



**Faculty of Electrical and Electronic Engineering Technology**



**A DEVELOPMENT OF PLANT WATERING DEVICE USING SOLAR  
ENERGY WITH MICROCONTROLLER**

**MUHAMMAD HAZIM BIN ZULKIFLI**

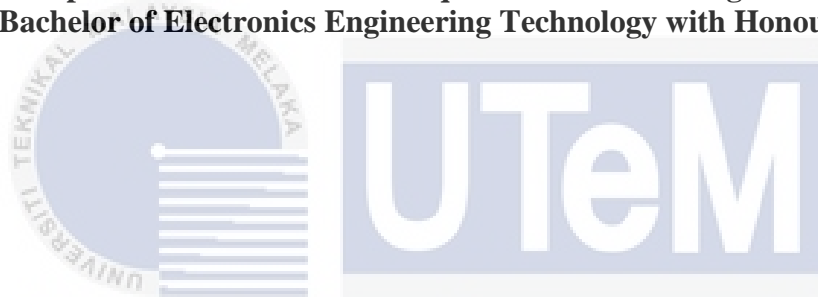
**Bachelor of Electronics Engineering Technology with Honours**

**2022**

**A DEVELOPMENT OF PLANT WATERING DEVICE USING SOLAR ENERGY  
WITH MICROCONTROLLER**

**MUHAMMAD HAZIM BIN ZULKIFLI**

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



**Faculty of Electrical and Electronic Engineering Technology**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2022**

## DECLARATION

I declare that this project report entitled “A Development Of Plant Watering Device Using Solar Energy With Microcontroller” 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.

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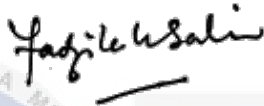
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## APPROVAL

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.

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20 / 2 / 2023

## DEDICATION

My dissertation is dedicated to my family and many friends. I am very grateful to my loving parents, En. Zulkifli and Pn. Azlina, whose words of support and push for persistence continue to ring in my ears. My precious brothers and sisters who have never left my side.

I also dedicate this dissertation to my numerous friends and family members who have been there for me throughout the process. I will be eternally grateful for everything they have done for me, especially my fellow friends who have assisted me in developing my technological abilities, as well as the many hours of proofreading and technical competence.



## ABSTRACT

The watering plants using solar panel works on the principal of conductivity within the soil. The moisture content or wetness of the soil also plays a vital function in plant growth. As a result, it is critical to keep the moisture contained. The use of adequate watering systems, such as irrigation, is critical in the agricultural field since the major cause is a lack of rain and a scarcity of land reservoir water. To address agriculture sector irrigation system difficulties using available water resources, new technological technologies are being explored to allow agricultural automation to increase crop productivity. The project's goal is to reduce the agriculturist's manual intervention. The automated irrigation system will be used for the following purposes. The solar panels are estimated to generate at least 12W for the system to function. The microcontroller will be monitored using blynk application when the moisture of the soil is lower. The water pump will be controlled by using a smartphone to switched on or off. This system will be easily adjusted with the mobile application. As result, this system will be functioning independently and also reducing the consumption of energy.

## ***ABSTRAK***

Menyiram tumbuhan menggunakan panel solar berfungsi berdasarkan prinsip kelembapan tanah. Kandungan lembapan atau kebasahan tanah juga memainkan fungsi penting dalam pertumbuhan tumbuhan. Oleh itu, adalah penting untuk mengekalkan kelembapan yang terkandung. Penggunaan sistem pengairan yang mencukupi, seperti pengairan, adalah kritikal dalam pertanian kerana punca utama adalah kekurangan hujan dan kekurangan air takungan tanah. Untuk menangani kesukaran sistem pengairan dalam sektor pertanian menggunakan sumber air yang ada, teknologi teknologi baharu sedang diterokai untuk membolehkan automasi pertanian meningkatkan produktiviti tanaman. Matlamat projek ini adalah untuk mengurangkan campur tangan manual petani. Sistem pengairan automatik akan digunakan untuk tujuan berikut. Panel solar dianggarkan menjana sekurang-kurangnya 12W untuk sistem berfungsi. Kemudian mikropengawal akan memantau menggunakan aplikasi blynk apabila kelembapan tanah lebih rendah. Pam air boleh dikawal dengan menggunakan telefon pintar untuk menghidupkan atau mematikannya. Sistem ini akan disepadukan dengan mudah dengan aplikasi mudah alih. Akibatnya, sistem bukan sahaja akan berfungsi secara bebas tetapi mengurangkan penggunaan tenaga.

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## LIST OF SYMBOLS

$\delta$	-	Voltage angle
	-	
	-	
	-	
	-	
	-	
	-	
	-	



## LIST OF ABBREVIATIONS

V	-	Voltage
	-	
	-	
	-	
	-	
	-	
	-	
	-	



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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background of study**

Plants are essential for human survival and the survival of the entire world because they produce oxygen, which has been required for life on the planet from the beginning of time. The earth's surface is covered in luxuriant flora, regardless of location or area. Plants growing within or near a house help to filter the air. They were confirmed by NASA and the Associated Landscape Contractors of America (ALCA).

Planting without water irrigation may harm certain gardens, while over-watering will harm others much more. The problem is that owners utilize far too much water in their irrigation system, endangering their plants and gardens. Some gardeners harm their plants by just watering them once a week because they are too consumed with their daily activities. Some gardeners harm their plants by just watering once a day because they are too absorbed with their daily responsibilities. The plant must be adequately watered to remain productive. The key environmental demands for plant development, according to the previous researcher, include area and canopy, as well as physiologic processes for optimal temperature.

During the summer, the agriculturist's main concern is a day's water. Because water is so important in plant development, the agriculturist should have been implementing some modern agricultural technologies and equipment. Electricity plays an important role in agriculture. Solar energy will be used to supply more and efficient

energy. Solar, which really is unlimited and continuous, may be harnessed by installing solar panels. Solar panels (an array of photovoltaic cells) are increasingly being applied to power streetlights, water heaters, and other household loads. Solar panels are becoming more affordable, which stimulates their application in several businesses.

The installation of solar panels is a one-time investment that requires little maintenance, which is a huge relief for agriculturists or farmers. As a result of the use of modern methods such as the automatic plant watering system in their farms, this new technology can keep the moisture content of the plants in good condition, which aids in the development of the plants.

In the existing energy situation, a solar high-powered irrigation may be a viable option for farmers. Water pumps that carry water from a bore well to a tank are powered by alternative energy in the autonomous irrigation system. The tank's output valve serves as an automated exploitation controller. A wet detector controls the flow of water from the tank to the irrigation area, therefore optimizing water utilization because our country ranks second in agriculture and has daylight all year, solar energy may be used for irrigation.

Renewable energy is perfect for use with irrigation systems in gardens, flats, greenhouses, and other settings. Improving irrigation capacity will drastically lower agricultural production costs, allowing for more effective demand-supply responsiveness. Using proper irrigation systems, average vegetable yields can be maintained or enhanced [1].

## 1.2 Problem Statement

Watering plants can be a problem if it is not properly done. If pore spaces in wet soils are filled with water, they have poor aeration. Poor design and planting procedures, such as inappropriate irrigation system functioning, can result in far more water in the soil. Moreover, a big challenge towards this solar photovoltaic power is when the unavailability of sunlight, means there is no light radiance to operate the solar panel. Meanwhile, there is still a demand for the supply either during the night or the changes of weather in days. Then, irrigation system relies on-grid electricity to supply the power. So far as all known, the irrigation system typically located far away in a rural or secluded area. Hence, the on-grid electricity supply cannot be depended anymore.

Thus, to solve the problem, the irrigation system must be equipped with an off-grid or standalone electrical generator. In this situation, solar energy as a renewable energy has taken an important role. This situation will lead to the implementation of solar energy storage which is battery or capacitor as a reserve in supply.

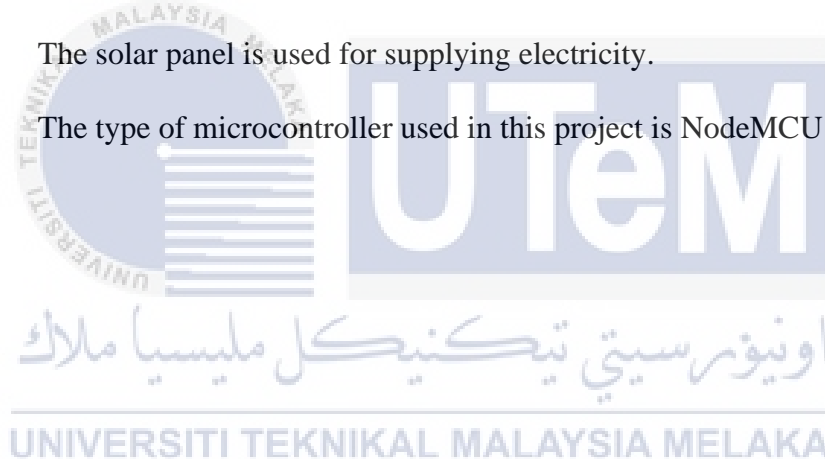
### 1.3 Project Objective

- a) To analyze the saving energy by using smart watering system.
- b) To design and develop a plant watering device using solar energy.
- c) To evaluate the effectiveness of a plant watering device using solar energy developed in this project.

### 1.4 Scope of Project

To achieve the objective, several scopes were outlined:

- a) The soil moisture sensor is used to check the moisture of the plant soil.
- b) The solar panel is used for supplying electricity.
- c) The type of microcontroller used in this project is NodeMCU ESP8266.



## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter discusses the related studies by other researchers about watering plants using solar system as a power source. In addition, this chapter also explains the overview of solar panels, microcontrollers, and moisture sensors. In comparison, this chapter also discusses a variety of previous related articles, works, and journals that relate to this project.

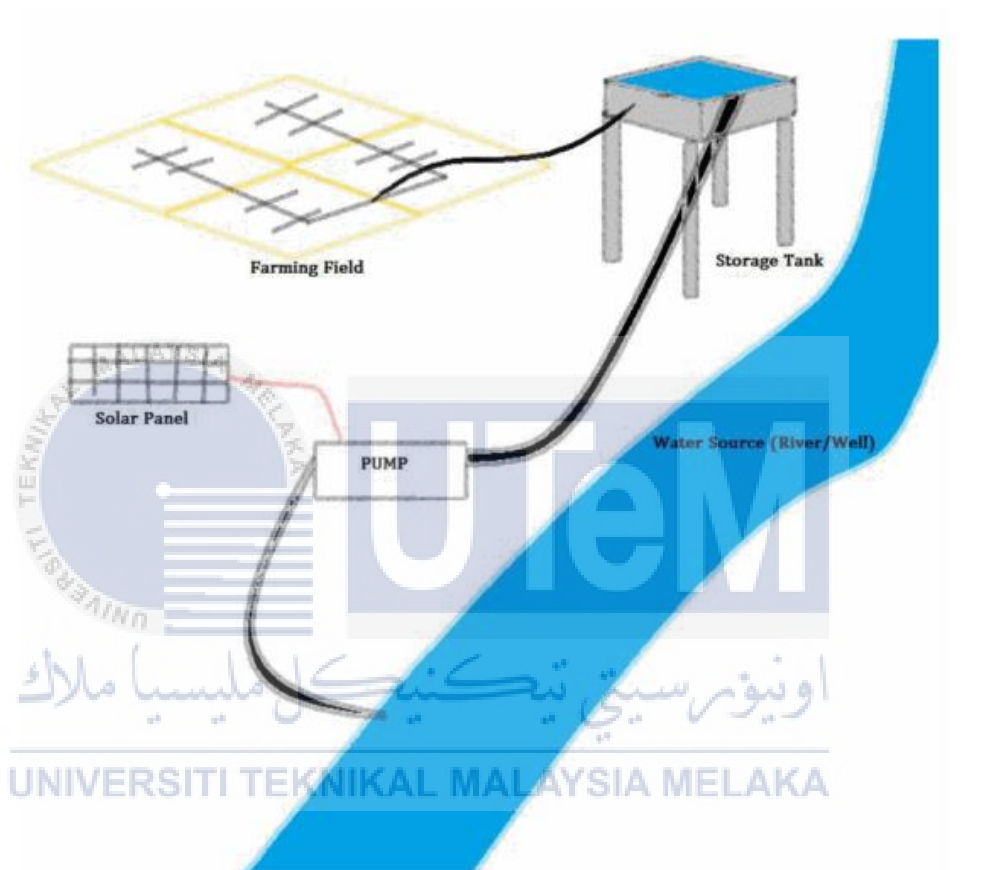
#### **2.2 Overview of Existing Project System**

This section will analyze some previous existing project implementation that has been applied related with this project system. Some great researchers have done their research in developing the best method to watering plants using solar.

