FAKULTI KEJURUTERAAN ELEKTRIK

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PORTABLE SOLAR POWERED IRRIGATION SYSTEM

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Bachelor of Mechatronics Engineering

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SUPERVISOR ENDORSMENT

" I hereby declare that I have read through this report entitle **"Portable Solar Powered Irrigation System"** and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Mechatronics Engineering"

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PORTABLE SOLAR POWERED IRRIGATION SYSTEM

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A **report submitted in partial fulfilment of the requirements for the degree**

Of Bachelor of Mechatronics Engineering

Faculty of Electrical Engineering

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DECLARATION

"I declare that this report entitle" **Portable Solar Powered Irrigation System** "is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree"

Signature : ....

Name : Thinagaran A/L Mahendran

Date : ....

DEDICATION

To my beloved mother and father

ACKMOWLEDGEMENT

First and foremost, I would like to thank the God who with his willingness gave me the strength and knowledge to complete my final year project successfully without any issues. I have tried my level best and gave my full commitment to complete this project on the right time without any delays. I would like to express deepest gratitude to Prof. Madya Dr Mariam Binti Md Ghazaly, who is the supervisor for my final year project at Faculty of Electrical Engineering who have gave me all the knowledge, advice, ideas and motivation to complete this project successfully. I also like to take this opportunity to thank Universiti Teknikal Malaysia Melaka (UTeM) that gave me all the facility to do my project and experiment.

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ABSTRACT

It is known that irrigation is one of the important process in agriculture. Solar power can be a solution to the decreasing availability of energy resources. The aim of this project is to develop an entirely solar powered irrigation system which is sub-irrigation system capable of performing irrigation or watering task automatically and is powered by solar photovoltaic panels (PV). A moisture sensor in the soil is used for irrigation in order to operate a DC motor powered by PV system and rechargeable battery. Arduino Uno was also applied to the project as a controller and it will control the soil moisture sensor, solenoid valve and humidity and temperature sensor to ensure the plant not have growth problems due to overwatering. In this system, the soil moisture sensor in the soil to detect the moisture content of the soil and based on these values, the motor and the solenoid valve is operated accordingly. It is the proposed solution for the energy crisis for the gardener or farmers. Then, this system conservers electricity by reducing the usage of grid power and easy to environment friendly for the irrigation. As expected that this automated solar irrigation system is will perform with the result obtained is analysed.

ABSTRAK

Seperti diketahui bahawa pengairan adalah salah satu proses penting dalam bidang pertanian. Kuasa solar boleh menjadi penyelesaian kepada kekurangan bekalan sumber tenaga. Tujuan projek ini adalah untuk membangunkan sistem pengairan sepenuhnya tenaga solar yang merupakan sistem sub-irigasi yang mampu melaksanakan tugas pengairan atau menyiram secara automatik dan dikuasakan oleh Panel Photovoltaic (PV). Sensor kelembapan di tanah digunakan untuk pengairan untuk mengendalikan motor DC yang dikuasakan oleh sistem solar PV dan bateri boleh dicas semula. Arduino Uno juga digunakan untuk projek itu sebagai pengawal dan ia akan mengawal sensor kelembapan tanah, injap solenoid dan kelembapan dan sensor suhu untuk memastikan kilang tidak mempunyai masalah pertumbuhan disebabkan oleh terlebih menyiram. Dalam sistem ini, sensor kelembapan tanah di tanah untuk mengesan kandungan kelembapan tanah dan berdasarkan nilai-nilai ini, motor dan injap solenoid dikendalikan dengan sewajarnya. Ia adalah penyelesaian yang dicadangkan untuk krisis tenaga bagi tukang kebun atau petani. Kemudian, sistem ini menjimatkan tenaga elektrik dengan mengurangkan penggunaan kuasa grid dan mudah mesra alam untuk pengairan. Seperti yang diharapkan sistem pengairan solar automatik ini akan dilaksanakan dengan hasil yang diperoleh dianalisis.

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LIST OF THE SYMBOLS

V – Voltage

m^3 - Volume

LIST OF ABBREVIATIONS

PV – Photovoltaic Panel

DC – Direct Current

AC – Alternative Current

FYP – Final Year Project

CHAPTER 1

INTRODUCTION

1.1 Introduction

A sustainable solar energy power such as solar is a best alternative to electrical power which can be used in rural areas where an electrical source is difficult to be provided. Solar is eco-friendly energy which frees from pollution where the energy usage is demanded across the world. According to the statistics published, the surface of the earth receives about 124 exa (1018) Watts or 3,850 Zetta (1024) Joules per year of solar energy [1]. It is said to be the amount generated by solar energy is the most on the earth. Photovoltaic (PV) cells are made of exceptional materials called semiconductor which is silicon. A photovoltaic (PV) module is a bundled, associated get together of various sun based cells. Fundamentally, when light strikes the cell, a specific part of it retained inside the semiconductor material. The power will be produced by the semiconductor which is called direct current (DC) and can be utilized quickly or stored in a battery [1].

The cost of solar together with batteries for capacity has kept on falling so that in numerous countries it is less expensive than common non-renewable energy source power from the power grid. This has motivated the application of solar energy in different sectors. Therefore, the application of solar can be used in agriculture for the purpose of irrigation. One of the important process in agriculture system is irrigation system which is the process controlled amounts of water to plants at needed intervals. Irrigation helps grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of inadequate rainfall [2].

Therefore, this project is to design and construct an automatic irrigation system powered by solar photovoltaic (PV) on a small scale. The project consists of the electrical part and mechanical part. The electrical part consists of Photovoltaic panel, charge controller module, a battery which is to store the current, and other required electronic components to form the circuitry for the controller whereas the mechanical part would be a solenoid valve and water pump which enable to watering the plant.

There are a lot of type of irrigation system which is sprinkler, sub, and drip system. One of the type of irrigation system that chooses for this project is sub-irrigation system. When the plant requires water, the soil dryness level is to be implemented and it can be achieved with the use of soil moisture sensor. This project also carries the function of storing energy when not in use in the form of battery and thus saves energy. The control is made by of an Arduino Uno which is a microcontroller board based on the ATmega328P. The utilization of Automatic Solar powered water supply and irrigation system can reduce the cost of agriculture, the better alternative of energy source and solve many other problems in the field of agriculture.

1.2 Motivation

This project aims to design a solar-powered automation irrigation system to reducing the agriculture cost, provide a better alternative of energy source. It also increases the rate of the growth and optimizes the wastage water. Previously, the projects using electrical and chemical energy which powered by fuel as a power source to water the plant and it causes them cost and time-consuming. Then, it also have to monitor the productivity of the plant, soil moistening for 24 hours. The current watering system for both plants in the small scale and irrigation for large field of crops can be separated into manual and automated.

Indian economy is known as one of the biggest developing economies in the world. Whereas the largest contribution the growth of the economy has come from the agriculture sector. To reach the ultimate usage of the man power and obtain supreme profit, their several developments has been done in various engineering field. So, it is necessary to maintain a good amount of water level in the soil, in order to obtain a good harvest that could provide nutrients to us. The Indian farmers have suffered a great loss in the agriculture field due to failure in crops in the drought season. To overcome this type of situation, the usage of an automated irrigation system would be the ideal way. An automated irrigation system basically reduces the water waste, where it provides water to the plant only when it is necessary. Provided with the renewable energy fitted with it the electrical cost consuming could be reduced.

1.3 Problem Statement

Under the field of agriculture, the demand for food crops to satisfy today's population had been increasing from day to day but since both water, electricity and fuel to drive pump are costly and scarce in supply, the production or yield of crops in many countries and rural areas has been decreasing [2]. The current watering system for both plants in the small scale and irrigation for large field of crops can be separated into manual and automated. The manual system needs labor for monitoring the productivity and health crop whereas the automated system would be systems that make use of a device like a timer. As the automated system works based on timing, it can cause wastage of water and oversupply to plants. Hence the watering system that responds based on soil moisture in the soil would provide a sustainable solution. In addition, the current watering system in agriculture consumes energy based on the size of a field [3]. A renewable energy source such as solar can be an excellent alternative and development of technology based on it can be used in areas where electrical power is difficult to obtain. Thus a project that is powered by sunlight to help supply water to the desired area, only when needed through the use of a microcontroller and also at the same time stores the power in the form of storage device like a battery would greatly help the agriculture industry.

1.4 Project Objective

The objectives of the project are:

1. To design and evaluate solar powered automatic irrigation system.
2. To analyse the solar power capacity and implement automatic irrigation system.

1.5 Project Scope

The scopes of the project are:

1. Cover the studies on the principle of the solar power automatic irrigation system using Arduino for watering.
2. Arduino is used to develop a program for solar power automatic irrigation process and connect with soil moisture, temperature and humidity sensor and solenoid valve.
3. Green energy involves due to solar energy convert to electrical energy and then to mechanical energy.
4. Limitation: house garden area, small-scale garden, same type of plant

1.6 Report Outline

This report consists of 5 main chapters. Firstly, the title of the project was confirmed at the initial stage. This report starts with the chapter 1 that is an introduction. The first chapter discussed the overview of the project background, motivation, problem statement, objective, scope, and the expected outcome of the project. Then this report is continued with the second chapter literature review. Chapter 2 discussed literature review that is related to this project based articles, journal, books, and internet. In this particular chapter, it is discussed briefly the fact, technique and results about from the previous studies. Next in chapter 3 is the methodology described the planning of design structure, methods going to use, procedures of experiment going to be done throughout the project and controller such as Arduino. Chapter 4 discussed the results and analysis with construct a table. The results obtained from the project will be analysed in this chapter. Finally, chapter 5 is discussed the project achievement and future recommendation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

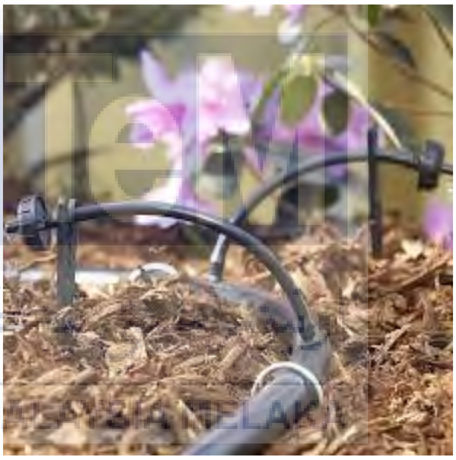
At present, there are multiple automated solar-powered water supply project throughout the world and most of them are developed for the integration of agriculture field. The dissimilarity among these projects is in their attributes and method of control to achieve the same goal. This chapter will discuss all the previous study and comparison of the methods that related to solar power irrigation system.

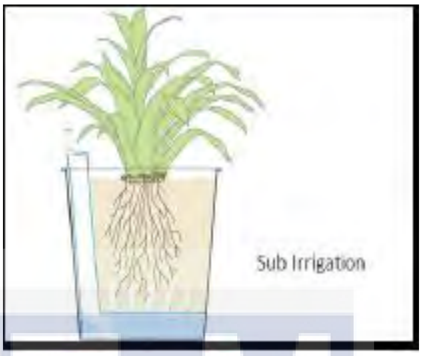
2.2 Types of Irrigation System

There are three types of the irrigation system that had been found from journals and articles which is sprinkler, sub, and drip irrigation system. The Table 2.1 show that the descriptions of each irrigation system. In next sub-topic will show all previous study and related to the type of irrigation system.

Table 2.1: The Types of Irrigation System

No.	Types Of Irrigation System	Description
1.	Sprinkler irrigation system [3,7,12]	• The water is supplied to some particular areas through pipes and circulated to the field by high pressure enduringly equipped guns or sprinkler. • The rotor in a pivoting the sprinkler is constructed to rotate in the area of a circle pattern. • This system usually uses at golf field, the big scale of agriculture field, football field.  Figure 2.1: Sprinkler System

2.	Drip irrigation system [14,15].	• Is similar to emitters, micro-sprays, drip lines, and mini rotors. • Flexible tubing with emitters which have a tiny water-flow regulator in each hole in the line. • System that can save water because only the plant's root zone receives moisture. • Help reduce the problems associated with water waste in farming, avoid evaporation. • Water is applied very slowly in gallons per hour. • Operate at a reduced pressure.  Figure 2.2: Drip System

3.	Sub-irrigation system [14].	• The soil below the plant root zone is moistened by applying water. • The water flow through holes in the bottom of the pot. • Can easy to the plant root zone absorbs the water. • Provide better in term of growth and the production.  Figure 2.3: Sub System

2.2.1 Application of Solar Powered Automatic Water Pumping In Turkey

Figure 2.4 shows that the application of the system which conducts an automatic drip watering system of dwarf cherry trees system with solar powered brushless DC motors (BLDC) has been designed and put into use in Zille District of Tokay Province of Turkey [2]. One of the motor was used for driving deep well pump which has been used for the purpose of the water storing in a pool. The other one was used for driving centrifugal pump which has been used for the purpose of importing of the water waiting in the pool to drip irrigation system. Best solar panels were selected according to the calculated maximum power consumption of motors. The need of brushless DC motors (BLDC) has been given from solar panels and batteries. A DC-DC buck converter has been developed to Dc motor and charges the batteries guardedly. The automation of the system consists of the soil moisture sensors, RF modules, and solenoid valves [2].

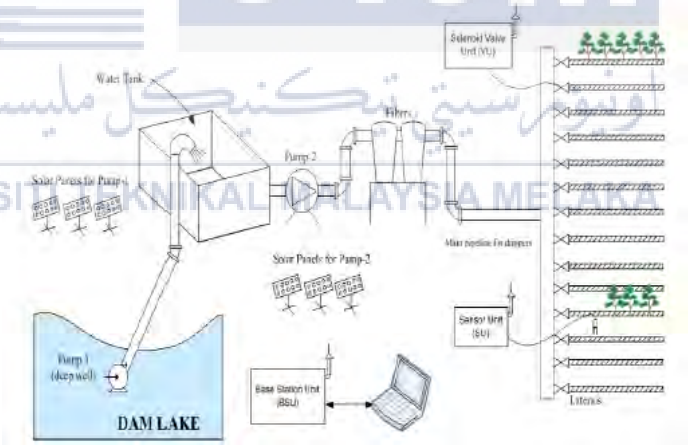


Figure 2.4: Application of the System [3].

The architecture, in this case, is enormous as it accommodates 48 PV arrays of 80W, a Brushless DC motor (BLDC) motor of 96V 1.6kW, another BLDC of 48V 3kW, 8 batteries summing up to 6240W power and 3000 drippers to perform irrigation to 1000 dwarf cherry trees planted [3]. Control mechanism splits into two utilizing the different BLDC motor of different power. The first portion of execution is the direct connection of 24 PV panels with a driver that operates the 96V 1.6kW BLDC-1 motor to revolve deep well pump and transport water from the Dam Lake to the water tank [2].

The second portion incorporates 48V 3kW BLDC-2 motor coupled with a centrifugal pump and powered by the remaining 24 PV panels. However, battery bank is also added in the system to provide energy for the motor in case sun irradiation is minimal. Solenoid Valve Unit (VU), Sensor Unit (SU) and Base Station Unit (BU) were designed to realize control of drip irrigation. These units comprise of RF module, the Omni-directional antenna, 7V 1.8W solar panel and low power PIC18F452 micro controller [2]. Additionally, the SU has soil moisture sensor and the solenoid valve is 12V 10W rated. The soil moisture module measure water content in SU and this analog data was sensed with ADC on PIC chip and evaluated. Afterwards, the valves position either ON or OFF are defined and the information is transmitted to VU for completion. Some other feature of the build is DC-DC converter usage to feed and charge battery safely plus solar tracker structure for increased efficiency of PV.

