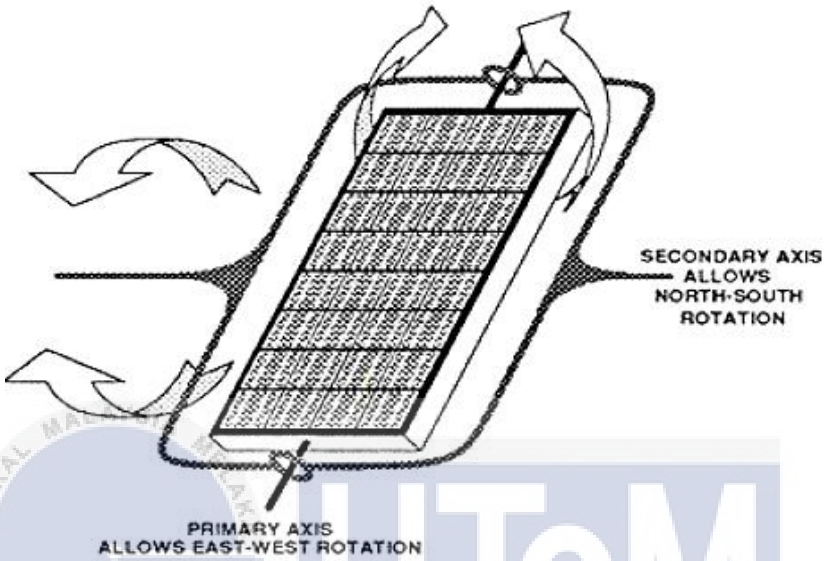

Figure 2.11: Dual axis tracker.

2.1.6 Automatic Irrigation with PV Solar Tracking

This paper by Basim Alsayid, Jafar Jallad, Muhammad Dradi and Ola Al-Qasem on December 04, 2013[8] includes variety of components and set up for that project. This paper also explained about humidity sensors in the soil and temperature sensors in the air are utilised to control the functioning of the DC water pump. Four light dependent resistance (LDR) sensors detect the sun's position; this data is read and processed by a 16F877A PIC microcontroller, which then moves two stepper motors, which act as actuators for the two-axis PV solar tracking system, to control azimuth and tilt angles. This paper also mentioned that the PV module utilised has a 12V dc output voltage and can deliver a dc current of 300mA, which is sufficient to turn on the pump.

2.1.7 A Review of An Automatic Water Level Indicator

This paper by Muhammad Ahmad Baballe, Abubakar Sadiq Muhammad,Fatima Abubakar Usman, Naja'atu Kabir Mustapha, Abdulkadir Habibu Kofar Naisa, Abdullahi Kabiru Shehu, 2022 [9]. This paper explains about these automated water level controllers based on Figure 2.12 shows simple water level controller are used to monitor the water level in the overhead tank automatically replenish it with water when it starts or runs out. When the water level in the overhead tank drops below the predetermined level it turns the pump off.

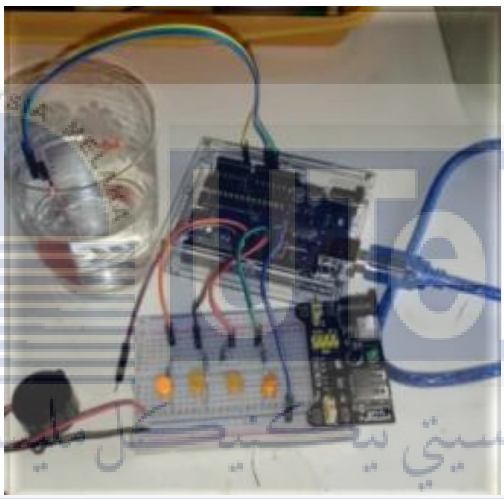

Figure 2.12: Simple Water Level Controller

2.2 Summary

Table 2.1 shows the summaries of journals and articles.

Author	Title	Functional	Remark
S Sushruthi Pai, Yashaswini Y Acharya, Vibha K P	Solar Tracking and Automated Water Pumping System.	Discussed a single axis solar tracking system that collects the maximum amount of energy from the sun rays and stores it in a battery for future use.	- Solar panel - LDR - DC motor - Water level sensor - LCD - Relay - Pump - Ultrasonic sensor
Basim Alsayid, Jafar Jallad, Muhammad Dradi, Ola Al-Qasem.	Automatic Irrigation System with PV Solar Tracking.	Sun energy is the most promising due to the abundance of solar irradiance. Photovoltaic (PV) off-grid solar systems could provide a solution for pumping and irrigation systems.	- DC pump - LDR (light dependent resistances) - use 4 are used to detect the sun position. - Two of them (LDR1 and LDR4) are used to control the azimuth angle and the other two (LDR2 and LDR3) are used

			to control the tilt angle. - Two stepper motor. brushless, load independent, has open loop position control capability, good holding torque and excellent response characteristics. - Pump - Relay - PV module - Motor driver (L298 IC used to drive the two stepper motors) - 16F8877A PIC microcontroller. - Temperature sensor - Humidity sensors - LCD displays
S. Muralidhar, T.M. Chandrashekharaiah,	Solar Tracking for Automatic Irrigation System	It is describe about the components that use in project and describe the	- LDR - Arduino software - Servomotor

Saleemasb Doddamamani		irrigation pump in this automatic irrigation with solar tracking system and how it is functioning.	- temperature sensor - soil moisture sensor - water pump, - LCD Panel - Arduino UNO - microcontroller (IDE)
Shrey Verma, Shubham Mishra, Subhankar Chowdhury, Ambar Gaur, Subhashree Mohapatra, Archana Soni, Puneet Verma.	Solar PV Powered Water Pumping System-review	A review of solar water pumping system focuses on a different configuration of the water pumping system and the numerous types of motors and pumps used for various purposes.	- Dc motor - Dc pump - Water storage tank - Charge controller - Battery - Solar pump - Inverter (if using AC motor) - Pump head
V Mohanapriya , V Manimegalai, V Praveenkumar and P Sakthivel.	Implementation of Dual Axis Solar Tracking System.	These trackers enable photovoltaic systems to reduce the angle of incidence between incoming sunlight and the sensor within the solar tracking device, hence lowering the amount of power consumed.	- Arduino microcontroller - LDR - Stepper motor - Solar panel - LCD

Dhanabal.R, Bharathi, Ranjitha.R, Ponni.A, Deepthi.S, Mageshkannan.P	Comparison of Efficiencies of Solar Trackers System with Static Panel single axis tracking system and Dual axis tracking system with fixed mount.	These panels can be used in a fixed configuration or in a single axis or dual axis solar tracking system.	Single axis solar tracker - A single axis system that uses two LDR positioned on both sides of panel is moved from east to west respect to the sun, is more efficient than fixed panel - Estimated to be 32.17% than the static panel. Dual axis solar tracker - Use four LDR, two motors and a controller. Each of the four LDR is positioned in a different direction. - Estimated to be 81.68% more

			efficient than the static panel.
Muhammad Ahmad Baballe, Abubakar Sadiq Muhammad,Fatima Abubakar Usman, Naja'atu Kabir Mustapha, Abdulkadir Habibu Kofar Naisa, Abdullahi Kabiru Shehu	A Review on An Automatic Water Level Indicator	Automated water level controllers are used to monitor the water level in the overhead tank automatically replenish it with water when it starts or runs out.	Benefits - Water level controller can reduce water and power waste - A water level controller is a suggestion for a power saver in this age where we need to be more aware of the energy we consume.

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter explains the whole development process for the 'Development of Two Axis Solar Tracker for Water Pumping System'. This chapter also consists of block diagrams, flow charts, each component used in the project and others. It is explained in every technical part in order to understand more about this project. In addition, to make sure this project is successful, the parts of hardware design and software development for the project are described detailed. To present this project, the production flows and procedures are described and explained from start to finish. Each full explanation of the steps done is defined individually.

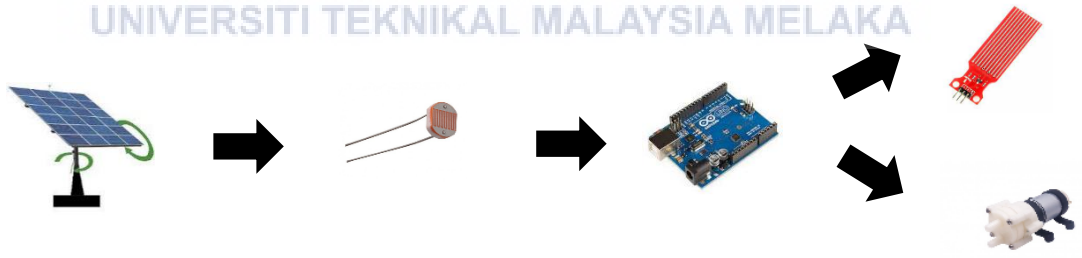

Figure 3.1: Project concept

Based on Figure 3.1, it shows the project concept of this project. It starts with the two axis solar tracker that captures the maximum sunlight. Then, the arduino is the brain of the entire system since it uses c-based language programming. To track the maximum sunlight LDR sensor and can travel across two axis solar trackers. There will be light whenever one of the LDRs detects the presence of solar energy. It will be easy to build and set up the project in rural places throughout the world to generate electricity on a regular basis. On top of that, by specifying water level sensor data, the water pump system functions in automated mode. The water tank is low if the sensitivity value is less than the particular value, and the water pump is triggered.