##### **2.2.1 Watering Plants using Solar System from a River**

Solar energy may be converted into electricity in two ways: immediately after conversion or by storing the energy in an external battery. The second module would be made up of motors that would run on the electricity stored from the electric generator. The technique might be automated by incorporating a few sensors. Agriculture would be chosen, and moisture sensors would be set in the soil to constantly monitor the moisture

level of the soil. If the moisture content fell below a certain level, the motors would automatically turn on and begin pumping water to the field. For this reason, we use a microcontroller. A microprocessor is used for this purpose, which monitors the sensors and controls the motors [2]. Figure 2.1 shows how the automatic watering plants system working.



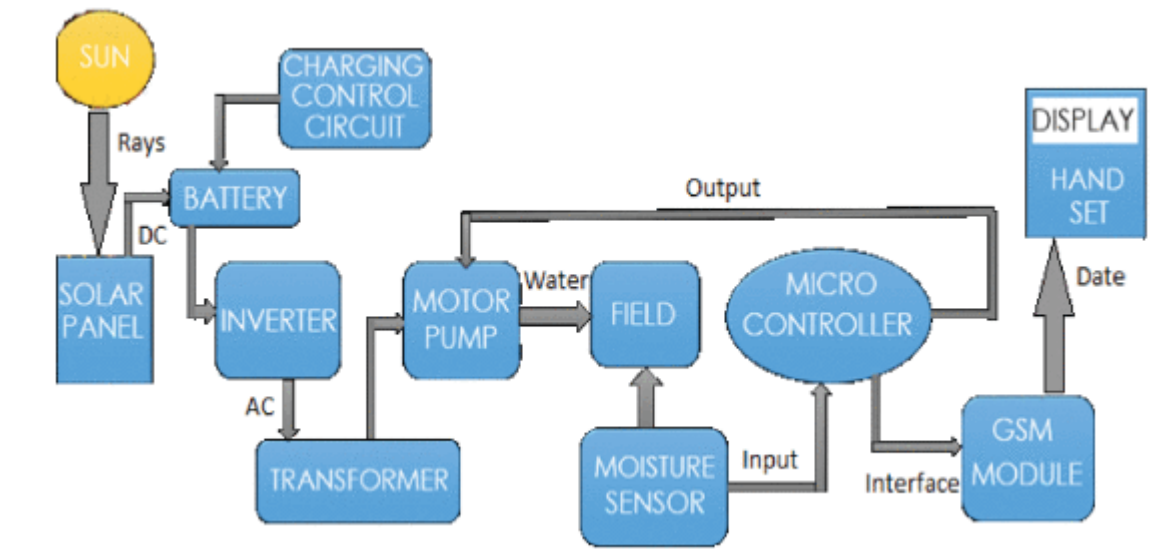
**Figure 2.1 Sample of watering plants using solar system**

The system architecture is designed with the community's geographical location and practicality in mind. There is a river that serves as the community's principal source of water and may also be utilized for agriculture. As previously noted, few farmers utilize diesel-powered pumps to obtain river water. So, using solar energy to replace this, we develop a motor system that draws water from the river and is powered by solar energy stored in a battery. This method can also be used to recover groundwater [2].

### **2.2.2 Solar water Irrigation System with Wireless Control**

There are two types of PV-powered water pumping systems: battery-coupled and direct-coupled. In our study, the proposed pumping system is battery-linked because it presents a fee option by storing excess electricity generated. Rechargeable batteries PV water pumping systems are selected because they are used both during day and night without causing a power outage. In our work, we employ PV panels, a potential power regulator, batteries, an inverter, humidity sensors, a GSM module, a tank, and a water pump. The Pv systems are in charge of producing electricity and charging the battery. The pump uses batteries to move water from beneath to the surface.

Humidity sensors and a GSM module are put in agricultural fields for automation and wireless control in this project. The humidity sensor gathers data on soil humidity and sends it to the control room through the GSM module. Based on sensor data, the microcontroller automatically turns on or off the pump. The GSM modules also provide information to the farmer and keep him up to date on weather conditions [3]. Figure 2.2 shows the block diagram for produce solar water irrigation system.



**Figure 2.2 Block Diagram**

### 2.2.3 Solar Air Source Heat Pump Hot Water Unit

Initially, the collector receives renewable electricity to heat water. When heated water comes into the main tank, the valve is opened, allowing hot water to travel down the line to the little tank. Temperature is utilised to control the water cycle of a large tank and collector. Based on hotel demand, management is also essential. Winter water use is reduced, thus the water level must be kept at 50% of the tank's total content. During the summer, if it is impossible to meet the conditions in a timely manner, the water level is kept at 100 percent of the tank's volume. In the summer, the water level is kept at 100% of the tank volume when it is unable to satisfy the needs of filling the tank in a timely way.

The control system can regulate the heat pump's switch cycling and collect hot water to raise the tank temperature to the desired level. If the solar hot water temperature does not reach the constant temperature, open the valve to the large tank, command the air source heat pump and a circulating pump P3, and open the valve to the small tank, control



the external heat pump and a circulating pump P2, so that the temperature of the water meets the user's requirements. Hot water is produced via a solar air source heat pump. The ultimate purpose of the control system is to reduce the external heat pump unit's total energy demand ratio. As a result, it is necessary to maximise solar energy to set of thermal module heat production and usage [4]. Figure 2.3 shows how the the solar air source heat pump hot water working.

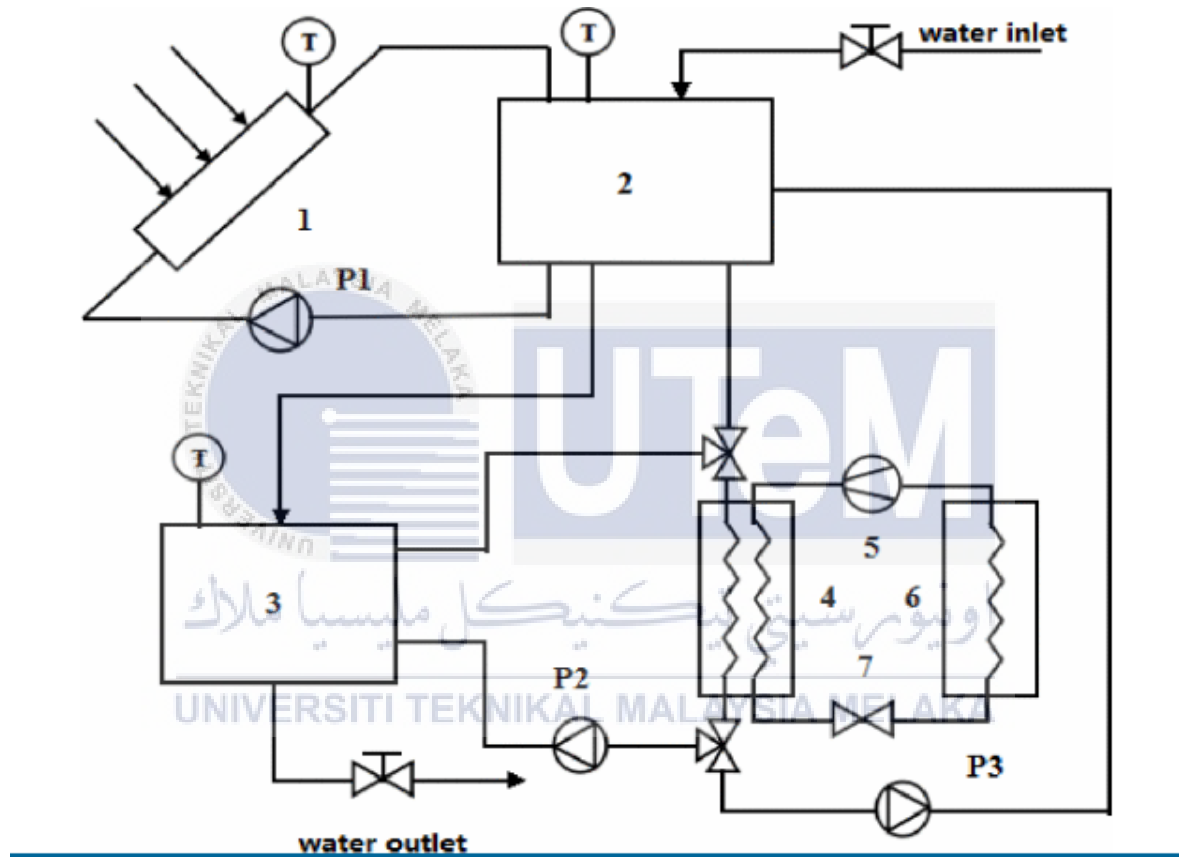


Figure 2.3 Hot Pump Hot Water System

### 2.3 Water Storage Tank and Variable Speed Pumps

Let  $V_t$  be the  $T \times 1$  vector of tank water volume at time,  $t$ . The dynamic behavior of water storage tanks is described by the state equation in (1). In (2), tank water volume is confined to the upper and lower limits water volume limits, and the volume of water stored in tanks at the beginning of the schedule horizon is initialized (3), where  $V^{init}$  is the vector

of initial water volume stored in tanks. The water volume of tanks fluctuates in (4) depending on the pressure head at the tank nodes, where is the  $T \times T$  diagonal matrix holding the surface values of the tanks. Constraints (5) and (6) limit water tank input and outflow rates to their maximum values outflow and inflow rate boundaries [5].

$$\mathbf{V}_{t+1} = \mathbf{V}_t + \mathbf{C}_t - \mathbf{D}_t \quad \forall t \quad (1)$$

$$\underline{\mathbf{V}} \leq \mathbf{V}_t \leq \overline{\mathbf{V}} \quad \forall t \quad (2)$$

$$\mathbf{V}_1 = \mathbf{V}^{\text{init}} \quad (3)$$

$$\mathbf{V}_t = \Delta \Lambda \mathbf{H}_t \quad \forall t \quad (4)$$

$$0 \leq \mathbf{C}_t \leq \overline{\mathbf{C}} \quad \forall t \quad (5)$$

$$0 \leq \mathbf{D}_t \leq \overline{\mathbf{D}} \quad \forall t. \quad (6)$$

Variable-speed pumps' pressure head growth and power consumption are shows in (7) and (8), respectively, where  $\Omega U_t$  is the  $U \times I$  decision variable vector of pump speed at time  $t$ ,  $BU$  is the  $U \times J$  pump-arc incidence matrix,  $1U$  is an  $U \times I$  vector of ones, and a, b, c, d, and e are pump-specific parameters. Signs  $\odot$  and  $\oslash$  in (7) and (8) indicate element matrix multiplication and division. The  $U \times I$  decision variable vector of a pump's power consumption  $P_t^U$  is confined in (9), but, the flow rate of water via a pump is positive in (10), showing that pumps only can work in one direction [5].

$$\mathbf{B}^U \mathbf{A}^T \mathbf{H}_t = \Omega_t^{U^2} \odot \left( a \mathbf{1}^U - b \left( (\mathbf{1}^U \oslash \Omega_t^U) \odot \mathbf{B}^U \mathbf{Q}_t \right)^c \right) \quad \forall t \quad (7)$$

$$\mathbf{P}_t^U = \Omega_t^{U^3} \odot \left( d \mathbf{1}^U - e \left( (\mathbf{1}^U \oslash \Omega_t^U) \odot \mathbf{B}^U \mathbf{Q}_t \right) \right) \quad \forall t \quad (8)$$

$$0 \leq \mathbf{P}_t^U \leq \overline{\mathbf{P}}^U \quad \forall t \quad (9)$$

$$\mathbf{B}^U \mathbf{Q}_t \geq 0 \quad \forall t. \quad (10)$$

## 2.4 IoT System

Sensors deployed at various points throughout the system maintain automatic control and monitoring of water delivery. The system seeks to conserve water by monitoring the system at two critical points: the water collecting taps and the water level in

various reservoirs. The data from the sensors is seen via a mobile app linked to the intended system. All data obtained must be sent to a cloud storage server for subsequent analysis. The automated control also guarantees water conservation since water loss due to human ignorance has been fully eliminated. An ultrasonic sensor is installed on the water tank to assist monitor the various water reservoir levels, which can be accessed via a mobile app. The mobile app allows the motor to be activated automatically when the water level drops or rises [6].