2.2.2 Intelligence Irrigation System Employing the Use of Solar PV

The system operates mainly on the concept of Data acquisition system (DAQ) and Laboratory Virtual Instrumentation Engineering Workbench (LabVIEW). DAQ denote the process of sampling signals and translating analog waveform into digital as for control from a computer. DAQ of choice has specifications of four channels which is three analog and one digital, plus screw terminal for digital I/O, analog output, counter, +5 Volt line, two more analog input used to construct circuits, custom sensors, manage Radio- Controlled (RC) and turn on servo motors. The constructed system is a close-loop type that functions depending on the soil moisture level detected by the sensor. Data or feedback from the sensor is passed to LabVIEW software via DAQ as an interface. The condition of the soil when dry will initiate LabVIEW to trigger valve open and sprinkler starts watering till the desired level is achieved [3]. The term intelligence was applied to the title of this project due to the fact that valve operates based on the current soil moisture and also system scheduling was recorded for future reference. The Figure 2.5 shows the block diagram of intelligence system. Then, the flowchart of the system shows in figure 2.6. In addition, the condition of valve whether on or off are showing in figure 2.7 and 2.8.

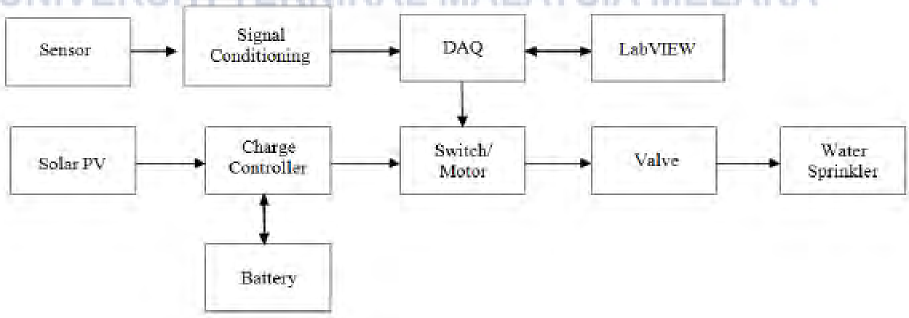


Figure 2.5: Block Diagram of Intelligence Irrigation System [3].

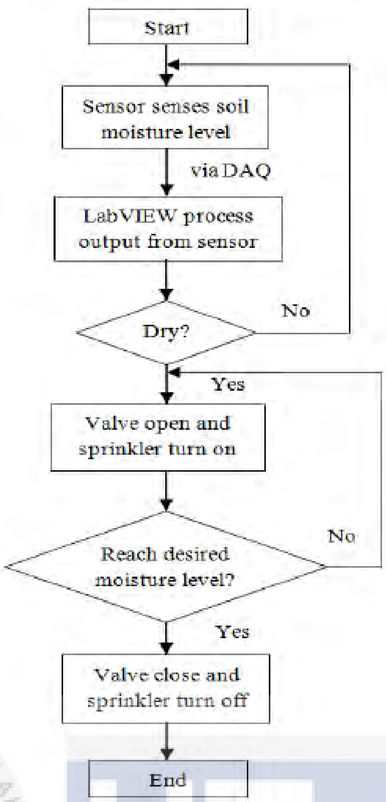


Figure 2.6: Flow Chart of the System [3].

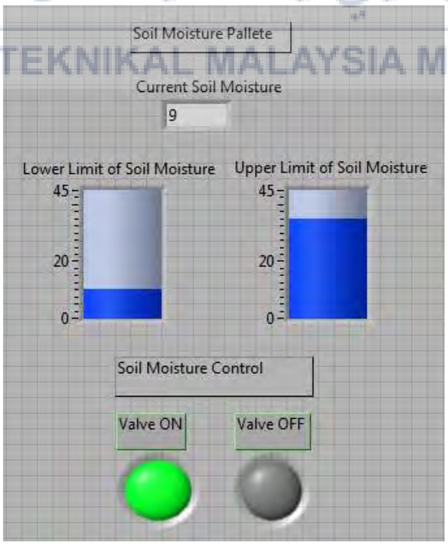


Figure 2.7: The Valve Is Open [3].

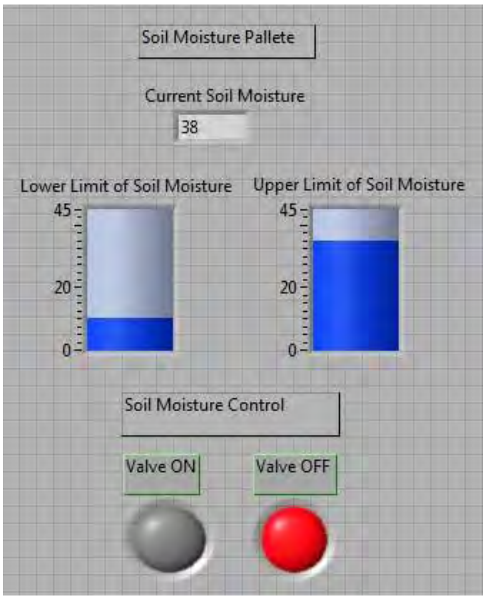


Figure 2.8: The Valve Is Close [3].

2.2.3 Design and Development of a Sensor Based On Intelligent Auto Irrigation System

Figure 2.9 shows the flowchart of the entire irrigation system. The purpose to the entire system to reduce the money spent on fossil fuel and optimize by reduce wastage of the water and overwatering. From this system, they can improve the quality of yield production. There are lot type of irrigation system and for this entire system they using sprinkler system which is using tube and nozzle for spreading water if needed. The whole system controlled by Arduino Uno which is needed 5V. There is two conditions for activated the pump. Firstly, detected by a photo resistor for detecting the presence of sunlight. Secondly, use soil moisture sensor to detect the dryness of the soil. Both conditions will be programmed by Arduino Uno in both hardware and software. They also using a rechargeable battery for the purpose regulating the charge and discharge the battery [4].

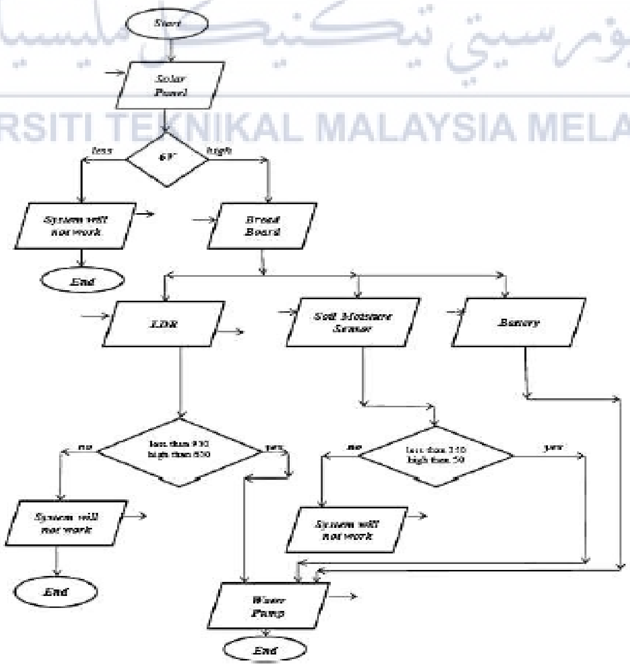


Figure 2.9: The Flow Chart of Entire System [4].

As a conclusion, the project successfully implemented and very useful the farmer which have a large field of agriculture. The system can reduce the cost of fossil fuel and the pollution. They can also improve their quality of yield in crop production. The more important thing is to provide a comfortable duration power to the water pump by using the large solar panel and the batteries. The project is suitable for a large scale.

2.3 Photovoltaic Panel (PV)

All photovoltaic (PV) cells consist of two more thin layers of semi-conducting material, frequently silicon. When contact with light, electrical charges will be generated and then can be published via a conductor s direct current (DC). The electrical output from a single cell is not adequate and so more than one cell are connected in an array to form a module with its specific rating on power (W), open circuit (Voc), short circuit (Isc), maximum power voltage (Vmpp), and module efficiency (%). There are three types of a photovoltaic panel which is monocrystalline silicon PV panel, polycrystalline silicon PV panel, and amorphous silicon PV panel [5].

2.3.1 Monocrystalline Silicon PV Panel

The monocrystalline silicon which silicon from pure crystalline silicon bars is according to make this kind of panel. The entire cell aligns in one direction, thus making them extraordinary efficient provide the sun is shining brightly at the perfect angle. The composition of mono-Si is rigid and it has to install on a rigid frame as well to protect them. The advantages and disadvantages of monocrystalline silicon PV panel are shown in Table 2.2.

Table 2.2: Advantages and Disadvantages

Advantages	**Disadvantages**
Made from highest grade silicon leading to highest efficiency rate which is 15-20%.	The most expensive.
Space efficient but require the least amount of space	Performance impact as temperature goes up
Better durability of power delivered and better performance at the low light condition.	

2.3.2 Polycrystalline Silicon PV Panel

The polycrystalline silicon which is built from silicon off cut moulded to form blocks and produce a cell made up of several bits of the pure crystal due to the individual crystals not being necessarily aligned in perfect condition and losses at the separation joint, this type is not as efficient as the monocrystalline type. The composition is also rigid and needs a rigid frame to be mounted on. The advantages and disadvantages of polycrystalline silicon PV panel are shown in Table 2.3.

Table 2.3: Advantages and Disadvantages

Advantages	**Disadvantages**
Simpler and reduce cost.	The efficiency of polycrystalline PV panel is typically 13-16%.
Lower heat tolerance	Lower space efficiency.

2.3.3 Amorphous Silicon PV Panel

Amorphous silicon cells are built by deposition of silicon in a thin homogenous layer onto a substrate instead of the normal creation of rigid crystal structure. This type of PV absorbs light more effectively than crystalline silicon thus making the cell to be thinner in dimension. It is one of the sub-products under the category of Thin-Film Solar Cell (TFSC). Amorphous nature thin layer enables it to be flexible and can be manufactured on a flexible surface. The advantages and disadvantages of amorphous silicon PV panel are shown in Table 2.4.

Table 2.4: Advantages and Disadvantages

Advantages	**Disadvantages**
a mass production and cheaper to manufacture	Low space efficiency
Flexible	The efficiency of typically around 6% only.
High temperature and shading have less effect on performance	Thin film PV panel has faster degradation rate

2.4 Types of the Controller

There are a lot of controller had been used by previous researchers which are using related to the automatic irrigation system. Table 2.5 shows the types of controllers and its descriptions. In next sub-topic will show all previous study and related to the type of controller.

Table 2.5: The Types of Controller

No.	Type of controller	Description
1.	**Arduino [4, 6, 8, 14].**	• provided with power from the USB connector an external power supply(5V) • Arduino is an automatic unit conversion capability. • The Arduino website itself explains each and every function of Arduino. • Easy to execute programme • Large community • High cost • Libraries are not very efficient in certain parts and waste RAM and CPU cycles.
2.	**Fuzzy control technology [8].**	• Uses fuzzy set theory • Fuzzy logic to simulate the fuzzy way of thinking of human • Does not require precise input • Hard design

3.	**Microcontroller (89S510 [3, 7, 8, 10, 12].**	• Faster speed for executing • Labour saving • Complex architecture- difficult to understand the function its quite difficult • Development time – has the complexity of circuit board. • The useful option for beginners and as well as the high-end application developer. • Prone to damage when exposed to harsh and rough condition • Consume more processing time
4	**Data acquisition system (DAQ) [3].**	• Acts as a data collector consist of the computer system • An interface circuit in order to collect and process data. • It can be monitored virtually and remotely, the performance of the PV system • Complex and time-consuming

2.4.1 Automated Solar Based Agriculture Pumping

An automated agriculture pump system can be controlled the uses of a suitable 12V programmable timer which can turn on the pump at the same time at each night. Instead, a bespoke electronic relay manipulate board may be prepared to supply energy to the pump with the preference of switch on/off instances each day. To guard the pump against being broken if it runs out of the pump and to prevent any secondary tanks from overflowing, go with the flow switches may be used to locate water tiers and their reading fed into electronic controller [6].

Figure 2.10 shows the flow system of this project. The control algorithm of the design involves a 15V PV panel charging a 12V electric storage device which is the battery that runs the 12V DC pump. It has circuit connecting for input from analog sensor light, water and humidity sensor. The main body makes use of 8-bit ADC0808 to give digital input to the microcontroller (AT89S51) and relay board to protect the microcontroller from the back electromagnetic field (e.m.f) of the pump. The core AT89S51 enables crop watering to happen at the time of choice based on the coding embedded and sensor inside it [6].

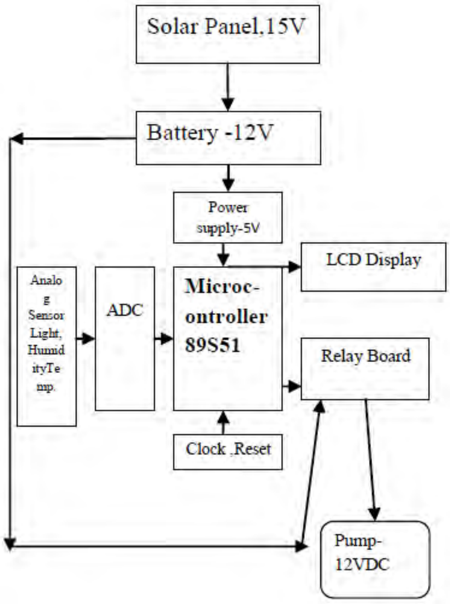


Figure 2.10: The Flow System [6].

2.4.2 Solar-Powered Automated Plant/Crop Watering System

The system aims at developing a whole automated plant watering system. The main reason for doing this system to reduce the wastage of the water and to effectively manage the amount of the watering of the plants. This system also aims at reducing human energy and cost and errors due to human irresponsibility. The system uses solar panels to provide power to the system at daytime. Solar energy is used to operate the system during daytime and charge the electrical storage devices to operate at night. It uses soil moisture sensors to sense the level of the moisture in the soil. When the moisture content of the soil in a dry condition or goes below a certain limit for a plant, the pump system is will trigger and the plant is watered. The plants are watered systematically till the desired value is reached and the pump is switched off automatically [7].

Figure 2.11 shows the block diagram of the system and the controller that use for this system is Arduino Uno microcontroller embedded board which is an open-source prototyping platform based on easy-to-use hardware and software. The reading from the moisture sensor is directed to the LM3914 IC (Integrated Circuit) which detects the moisture level. Other than that, another device applied is the Optocoupler PC817 and its output is controlled as the driving input to the Arduino [7]. A particular threshold value triggered, informs the Arduino to activate the pump.

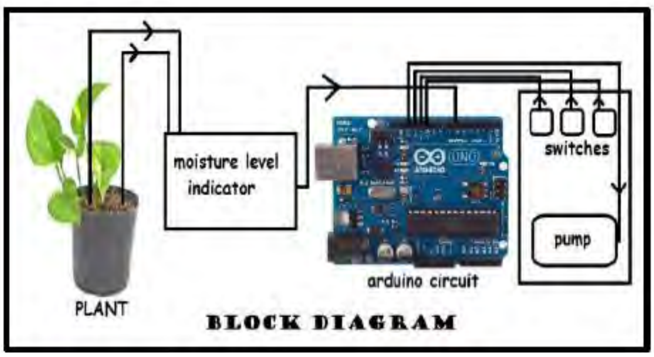


Figure 2.11: The Block Diagram [7].

2.4.3 Smart Orchard Soil Moisture Monitoring System Based On Wireless Communication Technology

The approach taken is project has variance because of the application of microcontroller MSP430F149 for the irrigation system and another additional module which is GSM module, flow sensor module, a solar panel module, and a solenoid valve which to monitor the information of the soil and inform the authority via SMS. To achieve the precision of the irrigation system. They controlled by using fuzzy control technology [8]. The block diagram of this project shown in Figure 2.12.