3.1 Project Design

To be designed, a project must have a process from start to finish. A flowchart is one of the methods and visually displays the sequence to show the process flows. It is one of the most crucial steps in ensuring that the project runs well throughout the implementation phase. Figure 3.2 and Figure 3.3 shows the flowchart as the project's creation as a guide for this project. It starts with an explanation of each phase in order to achieve the outcome and the objectives. Moreover, since it uses software, the flowchart starts with solar tracking and ends with the water pump. It shows how the process works and how the operation works from beginning to end.

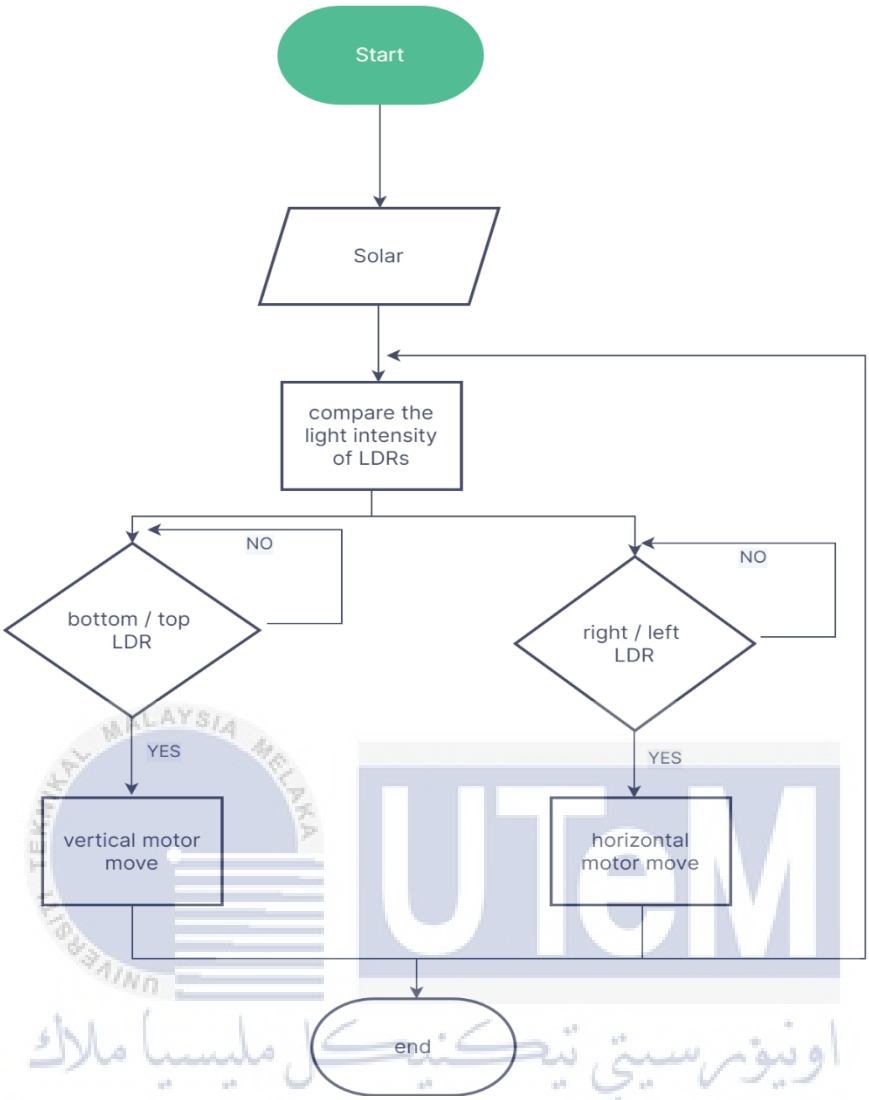

Figure 3.2: Flowchart of two axis solar tracking system

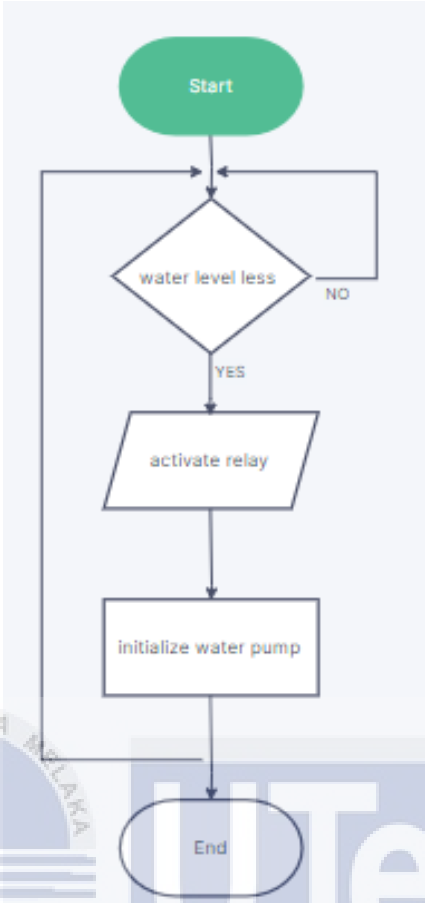

Figure 3.3: Flowchart of water pump

3.2 Project Architecture

To demonstrate the operation involved, this project shows the block diagram as refer to Figure 3.4. It directly describes the whole process of this project. With this way, it is easy to detect any problems and if they have some difficulties.

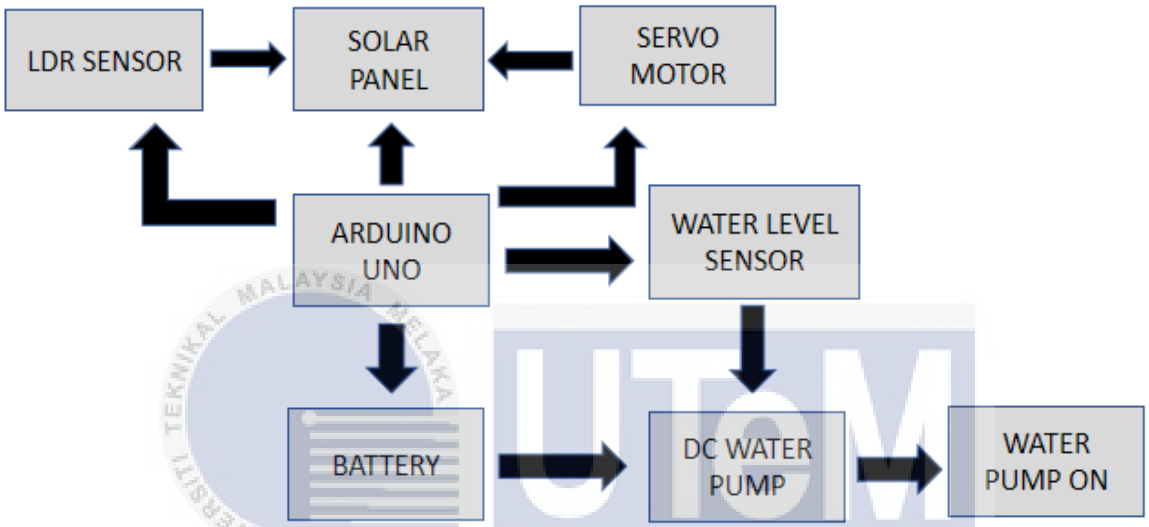

Figure 3.4: Block diagram of the project

In this project, 6 V solar panel is used to track the maximum sunlight. Since four LDR sensor functions as a light sensor to track solar energy. Then, Arduino as a brain of system will give instruction to 5V servo motor to rotate the solar panel. The solar panel is pushed towards the LDR by the servo motor, which lower resistance. After that, the solar energy is reached, if the battery is drained, it can charge to the solar. Meanwhile, water level sensor will detect water levels. Then, if water level reaches its maximum point of water level, it will turn on the dc water pump.

3.3 Hardware Requirements

3.3.1 6 V Solar Cell

Solar cells capture the sun's rays and convert them to power or heat. Solar panels are made up of solar (or photovoltaic) cells that may be used to generate power via the photovoltaic effect. These cells are arranged in a grid-like pattern on the surface of solar panels. As a result, it can alternatively be described as a collection of photovoltaic modules put on a supporting framework. A photovoltaic (PV) module is a 610 solar cell packaged and linked assembly as shown in Figure 3.5.