## **2.5 Gading Kencana Sdn Bhd Solar System**

Since 1993, Gading Kencana Sdn Bhd (GKSB) has been a leader in the Malaysian solar photovoltaic sector and a producer of renewable energy power plants and projects. The firm created, built, and manages two solar farms, one in Ayer Keroh, Melaka, and the other in Bidor, Perak, with a combined capacity of 46MWp and a total annual power output of 63,771 MWh sold to TNB. Many big rooftop solar PV plants for industry and small-scale systems for residential residences have been planned and built by GKSB. It intends to expand its scope of power delivery to commercial and residential organizations under Net Energy Metering systems to assist them in lowering their electricity bills by utilizing its expertise in the installation of solar PV systems and energy efficiency initiatives [7]. Figure 2.4 shows a solar farm in Bidor, Perak.



**Figure 2.4 Solar Farm in Bidor, Perak**

## 2.6 Large Scale Solar in Malaysia

Table 2.1 shows the solar farm in Malaysia and how much power it produces.

**Table 2.1 Solar Energy In Malaysia**

Location	Power
Dengkil, Selangor	12.995MWp
Kamunting, Perak	12.5MWp
Kampar, Perak	13MWp
Kinta, Perak	12.9MWp
Bukit Kayu Hitam, Kedah	12MWp
Gambang, Pahang	61MWp

Gurun, Kedah	65MWp
Kuala Ketil, Kedah	58.5MWp

## 2.7 Type of Solar Panel

### 2.7.1 Polycrystalline Solar Panel

PV cells in polycrystalline solar panels are blue in color and have straight edges. They are less efficient than monocrystalline cells and require more panels to produce the same amount of electricity. Polycrystalline panels, on the other hand, are less costly due to a simpler production method. Polycrystalline panels are exceptionally robust but have a somewhat shorter lifespan than monocrystalline panels. They are also more sensitive to high temperatures, reducing their output on hot days [8].

### 2.7.2 Monocrystalline Solar Panel

The rounded edges and black PV cells of monocrystalline solar panels differentiate them. Because of its higher conversion efficiency, they produce more kilowatt-hours of power than polycrystalline panels. If you want to construct a solar panel system but have limited space, monocrystalline panels will be more productive per square foot. It has the highest efficient solar panels, but they are also the most expensive because of the more complex manufacturing process of single-crystal silicon cells [9].

## **2.8 Solar Panel System**

Solar panels convert pure renewable energy in the form of sunlight into electricity, which may then be used to power loads. Individual solar cells comprised of silicon, phosphorus (which generates the negative charge), and boron make up solar panels (which provides the positive charge). Photons are absorbed by solar panels, which create an electric current. The energy created by photons striking the solar panel's surface knocks electrons out of their orbit around the nucleus and releases them into the electron beam formed by the solar cells, which then draws these released electrons into a direct current. The Photovoltaic Effect encompasses the whole procedure. A typical home has enough roof space to accommodate the number of solar panels necessary to generate enough solar electricity to fulfil all its power needs. Excess electricity is sent into the major power system, resulting in lower overnight electricity use [10].

## **2.9 The Benefits of Solar System**

Solar cells are a practical and useful way of generating power for a range of applications. Off-grid living is the obvious choice. Living off-grid implies living in a location that is not serviced by the major electric power grid. Solar energy systems are suitable for outlying homes and cottages. Aside from the ability to live off-grid, the most major advantage of using solar energy is that it is both a clean and sustainable source of energy. Solar panels still had no moving parts and required little maintenance. They are well-built and will last for decades if maintained properly. Then, once a system has covered for its initial setup costs, the power it provides for the length of the program's lifetime, which may be as long as 15-20 years dependent on the system's quality, is absolutely free [11].

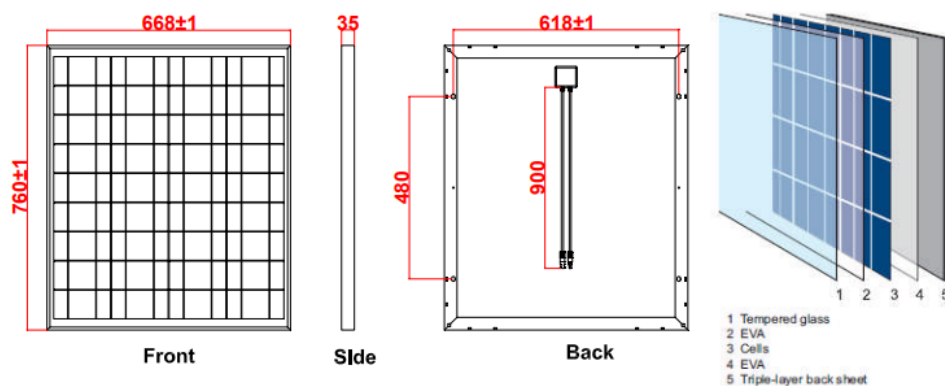
## 2.10 Specification Solar Panel

### 2.10.1 Solar Polycrystalline

Table 2.2 shows the polycrystalline solar panel specification. Besides, Figure 2.5 shows the thickness and the length of the solar panel.

**Table 2.2 Polycrystalline Specification**

Cells	Polycrystalline silicon solar cells 156x156mm
Number Of Cell	36(4×9)
Dimension (mm)	760 x668 x 35
Weight (kg)	6.5
Solar Cell Efficiency	Up to 17.37%
Module Efficiency	Up to 14.62%



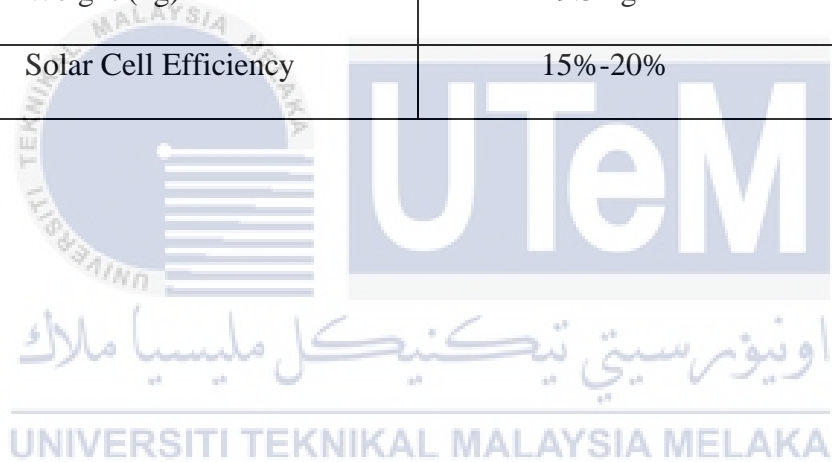
**Figure 2.5 Physical Characteristics**

### 2.10.2 Solar Monocrystalline

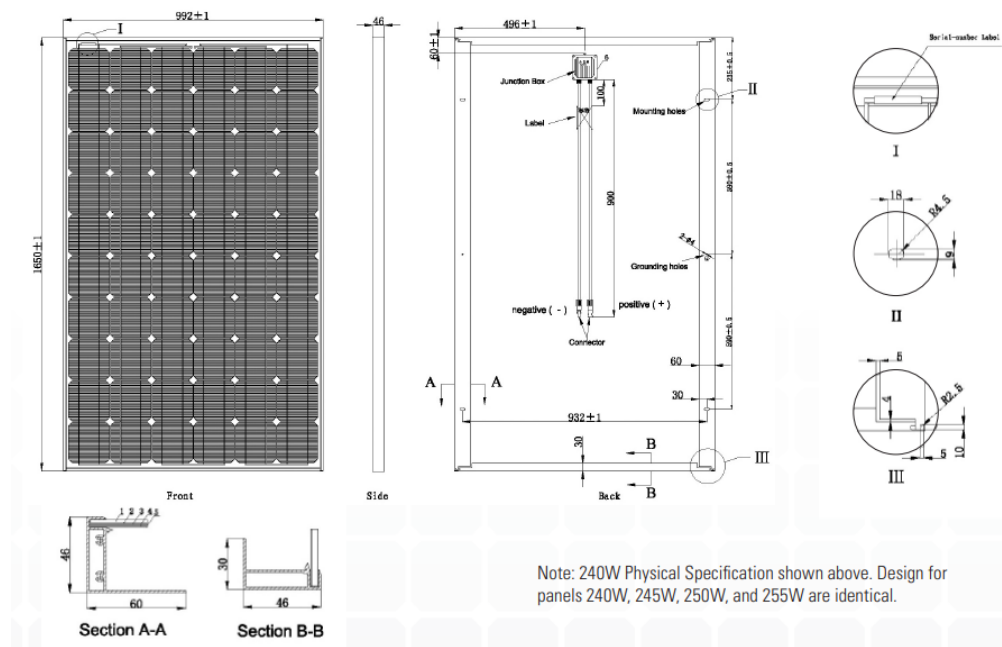
Table 2.3 shows the monocrystalline solar panel specification. Besides, Figure 2.6 shows the thickness and the length of the solar panel.

**Table 2.3 Monocrystalline Specification**

Cells Size	156 mm x 156 mm
Number Of Cell	6 x 10 = 60
Dimension (mm)	1650 mm x 992 mm x 46 mm
Weight (kg)	19.5 kg
Solar Cell Efficiency	15%-20%





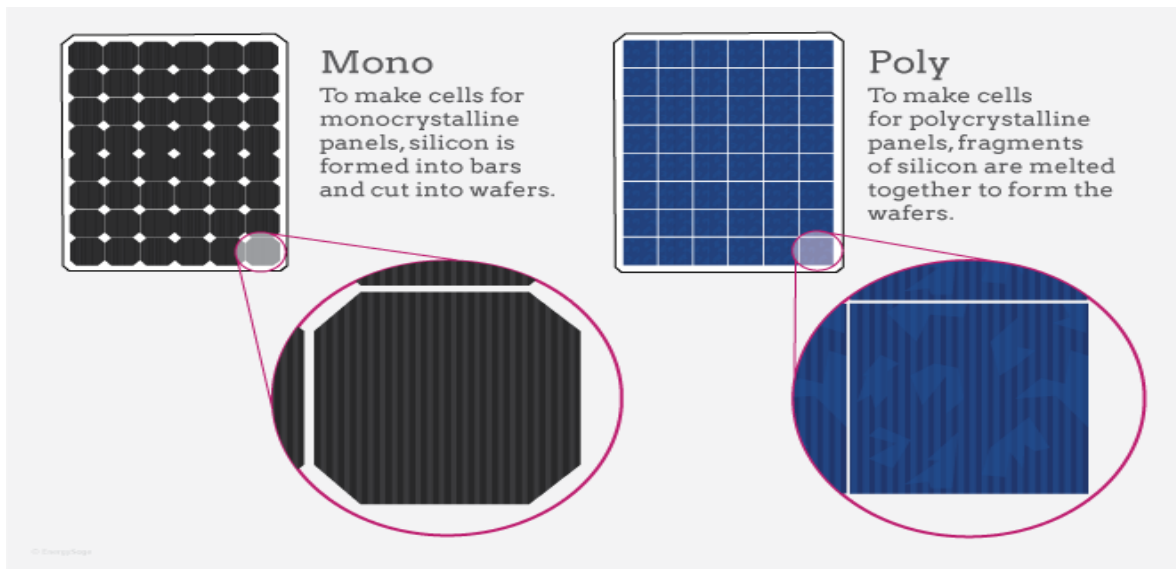


**Figure 2.6 Physical Characteristics**

## 2.11 Efficiency Solar Panel

Monocrystalline, or single, silicon solar panels are currently the most efficient form of photovoltaic solar panel available. They are more costly than other types of panels due to the increased silicon content employed in the design. Because more energy is turned into electricity, most roof installations use fewer panels to satisfy the same power demand. These square-shaped panels are perfect for solar power systems that are put on the roof [12].