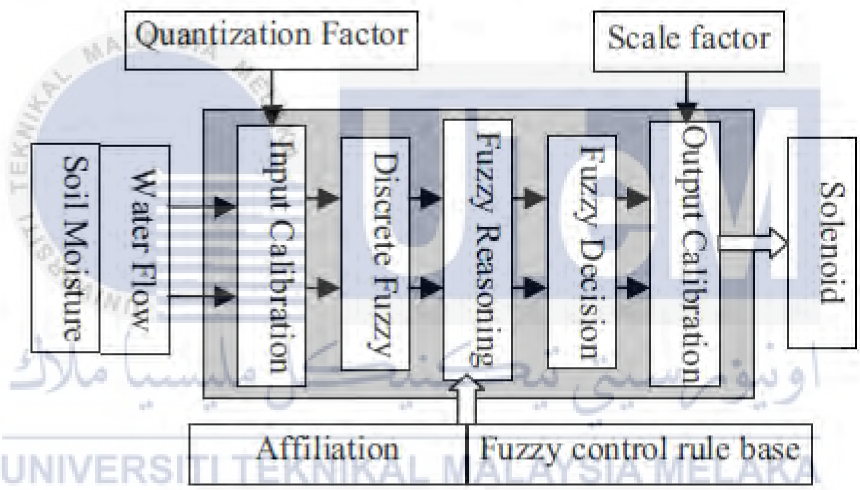


Figure 2.12: The Block Diagram of Fuzzy Control [8].

The utilization of microcontroller MSP430F149 provides a flexible solution because it can run the system in low power mode. The system demonstrates that the entire system is solid and stable and remotes in condition. The project is suitable for a large scale area and it can save the usage of the water from 20-30% compared to manual irrigation system method [8]. They can control all the data through the mobile via SMS and understand the elements of the plantation soil information's remote transmission and programmed exact water system by using fuzzy control technology.

2.4.4 Proposal of Solution for Automated Irrigation System

This paper referred an automated irrigation system using a waspmote board which is supplied with GPRS communication module with a antenna. Figure 2.13 shows the block diagram of the irrigation sysyem. The waspmote is an open wireless sensor platform which is similar to the Arduino with XBee. For the backup power, they using 3.7V 6600mAh lipo battery and use LCD to display the status of the system [9]. They also use plastic case as a controller box. In addition, they also using the electromagnetic valve to control the flow of the water which is powered 24V AC.

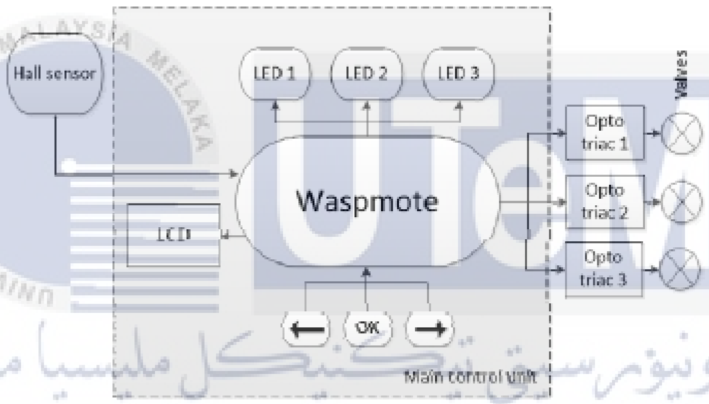


Figure 2.13: Block Diagram of Waspmote [9].

From the proposed of this project, they can control the irrigation system smoothly and malleable. Other than that, they can also provide an excellent water utilization. Finally, this system very helpful for a bigger scale of farming because this system can control the irrigation of the plants perfectly and reduce time and water consumption.

2.5 Summary of the Input Source in the Previous Study

There are several types of input power for the irrigation system from the previous studied. Then, table 2.6 shows the comparison of the input source in different kind of factors. The factors are in term of maintenance, gas emission, free energy, operation mode, noise factor, and costing. In next sub-topic will show all previous study and related to the type of input source.

Table 2.6: The Summary of the Input Source

Power input	**Solar panel (pv) [2, 3, 6, 7, 12,].**	**Diesel pump [14].**	**Spin cell [13].**	**Power supply to pump [8].**
Low maintenance	Yes	No	Yes	No
Gas emissions	No	Yes	No	Yes
Free energy	Yes	No	Yes	No
Low operation	Yes	No	Yes	No
Noise	No	Yes	No	Yes
Cost	Low	High	High	High

2.5.1 Automated Irrigation System Using Solar Power

The prototype constructed under this journal paper is a model of variable rate automatic microcontroller based irrigation system. Figure 2.14 shows the block diagram of the system and the objective of the project is mainly due to the application of control from the cellular phone, the components utilized was a 6V PV panel, battery, AC driven ump, PIC16F628, Dual Tone Multi-Frequency Module (DTMF), inverter, and soil moisture sensor by using two separate plates [10]. There are three separate levels to detect the level of the water which is 0cm, 3cm, and 10cm. however, if the water level reaches below the middle sensor then a message will be conveyed to the user. Then, the microcontroller will standby to trigger pump if assigned codes are sent to the user back. The code will be sent through the Dual Tone Multi-Frequency Module (DFMT) and correct binary received by the microcontroller to enable activation of a pump from afar. In addition, the microcontroller will wait for the command till the third sensor which is (0cm) triggers if the user does not send any feedback code. The third sensor will cause the microcontroller to automatically "ON" pump and it will be turned "OFF" once the water level reaches to the first sensor [10].

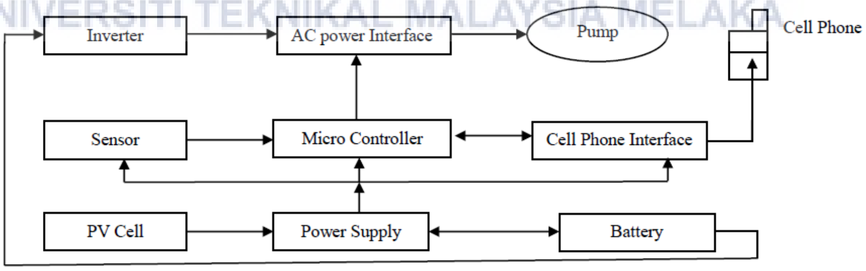


Figure 2.14: The Block Diagram [10].

2.5.2 Solar Based Plant Irrigation System

The purpose of this project which is solar based automatic irrigation system is to reduce the cost and time of the irrigation system by using microcontroller 8051 Series. For the power source they using one of the types of solar panel which is Spin Cell. The Spin cell produces 20 times more current compared to another solar panel. The characteristics of the spin cell show in Table 2.7. After that, the DC motor controlled by in two mode which is automatic mode and GSM mode. The GSM mode is controlled by the phone for the purpose controlling the pump [11]. They also using a rechargeable battery for the purpose regulating the charge and discharge the battery. For this project, they also using water level sensor and humidity sensor which is for measuring the surrounding water evaporation.

Table 2.7: The Characteristics of Spin Cell [11].

Spin cell
Self-cooling
Reducing the wind sheer
Accrued power density
Remote management
Stealing protection
Lower price per watt produced

Figure 2.15: Spin Cell [11].

As a conclusion this project achieved their objective because the entire system will make easier to the farmer for monitoring the growth of plant and soil moistening. They no need to monitor the crops 24 hours and they can monitor by GSM module. In addition, this project reducing the usage of grid power by using solar power which is an environment-friendly. They also do not worry about the electricity consumption [11].

2.6 Summary of the Actuators in the Previous Study

There are a lot of actuator had been used by previous researchers which are using for the irrigation system. The table 2.4 shows the types of actuators and its descriptions. In next sub-topic will show all previous study and related to the controller that had been used.

Table 2.8: The Types of Actuator

Types of actuators	**Description**
Submersible pump [15].	• Provide high torque • Highly efficient • Easily not leak when submerged • Waterproof and tightly sealed • It is a self-primed
Dc water pump **[2, 4, 6, 7, 9, 14].**	• It is waterproof • Use in low voltage power supply • High efficient • Convenient and portable • Easy to control • Pretty noise • Less cost
Solenoid valve **[2, 3, 4, 8, 9].**	• Operates electromechanically • Not easily to leakage in internal and external area • Low cost and simple • Limitation of precision • Turn on the valve when the relay is on else shut off the valve when the relay is off.
Ac water pump **[10, 12].**	• Operates on alternating current • Require high maintenance • It is waterproof • Use in high voltage power supply • The direct current produced by the solar panels gets converted to AC using the inverter

2.6.1 Solar Powered Smart Irrigation System

This system fragments into two modules. First is solar pumping module using a control circuit to charge a 12V, 100Ah capacity battery which shows in Figure 2.16. A DC-DC boost converter is afterward applied to amplify the 12v DC from the batter to 230V DC and is then feed into inverter circuit to transform and generate 230V AC [12]. The output is applied to drive the pump and funnels water into an overhead tank as temporary storage of water before it cooperates with the soil moisture sensor giving a signal to a controller that excites a control pulse toward the driver circuit that movements of the stepper motor. Controller remains in low power consumption mode till sensor gives reading below a certain level.

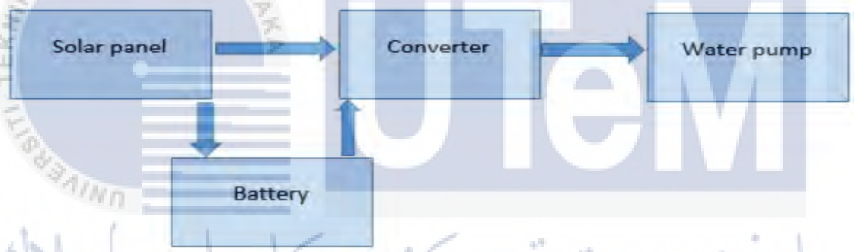


Figure 2.16: Block Diagram Solar Power Module [12].

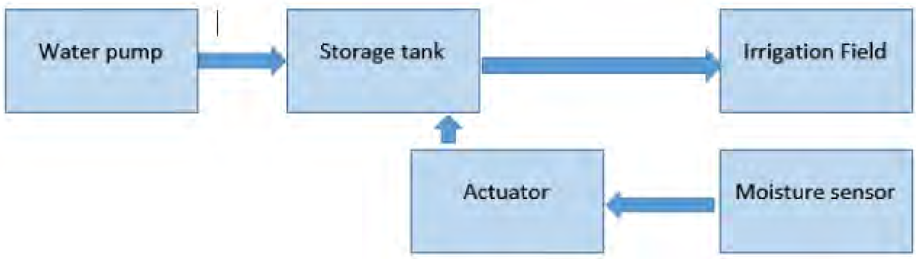


Figure 2.17: Block Diagram Automation of Irrigation Module [12].

One difference in schematics can be seen in the application of amorphous silicon type PVL-68 solar panel that is a second-generation thin-film solar cell technology. This type of solar panel is unbreakable as there is no glass. Furthermore, it is lightweight, flexibility and high resistance to corrosion and temperature. Its advantages come out of its cost and performance as this amorphous type has lower electronic performance and is higher priced than the conventional crystalline silicon of the same power rating. The initial investment of the project comes at a high price for small scale [12].

As a conclusion of this project, can reduce the energy crisis, optimizes the usage of the water by reducing the man intervention for the farmers and reduce wastage of the water. This system demonstrates the feasibility and application of using solar PV to provide energy for the pumping requirements for sprinkler irrigation.

2.6.2 Solar Smart Irrigation System

Figure 2.18 shows the block diagram of the system. This project mainly conducts for the farmers to give them a solution for energy crisis. The whole system was controlled by PIC microcontroller 16F873A. Then, this project uses solar PV panel as a power source and battery for the backup purpose. They also use a servomotor for the purpose of controlling the valve. The servomotor was controlled through by the PWM signal which is received from the PIC controller [13]. The PWM signal also depending on the value of moisture sensor. The servomotor activates according to the presence of soil moistening.

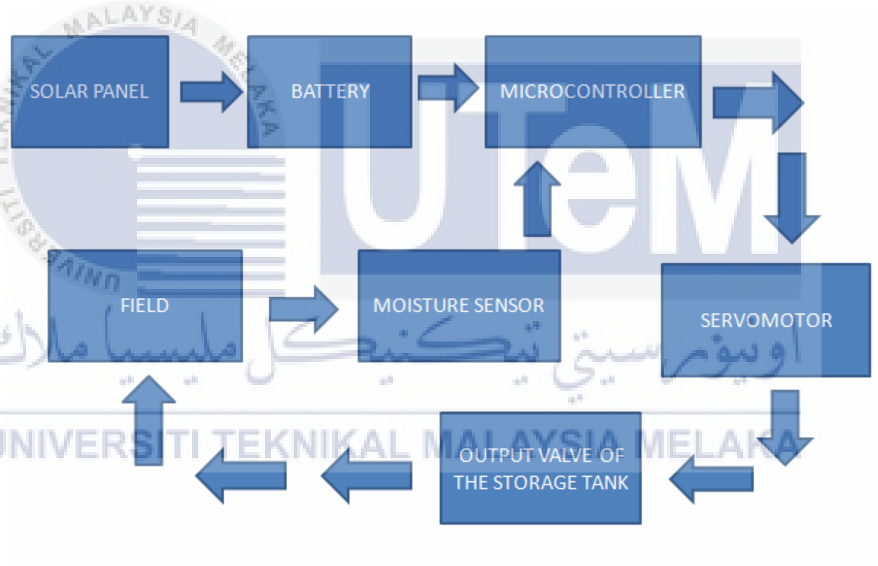


Figure 2.18: Block Diagram [13].

. The project successfully implemented. The results show that the implementation is successful. This decreasing the wastage of water and the human energy. In addition, this project reducing the usage of grid power by using solar power which is an environment-friendly.

2.7 Summary of the Sensors in Previous Study

The Table 2.8.1 shows that the sensors are used in the previous study which are soil moisture sensor, humidity and temperature sensor, and flow sensor. In next sub-topic will show all previous study which is related to the sensors that had been used.

Table 2.9: The Sensors

Sensors	**Description**

Soil moisture sensor [2, 3, 4, 6, 10, 11, 13].	1. To measure a physical quantity and convert this information into a signal that can read by the observer or by a tool.
	2. There is two type of the soil moisture sensor which is self-made soil moisture sensor and the soil moisture sensor module.
	  1. Self-made sensor
	    • Consists of two electrical conducting probes separated at a fixed distance by some holding block that is insulated material.
	    • DC current is supplied going between the two probes and it causes itching to take place and corrode the metal rod.
	    • The resistance of the soil changes of several factor such as temperature developed due to sunlight from the sun and false “soil dry” reading can be obtained.

	2. The soil moisture sensor module • Has nickel coated on the two probes. • Consists of two prongs to be used in the soil. • Prevent corrosion. • Enable longer duration of the application. • More precise and easy to use.
Temperature sensor (TMP25/36/37) [4, 7].	1. Function as detecting the surrounding of the temperature. 2. Low voltage. 3. High precision. 4. Enable use of longer duration.
Humidity sensor [4, 7].	1. Function as detecting the surrounding of the temperature. 2. Low voltage. 3. High precision. 4. Is cost-effective solution for measuring relative humidity within +-5%.
Flow sensor [4, 8, 15].	1. Detect and measure the amount of the water that used for the system. 2. Low voltage. 3. Low cost. 4. Easy to install. 5. High precision. 6. Enable use of longer duration.