Figure 3.5: Solar Panel

3.3.2 Light Dependent Resistor (LDR) sensor

Figure 3.6 shows Light dependent resistors, also known as LDRs or photoresistors, are electrical components that are often used in electronic circuit designs when the presence or amount of light must be detected. LDR sensors are extremely light sensitive. Moreover, the lesser the resistance, the greater the light can be detected. The resistance value of the LDR photoresistor resistance decreases with increasing light intensity and it may be decreased to less than 1k. Table 3.1 shows the LDR’s features and the description to know more about LDR sensor.

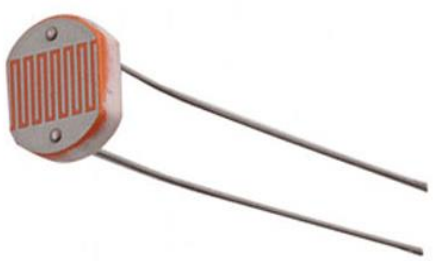

Figure 3.6: 3.3 V to 5 V Light Dependent Resistor sensor

Features of LDR:

Table 3.1: LDR's features

Features:	Description:
Input voltage	DC 3.5V to 5V
Output	Analog and digital
Operating current	15 mA
Material	Cadmium
Power dissipation	100 MW
Maximum withstand voltage	150V DC

3.3.3 MT3608 DC-DC Boost Converter

A boost converter dc-dc is used to boost and enhance the input voltage of an unregulated DC supply to a stable higher output voltage as in Figure 3.7. This is also a step-up converter with minimal power requirements and has the capacity to provide a maximum output current of 2A and control output voltage up to 28V. Table 3.2 shows DC-DC Boost Converter's specification.

Figure 3.7: DC-DC Boost Converter

Specification of dc-dc boost converter:

Table 3.2: DC-DC Boost Converter's specification

Specification	Description
Efficiency	95%
Input voltage	2V to 24V
Output voltage	5V to 28V
Maximum output current	2A
Switching frequency	1.2 Mhz
Module size	37.2mm X 17.2mm X 14.00mm

3.3.4 Servo Motor

A servo motor is a rotary or linear actuator that provides for accurate angular or linear position, velocity, and acceleration control as in Figure 3.8. In other words, it is also functioning as a self-contained electrical device that rotates machine components with high accuracy and efficiency. Table 3.3 shows the servo motor's features.

Figure 3.8: Servo Motor

Specification of servo motor:

Table 3.3: Servo Motor's features

Specification	Description
Weight	55g
Dimesion	39.5mm x 20.5mm x 40.7mm
Operating voltage	4.8V to 6.6V
Temperature range	0-55 deg
Servo wire length	30 cm
Rotation angle	180 degree

3.3.5 3400mAH Doublepow Lithium Li-ion Battery

Figure 3.9 shows 3400 mAH Lithium Li-ion battery that have one of the best energy-to-weight ratios, a high open circuit voltage, a low self-discharge rate, no memory effect and a slow erosion of charge while not in use.

Meanwhile Li-ion battery is one of the most widely used types of rechargeable batteries and also can charge from any USB port so the user don't need a specialized charger. Table 3.4 shows 3400 mAH Lithium Li-ion battery's characteristics.

Figure 3.9: 3400mAH Lithium Li-ion battery

Characteristic of lithium Li-ion batteries.

Table 3.4: 3400mAH Lithium Li-ion battery

Characteristic	Description
Shelf life	1 year
Charging voltage	5V
Discharging voltage	1.5V
Net weight	29g

3.3.6 1kΩ Resistor

Resistor as in Figure 3.10 is one of the passive devices used to control the flow of electric current in a circuit. It is made of copper wires that are wrapped around a ceramic rod and has an insulating paint coating on the outer part. Characteristic of resistor is shown in Table 3.5.

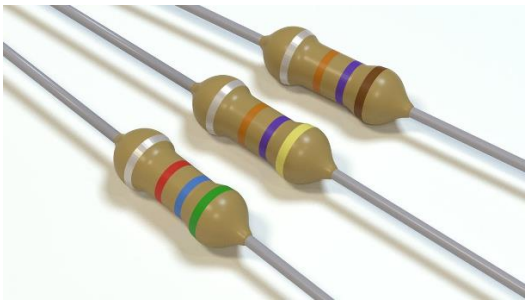

Figure 3.10: 1kΩ Resistor

Characteristic of resistor:

Table 3.5: Resistor's characteristic

Features	Description
Capacitor value	1kΩ
Tolerance	±1% to ±20%
Temperature coefficient	25℃

3.3.7 5V Relay

The relay module as shown in Figure 3.11 is an electrically actuated switch that may be switched on or off, allowing or disallowing current flow. On this relay module, there are two channels (those blue cubes). One, four, and eight channels are among the other

options. This module should be powered with 5V, as needed by an Arduino. Relay module pin description is shown in Table 3.6.

Figure 3.11: 5V Relay

Relay Module pin description:

Table 3.6: Relay's description

Pin Number	Pin Name	Description
1	Relay Trigger	Activation input for the relay
2	Ground	0V
3	Vcc	The relay coil is powered by the supply input
4	Normally open	The relay normally open terminal
5	Common	The relay's common terminal
6	Normally closed	The relay's normally closed contact

3.3.8 12V DC Water Pump

Figure 3.12 shows DC water pump as it is used to move fluid by utilising direct current from a motor, battery, or solar power. Because this pump is powered by a direct-current motor, no inverter is required. Hence, DC water pumps are more efficient, making them more portable and practical.

Figure 3.12: DC Water Pump

3.3.9 Water Level Sensor

The water level sensor is a device that detects an excessively high or low liquid level in a fixed container as shown in Figure 3.13. This water level sensor functions as a variable resistor as well. The resistance changes with the amount of water present. The sensor has stronger conductivity and reduced resistance when submerged in more water. Due to its poor conductivity, the sensor has a larger resistance when submerged in low water. Table 3.7 shows water level sensor's features.

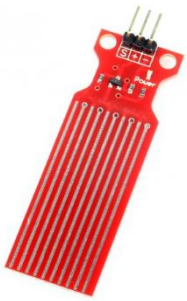

Figure 3.13: Water Level Sensor

Features of water level sensor:

Table 3.7: Water level sensor's features

Three main pins	Description
Vcc	3.3 V to 5 V
Signal	Get the water level as an analog value
GND	Ground of this sensor

3.4 Arduino Uno

Figure 3.14 shows arduino uno board that acts as a brain of the project , because it's a key component of Arduino boards. The microprocessor in the Arduino allows for speedier and more dynamic control. Moreover,it is open-source platform that implement basic hardware and software to make it simple use [10]. Table 3.8 shows the features of arduino uno.

Figure 3.14: Arduino Uno Board

Table 3.8: Features of Arduino Uno

Features	Description
Operating value	Between 1.8V and 5.5V
Temperature range	Between 40°C and 105°C
Speed grade	0-4 Mhz @ 1.8-5.5V
	0 - 10MHz @ 2.7 - 5.5V
	0 - 20MHz @ 4.5 - 5.5V
Power consumption	Active mode: 0.2mA
	Power-down Mode: 0.1μA
	Power-save Mode: 0.75μA (Including 32kHz RTC)

3.5 Software Requirement

3.5.1 Arduino IDE

Figure 3.15 shows Arduino IDE. This software for the Arduino Uno controller was used to build the programming coding for this project. The programmer may simulate the coding before uploading it to the Arduino controller board. The open-source nature of this software makes it simple to develop code and upload it to Arduino-compatible devices.

The Arduino IDE is simple, but it gives a nearly complete setting for most Arduino-based projects. The options on the top menu bar are standard, such as “File” to create a new file and name it. Then, click “Edit” to edit the font, copy or paste. To compile and set up, you need to click “Sketch”. After that, to test the project might use “Tools”, after inserting the coding, if something occurs can click “Help”. The output screen at the bottom of the IDE displays the compilation status, how much memory was consumed, any error identified in the software, and several other important notifications.

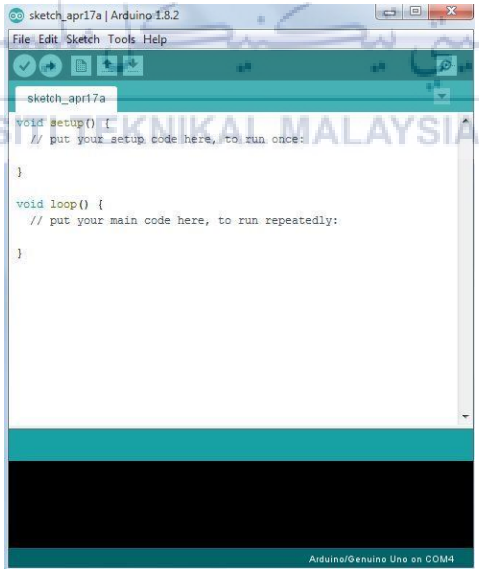

Figure 3.15: Arduino IDE

3.5.2 Proteus Software

To complete this project must have circuit and simulation. Figure 3.16 shows Proteus Software as it was utilised to implement the simulation of the circuit. Proteus is a programme for designing electrical circuits that combines schematic capture, simulation, and PCB design (Printed Circuit Board). The software's features are powerful, integrated and simple for a beginner to use. For development of two axis solar tracker for water pumping system, the components in the proteus is used such as arduino uno, motor, relay, solar panel, water level sensor and others.