Polycrystalline, or multi-layered, silicon panels are frequently less expensive than their more efficient counterparts because they use less silicon. They use a design that helps to decrease efficiency loss and allows them to be used on roof-mounted systems. Because they are less expensive, they are suited for larger projects and installations. Polycrystalline silicon panels are also more heat resistant than monocrystalline silicon panels [13]. Figure 2.7 shows the structure of monocrystalline and polycrystalline solar panel.



**Figure 2.7 Solar Panel**

## 2.12 Summary

Solar energy is a renewable source of readily available energy that creates a variety of energy sources such as bioenergy, wind, hydroelectric, and wave energy. Despite significant variations due to geography and seasons, much of the Earth's surface receives enough radiation from the sun to allow for low-grade heating of water and buildings. At low latitudes, simple reflector systems may concentrate sun energy sufficiently to cook and even generate steam turbines. Light energy causes electrons to shift in some semiconducting materials. This photovoltaic cell has the ability to create a lot of electricity. However, because of the current low efficiency of the solar PV cells, meeting electricity demands necessitates rather large areas.

## CHAPTER 3

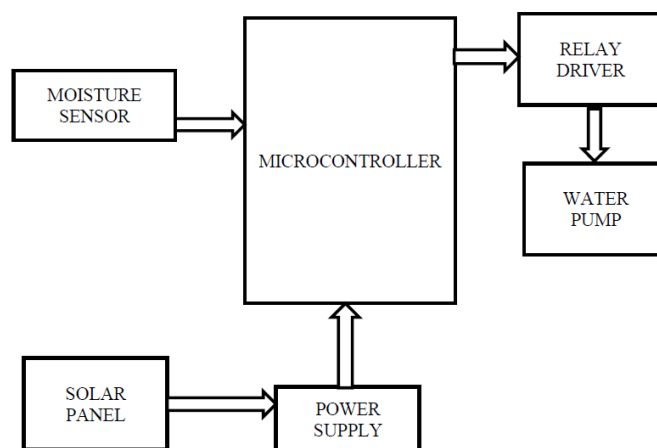
### METHODOLOGY

#### 3.1 Introduction

This chapter focuses on the methods used to construct this project. The hardware and software components of this project will be separated. To ensure the success of this project, several components must be examined and organized properly to ensure the project completion. In general, this chapter will explain and describe the project's development process briefly through flowcharts and block diagrams to ensure a better knowledge of the process.

#### 3.2 Block Diagram

Figure 3.1 shows a system diagram in which the major pieces or functions are represented by blocks linked by lines that indicate the links between the blocks.



**Figure 3.1 Block Diagram**

### 3.3 Flowchart

Figure 3.2 represents the whole project flow from hardware to software in order to achieve the project's goal. A flowchart will also be constructed to handle the working segment to avoid any issues during development. The flowchart depicts the general scope of the project, as well as how it will be developed and troubleshooted until the intended results are achieved. The approach starts with research from previous papers or theses, as well as a variety of additional sources.

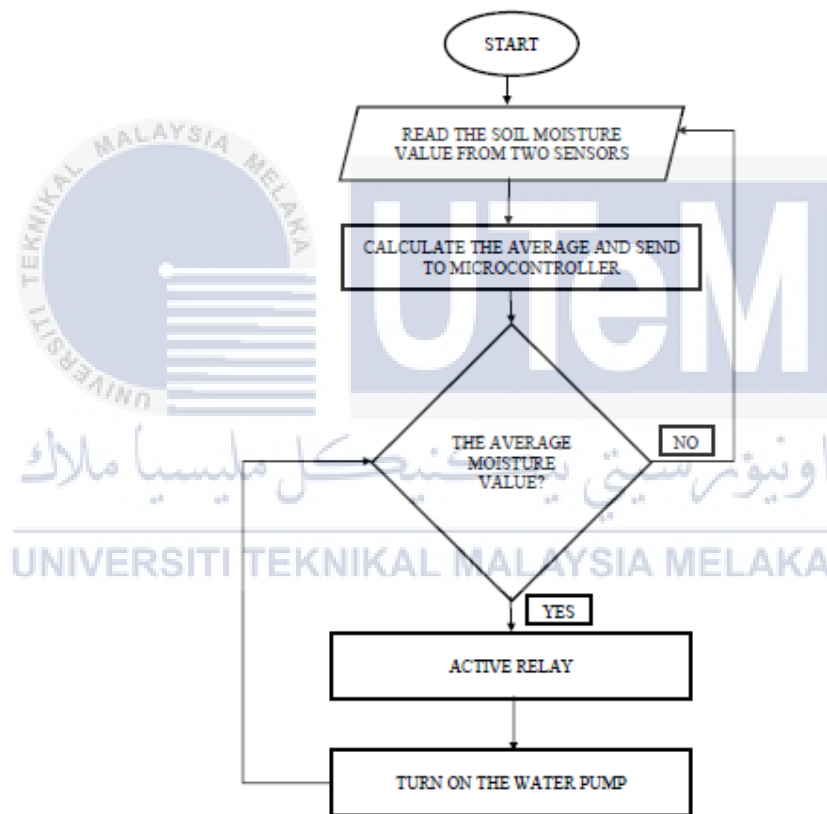


Figure 3.2 Flowchart

### 3.4 Connection Diagram

Figure 3.3 Describes the design of equipment and the connections between them.

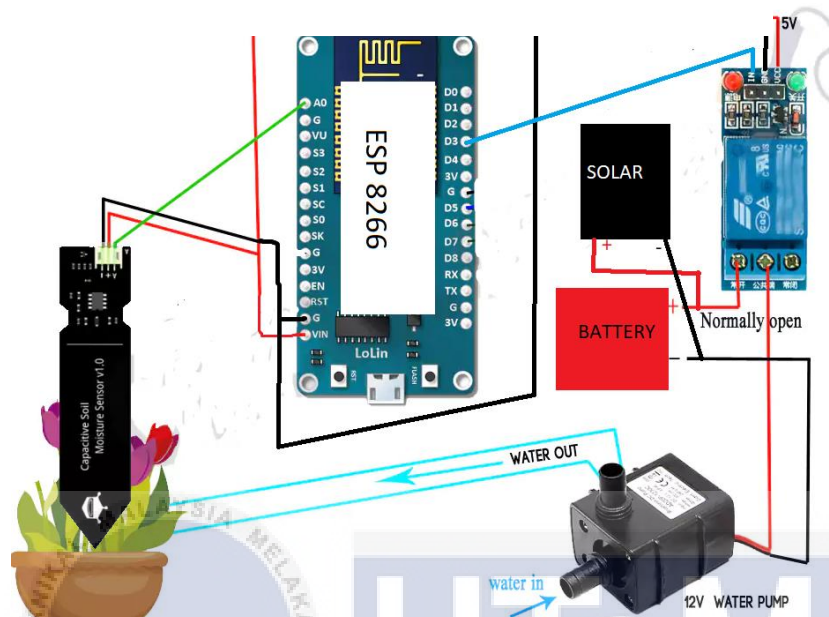


Figure 3.3 Connection Diagram

### 3.5 Project Design

Figure 3.4 shows the project design for smart watering system using solar panel.

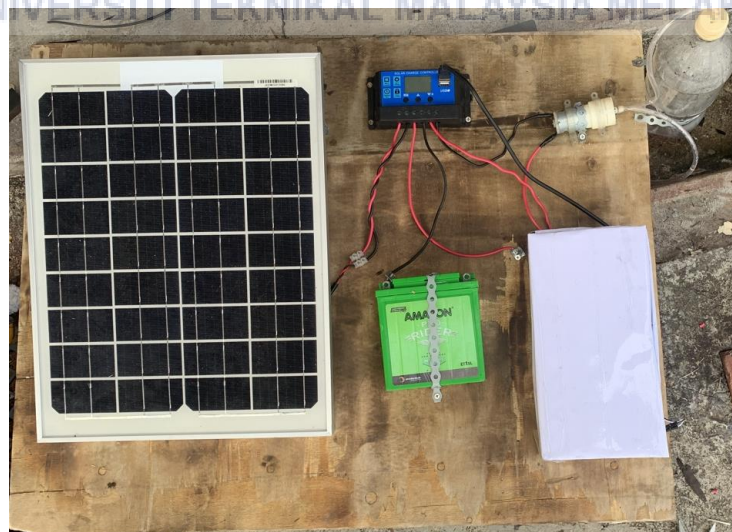


Figure 3.4 Design

### **3.6 Hardware Component**

#### **3.6.1 Solar Panel Monocrystalline**

A monocrystalline solar panel is one that is made up of monocrystalline solar cells. The panel gets its name from a cylinder silicon ingot grown in the same way as a semiconductor from single-crystal silicon of high grade. Because the cell is made of a single crystal, electrons have more room to move, allowing for better electricity flow. The cylinder ingot is cut into wafers, which form cells. The shaped cubes are wire cut to an octagonal shape to maximise the utility of the cells. Because of their octagonal shape, those certain cells have a distinct appearance. They are also the same colour.

#### **3.6.2 Lithium-ion Battery**

Rechargeable battery composed of cells inside which lithium batteries move from the negatively charged electrode to the positively charged electrode via an electrode during discharge and then return during charging. The positive electrode material in lithium-ion cells is an intercalated lithium compound, whereas the negatives electrode material is often graphite. Lithium-ion batteries power density, a low self-discharge rate, and a low memory effect. Cells can be optimised for energy or power generation. They can, however, generate explosion and flames if broken or incorrectly charged since they contain volatile electrolytes.

### **3.6.3 PWM Solar Charge Controller**

A PWM controller can be viewed as a (electronic) switch that connects the solar panels to the battery: So when charger mode is in large volume charge mode, the switch is turned on. To keep the battery voltage at the intake voltage, the switch is "flipped" on and off as required (pulse width modulated).

### **3.6.4 NodeMCU ESP8266**

The NodeMCU is a device and advancement kit for prototyping or building IoT products. It includes firmware based on Espressif Systems' ESP8266 Wi-Fi SoC and hardware based on the ESP-12 module. The Modelsim programming language is used in the firmware. It is built on the Espressif Non-OS SDK for ESP8266 and is based on the following hardware project.

### **3.6.5 Water Pump (12V)**

The water pump is used to provide water for a specific job. It can be operated electrically by connecting it to a microcontroller. It may be turned on and off by sending signals as needed. Pumping is the technique of artificially providing water.

### **3.6.6 Soil Moisture Sensor**

The soil moisture monitors the soil's moisture content. If the soil dries up, the sensor can detect a moisture level and immediately starts the water pump to supply water to the plant. The sensor detects adequate soil moisture whenever the plant gets enough water as well as the soil become wet. Following that, the pump will be shut off automatically.

### **3.6.7 Relay**

Relays are mechanical or electronics switches that allow circuits to be opened and closed. Relays control one circuits by opening and closing contacts in another. When the controller receives this signal, it generates an output that triggers a relay, which then turns on the water pump.

### **3.6.8 Ammeter**

The ammeter is an instrument used for measuring the amount of current flowing through an electric circuit. The ammeter can be used to measure both direct current and alternating 43 current. Ammeter comes in both analog and digital. It can be used for measuring a wide range of current as the shunt mechanism in the ammeter will ensure that only a small portion of current will be directed through the meter even when measuring high-value currents. The ammeter must connect in series to the circuit or equipment that requires measuring. By connecting to the circuit, the current flowing through the circuit can then be measured and shows in Ampere by the ammeter.



### **3.7 Software Requirement**

#### **3.7.1 Arduino IDE**

The Arduino IDE is a well-known software for Arduino programming. This software was created to programme the command for the Arduino function. This programme will include the commands necessary for the specified function, which will then be built and uploaded to the Arduino. The Arduino linked to the software will then receive the command and execute it as programmed. The commands can also be uploaded to the Proteus 8 programme to simulate the Arduino's function.

#### **3.7.2 Blynk Application**

Blynk is a platform for internet-of-things (IoT) and machine-to-machine (M2M) communication. It can control hardware remotely, shows sensor data, save data, and visualise data. The technology is being developed to make it easier to integrate data from a variety of sensors and actuators through the internet. In recent years, receiving and collecting data from Internet of Things devices has become more simpler. Furthermore, the platform aids developers in the creation of vertical apps.

### 3.8 Summary

This chapter describes the approach utilized in designing the whole functioning of this project. The approaches are used in development to ensure that the various elements of the system work as intended. The design of the block diagram and flowchart has been documented, as well as the equipment or software utilized for each function.