2.7.1 Solar Powered Smart Irrigation System-An Innovative Concept

The motivation to do this project mainly to the farmers. They always control the irrigation system by manually. From this, they require extra manpower for monitoring and reduce the field efficiency. Other than that, they also lack or overwatering the plant. So, it can reduce the yield crop production. Figure 2.19 shows the block diagram of the system and the entire system uses solar photovoltaic panel (PV) as power source and change solar energy to electrical energy to the pump. There are also install the rechargeable battery for charging and discharging the current for the system. For the control the flow of water is controlled by using solenoid valve and the solenoid valve will be energized by the relay switch. Then, they also using soil moisture sensor to detect the condition of the soil. The entire system controlled by microcontroller ARM-LPC2148 and they use GSM modem to send the status level of the moisture of soil to the farmer via mobile [14]. Table 2.10 shows the advantages of the spin cell.

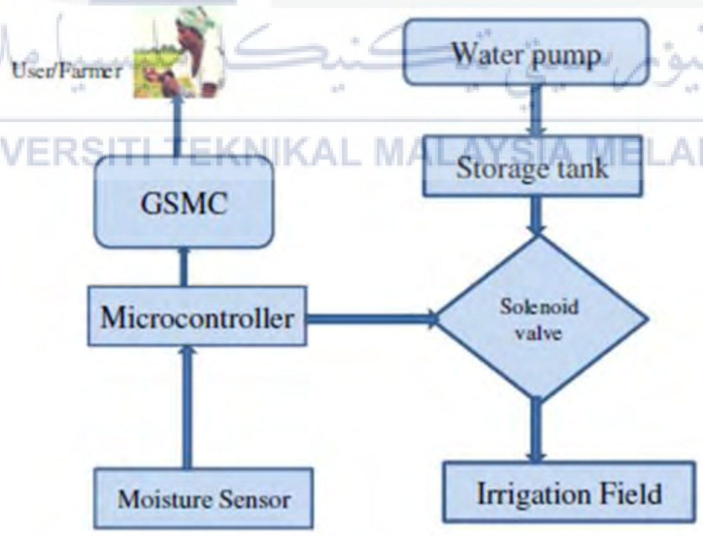


Figure 2.19: The System Design [14].

Table 2.10: The Advantages of the Whole System [14].

The Advantages of the Whole System
Reduce the wastage of the water
Control the flow of the water by the condition of the soil
Automatic system and does not need monitoring
Can implement in agriculture, parks, and garden
No pollution

2.7.2 Experimental Investigation of Remote Control via Android Smart Phone of Arduino Smart Phone of Arduino-Based Automated Irrigation System Using Moisture Sensor

Figure 2.20 shows the block diagram of the system and the project designed an Arduino Uno structured automatic irrigation system model that aims to provide a precise the data of soil moistening by using soil moisture sensor. For this entire system, they using 415V three phase as power supply and using 1.5HP 415V 3 phase motor for irrigation system [15]. Then, they using power controller to give supply to the Arduino which is 5V only. Other than that, they also using GSM wireless module to receive the data of the soil through android smartphone via SMS. They using comparator circuit to determine the input value reach the predetermined value that they set. In addition, they use a potentiometer for control the sensitivity of the soil moisture sensor

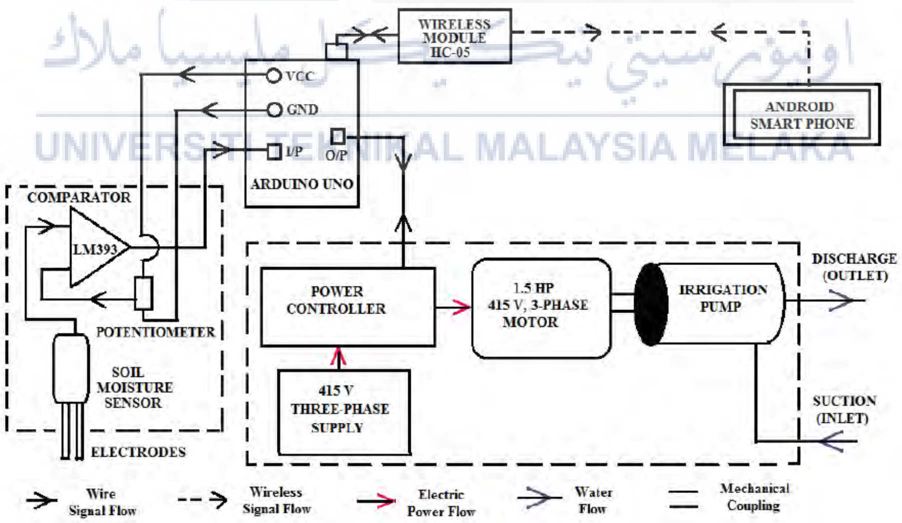


Figure 2.20: The Entire System [15].

Finally, the project successfully implemented in real time precision for the agriculture application by a soil moisture sensor. With using wireless communication system, easy to monitor the soil condition level and reduced human intervention. In addition, from this system can reduce the greenhouse effect.

2.8 The Overall Summary

Arduino was chosen to control the entire system for the actuation and sensors because it easy to execute programme, example present in the software itself, easy to use, and large community. The sensor that uses for detecting the moisture level of soil is soil moisture sensor module because it prevents corrosion, enables longer duration of the application, more precise and easy to use it. Moreover, dc water submersible pump is used as actuation for this project because it is a waterproof, less cost, convenient, and easy to control and less noise. In addition, the solenoid valve was chosen to control the drain flowing water. Other than that, the important of this project is the type of the irrigation system. The sub-irrigation system is chosen for this project. This is because this system can easy to plant root zone absorbs the water and provide better growth and the production.

CHAPTER 3

METHODOLOGY

Generally, the methodology is about the theoretical analysis of the methods applied in this project and represented in flow chart or diagram with elaboration on the step.so in this chapter, the methods will discuss which is will be implemented to complete this project. From the previous studies, the most suitable technique and understand the project's views is chosen. For the succession of this project and to achieve the objectives that have been listed before, we need to plan and choose the proper method and hardware tools. The student must also have the knowledge about solar-related irrigation system, review of other related and similar project that has same basic fundamental principle. Other than that, the student must also have the knowledge about Arduino controller programming which can control the entire system for this project and the sensors that using in this project which is soil moisture sensor, humidity and temperature sensor and solenoid valve. In this project, planning on components to be utilized and specification on PV panel, Arduino, motor driver, water submersible pump, charge controller module and other required materials.

3.1 Flow Chart

In this part, this chapter will discuss the steps and methods included in this project in the form of a flowchart. There are two types of a flowchart, which is an overall planning flowchart and a system planning flowchart. The overall planning flow chart will briefly show the process of the whole final year project system. The system planning flow chart will explain the steps of this system.

3.1.1 Flow Chart of Final Year

The Figure 3.1 and 3.2 show that the planning flow chart for Final Year Project 1 and Final Year Project 2. The first step of the project, the project will start to identify the problem. After finding out the problem statement and start to search or collect some resources such as in articles and journals. Then, determine the objective and the project scope. From determine the methodology, needs to prepare a conceptual design of this project and select the suitable design for this project. After the components selection, testing the sensors that using for this project. Table 3.1 shows the Gantt chart of FYP 1.

In FYP 2, start the progress with the mechanical fabrication of the parts for the irrigation frame. After that, do the programming for the project by using Arduino. After the programming and modification are over, the testing part is started. After the testing part give the green signal, start the final progress which the final analysis. Finally, the final progress is to do the final report after the final analysis is successes. Table 3.2 shows the Gantt chart of FYP 2.

Figure 3.3 shows the flowchart of charging the rechargeable battery to run the Arduino and the motor driver. When the presence of sunlight, the solar panel converts sunlight into DC electricity to charge the battery. This DC electricity is fed to the battery via a solar charger controller which ensures that the battery is charged properly and not damaged. Then, the solar panel will charge the rechargeable battery through by solar charger controller. If the rechargeable battery is full charged, there will on an indication display at solar charger controller.

After that, the figure 3.4 shows that the flowchart of the irrigation system of this project. Firstly, when the system is started, there will an indication display will turn on and show the text “sub-irrigation auto system”. After that, the indication display will show the reading of humidity and temperature and the volumetric of soil. When the soil is dry, the DC submersible pump will turn ON and the solenoid valve is in closed condition. If the volume of the soil reach the desired value, the submersible pump will turn off and the solenoid valve is will energized and it will in open condition.