Figure 3.16: Proteus software

3.6 Product Design

The Figure 3.17 and Figure 3.18 shows the design of a two-axis solar tracking system for water pumping. It contains a solar cell, an Arduino Uno, a resistor, an LDR sensor, and a servo motor. All the components have been attached in order to make sure the project of two axis solar tracking is successfully implemented. For example, it shows the

design used for water pumping that uses a DC motor and a water level sensor. Due to this design, it is inspired for users to apply since it is convenient to use and the simplicity.

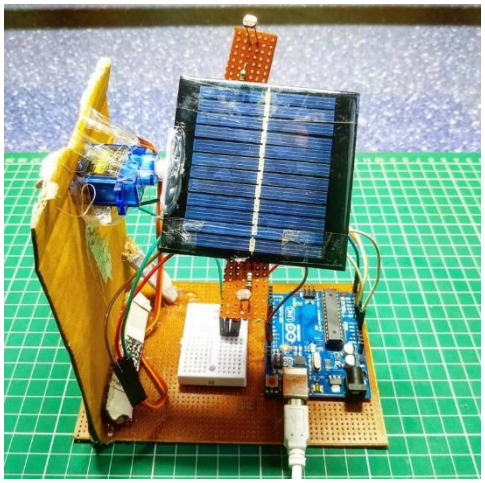

Figure 3.17: Two axis solar tracking system

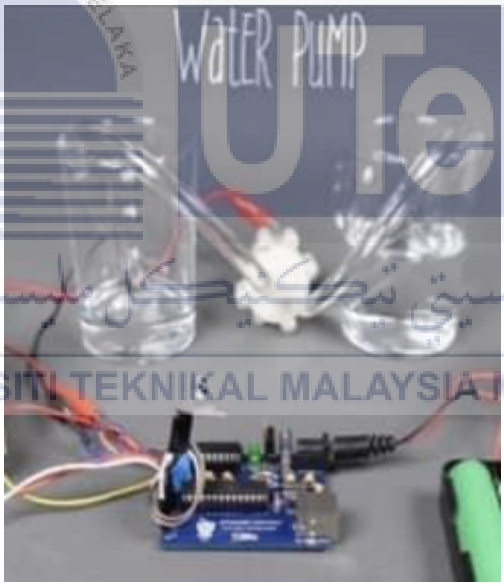

Figure 3.18: Water pumping system

3.7 Gantt Chart

The Gantt diagram in Figure 3.19 and 3.20 depicts the timeframe for scheduling and monitoring numerous aspects of this project. In the Gantt chart below, the progression of Bachelor's Degree Project 1 and Bachelor's Degree Project 2 is shown.

No.	Project Activity	Expected / Actual	WEEK													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Topic confirmation and discussion with the supervisor	Plan														
		Actual														
2	Final year project (PSM1) briefing by panel	Plan														
		Actual														
3	Research on academic papers	Plan														
		Actual														
4	Study background project	Plan														
		Actual														
5	Prepare for Chapter 1: Introduction	Plan														
		Actual														
6	Initial project: Simulation	Plan														
		Actual														
7	Update to supervisor: Progress Work 1	Plan														
		Actual														
8	Prepare for Chapter 2: Literature Review	Plan														
		Actual														
9	Prepare for Chapter 3: Methodology	Plan														
		Actual														
10	Report Draft Submission	Plan														
		Actual														
11	Update to supervisor: Progress Work 2	Plan														
		Actual														
12	Report Submission to Panel	Plan														
		Actual														
13	PSM Presentation Evaluation	Plan														
		Actual														

Figure 3.19: Gantt Chart Progress Bachelor's Degree Project 1

No.	Project Activity	Expected / Actual	WEEK													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	PSM 2 briefing and buy project components	Plan														
		Actual														
2	PSM 2 talk and meeting supervisor	Plan														
		Actual														
3	Module implementation 1	Plan														
		Actual														
4	Send claim form	Plan														
		Actual														
5	Make a coding by part	Plan														
		Actual														
6	Logbook submission/progress work 1	Plan														
		Actual														
7	Start making overall project	Plan														
		Actual														
8	Start making connection and wiring	Plan														
		Actual														
9	Start making hardware	Plan														
		Actual														
10	Meeting with the supervisor	Plan														
		Actual														
11	Start writing draft report	Plan														
		Actual														
12	Submit draft report progress work 2	Plan														
		Actual														
13	Submit report to panels+feedback form	Plan														
		Actual														
14	PSM2 presentation and evaluation	Plan														
		Actual														

Figure 3.20: Gantt Chart Progress Bachelor's Degree Project 2

CHAPTER 4

RESULTS AND DISCUSSION

4.0 Introduction

Throughout this chapter, we can observe and view that after testing and discussing of each data collected. There really are various steps that must be managed to complete in order to achieve the desired outcome.

4.1 Hardware setup

4.1.1 Servo Motor Wiring Diagram

Based on Figure 4.1 servo motor wiring diagram in proteus, servo motor is connected to arduino. For this project, used a 5V servo motor to move a 6V solar panel. The solar panel is precisely moved by a servo motor, and the light detector sensor (LDR) is attached to the 6V solar panel. Since servo motor can rotate and regulate the position from 90 degree to 160 degree so it means it can move vertical to horizontal, which followed the sunlight. In this project, servo motor is one of the key components in the development of two axis solar tracking system. While the Figure 4.2 shows the actual hardware servo motor wiring that we can see the actual connection.

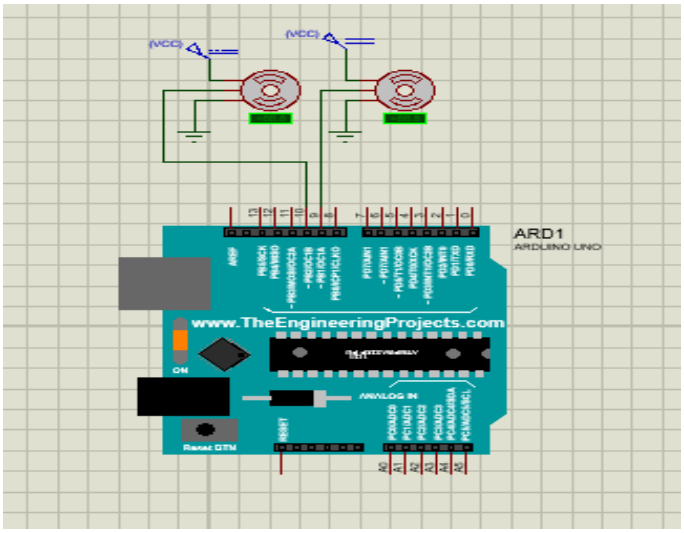

Figure 4.1: Servo motor wiring diagram

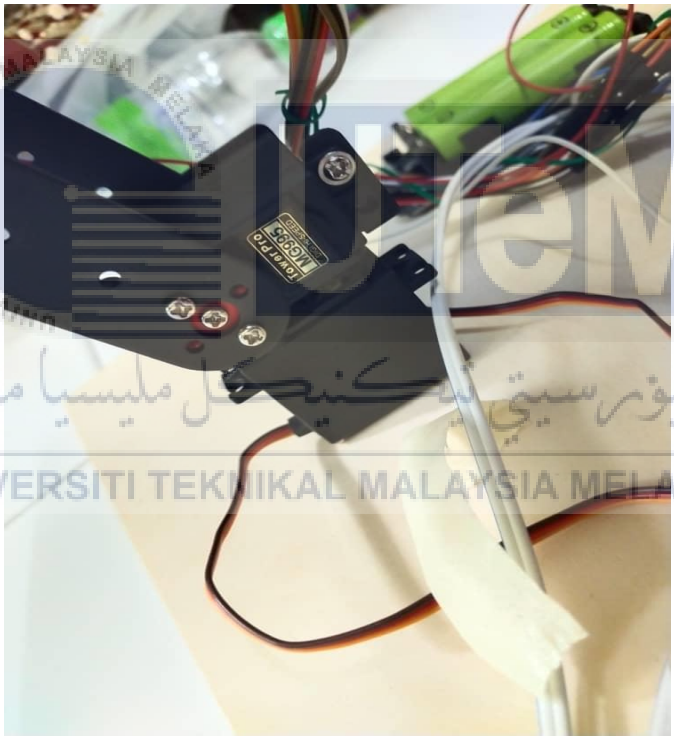

Figure 4.2: Actual servo motor wiring diagram

4.1.2 Solar Wiring Diagram

For this project based on Figure 4.3 solar wiring diagram and Figure 4.4 actual solar wiring diagram, 6V solar panel is used. The LDR sensor is attached to solar panel. The solar panel is outfitted with four LDR sensors. A four LDR sensor since it is two axis solar tracking system is used to detected the most presence sunlight and solar panel generate electricity energy. Moreover, this project makes use of a battery to power the entire project. So, if the battery is running low, the electrcity energy from solar panel can transfer to battery, allowing the battery to be charged to the four bars using solar panel.