## **CHAPTER 4**

### **RESULT AND DISCUSSIONS**

#### **4.1 Introduction**

This chapter records and discusses the results obtained through the development of the intelligent system integrated with solar panel. The result from this project will be focusing on the moisture of the soil and the power generated by solar panels.

#### **4.2 Project Prototype**

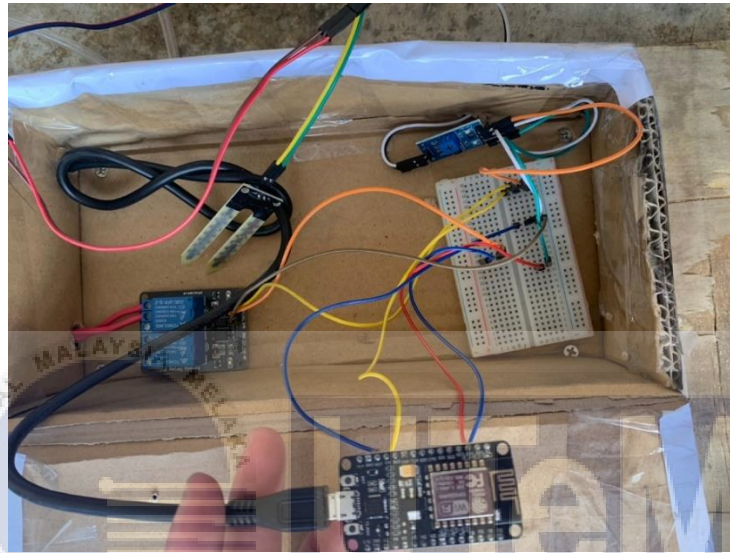
With research in Chapter 2 and Chapter 3, the prototype of the project is built with all the chosen equipment and tools. Besides, the design and coding for the software are also done through all the tools and programs that are mentioned in Chapter 3. The design has been tested by hand modified multiple times to match the requirement of the system.

##### **4.2.1 Hardware installation**

The prototype of the project is done by using a plywood for outdoor user. The solar panel is installed on the plywood with stand that from used iron to make the solar stay on 30°. The solar panel is connect to solar charge controller that controls the amount of energy flowing into battery. The second port of solar charge controller is attached to battery. This will allow the solar charge controller to direct the electricity generated to be stored in the battery or receive electricity from battery when need. The third port is connect

to load for supply electricity to water pump. The USB port on solar charge controller is used for supply electricity to microcontroller for control the water pump and soil moisture sensor.

Figure 4.1 shows the connection of microcontroller. The box is made from used board for microcontroller protection.



**Figure 4.1 Microcontroller Connection**

Figure 4.2 shows a stand for solar panel. This stand has made from used iron.



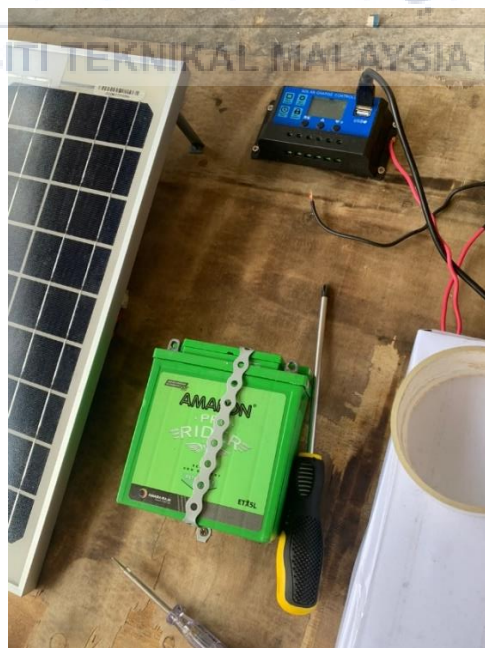
**Figure 4.2 Stand for Solar from Used Iron**

Figure 4.3 shows the solar panel stay on the stand. This stand will make the solar panel in a position of 30 degrees.



**Figure 4.3 Solar Panel On Stand**

Figure 4.4 shows the design of this project. This design has already attached to the plywood using screws.



**Figure 4.4 Screw PWM, Battery and Microcontroller Box on Plywood**

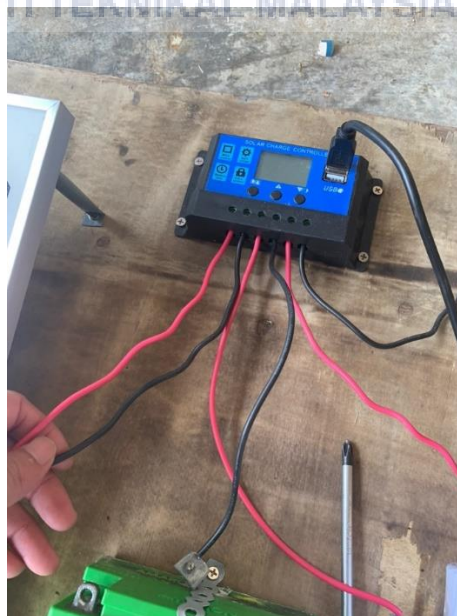


Figure 4.5 shows on microcontroller has been supply from solar charge controller. It will not over voltage the microcontroller because the solar charge controller has step down voltage.



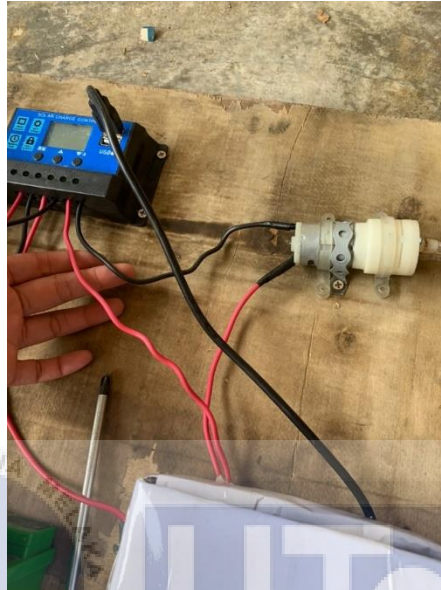
**Figure 4.5 Microcontroller Supply**

Figure 4.6 shows the connection wire from solar panel, battery and load into solar charge controller. The wire that has been use is 1.5mm.



**Figure 4.6 Connection wire from Solar Panel, Battery and Load**

Figure 4.7 shows the connection of the water pump to run. The negative wire from water pump has connected to solar charge controller and the positive wire has connected to relay.



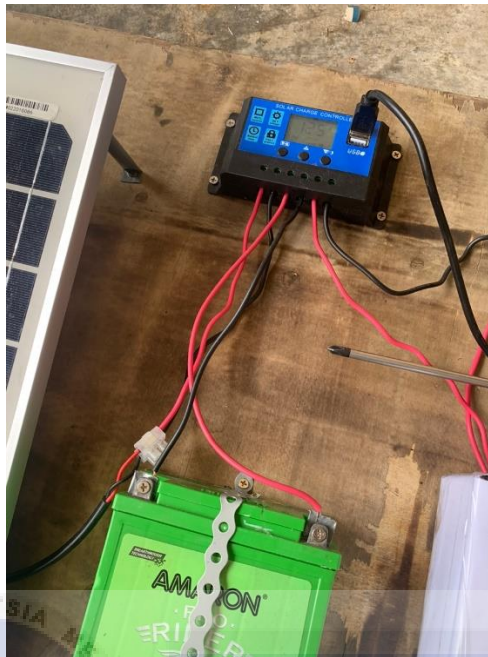
**Figure 4.7 Connection of Water Pump**

Figure 4.8 shows the used iron that used for stand and battery terminal. It also used screw to hold the terminal with battery.



**Figure 4.8 Battery Terminal from Screw and Used Iron**

Figure 4.9 shows the connection of battery with using the battery terminal.



**Figure 4.9 Battery Connection**

Figure 4.10 shows the water tank that function for water pump watering the plants. The water tank just use from a recycle bottle.



**Figure 4.10 Water Tank**



#### 4.2.2 Coding for Microcontroller

In the development of the system, the coding for commanding the function of the system is done by using Arduino IDE and test multiple time with NodeMCU. The final coding is uploaded to the NodeMCU ESP 8266. Table 4.1 shows the coding of the system done by using Arduino IDE.

**Table 4.1 Coding NodeMCU ESP 8266**

```
#define BLYNK_TEMPLATE_ID "TMPLh_xXHiln"
#define BLYNK_DEVICE_NAME "Watering System"
#define BLYNK_AUTH_TOKEN "w2mjJd5RS0v03Ouo_RXxMRn_CI46Da7l"
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

char auth[] = "w2mjJd5RS0v03Ouo_RXxMRn_CI46Da7l";//Enter your Auth token
char ssid[] = "Keluarga Bahagia";//Enter your WIFI name
char pass[] = "zmalqp10";//Enter your WIFI password

const int analogPinA0 = A0;
#define relay D3

BlynkTimer timer;
BLYNK_WRITE(V1) {
    bool value2 = param.asInt();
    // Check these values and turn the relay2 ON and OFF
    if (value2 == 1) {
digitalWrite(relay, LOW);
    } else {
        digitalWrite(relay, HIGH);
    }
}
```

```

int sensorData;
int output;

void sendSensor()
{

    sensorData = analogRead(A0); //reading the sensor on A0

    if ( !isnan(sensorData) ){
        Serial.println("Failed to read from Hygrometer Soil Moisture sensor!");
        return;
    } else {
        Serial.println(sensorData);
        sensorData = constrain(sensorData,1,50); //Keep the ranges!
        output = map(sensorData,1,50,1,100); //Map value : 50 will be 100 and 1 will
be 0

        Serial.println(output);
        Blynk.virtualWrite(V0, output);
    }
}

void setup()
{
    // Debug console
    Serial.begin(9600);
    pinMode(relay, OUTPUT);
    // Turn OFF the relay
    digitalWrite(relay, HIGH);
    Blynk.begin(auth, ssid, pass);
    WiFi.hostname("Siggy");
    timer.setInterval(3000L, sendSensor);
}

void loop()
{
    Blynk.run();
    timer.run();
}

```

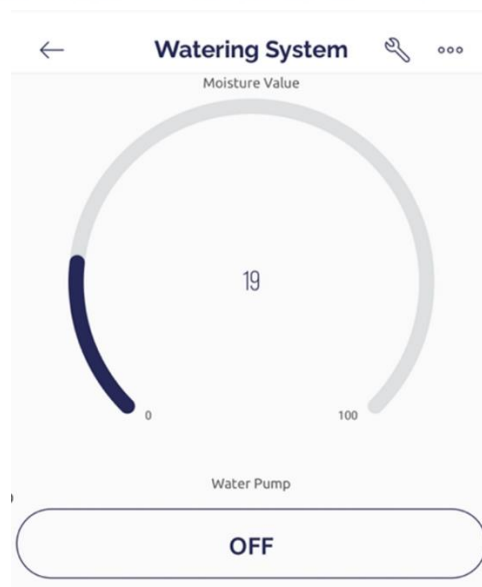
### 4.2.3 Design of Mobile application

For the development of mobile applications used for controlling the function of the system is Blynk application. Blynk application is used for control relay and monitoring percentage of moisture value. Figure 4.11 shows the blynk application for microcontroller.



**Figure 4.11 Blynk application**

Figure 4.12 shows the control panel for control relay water pump and monitoring moisture value of the soil.



**Figure 4.12 Control Panel**

#### 4.2.4 Experiment Test

This chapter will expose the project functional. Figure 4.13 shows the voltage that produce from solar panel. Figure 4.14 shows to measure data on current from solar panel to battery bank.



**Figure 4.13 Volatge from Solar Panel**

Figure 4.14 shows to measure data on current from solar panel to battery bank.



**Figure 4.14 Current from Solar Panel to Battery**

Figure 4.15 shows the controller to control the water pump and shows the moisture value.



**Figure 4.15 Turn on Water Pump and Monitor Moisture Value**

Figure 4.16 shows the water flow to watering plants and soil moisture sensor that has been in the soil to checking the moisture soil.



**Figure 4.16 Watering Plants**

### 4.3 Experiment Result

The experiment was carried out from 20/11/2022 until 28/11/2022. The results obtained are tabulate as below.