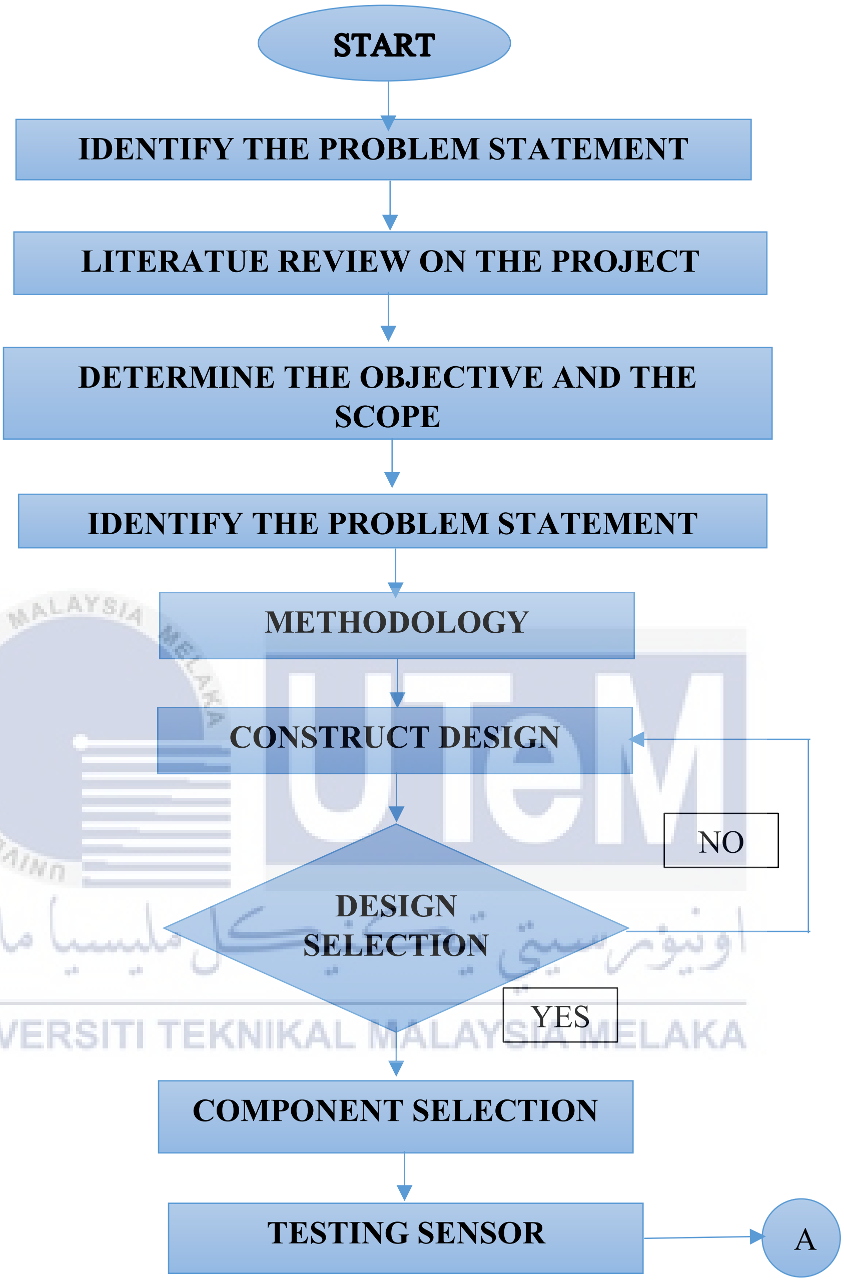


Figure 3.1: Flow Chart of FYP 1

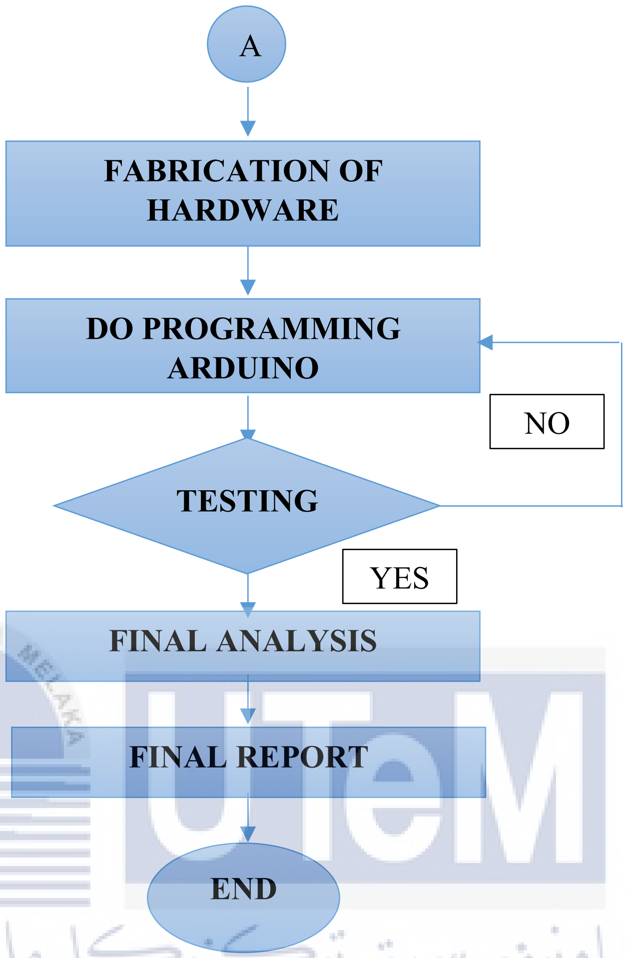


Figure 3.2: Flow Chart of FYP 1

3.1.2 Flow Chart of Charging the Battery

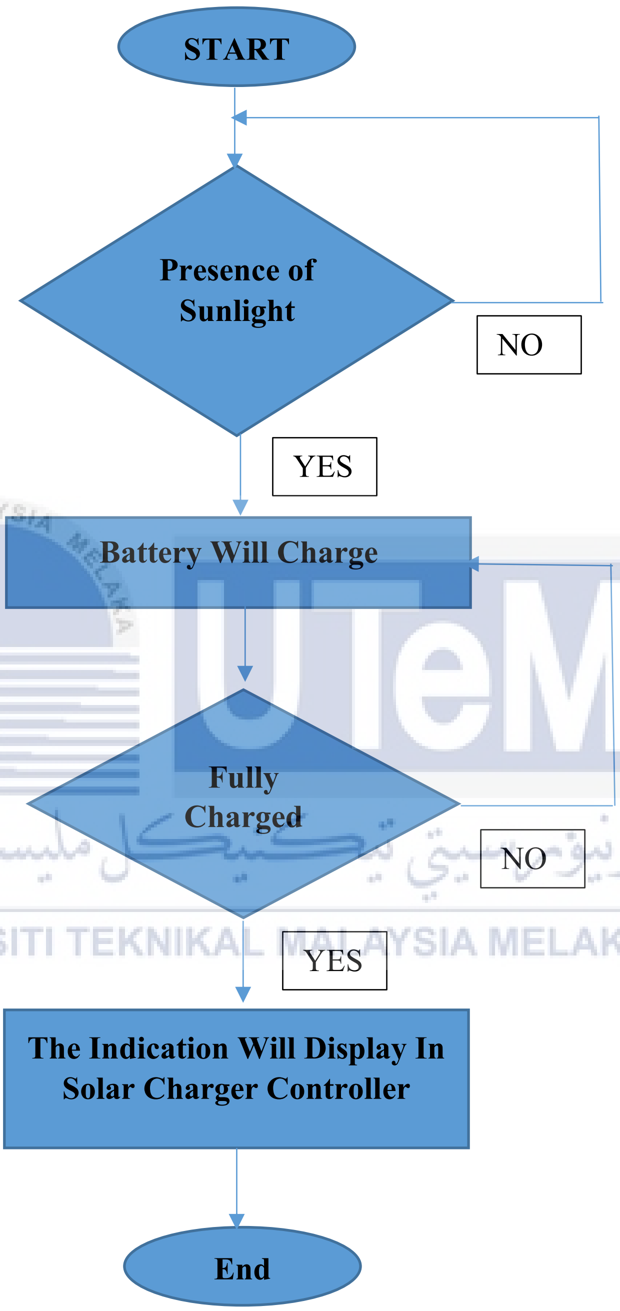


Figure 3.3: Flow Chart of Charging the Battery

3.1.3 Flow Chart of Irrigation System

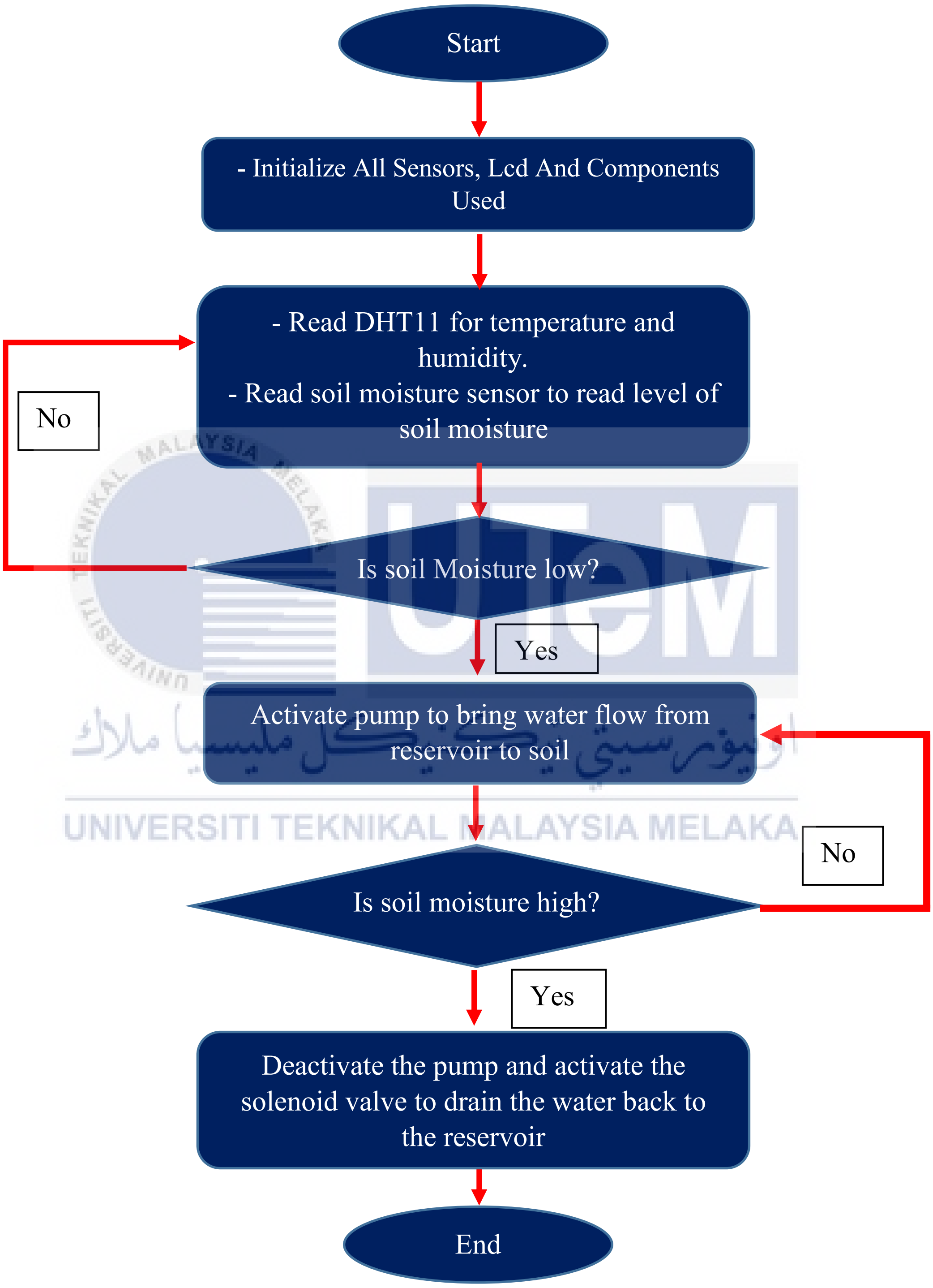


Figure 3.4: Flow Chart of Irrigation System

3.2 Gantt Chart of the Project

Table 3.1: Gantt chart of FYP 1

FINAL YEAR PROJECT 1	SEMESTER 1													
	WEEK													
PROJECT ACTIVITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14
MEET PROJECT SUPERVISOR	■	■	■	■	■	■	■	■	■	■	■	■	■	■
CONFIRMATION OF FYP TITLE	■	■												
FIND THE ARTICLE RELATED			■	■										
LITERATURE REVIEW			■	■	■									
PROBLEM IDENTIFICATION			■	■										
CONSTRUCT DESIGN						■	■	■						
SELECTION OF DESIGN								■	■					
COMPONENT SELECTION									■	■				
TESTING SENSOR										■	■	■		
REPORT WRITING (FYP1)											■	■	■	
PRESENTATION (FYP1)											■			
SUBMISSION REPORT (FYP1)														■

Table 3.2: Gantt chart of FYP 2

Final Year Project 2	Semester 2														
	Week														
Project Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Meet Project Supervisor	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Literature Review	■														
Fabrication Hardware		■													
Problem identification			■												
Do Programming Ardiuno			■	■											
Testing Electric Circuit					■	■	■								
Experiment Analysis							■	■	■						
Modification							■	■	■	■					
Final Analysis										■	■	■			
Report Writing (FYP2)												■	■	■	
Presentation (FYP2)															■
Submission Report(FYP2)															■

3.3 Overview of Solar Powered Irrigation System

The figure 3.5 shows that the system overview of solar powered irrigation system. The system consists of the solar panel as the main power which receives electrical energy from the sunlight and gives charge to the rechargeable battery. The function of the solar charger controller to protecting the battery from being overcharged by the solar panel. The controller also indicates whether the battery fully charged or not. Then the battery gives supply 12V to Arduino board and the motor driver. After that, the water flows control by using a submersible pump based on the values from a moisture sensor. If the soil moisture value is low, the motor driver gives the signal to run the pump. Then, when the soil moisture value reaches desired value, the pump will stop and immediately the solenoid valve will be energized for drain the water into the water tank back. The LCD Display shows the percentage of the humidity, value of the temperature and the volumetric of soil.

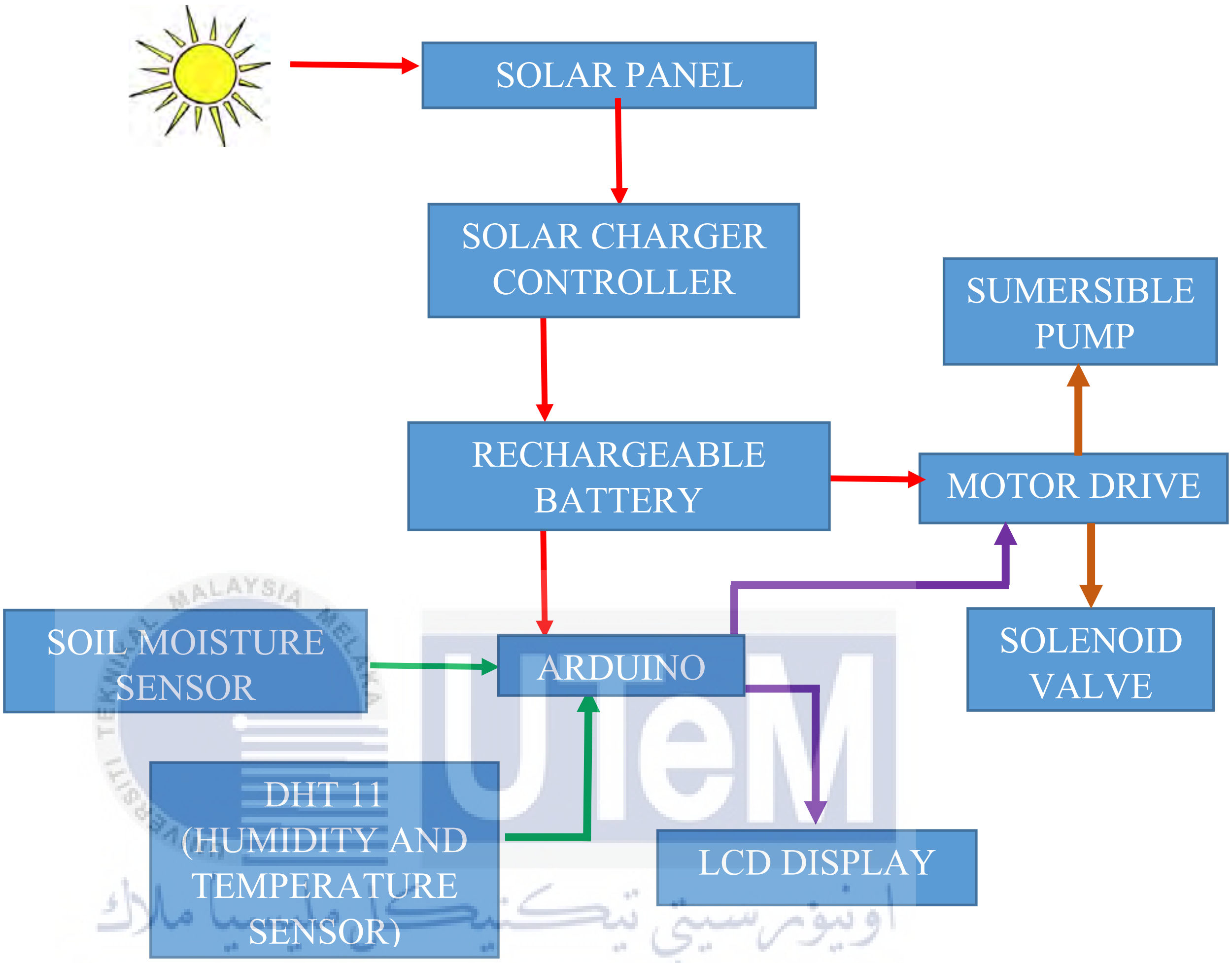
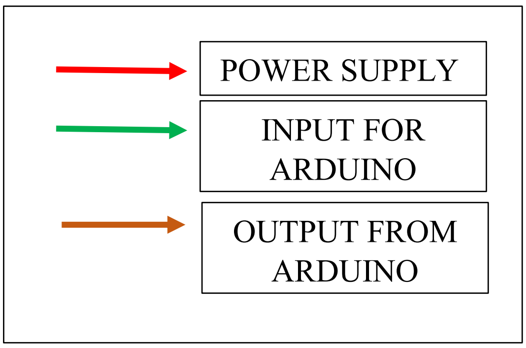


Figure 3.5: System Overview of Solar Powered Irrigation System



3.4 Hardware Part

In this section will discuss the hardware that will be used in this system. In the previous researches, some the researchers used Microcontroller, Arduino, PID Controller, Fuzzy Controller, Data Acquisition System as the controller but compare to previously researchers rarely used Arduino controller. For this project, I have chosen the Arduino because it is faster, easy to learn and more advantages compared to other controllers. Then, to detecting the moisture of the soil, soil moisture sensor is used. The humidity and temperature sensor is used for detect surrounding environment of the humidity and temperature. Other than that, 5 Watts solar panel are used as power source for this project and rechargeable battery used for storing and discharging. For the actuator part, the dc water submersible pump is used.

3.4.1 Arduino Uno

Figure 3.6 and 3.7 shows the Arduino Uno which is a microcontroller board on the ATmega328Pand their each name of the pins. The operation voltage of this controller is 5V. It has 14 digital input/output pins which 6 can be used as PWM outputs, 6 analog inputs, a USB connection, a power jack, and a reset button. The description of the Arduino shows in Table 3.3.The Arduino can be used for simple projects and it is an easy learn to execute their programming because of each every step of how to the programming in Arduino website. So it can reduce time-consuming and not complex. The disadvantage of using Arduino is high cost. In addition, it also has a large amount of community, which means can get any help from the internet source. For the beginners, it will very helpful.

Figure 3.6: The Arduino Uno (Atmega328p)

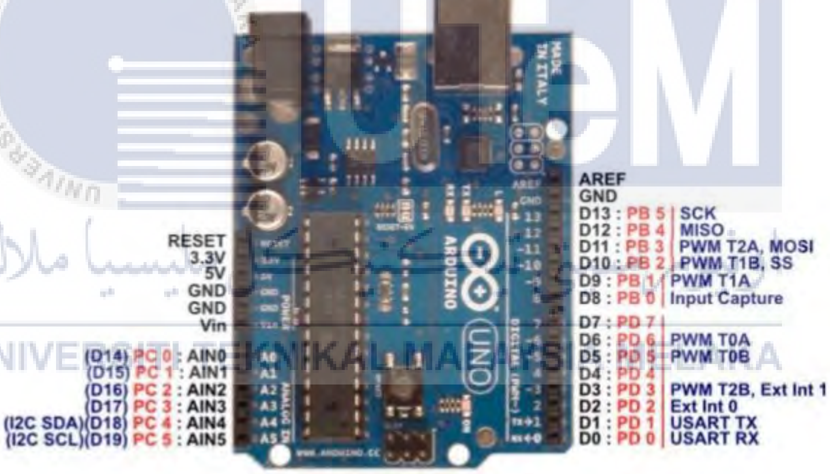


Figure 3.7: The Description of Arduino Pin

Table 3.3: The Description of Arduino

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current for I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328)
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

3.4.2 Soil Moisture Sensor

There is two type of soil moisture sensor which is self-made soil moisture sensor and soil moisture sensor module. The Figure 3.8 shows that the soil moisture sensor module that had been choosing for this project. In addition, the specification of soil moisture sensor shows in Table 3.4. This is because it prevents corrosion and enables longer duration of the application compared to another sensor. Then, it gives more precise and easier to be used. . It consists of two prongs to be inserted in the soil, an LM358 that acts as a comparator, a pot to change the sensitivity of the sensor and a LED to indicate operation. The function of the soil moisture sensor detects the moisture of the soil. The working voltage for this sensor is 3.3V-5V. So, it is very useful to conduct this project.

Specification

- Two-board interface description (4-wire)
  - 1 VCC External 3.3V-5V
  - 2 GND External GND
  - 3 DO small board digital output interface (0 and 1)
  - 4 AO small board analog output interface

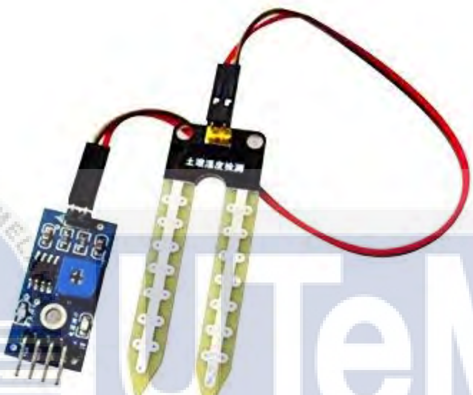


Figure 3.8: The Soil Moisture Sensor Module

Table 3.4: The Specification of Soil Moisture Sensor

Item	Condition	Min	Typical	Max	Unit
Voltage	-	3.3	/	5	V
Current	-	0	/	35	mA
Output Voltage	Supply Voltage 5 V	0	~	4.2	V
Output Value	Sensor in dry soil	0	~	300	/
	Sensor in humid soil	300	~	700	/
	Sensor in water	700	~	950	/

3.4.3 Humidity and Temperature Sensor (DHT11)

For this project, the Figure 5.9 shows that the humidity and temperature sensor module (DHT11) had been choosing for this project. This is because it has high reliability and excellent long term-term stability. The sensor function as to detect the surrounding environment of the humidity and the temperature. Then, the output of the data from the digital output and easy to installation. Other than that, the working voltage of this sensor is 5V and can measure the temperature range between 0 to 60 °C and for the range of humidity measurement is between 20%-90%RH. The Table 3.5 shows shortly the description of the humidity and the temperature sensor.