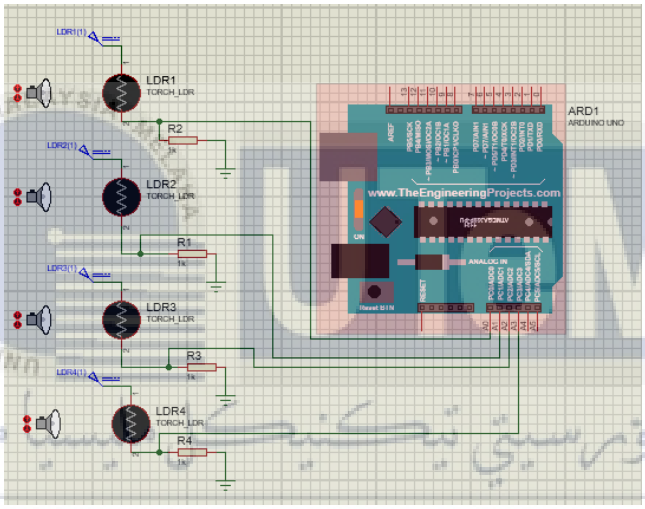

Figure 4.3: Solar wiring diagram

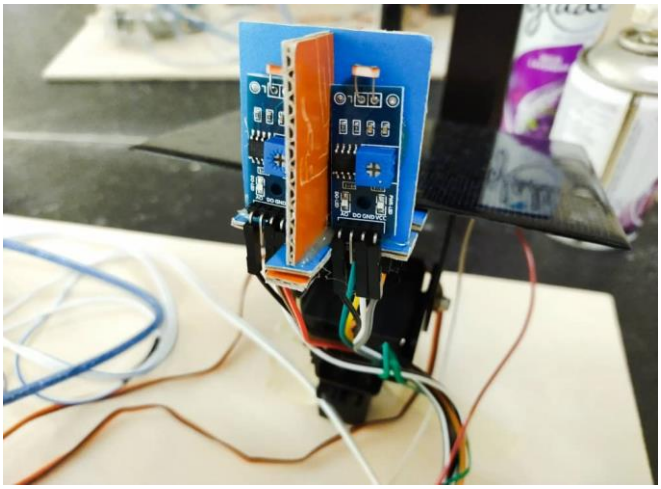

Figure 4.4: Actual solar wiring diagram

4.1.3 Water Pumping System Wiring Diagram

Based on Figure 4.5 water pumping system and Figure 4.6 actual water pumping system, 12V, 6 Watt DC motor water pump is used. It is connected to the 3400 mAH battery. While 12V step up dc-dc boost converter is use to support the battery to power up the 12 DC motor water pump. While the water level sensor is connected to the arduino. The DC motor pump will be turned with relay protection circuit, powered by the battery. When the water reaches the highest level, it will automatically turned off.

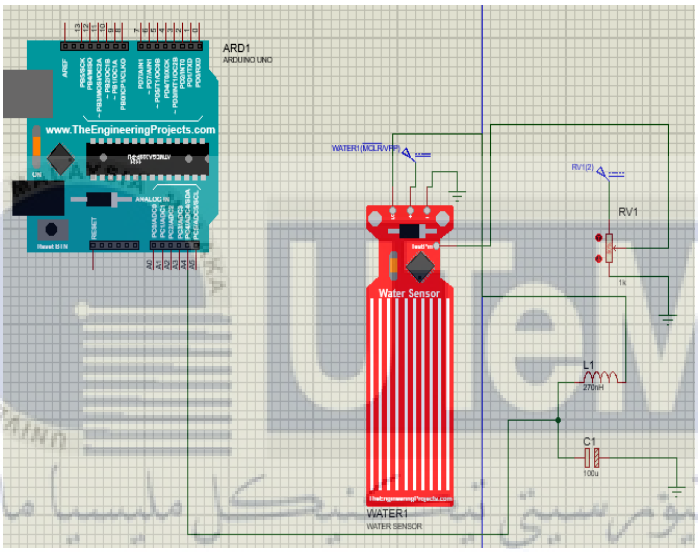

Figure 4.5: Water pumping system wiring diagram

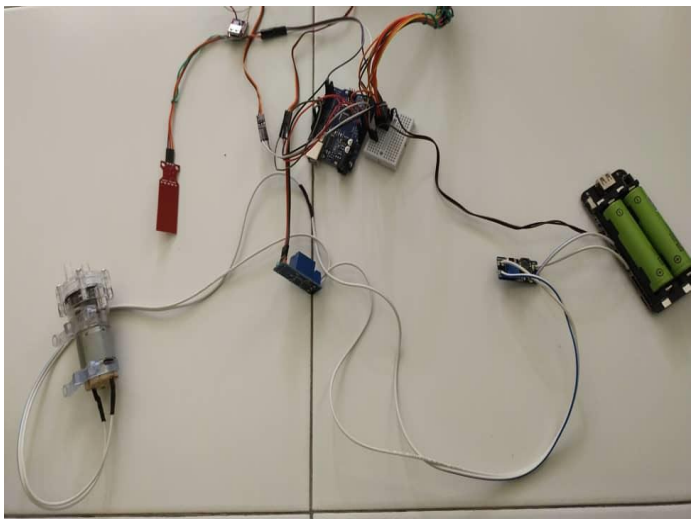

Figure 4.6: Actual water pumping system

4.1.4 Simulation Testing

Based on the figure 4.7 simulation testing on proteus, there is two system that divided into two system which is two axis solar tracking system water pumping system. A dc motor water pump is connected to the relay for two axis solar tracking, while the LDR sensor is connected to a servo motor. While, for water pumping system, water level sesnsor is connected to the battery. All of this system is connected to the arduino. Moreover, after conducting and constructing the circuit, the testing simulation is done and the circuit works successfully.

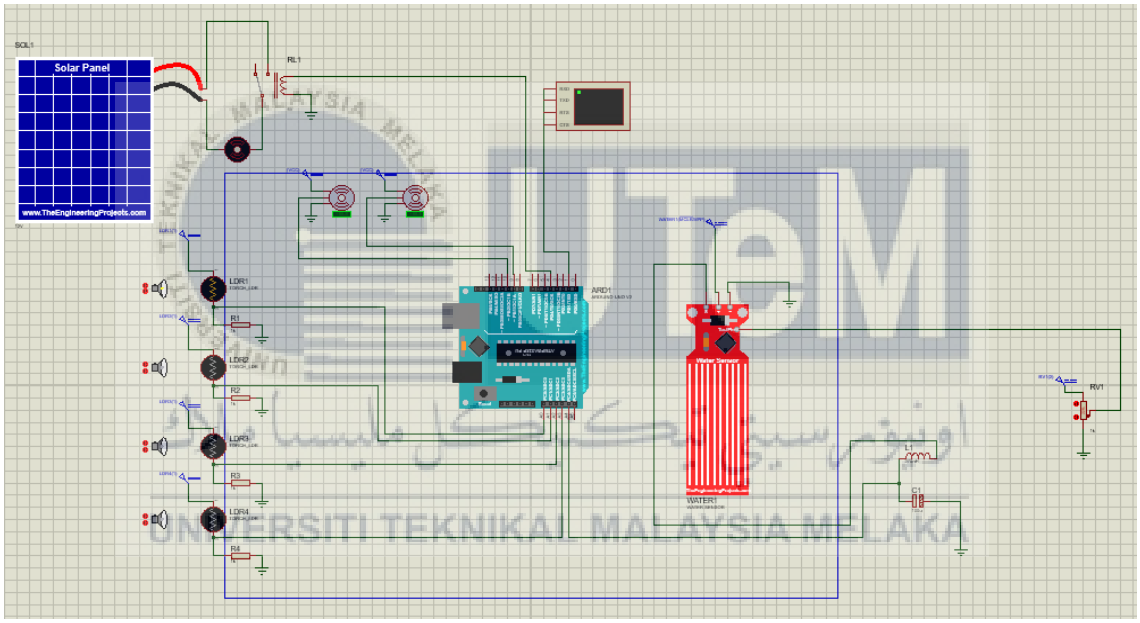

Figure 4.7: Simulation testing on Proteus

4.2 Hardware Design

4.3 Testing and Analysis Method

This section of the project is crucial since it requires an analysis of the development of two axis solar tracker for water pumping system. Following the completion of the two axis solar tracker for water pumping, this part will be discussed. To meet the goals and receive the best results, several experiments and analyses will be conducted.

This section has undergone testing to ensure the project's functionality is as shown in Figure 4.8. Two systems are being tested. Firstly, the testing on two axis solar panel, while the second one is water pumping system as the output.