#### 4.3.1 Solar Panel Output

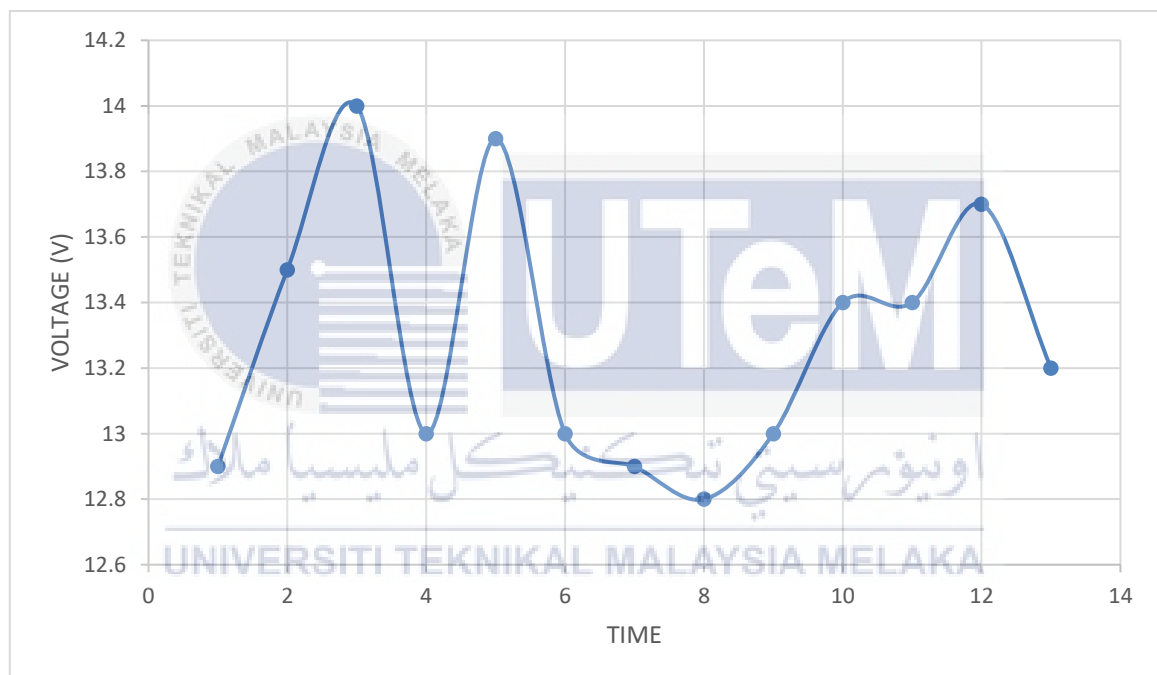
Solar panel monocrystalline output has been taken for 3 days. When sunny day solar panel take more electricity and supply more voltage than cloudy days. The data has been collected for 6 hours after every 30 minutes. Table 4.2 shows the data that has been collected for the first day.

**Table 4.2 20 November 2022**

TIME	VOLTAGE (V)	CURRENT (A)
11.00am	12.9	0.12
11.30am	13.5	0.15
12.00pm	14.0	0.18
12.30pm	13.0	0.20
1.00pm	13.9	0.13
1.30pm	13.0	0.15
2.00pm	12.9	0.15
2.30pm	12.8	0.17
3.00pm	13.0	0.22
3.30pm	13.4	0.18
4.00pm	13.4	0.15
4.30pm	13.7	0.20

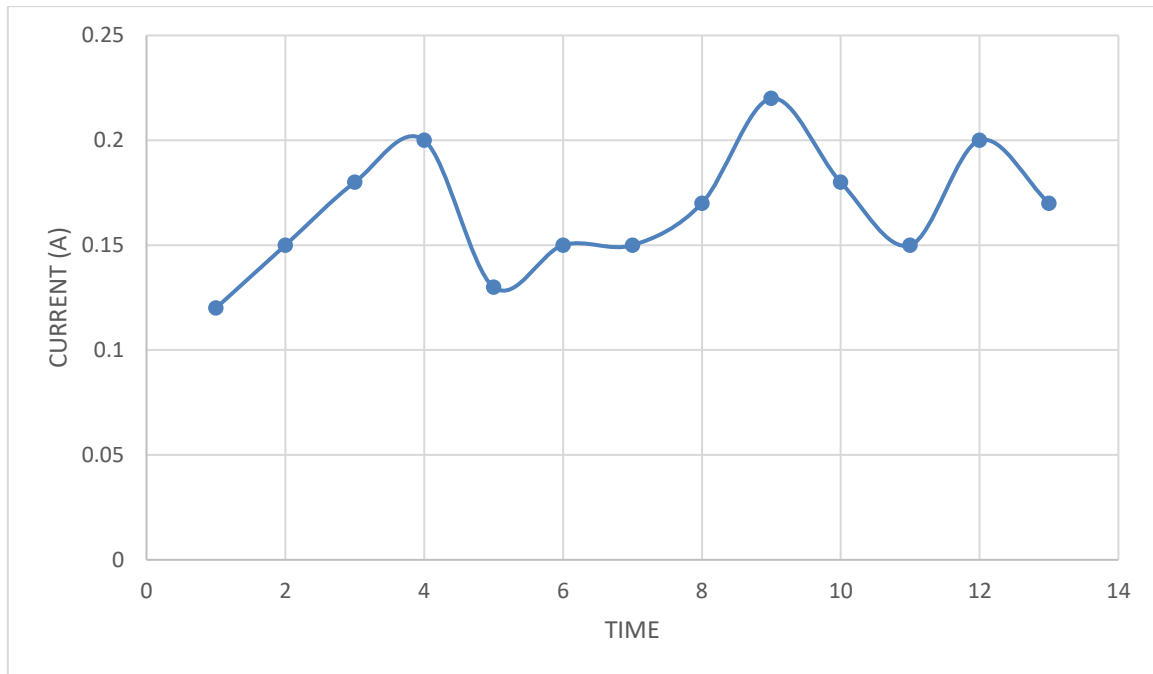
5.00pm	13.2	0.17
Average	13.3	0.17

Figures 4.17 show the voltage that solar panel produce. In 11.00 am until 12.00 pm the voltage increase, and start decrease in 12.30 pm because the weather start cloudy. Then, increase on 1.00 pm and then start decrease until 2.30 pm. From 3.00 pm, the voltage increase slowly until 4.30 pm. At 5.00 pm, the voltage has decrease because the weather is cloudy.



**Figure 4.17 Time VS Voltage**

Figures 4.18 shows the current that solar supplied. From 11.00 am until 12.30 pm the current is increase but at 1.00 pm it hat decrease because the weather. Then the current start increase at 1.30 pm until 3.00 pm. At 3.30 pm it start decrease until 4.00 pm and increase at 4.30 pm then decrease back at 5.00 pm.



**Figure 4.18 Time VS Current**

Table 4.3 shows the data that has been collected for second day on 24 November 2022.

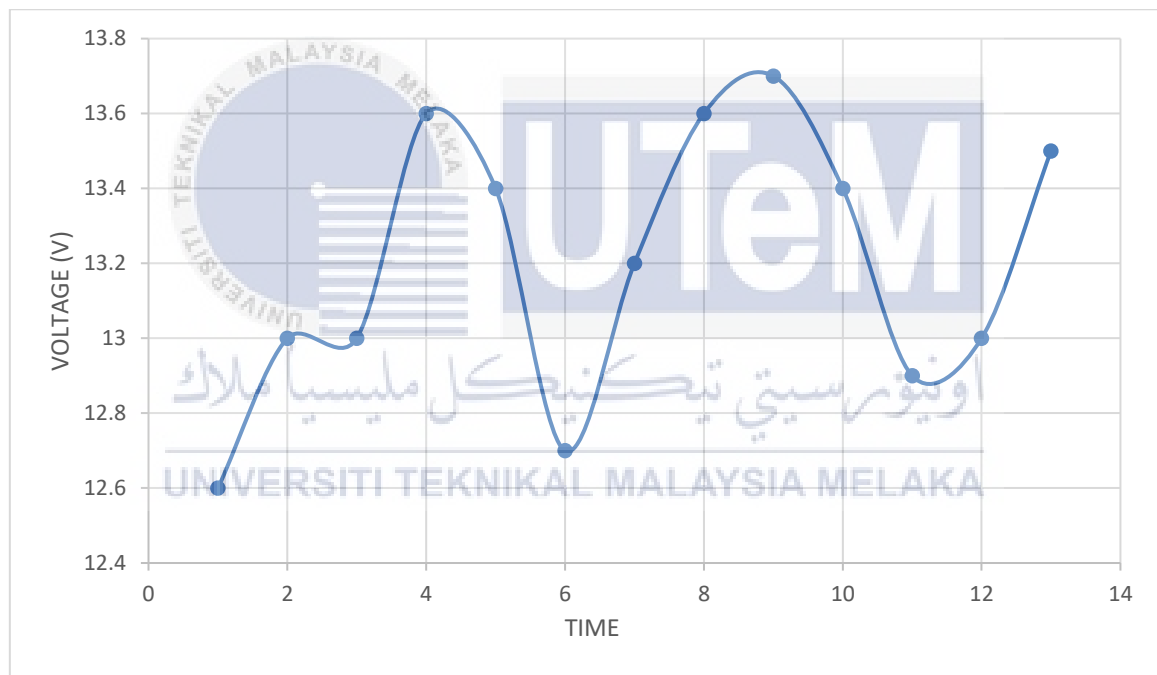
**Table 4.3 24 November 2022**

TIME	VOLTAGE (V)	CURRENT (A)
11.00am	12.6	0.06
11.30am	13.0	0.10
12.00pm	13.0	0.08
12.30pm	13.6	0.18
1.00pm	13.4	0.15
1.30pm	12.7	0.10
2.00pm	13.2	0.16
2.30pm	13.6	0.20
3.00pm	13.7	0.18
3.30pm	13.4	0.17



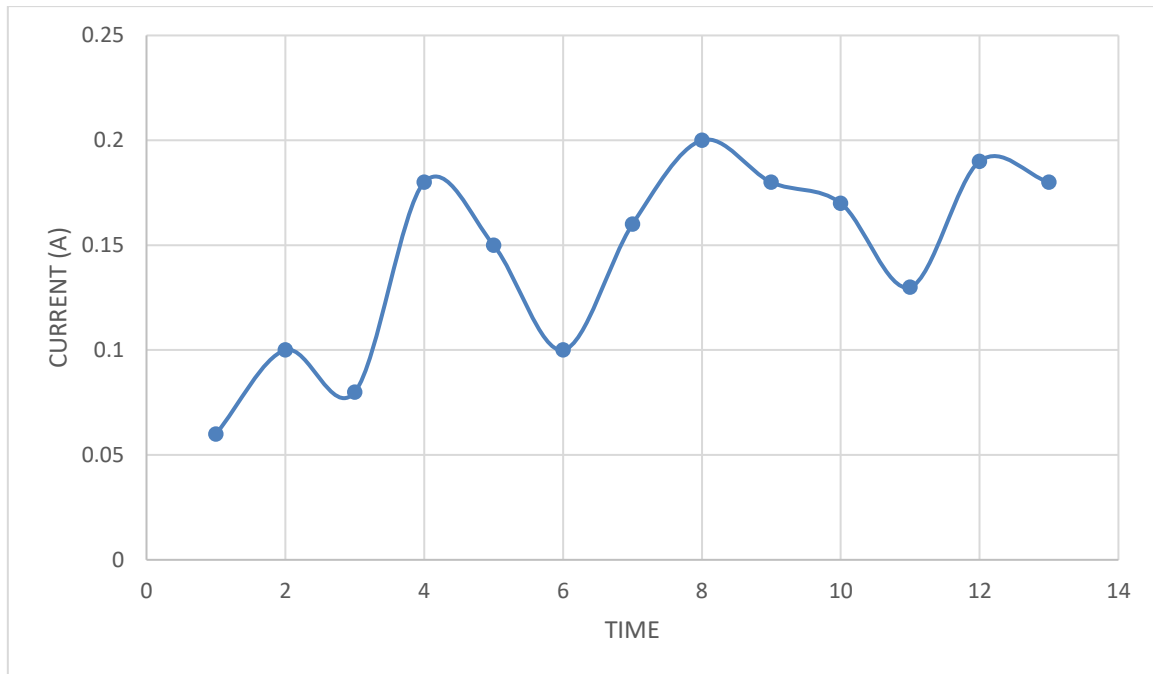
4.00pm	12.9	0.13
4.30pm	13.0	0.19
5.00pm	13.5	0.18
Average	13.2	0.15

Figures 4.19 show the voltage at 11.00 until 12.30 is increase then decrease until 1.30 pm because the weather is cloudy. At 2.00 pm the weather start sunny and give a impact for solar to supply high voltage until 3.00 pm. Then, the voltage start decrease at 3.30 pm until 4.00 pm and increase at 4.30 pm until 5.00 pm.