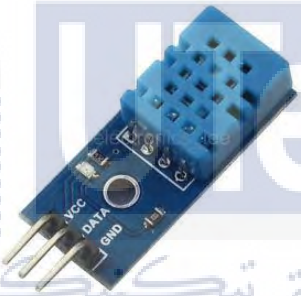


Figure 3.9: The DHT11 Sensor Module

Table 3.5: The Specification of DHT11 Humidity and Temperature Sensor

Temperature range	0-60°C /+- 2°C
Humidity range	20-90 / +- 5%
Sampling rate	1Hz(one reading every second)
Body size	15.5mm*12mm*5.5mm
Operation voltage	3.5v
Max current during the measurement	2.5mA

3.4.4 Solar Photovoltaic Panel (PV)

There is three type of Photovoltaic Panel which is monocrystalline, polycrystalline and amorphous solar PV panel. The monocrystalline PV panel which had been choosing for this project as shown in Figure 3.10 because it is the highest grade silicon and highest efficiency rate which is 15%-20% compare with other two types of PV panel. It requires less amount of space to generate power and good performance. Other than that it also excellent performance in the low light environment and high conversion efficiency guaranteed. In addition it also strong corrosion-resistant aluminium frames and both sides of the back sheet are coated with fluoro resin to prevent aging. So, I choose this type of PV panel which has 5W input power, the maximum output is 0.4A and the output voltage is 12V.

Features:

I. Waterproof(TPE layer and tempered glass)
II. Solid: can withstand 2400 pascal wind load and 5400 pascal snow load
III. High efficiency : about 17-19% conversion
IV. Long Guarantees: 90% performance in 10 years and 80% in 25 years

Figure 3.10: The 5W Solar Panel

3.4.5 DC Water Submersible Pump

The Figure 3.11 shows that the DC water submersible pump that had been choosing for this project. Then, the Table 3.6 shows that the specification of the submersible pump that had been using for this project. This is because it is stable in performance, less power cost, compact, light or durable and easy to repair. Then, the water pump also a great anticorrosion ability. Other than that, it will produce a tiny of noise and more efficiency easy to control it. It is also convenient and portable that can make the people relocate the water pump.

Figure 3.11: Dc Water Pump

Table 3.6: The Specification of Dc Water Submersible Pump

Input Voltage	DC 3V-5V
Flow Rate	1.2-1.6 L/min
Operation Temperature	80 Degree °C
Operation Current	0.1A-0.5A
Suction Distance	0.8meter (Maximum)
Size	4.5*3.0*2.5 cm
Weight	30g
Life of Pump	500 hour

3.4.6 DC Motor Driver Dual H Bridge (L293N)

The motor drive (L293N) as shown in Figure 3.12 which has been choosen for this project. This is because the motor driver can control two DC brush motor or one stepper motor. The cost of the motor driver is low. It provides control of start, stops, brake, direction, and speed of the motor. The maximum output per motor is 2A and there are built in back EMF diodes. The features of the motor driver were explained in Table 3.7.

Table 3.7: The Features of Motor Driver

Features
• Motor driver for two brush or one stepper motor
• 1.2A maximum output per motor
• Voltage motor : 5.5V to 35VDC
• Dimension : 5.5*4.4*2.7cm
• Compatible with Arduino, Raspberry Pi, but will require manual wiring

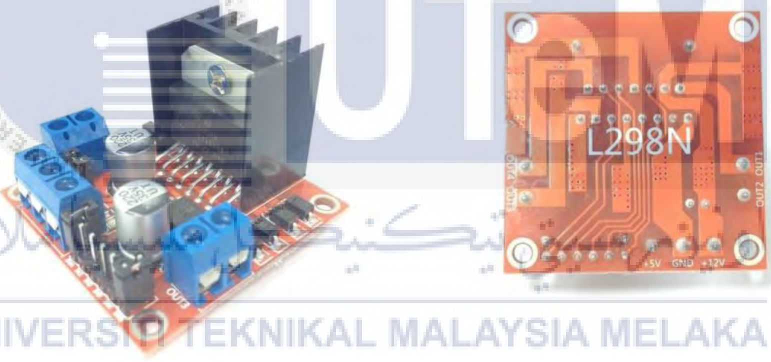


Figure 3.12: The Top and Bottom of Motor Driver

3.4.7 Rechargeable battery

The figure 3.13 shows that the rechargeable battery that had been choose in this project which is giving output 12V and 7Ah because it is, for the most part, a more sensible and sustainable replacement to one-time use batteries, which generate the current through a chemical response in which a reactive anode is consumed. The anode in a rechargeable battery gets consumed as well but at a slower rate, allowing for many charges and discharges. The features of the rechargeable battery that had to choose in this project a high efficiency, high recovery capability, long shelf life, sealed construction, no dissociative acid, maintenance-free operation and reliable consistent power. In addition, for this project, the battery will receive electrical energy from solar panel to charge the battery and then it will give supply to the Arduino and motor drive.

Figure 3.13: The Rechargeable Battery

3.4.8 Solar Charger Controller

The Figure 3.14 shows that the solar charger controller that had been choosing for this project. This new fully integrated solar charger a perfect solution for those wanted to utilize solar panel energy. If you plan to keep your solar energy in the battery, this is the right charger to use. Capable of charging Lead Acid battery up to maximum 10A and also control the load of maximum 10A. This charge controller is durable and high efficient. The charge controller continuously maintains the correct charge level on a 12V or 24V lead acid type backup battery, such as the 12V 7Ah battery pack, and ensure a smooth power transaction to battery power when needed. The charge controller allows maximum solar array current to charge into the battery, and the on-board temperature sensor adjusts the charging rate based on ambient conditions.

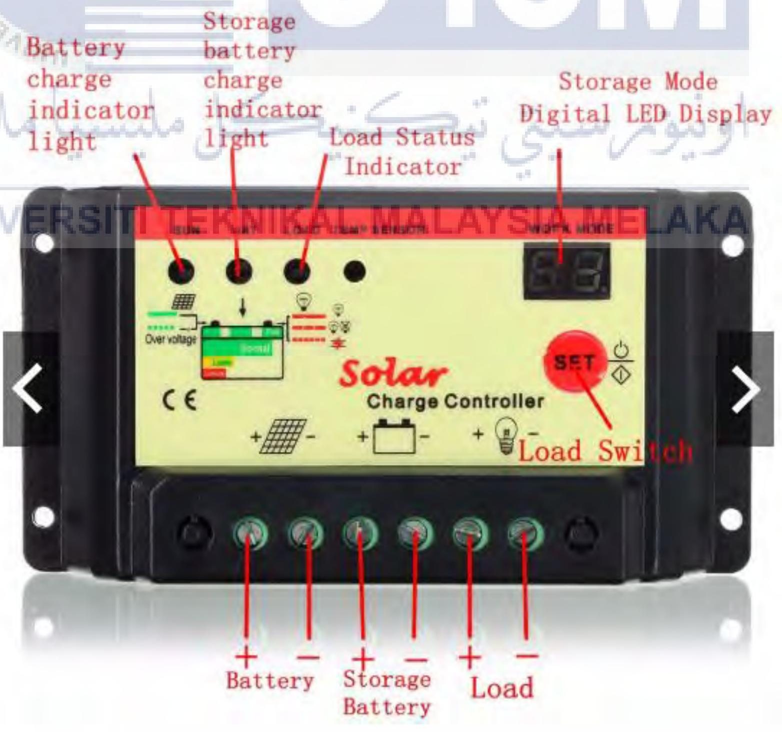


Figure 3.14: The Solar Charger Controller

Table 3.8: The Feature of the Solar Charger Controller

Features
• Complete solar power charging solution designed to work with photovoltaic panels and 12 or 24V back up Lead Acid battery. • Compact size, easy to mount on wall or panel. • Charge controller maintains batteries in optimum condition. • Auto sensing for 12 or 24V systems. • Built-in battery test function. • Convenient screw terminals for wiring • Terminals for Solar/PV panel, battery and load • Built-in overload and short shirt protection • Automatic self-recovery after fault removal • LED system status indicators • Requires no adjustments

3.5 The Irrigation System Experiment Setup

For this project, the irrigation frame was fabricated by the plastic container and the Figure 3.15 that the irrigation structure for this project. The irrigation frame consists of two parts which first is water tank and second is controller box. For the water tank part, a pot will be placed with a container, solenoid valve, and the DC water submersible pump. Then, the controller box consists of solar PV panel, humidity and temperature sensor, LCD display, and some electric circuit. The function of LCD is to display the data of the soil content, humidity and temperature value and the condition of the pump. The Figure 3.16 shows that the designing of the interior part of the water tank. Then, the Figure 3.18 shows that the design of the irrigation frame by using Solid Work and is divided by into four view which is top, front, side and isometric view.