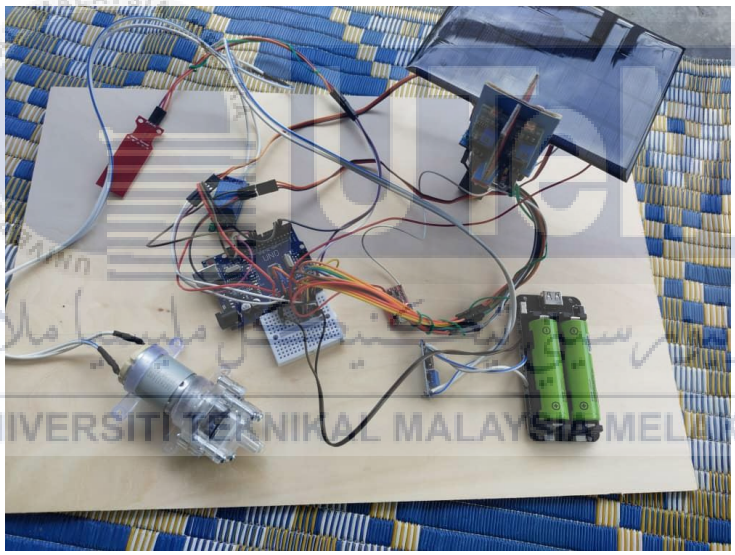

Figure 4.8: Testing functionality project

4.3.1 Data of Voltage Performance of Two Axis Solar Tracking System

The test was conducted for three days to test two axis solar tracking system. Due to testing two axis solar tracking system on various days, including overcast and bright days, the irridance of the sun may be one of the variations between both systems. Hence, the result may not be as accurate to compare since there is sunny and cloudy day. Table 4.1, 4.2 and 4.3 displays the data from the evaluated outcomes. A precise point value was used to measure the voltage for two axis solar tracker.

Table 4.1: Data of Voltage Performance of Two Axis Solar Tracking for Day 1

Time	Voltage (V)	Angle	
		Vertical	Horizontal
10.00 a.m	2.51	60	160
11.00 a.m	2.60	87	160
12.00 p.m	2.72	90	160
1.00 p.m	2.62	90	160
2.00 p.m	2.51	148	160
3.00 p.m	2.40	150	160
4.00 p.m	2.34	155	160
5.00 p.m	2.15	160	160

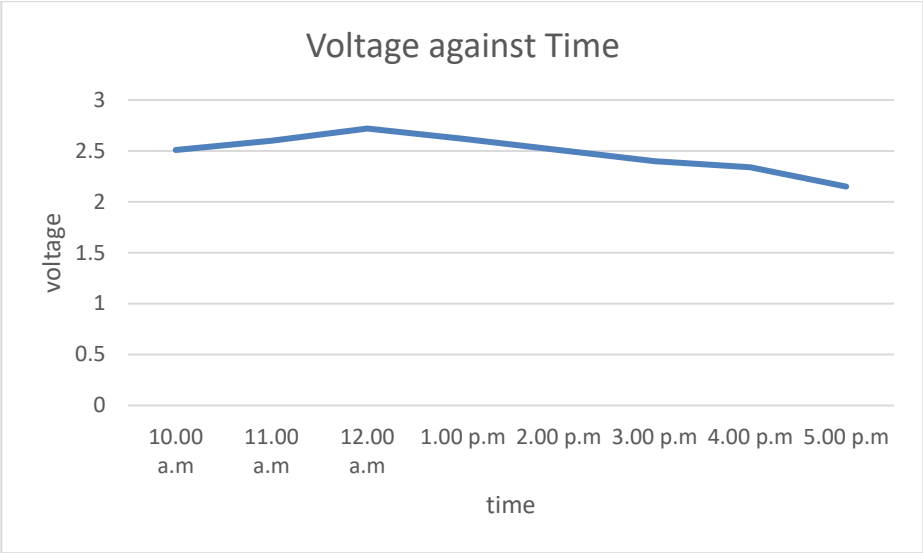

Figure 4.9: Voltage against time graf Day 1

Based on Figure 4.9, the graf is plotted and can be observed starting from 10.00 a.m to 5.00 p.m. The voltage reading is increasing starting on 10.00 a.m to 12.00 p.m. The highest voltage taken is on 12.00 pm which is 2.72 V. After that, the voltage is decreasing as the time is getting late to 5.00 p.m. This is because at 12.00 p.m. due to sunny day, the solar panel can capture most light intensity and two axis solar tracker will generate the highest voltage for measurement taken.

Table 4.2: Data of Voltage Performance of Two Axis Solar Tracking for Day 2

Time	Voltage (V)	Angle	
		Vertical	Horizontal
10.00 a.m	2.32	80	160
11.00 a.m	2.45	85	160
12.00 p.m	2.54	90	160
1.00 p.m	2.44	90	160
2.00 p.m	2.32	150	160
3.00 p.m	2.28	155	160
4.00 p.m	2.13	157	160
5.00 p.m	2.14	160	160

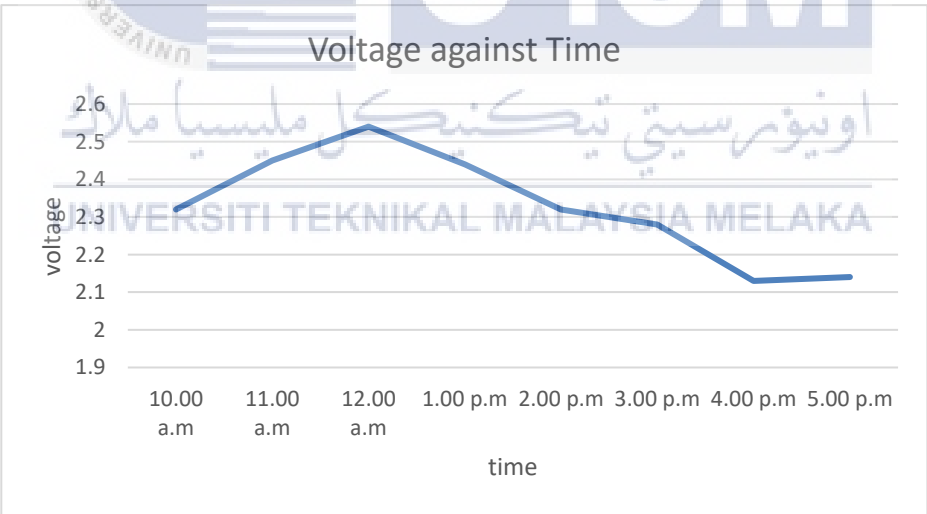

Figure 4.10: Voltage against time Day 2

Based on Figure 4.10, the graf is plotted and can be observed starting from 10.00 a.m to 5.00 p.m. The voltage reading is increasing starting on 10.00 a.m to 12.00 p.m. The highest voltage taken is on 12.00 pm which is 2.54 V. After that, the voltage is slowly decreasing as the time is getting late to 5.00 p.m. This is because at 12.00 p.m. due to cloudy day at day two analysis of data taken, the solar panel can capture most light intensity and two axis solar tracker will generate the highest voltage for measurement taken at day two.

Table 4.3: Data of Voltage Performance of Two Axis Solar Tracking for Day 3

Time	Voltage (V)	Angle	
		Vertical	Horizontal
10.00 a.m	2.85	90	160
11.00 a.m	2.92	90	160
12.00 p.m	3.09	90	160
1.00 p.m	3.08	90	160
2.00 p.m	3.00	90	160
3.00 p.m	2.73	153	160
4.00 p.m	2.41	156	160
5.00 p.m	2.20	160	160

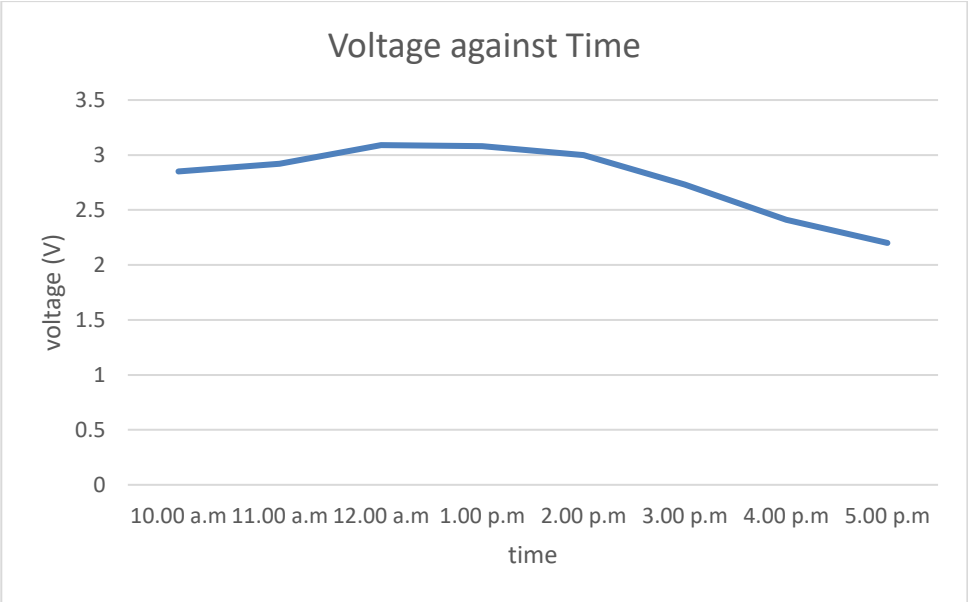

Figure 4.11: Voltage against time Day 3

Based on Figure 4.11, the graf is plotted and can be observed starting from 10.00 a.m to 5.00 p.m. The voltage reading is increasing starting on 10.00 a.m to 12.00 p.m. The highest voltage taken is on 12.00 pm which is 3.09 V. After that, the voltage is decreasing as the time is getting late to 5.00 p.m. This is because at 12.00 p.m. due to sunny day, the solar panel can capture most light intensity and two axis solar tracker will generate the highest voltage for measurement taken at day three.