**Figure 4.19 Time VS Voltage**

Figures 4.20 show the graph of current on second day. At 11.30 am the current increase and decrease at 12.00 pm. After that, the current increase at 12.30 pm then decrease until 1.30 pm. At 2.00 the voltage increase and maintain until 5.00 pm. On 2.00 pm until 5.00 pm the voltage just decrease and increase a little bit.



**Figure 4.20 Time VS Current**

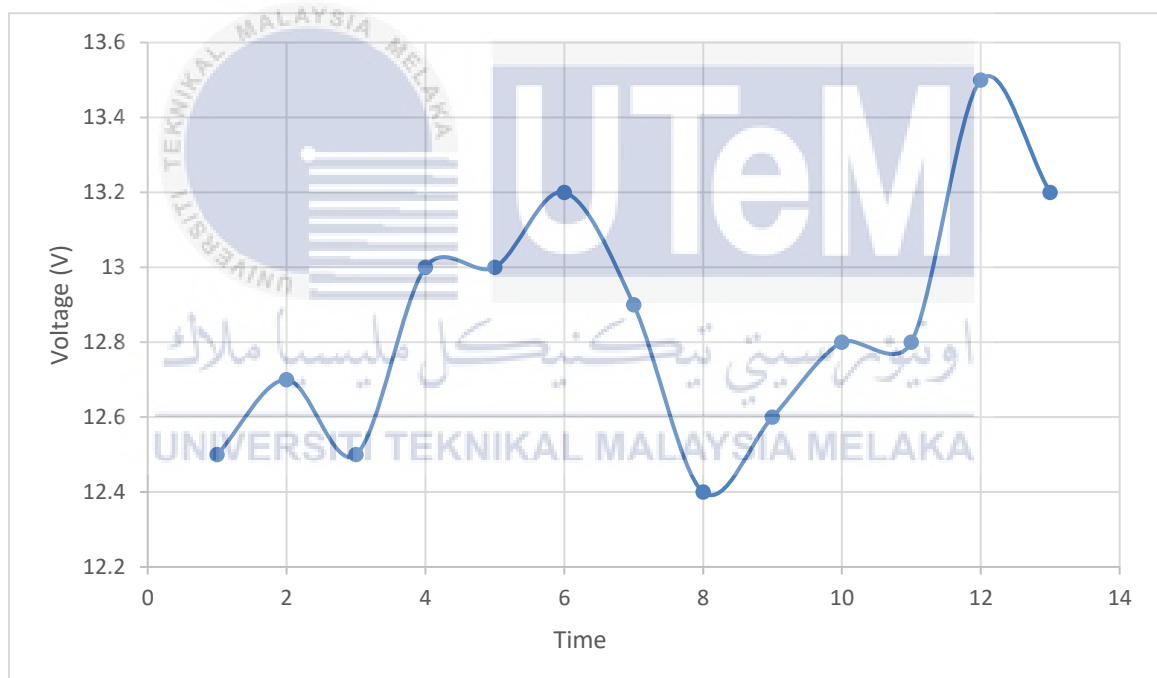
Table 4.4 shows the data that has been collected on third day on 28 November 2022.

**Table 4.4 28 November 2022**

TIME	VOLTAGE	CURRENT
11.00am	12.5	0.08
11.30am	12.7	0.10
12.00pm	12.5	0.10
12.30pm	13.0	0.18
1.00pm	13.0	0.14
1.30pm	13.2	0.06
2.00pm	12.9	0.10
2.30pm	12.4	0.12
3.00pm	12.6	0.10
3.30pm	12.8	0.02

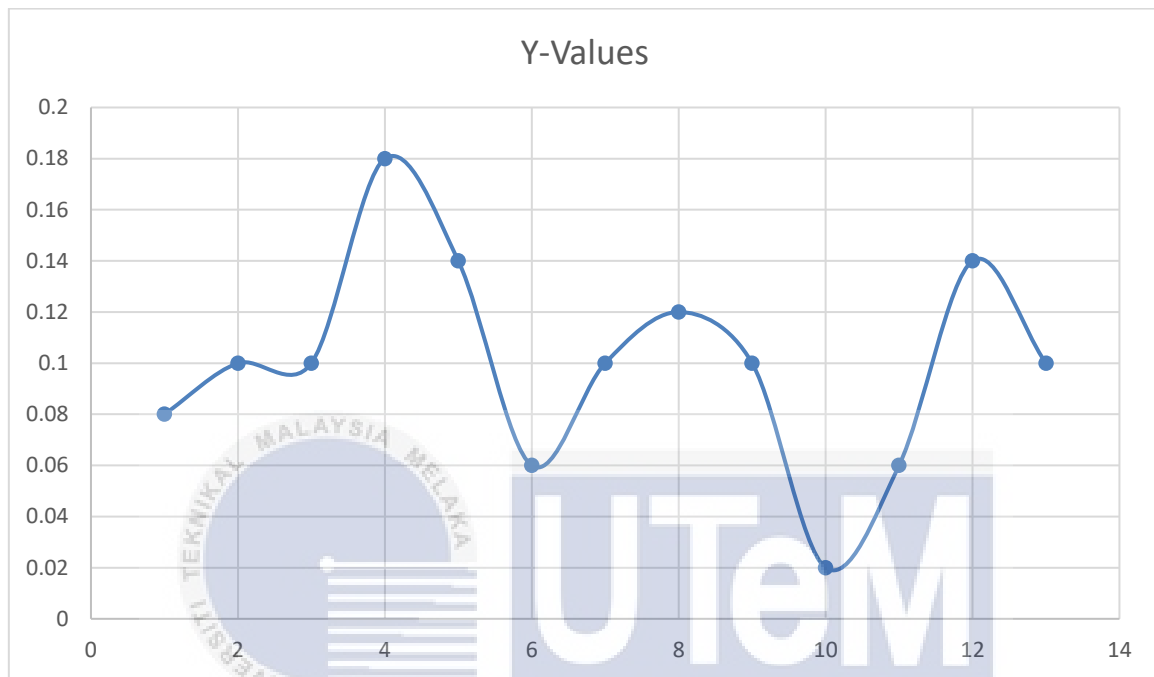
4.00pm	12.8	0.06
4.30pm	13.5	0.14
5.00pm	13.2	0.10
Average	12.85	0.10

Figure 4.21 shows the voltage on 12.00 pm increase until 1.30. Then, it start decrease because the weather is raining from 2.00 pm until 2.30 pm. Then, the voltage increases slowly from 3.00 pm until 4.30 pm. At 5.00 pm, the voltage has decrease a little bit.



**Figure 4.21 Time VS Voltage**

Figure 4.22 shows the current decrease from 12.30 pm from 1.30 pm. Then on raining time, the current increase a little bit until 2.30 pm from 2.00 pm and decrease until 3.30 pm. Then, The current increase from 4.00 pm until 4.30 pm.



**Figure 4.22 Time VS Current**

From the data that have been collected from solar panel, when on sunny weather solar produces more current than cloudy weather or rainy weather because receive more sunlight to produce electricity. From the data we can analyze, at 12.00 pm is the perfect time for solar because the sun is right overhead, so solar can get more voltage at that time. From the 3 data that has been collected, data for first day is the good because the average output of voltage and current is the highest which is 13.3 voltage and 0.17 current. Data for the third day is not good like first day because the weather is cloudy and raining.

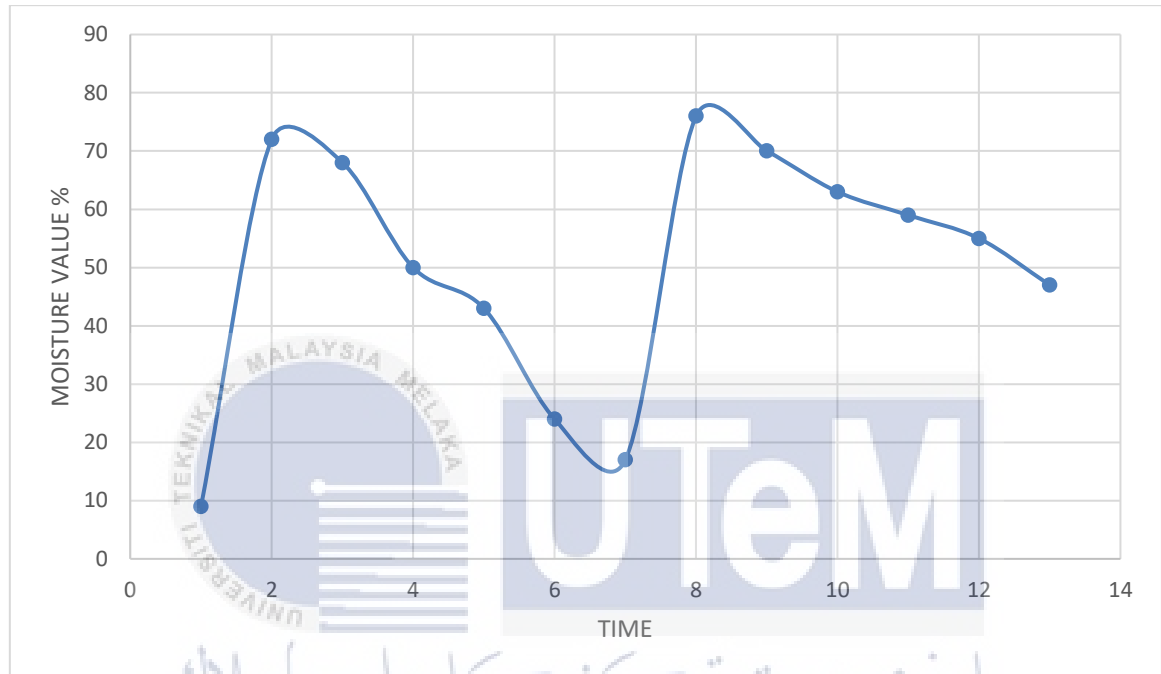
#### 4.3.2 Soil Moisture Sensor

Soil moisture sensor data has been taken for 3 days at 9.00 am for 12 hours. Data soil moisture sensor have been collect using Blynk application. Blynk application will shows how many moistures percentage of the soil. Table 4.5 shows the data that was collected on the first day.

**Table 4.5 Data of soil moisture day 1**

Time	Moisture Value (%)
9.00 am	09
After water have been pump to the soil at 9.00am until moisture value 85%	
10.00 am	72
11.00 am	68
12.00 pm	50
1.00 pm	43
2.00 pm	24
3.00 pm	17
After water have been pump to the soil at 3.00pm until moisture value 85%	
4.00 pm	76
5.00 pm	70
6.00 pm	63
7.00 pm	59
8.00 pm	55
9.00 pm	47

Figure 4.23 shows the graph that moisture value for first day. At 9.00 am the water pump has been switch on until 85% of moisture value. Then, the moisture start detect the moist of the soil has been decrease slowly from 10.00 am until 3.00 pm because that time is hot weather. Then water pump has been switch again for watering the soil for the moisture value get 85%. Then it start decrease slowly until 9.00 pm.