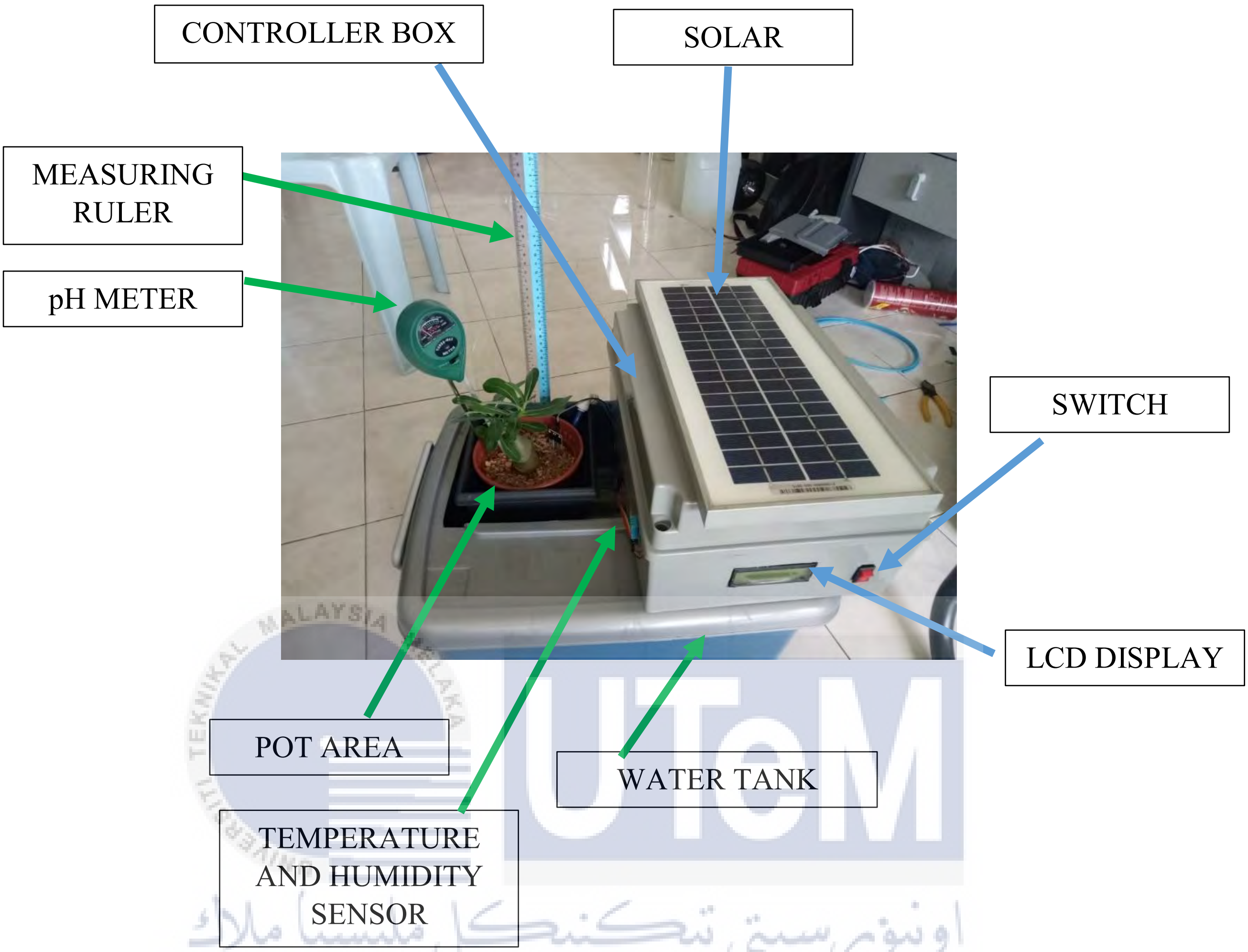


Figure 3.15: The Irrigation Structure

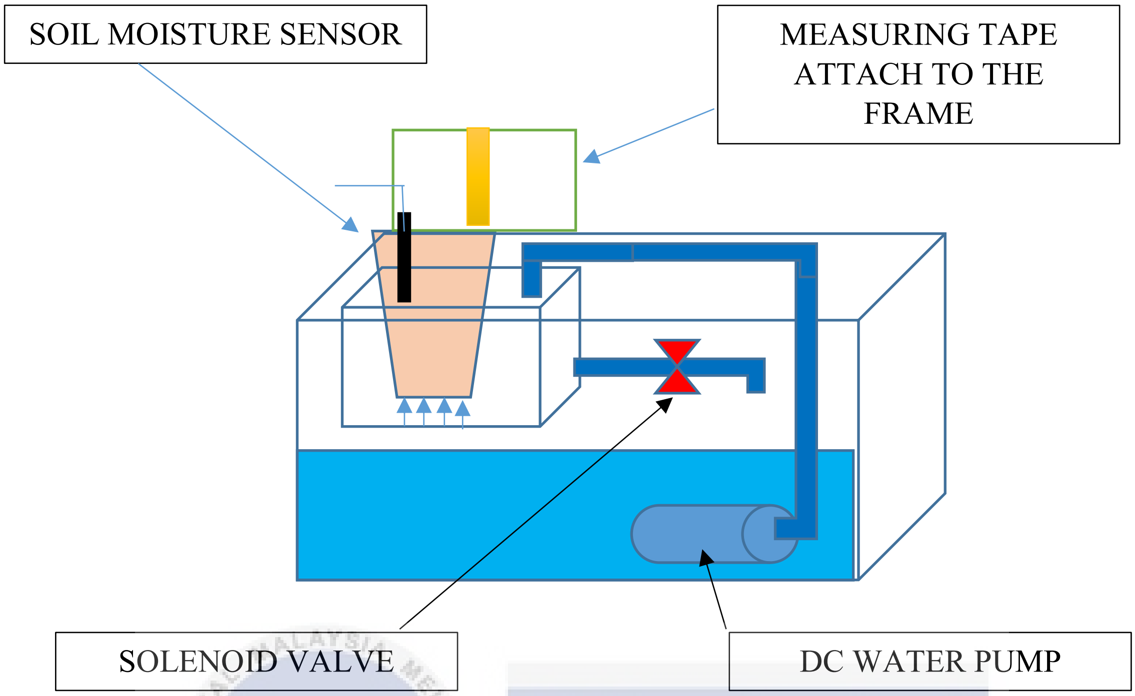


Figure 3.16: The Interior View of Water Tank

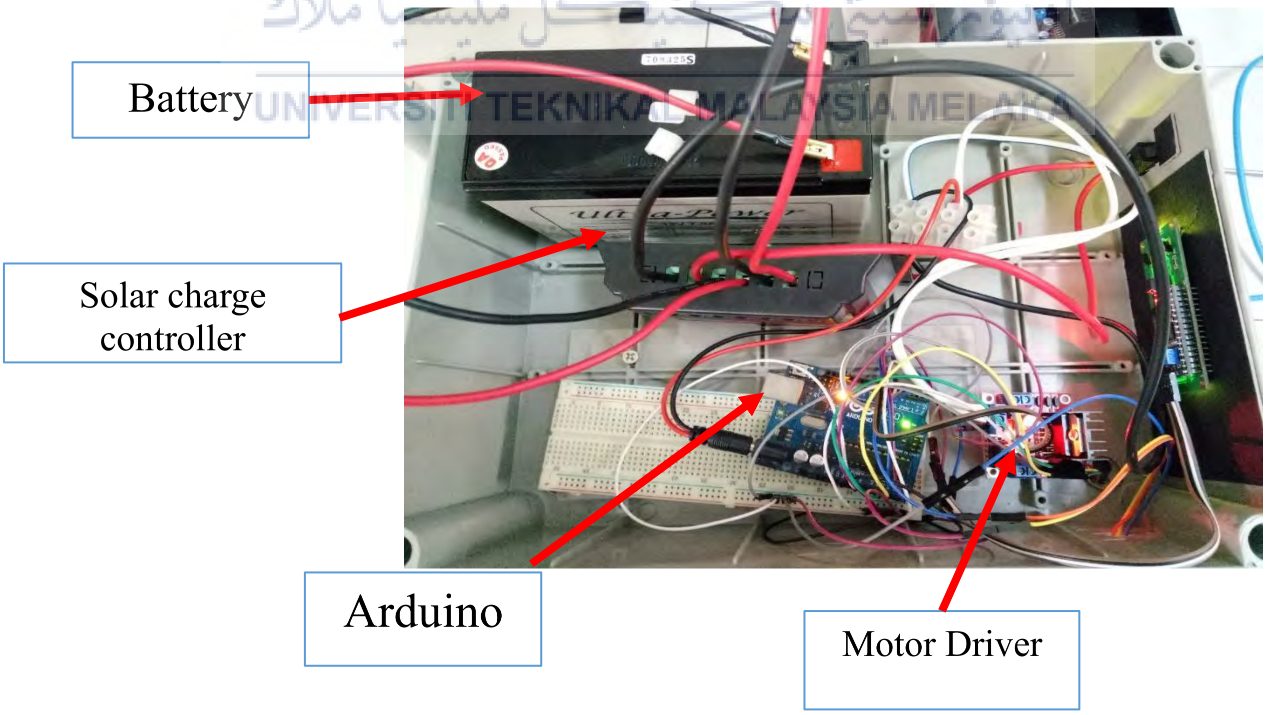


Figure 3.17: The Interior of Junction Box

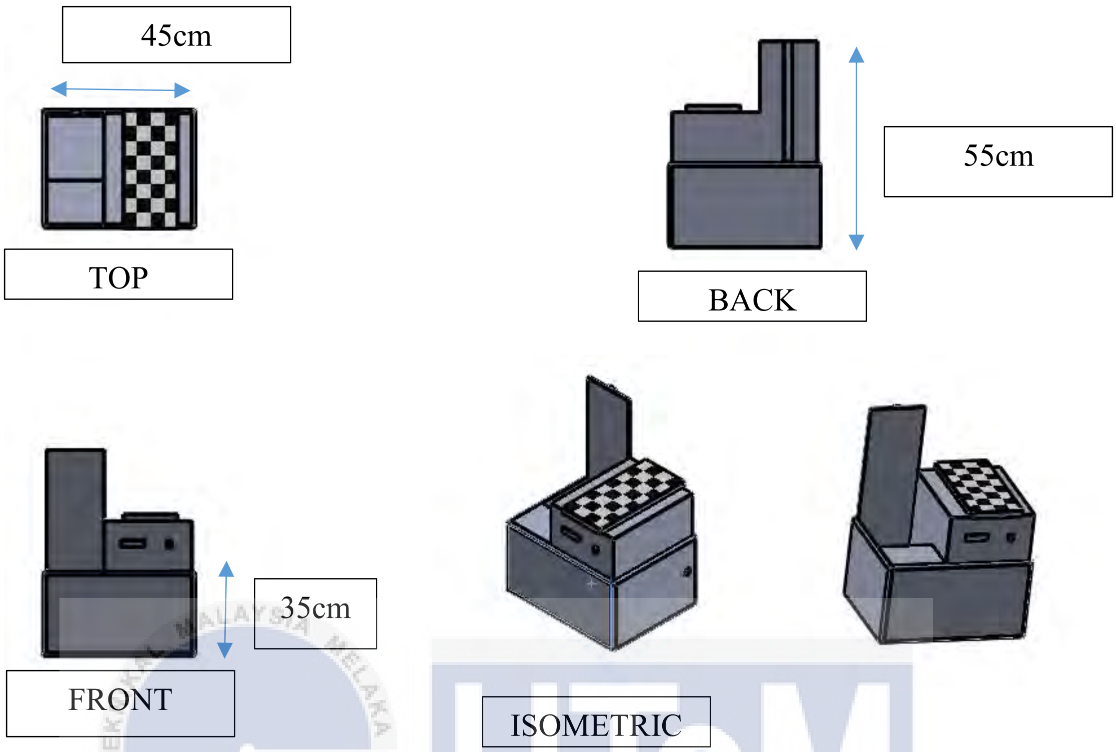


Figure 3.18: The Irrigation Frame Designed Using Solid Work

3.6 List of Experimental For Validating the Irrigation System

This section will show all the experiments that will be conducted in this system and the parameters that are included in this experiments. It will also explain the objective and procedures of the experiment. Table 3.9 shows all the experiments and their current status.

Table 3.9: Experimental Setup

No	Experiment	Status
1	Analysis of soil moisture sensor	Done
2	Analysis of the rate of growth plant over time	Done
3	Analysis of pH of the soil	Done
4	Analysis of humidity sensor (DHT11)	Done
5	Analysis of the solar	Done

3.6.1 Experiment 1: Analysis of Soil Moisture Sensor in Three Condition

The objective of the analysis of soil moisture sensor to measure the performance of the soil moisture sensor by identifying the value of the volumetric of the soil content in three different conditions. Other than that, the second purpose to test the capability and reliability of the soil moisture sensor.

There is a few steps to conduct this analysis. The first step was to connect the soil moisture sensor module to Arduino board and connect it to the computer via USB connector. Then, upload and compile the programming at Arduino software. There are three type of pot which is let pot A dry, pot B wet and pot C too wet as shown in Figure

3.17. The pot A poured $0m^3$, pot B poured $250m^3$ and port C poured $450m^3$ subsequently. Then, place the soil moisture sensor into each pot. After that, test the volumetric soil content (m^3) in three conditions and record the data which is display in the computer. Construct table and all steps were repeated 5 times for three conditions and calculated the average of the volumetric soil content of each condition.

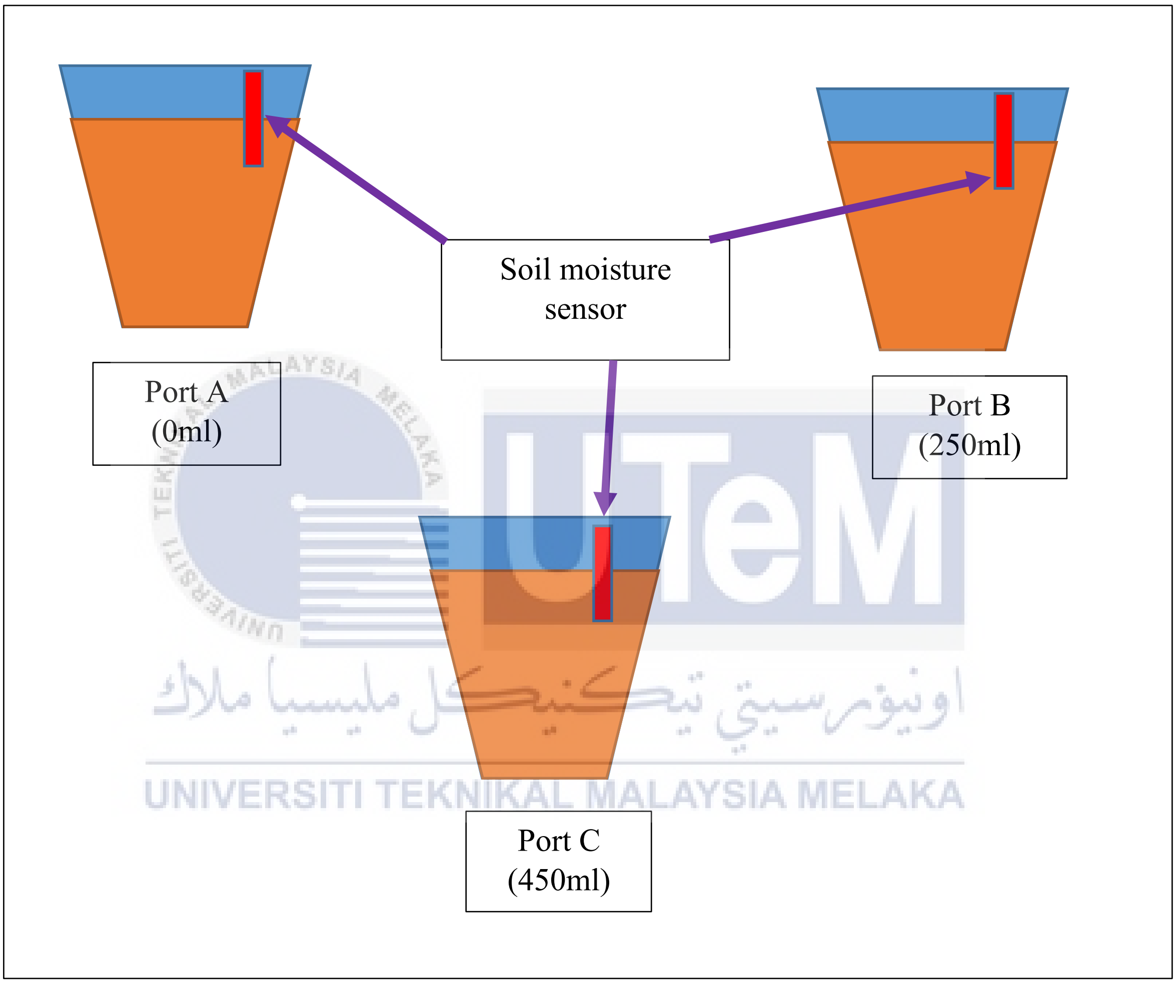


Figure 3.19: Three Pot with Three Different Condition

3.6.2 Experiment 2: Analysis of the Rate of Growth Plant over Time

The objective of the analysis of the growth plant over time to compare and identify the length of growth pant over time with manual watering and with automatic irrigation system.

For this experiment, prepared two same pot with the same mixing of the soil and same size fertilizer plant (Kemboja Tree). For this experiment, the length of the plant starts with 7.65cm. There is few steps to conduct this analysis. The first step is to place two pot in the same place but the one of the pot will place in irrigation frame. Then, switch on the "ON" button to start the automatic irrigation system. After that, water the plant for two times each day for the manual watering pot only. Record the length growth of the plant by using a measuring tape as shown in Figure 3.20 and construct a table and the steps were repeated in every week once.

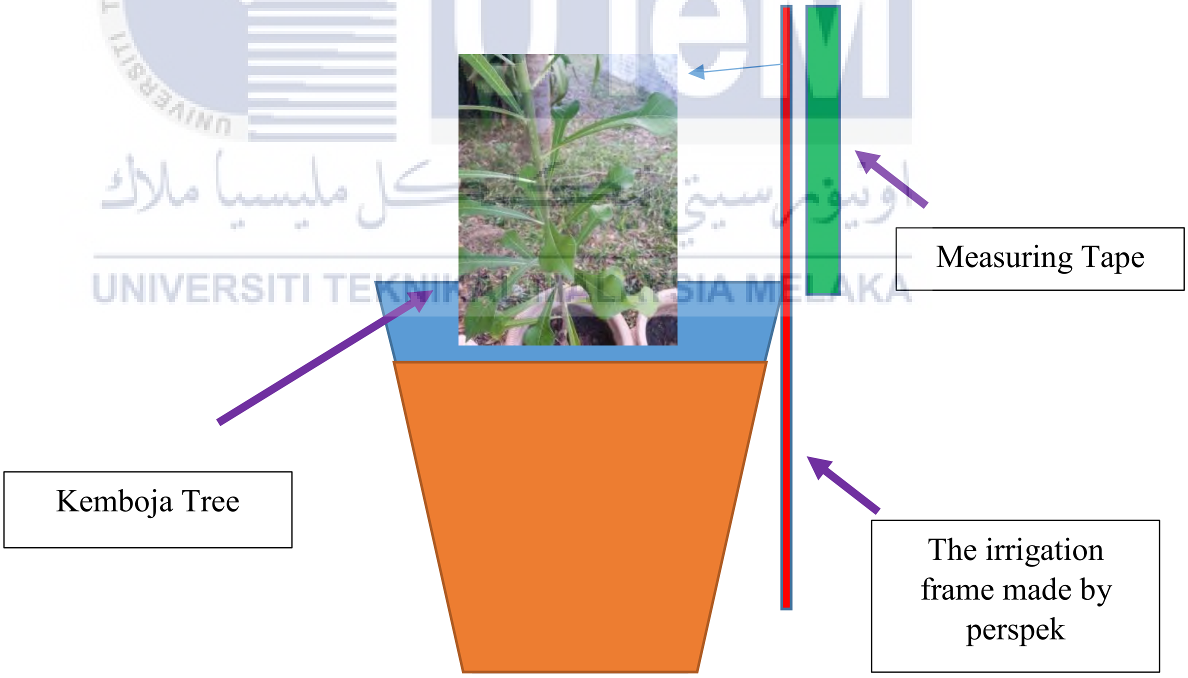


Figure 3.20: The Measurement Length of the Plant

3.6.3 Experiment 3: Analysis of pH of The Soil

The objective of the analysis of the pH of the soil is to determine the value of the acidic value of the soil by using pH meter. Then, compare the acidic value with manual watering plant and automatic irrigation system.

There was few steps to conduct this analysis. First step was to place two pot in the same place but the one of the pot will place in irrigation frame. Then, place the pH meter in both pots as shown in Figure 3.21. After that, measure the value of pH value. Record the pH value of bot both in the same time which is fixed and construct a table and the procedure was repeated in every day and selected time.