4.3.2 Data of Output Volume of The Water Pumping System

The test was conducted by measuring the amount of water by the water pumping system as shown in Table 4.4. The water level in the water tank is rising and the results were displayed every half minute. The results of this test show that the water pump with two axis solar tracker performs better and possible to get and quickly increase the volume of water during peak hours.

Table 4.4: Data of Output Volume of The Water Pumping System

Time (in seconds)	Volume (ml)
29s	200 ml
54s	500 ml

4.3.3 Testing Analysis for Two Axis Solar Tracker

This part for this project is to test and measure the output of voltage two axis solar tracker on sunny day for three days. Based on Figure 4.12, we can see the testing on two axis solar tracker using multimeter. Since the solar panel only use 6V, so the testing using multimeter is below 20V. The positive and negative probe is tapping to USB converter positive and negative side. The voltage is produced and the data taken.

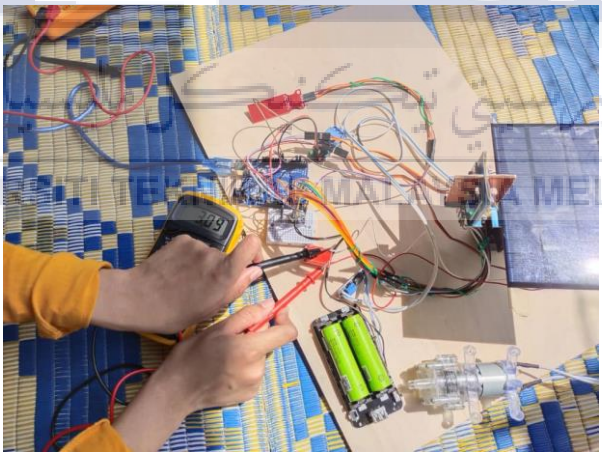

Figure 4.12: Testing analysis for two axis solar tracker using multimeter

From Figure 4.13 two axis solar tracker at noon and figure 4.14 testing angle of two axis solar tracker using arduino. Two axis solar tracker is placed at noon around 12.00 pm which is the most sunlight that ldr sensor and solar panel can catch. While, to measure the angle from 10.00 am to 5.00 p.m, we have to see it on the serial monitor that shows from Figure

4.15 serial monitor at arduino. This is because, by observing the movement of the sunlight from 10.00 a.m until 5.00 a.m we can know the angle from vertical to horizontol according to sunlight's movement.

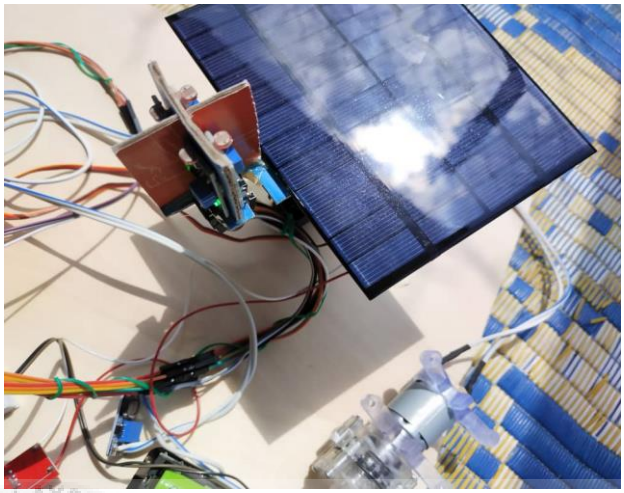

Figure 4.13: Two axis solar tracker at noon

Figure 4.14: Testing angle of two axis solar tracker using arduino

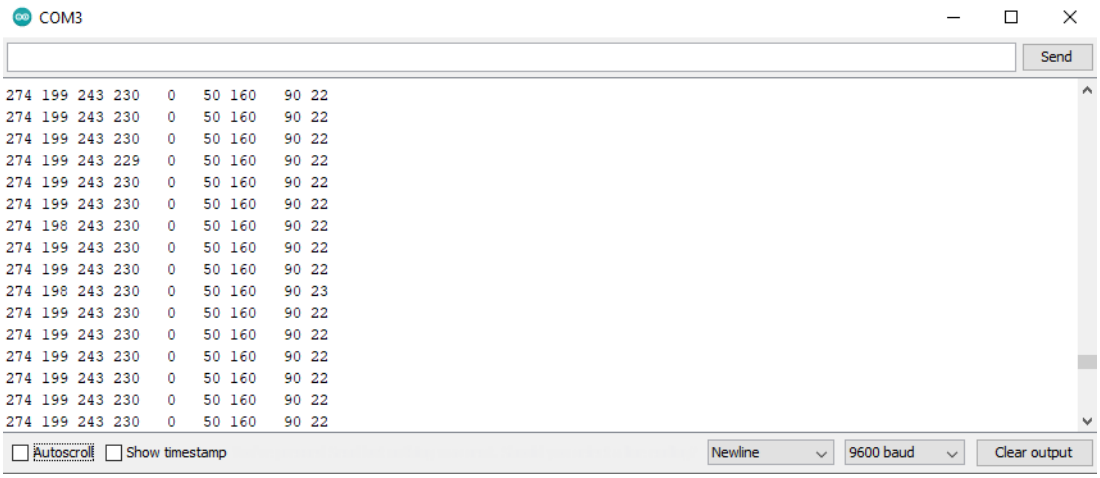

Figure 4.15: Serial monitor at arduino

4.3.4 Testing Analysis for Water Pumping System

This part of this project is to test and measure the output volume of the water pumping as shown Figure 4.16. The 12 V DC water pump has two tube at the end. So, the other side tube is inhaled water (in) as a water supply, the other one is exhaled water (out) as a water tank. When the water level sensor sense less water, the water pump will on. This meaning that,the water level is continuously sensed by the water level sensor. When the sensor determines that the water level is low, the relay protection circuit activates the water pump.

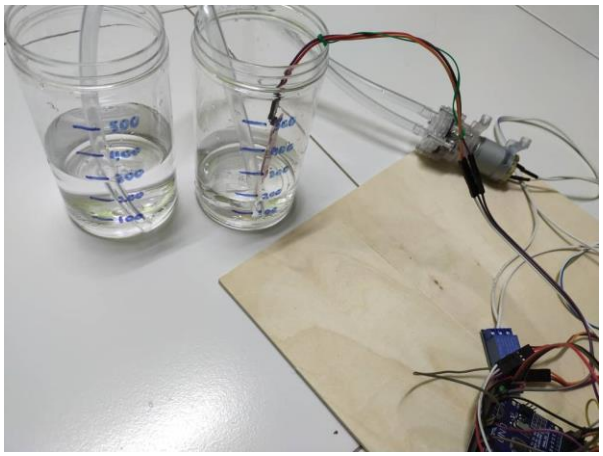

Figure 4.16: Testing Water Pumping System

CHAPTER 5

CONCLUSION

5.0 Conclusion

This last chapter will wrap up the project's overall functional achievement, which is the development of a two-axis solar tracker for water pumping system. The problem has been overcome, and through the project that has been made, there are some suggestions and recommendations for this project. We can also learn from the mistakes and lessons we made while doing the connection, circuit behaviour, coding and circuit in Proteus through this project. The most important thing in this chapter is that we can encounter the problem and face it until the project is finished. On top of that, we can know how to solve problems and improve to make sure that our project is successful. This chapter also discusses possible improvements to the project.

5.1 Achievement

All goals for this project to create a development of two axis solar tracker for water pumping system were accomplished in the end. The objectives of this project also have successfully achieved. This project is capable to guide and assist the user in restore water in a good way by storing it in a water tank. By utilizing solar tracking, a significant amount of power is available to ensure that the system will work successfully, and the water pump will efficiently pump water via a water tank. Other than that, the analysis has been done by measure the solar panel voltage for three days as we can see the objectives to develop a two axis solar tracker system using LDR is achieved and the volume water of water pumping. Hence, due to water pumping, wastage of water and electricity can be reduced.