**Figure 4.23 Time VS Moisture Value**

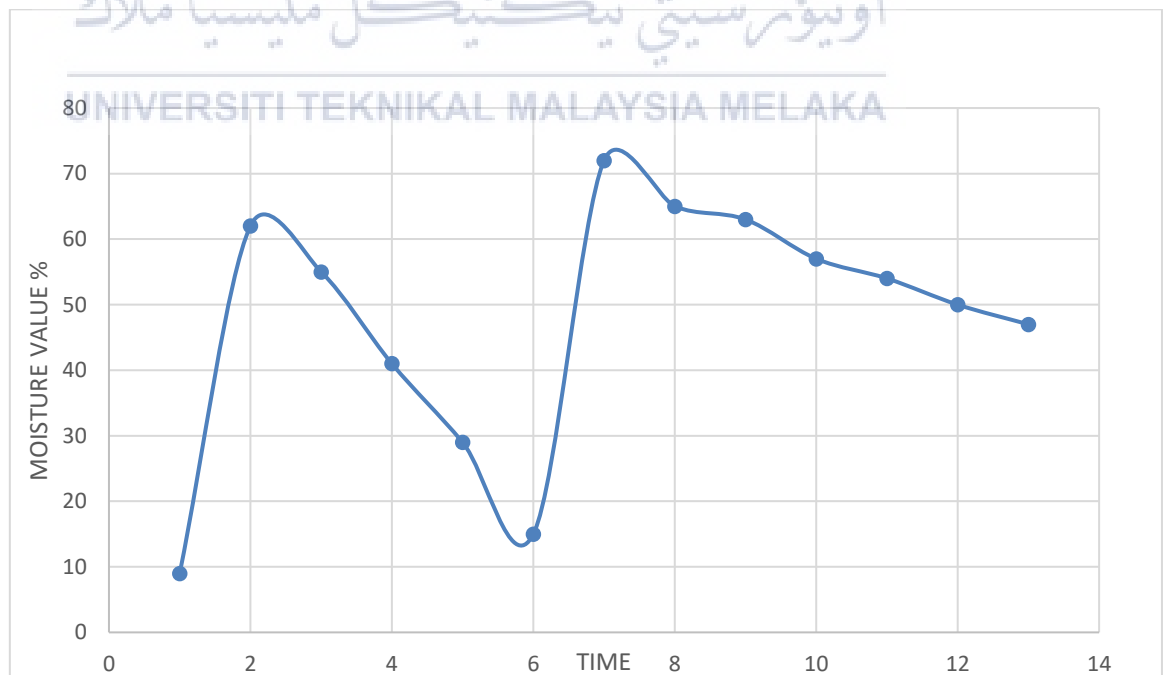
Table 4.6 shows the data that was collected on the second day. The evening on the second day is very hot weather.

**Table 4.6 Data of soil moisture day 2**

Time	Moisture Value (%)
9.00 am	01
After water have been pump to the soil at 9.00am until moisture value 85%	
10.00 am	62
11.00 am	55
12.00 pm	41

1.00 pm	29
2.00 pm	15
After water have been pump to the soil at 2.00pm until moisture value 85%	
3.00 pm	72
4.00 pm	65
5.00 pm	63
6.00 pm	57
7.00 pm	54
8.00 pm	50
9.00 pm	47

Figures 4.24 show the graph about moisture value on the second day. The soil has been watered at 9.00 am at 85% of the soil moisture. Then, it decreases from 10.00 am until 2.00 pm. Then, the water pump is switch on for moist the soil until 85%. Then, it starts decrease slowly from 3.00 pm until 9.00 pm because the weather is cloudy.



**Figure 4.24 Time VS Moisture Value**

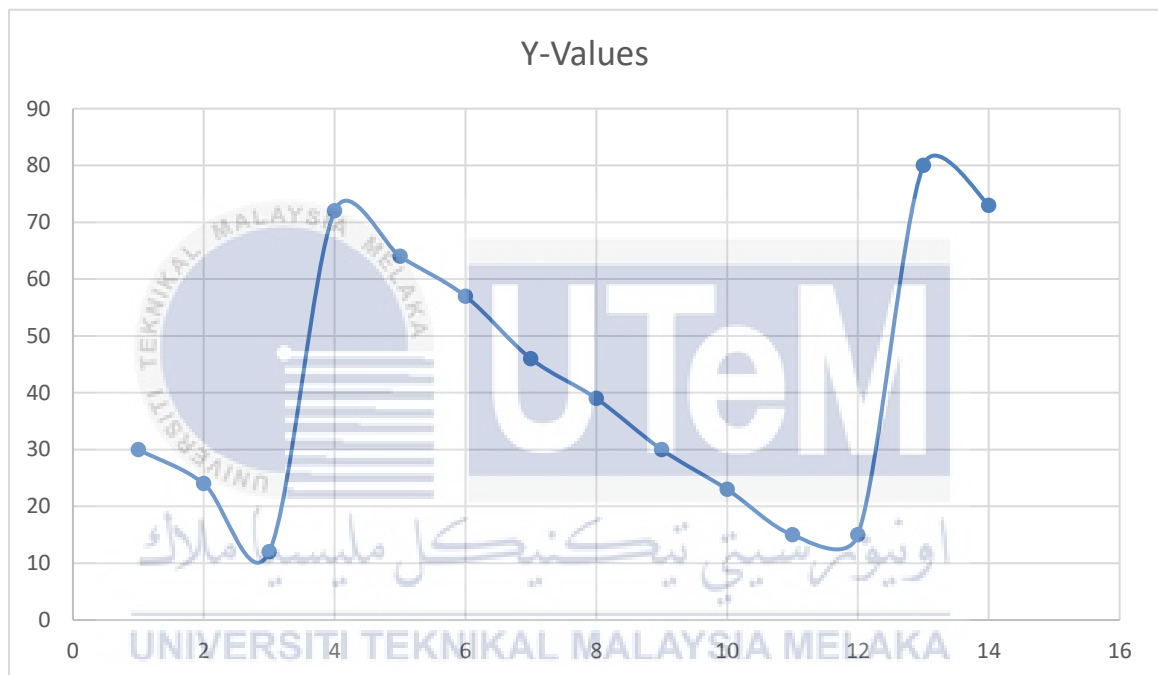
Table 4.7 shows the data that has been collected on the third day. On that day, the weather is good, neither hot or cold.

**Table 4.7 Data of soil moisture day 3**

Time	Moisture Value (%)
9.00 am	30
10.00 am	24
11.00 am	12
After water have been pump to the soil at 11.00am until moisture value 85%	
12.00 pm	72
1.00 pm	64
2.00 pm	57
3.00 pm	46
4.00 pm	39
5.00 pm	30
6.00 pm	23
7.00 pm	15
After water have been pump to the soil at 7.00pm until moisture value 85%	
8.00 pm	80
9.00 pm	73



Figure 4.25 shows the graph of the moisture value on the third day. At 9.00 am the data decreased until 11.00 am. Then, the water pump will switch on at 11.00 am to water the soil until moisture value reaches 85%. Then, the soil moisture value decreases slowly from 12.00 pm until 7.00 pm. At 7.00 pm, the water pump will switch on to watering the soil.



**Figure 4.25 Time VS Moisture Value**

From the data of moisture value on the third day, before 9.00 am the weather is raining a little bit, because of that the soil does not have to water. If the moisture value reaches below 20% the water pump must have switched on to water the soil. First day and the second day the weather is very hot compared to third day because the weather is dim.

The soil moisture sensors have advantages that will assist farmers in determining the moisture level of their plants while also saving money because these devices are readily

available at a low cost. In addition to its benefits, this project has some drawbacks that will be addressed in the long term because users can get the most out of it.

#### 4.4 Energy saved by Smart Watering Plants

The battery has been charged for 6 hours by solar panel. Therefore, this can show the system can work depending on grid and off grid. This happened because the battery bank still can supply energy to load without charging.

Since the power consumed by the system fully depends on renewable energy, the consumption of this energy is saved as the system runs on grid.

Energy consumed by the system =  $P = VI = 2.26W$

Energy consumed by the system everyday =  $2.26W \times 6 \text{ hours} \times 2 = 27.13W$

Energy consumed by the system in a week =  $27.13W \times 7 \text{ days} = 189.91W$

Energy consumed by the system in a month =  $27.13W \times 30 \text{ days} = 813.9W$

Energy consumed by the system in a year =  $27.13W \times 365 \text{ days} = 9902.45W$

#### 4.5 Summary

This chapter covered about result of solar panels and moisture value for analysis. The solar panel monocrystalline data has been taken using ammeter and pulse width modulation (PWM). The soil moisture sensor was introduced in this debate as a quick and straightforward approach to forecast volumetric water content in soils. The moisture value of soil moisture sensor readings was recorded in real time using a NodeMCU ESP 8266 board.

## **CHAPTER 5**

### **CONCLUSION**

#### **5.1 Conclusion**

In conclusion, while solar panel energy is valuable to the government, the answer to the energy issue is a problem. This automated irrigation system is always activated for the sensor detects that the soil requires water. It is more important to boost output and improve the agricultural sector by implementing modern equipment and modern techniques of technology. Implementing an Automatic Solar Plant Watering System is a current modern technology that may be implemented on their property to boost the efficacy of their farming while also lowering labor costs. Also, solar panel installation has a lower initial cost and lower maintenance costs, which is a huge comfort for farmers. This helps the agriculture industry and has an impact on the national economy.

#### **5.2 Project Objective**

To attain success from the previously discussed project objectives, there are some activities that will be conducted. Below will be discussed the objectives that have been achieved for this BDP 2 project. All three objectives have been completed for this semester.

Firstly, is to analyze the saving energy by using smart watering system. This project will be using the battery bank. This is because the battery bank can store energy to

supply the watering system. From Chapter 4, it shows the calculation that battery bank can save more energy for this watering system.

Secondly, is to design and develop a plant watering device using solar energy. This project will be using dependable solar energy from the monocrystalline solar panel. In this term, the system will be supplied from the solar panel off-grid. This objective has been shown in Chapter 3 and Chapter 4, about conducting the project.

Thirdly, Chapter 4 shows the effectiveness of plant watering devices using solar energy. Taking technological considerations into account, this paper presents an autonomous plant watering system. Where solar power is employed as a power source to manage the entire system. It is determined by an examination of soil moisture and ambient temperature.

### 5.3 Recommendations

First recommendation for this project is solar panels. If the solar panel is bigger than this project solar panel, it will produce more voltage and current to charge the battery bank quickly.

Secondly, battery banks are one of the most crucial elements of stand-alone systems. The bigger the quantity mAh battery bank, the more energy can be stored. It also can be used for the longest time without charging.

Thirdly, water pumps are the one thing that is important in this project. Using a greater water pump will allow for more irrigation flexibility in terms of field size. It also saves more water than sprinklers while giving the best watering results. It also can save time because the bigger the water pump, the faster it pumps water to watering plants.

Fourthly, water tanks are also an important thing for stored water. The bigger the water tank, the more capacity water can be stored. During the drought months, state

government may impose water restrictions. In times like these, getting a ready source of water in a full water tank can make it easier to water plants without worrying about exceeding the limit. It may save water for the rest of the year to be used during the drought months.

#### **5.4 Project Potential**

Farmers currently control irrigation methods manual process and irrigate their fields in a systematic manner. These mechanisms decrease a large amount of water, resulting in less water. While dry areas receive less amount of rain and irrigation is difficult.

Due to the simplicity of application, the ESP8266 Wi-Fi-based communication system was chosen. The cost of upkeep and the price. The device is automated and will accurately control and monitor the water requirement. The communication via the website enabled the user to work with sensors from any location, which is beneficial for the user to work. It also reduces power consumption by increasing system life for a relatively small investment.

Besides, users must wait for it until field has been properly watered, which forces them to abandon other activities. Here's an idea that can help not only farmers but also gardeners by measured soil moisture and switching the pump on automatically.

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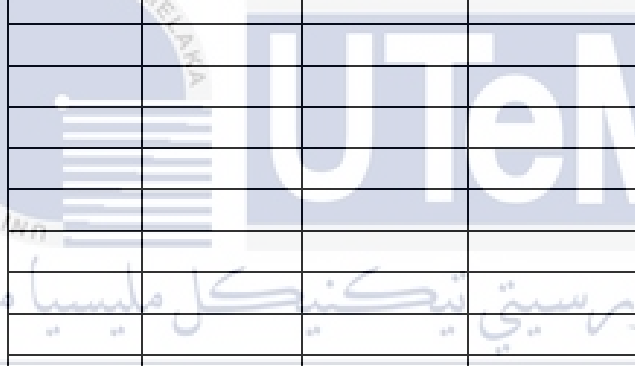
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## APPENDICES

### Appendix A Example of Appendix A *(optional)*

No.	Parameters	No.	Parameters
1.		25.	
2.		26.	
3.		27.	
4.		28.	
5.		29.	
6.		30.	
7.		31.	
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16.		40.	
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18.		42.	
19.		43.	
20.		44.	
21.		45.	
22.		46.	
23.			
24.			

## Appendix B Example of Appendix B (*optional*)



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