5.2 Final Product

For this final product as show in the Figure 5.1, 5.2 and 5.3 below, there are two system, one is using battery to power up the water pumping system, the other one is using battery to power up the solar panel. Since it is a small prototype, it can only fit to the size A3. The solar panel must put at the higher place since it can rotate 20 degrees minimum to 160 degrees maximum, vertical to horizontal. So, we can see the rotation that make by two axis solar tracker. Other than that, the wiring requires a limited amount of space that can fit the container.

Figure 5.1: Final Product of The Project

Figure 5.2: Final Product Close Up of TwoAxis Solar Tracker

Figure 5.3: Final Product Close Up of Water Pumping System

5.3 Problem Encountered and The Limitation of Project

The most common issue is when solar panel' s voltage is not precise since only use 6V solar panel. There is some limit to the data voltage taken since solar panel only produced small voltage. Output voltage of solar panel produced is low and the 3400mAH battery would take a lot longer to charge and supply. It might take a couple of hours until it reaches to maximum. Hence, 6V solar panel are not as good as solar farm or 12V solar panel that can capture the most sunlight and maybe the output voltage is more accurate. The degree angle also not accurate since the prototype is small and the light detector resistor sensor cannot capture the sunlight so that the servo motor can rotate to follow the sunlight. Moreover, the pan and tilt that consist of two servo motor that use to rotate and move the solar panel are not so smooth. Others, the water level sensor should be attached to water supply, but since the water supply container is small and only can go to 500 ml only and the dc water pump also not so stable.

5.4 Recommendation for Future Project

It is possible to improvised based on the issue that was encountered and the project's limitations in order to make the project more portable and more better functioning. The issue that arises when 6V solar panel cannot catch the most energy electricity since it just a small prototype, it can be improved maybe can use a bigger one like 12V solar panel. So that, the analysis of output voltage of two axis solar tracker is more precise and accurate since it can produce more high voltage. On top of that, with the higher voltage taken the battery can take quick to charge and supply. In a future project, for water pumping system maybe can-do automatic water pumping more stable like use bigger container for the water supply to water tank.

REFERENCES

[1] Energy Watch, "Watts the Deal with Electricity Consumption Around the World? | Energy Watch : Global & Regional Energy Insights, Thought leadership, & Conversations," 2019. https://www.energywatch.com.my/blog/2019/08/14/watts-the-deal-with-electricity-consumption-around-the-world/ (accessed Jun. 06, 2022).

[2] F. Ahmad, T. Ushiyama, and T. Sayama, "Determination of Z-R Relationship and Inundation Analysis for Kuantan River Basin," *Res. Publ. No. 2*, pp. 1–39, 2017, Accessed: Jun. 06, 2022. [Online]. Available: http://www.met.gov.my/data/research/researchpapers/2017/researchpaper_201702.pdf

[3] V. Mohanapriya, V. Manimegalai, V. Praveenkumar, and P. Sakthivel, "Implementation of Dual Axis Solar Tracking System," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1084, no. 1, p. 012073, Mar. 2021, doi: 10.1088/1757-899x/1084/1/012073.

[4] S. Muralidhar and T. M. Chandrashekharaiah, "Solar tracking for automatic irrigation system 1. 2.," no. March, pp. 31–35, 2019.

[5] S. Pai and Y. Y. Acharya, "Solar Tracking and Automated Water Pumping System," 2019. [Online]. Available: www.ijert.org

[6] S. Verma *et al.*, "Solar PV powered water pumping system - A review," in *Materials Today: Proceedings*, 2020, vol. 46, pp. 5601–5606. doi: 10.1016/j.matpr.2020.09.434.

[7] R. Dhanabal, V. Bharathi, R. Ranjitha, A. Ponni, S. Deepthi, and P. Mageshkannan, "Comparison of efficiencies of solar tracker systems with static panel single-axis tracking system and dual-axis tracking system with fixed mount," 2013.

[8] B. Alsayid, J. Jallad, M. Dradi, and O. Al-Qasem, “Automatic Irrigation System with PV Solar Tracking,” 2013. [Online]. Available: http://excelingtech.co.uk/

[9] M. Baballe, A. Muhammad, F. Usman *et al.*, "A Review of an Automatic Water Level Indicator," 2022.

[10] E. Santosh Kumar, *et al.*," Arduino Working Principle and It's Use In Education," 2022.

APPENDICES

Appendix A Atmega328P Data Sheet

Atmel

ATmega48A/PA/88A/PA/168A/PA/328/P

ATMEL 8-BIT MICROCONTROLLER WITH 4/8/16/32KBYTES IN-SYSTEM PROGRAMMABLE FLASH

Features

- High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 4/8/16/32KBytes of In-System Self-Programmable Flash program memory
  - 256/512/512/1KBytes EEPROM
  - 512/1K/1K/2KBytes Internal SRAM
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/100 years at 25°C[1]
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - Programming Lock for Software Security
- Atmel® QTouch® library support
  - Capacitive touch buttons, sliders and wheels
  - QTouch and QMatrix® acquisition
  - Up to 64 sense channels
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel 10-bit ADC in TQFP and QFN/MLF package
    - Temperature Measurement
  - 6-channel 10-bit ADC in PDIP Package
    - Temperature Measurement
  - Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Byte-oriented 2-wire Serial Interface (Philips I²C compatible)
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change

- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage:
  - 1.8 - 5.5V
- Temperature Range:
  - -40°C to 85°C
- Speed Grade:
  - 0 - 4MHz@1.8 - 5.5V, 0 - 10MHz@2.7 - 5.5.V, 0 - 20MHz @ 4.5 - 5.5V
- Power Consumption at 1MHz, 1.8V, 25°C
  - Active Mode: 0.2mA
  - Power-down Mode: 0.1µA
  - Power-save Mode: 0.75µA (Including 32kHz RTC)

1. Pin Configurations

Figure 1-1. Pinout ATmega48A/PA/88A/PA/168A/PA/328/P

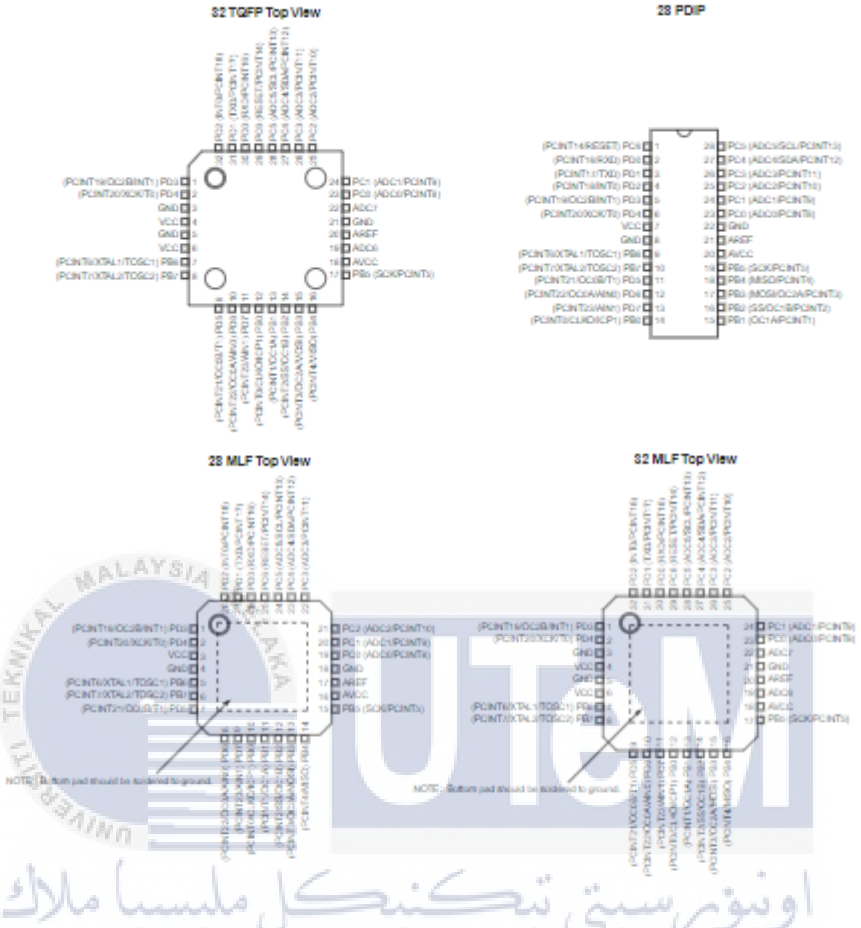

Table 1-1. 32UFBGA - Pinout ATmega48A/48PA/88A/88PA/168A/168PA

	1	2	3	4	5	6
A	PD2	PD1	PC6	PC4	PC2	PC1
B	PD3	PD4	PD0	PC5	PC3	PC0
C	GND	GND			ADC7	GND
D	VDD	VDD			AREF	ADC6
E	PB6	PD6	PB0	PB2	AVDD	PB5
F	PB7	PD5	PD7	PB1	PB3	PB4