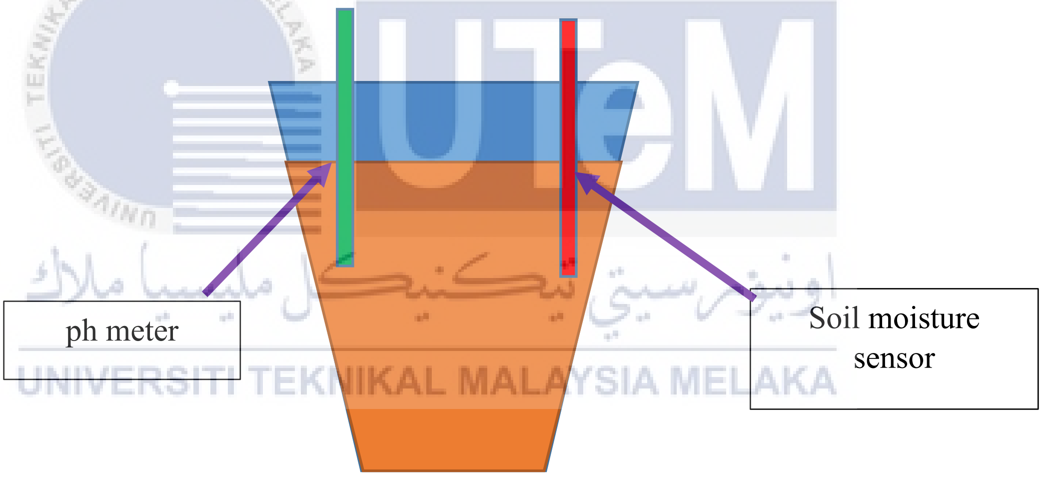


Figure 3.21: The Measurement pH Value From pH Meter

3.6.4 Experiment 4: Analysis of humidity sensor (DHT11)

The objective of the analysis of humidity sensor (DHT11) to determine the percentage of water evaporation held in the air. Water vapour is the gaseous state of water. As the temperature of the air increases more water vapour can be held since the movement of molecules at higher temperatures prevents condensation from occurring.

There was few steps to conduct this analysis. The first step was to connect the humidity and temperature (DHT11) sensor module to Arduino board and connect it to the computer via USB connector. Then, upload and compile the programming at Arduino software. Record the percentage of water evaporation held in the air for one hour once as shown in Figure 3.22. After records the data, construct a table of the percentage of humidity and construct a graph according to the table.

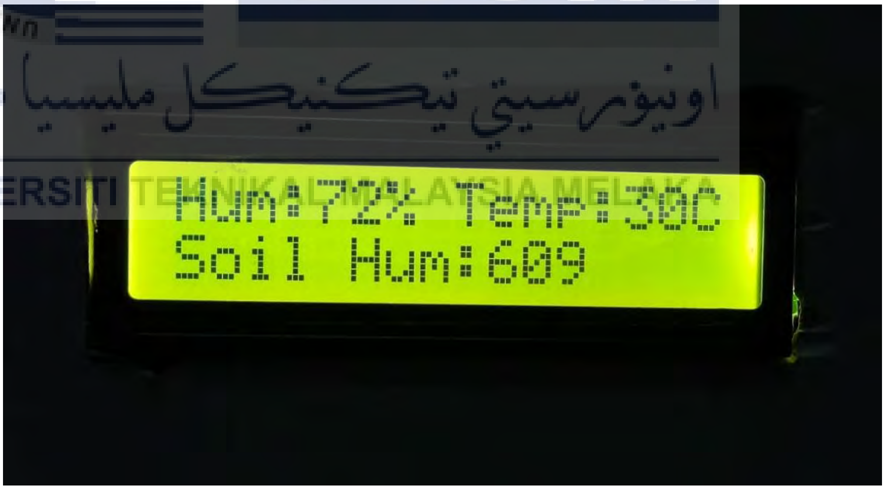


Figure 3.22: The Percentage Value of Humidity

3.6.5 Experiment 5: Analysis of solar

The objective of the analysis of solar is to determine how long it will take to charge and discharge the rechargeable battery which the system can last. This is because solar power is the main electrical source to run this automatic irrigation system. The time taken for charging and discharging the rechargeable battery was calculated by the formula. Before calculating the time taken for discharge the battery, calculate the total maximum current output of this system by constructing a table.

The formula below for the time take to charge the battery:

$$= \frac{(Vbattery)(Cappacity\ battery)}{Power\ \ pv} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (1)$$

The formula below for the time take to discharge the battery:

$$X = \frac{Capacity\ battery}{\max imum\ output\ current} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. \quad (2)$$

X: The Time Taken For Discharge the Battery

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CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results will be discussed from the experiment done from the solar powered irrigation system which was developed. The results on this system were obtained by running the source code manually in Arduino software except for the capacity of the battery of the solar was obtained from calculation method by referencing certain formula. Moreover, the pH value was measured by using pH meter. This experiment has shown the proof of the system performance and accuracy. The data collected from this experiments were tabulated into the tables and it was further analysed by plotting into the graph. Each graph and table was described briefly. The Table 4.1 shows that the list of experiments that have been conducted for this project.

Table 4.1: The Lists of Experiment

No	Experiments
1	Analysis of soil moisture sensor
2	Analysis of rate of the growth plant over time
3	Analysis of pH of the soil
4	Analysis of the humidity
4.	Analysis of the solar

4.2 ANALYSIS OF SOIL MOISTURE SENSOR

Once the fabrication of the project has been done, the project continued with soil moisture sensor testing. Figure 4.1 shows that the pots with three different type of condition. Figure 4.2 shows the experimental setup moisture sensor module. An USB cable was used to connect the computer to an electrical board. After uploading and compiling the programming at the computer, a light will appear and blinking. This is because the Arduino give a signal that the coding already uploads at Arduino board. First, do repetition for the dry condition for 5 times without pouring water. Then, secondly repeat the same test for the wet condition by pouring 250ml of water into the soil. Finally, the test was repeated with too wet condition with pouring 450ml of water. The result of this analysis was recorded and constructed into the table as shown in Table 4.2. From the tabulated table a graph was plotted. Figure 4.2 indicates the analysis of soil moisture sensor. The objective of the analysis of soil moisture sensor to measure the performance of the soil moisture sensor by identifying the value of the volumetric of the soil content in three different conditions. Other than that, the second purpose to test the capability and reliability of the soil moisture sensor.

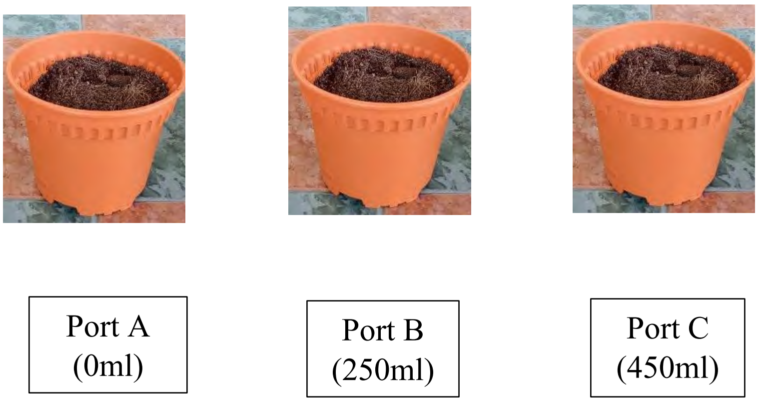

Figure 4.1: The Pots with Three Type of Condition

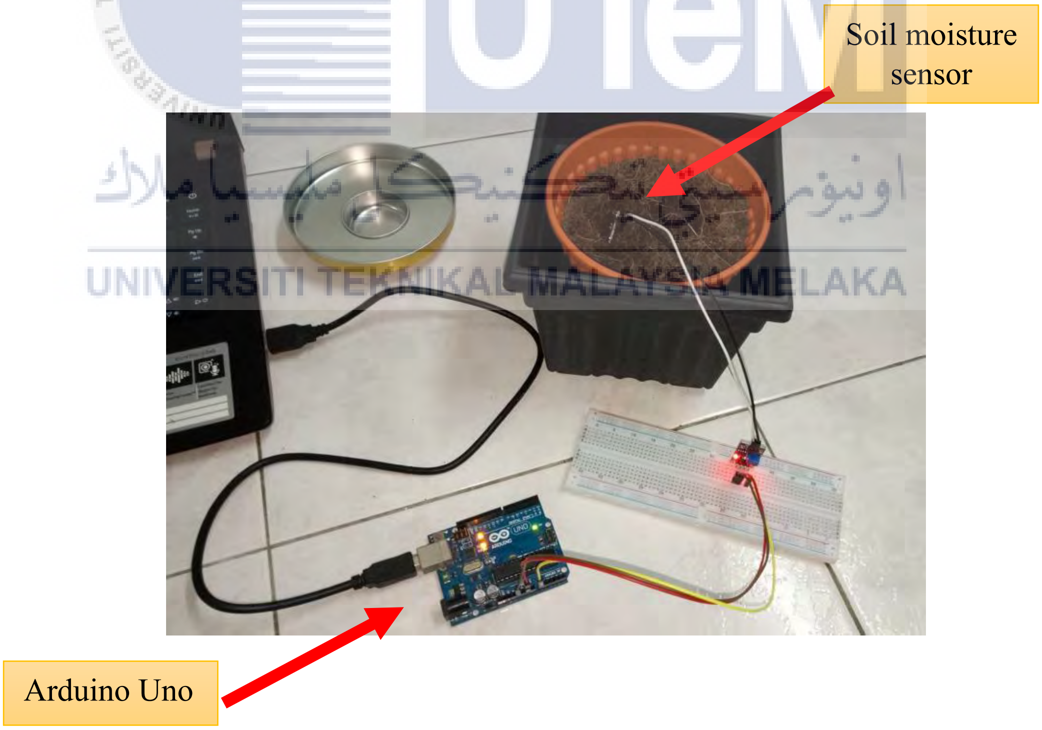

Figure 4. 2: The Setup of This Experiment

As shown in Table 4.2 the lowest volumetric soil content reading during too wet condition which has the average of 350.4 m3. Whereas the highest the volumetric soil content reading is in the condition of dry, with the average reading of 995.6. The soil moisture reading is crucial in this project because the water discharge from the pump to the soil is based on soil moisture reading. So this experiment is to test the performance and capability of the soil moisture in the order it to work in well in all conditions. Thus, this help to increase the rate of the growth of plant faster than the manual plant watering method. The graph from Figure 4.3 shows the reading produce for five times of repeatability has similar kind of variations. Figure 4.4 shows the average of the repeatability test for the soil moisture sensor.

Table 4.2: The Result of the Volumetric Soil Moisture Content (m^3)

CONDITION (m3)	REPEATABILITY					AVERAGE
	1	2	3	4	5	
(DRY)	1015	989	985	980	1009	995.6
WET)	502	498	479	467	458	480.8
(TOO WET)	300	295	393	385	379	350.4

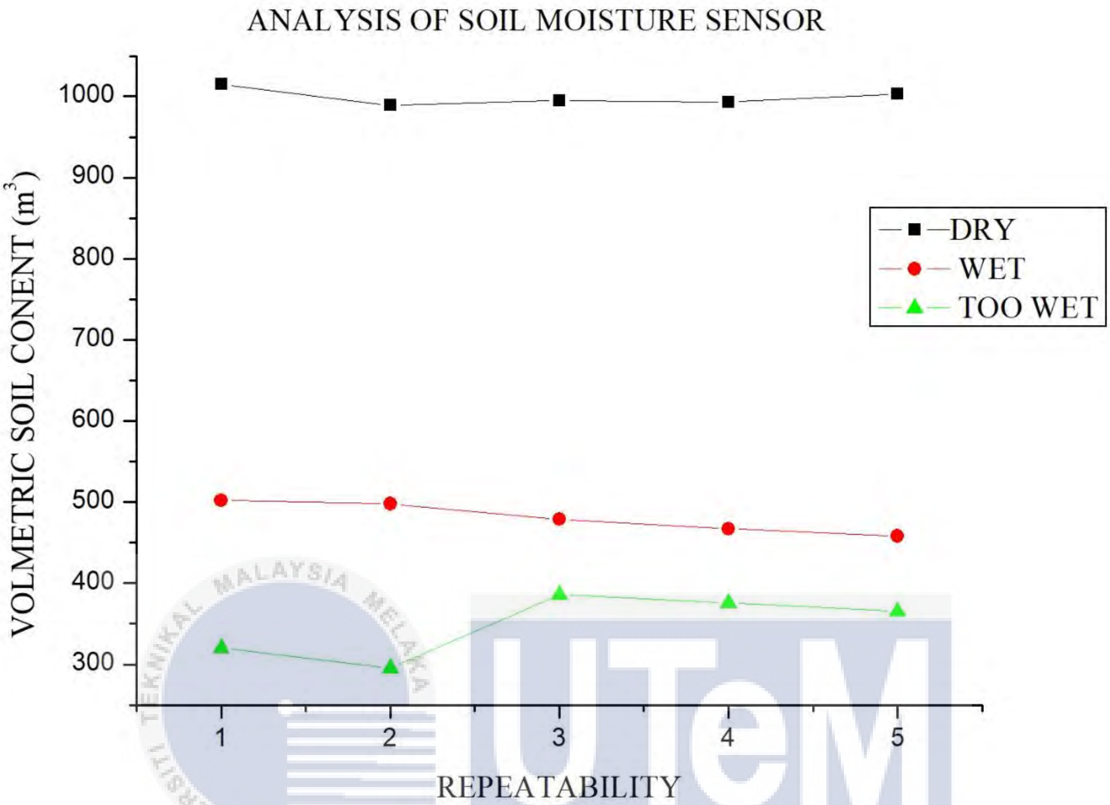

Figure 4.3: Graph of the Results of Three Condition

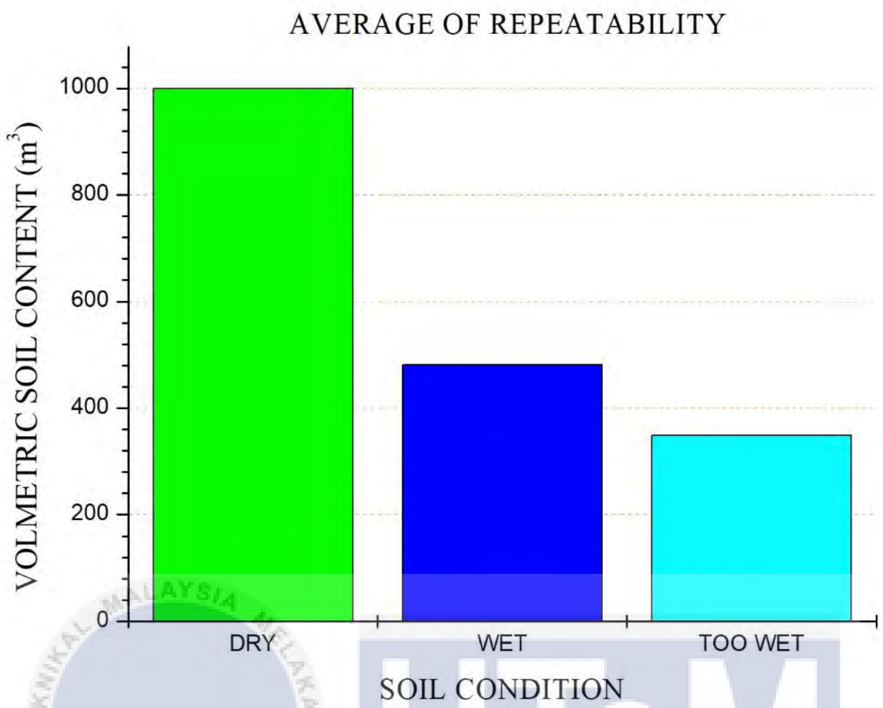

Figure 4.4: The Average of the Repeatability Test

4.3 ANALYSIS OF RATE OF THE GROWTH PLANT OVER TIME

The analysis the rate of growth of plant was done in two conditions which is manually and automatic. Before starting this analysis certain parameters should be taken into account. The parameters are the amount fertilizer, pot size, soil content is set as the same both condition. The initial length of both Kemboja tree is 7.65 cm. Table 4.3 shows the rate of growth for the plant in automatic condition. Based on Table 4.3 a graph plotted. Figure 4.5 shows Graph of Rate of the Growth Plant versus Time. The automatic plant watering system has shown the high rate of growth, especially during week 13 with the growth of around 0.3 cm. This is because the automatic plant watering system supplies water directs to the root of the plant which the plant even more refreshing than the manual method. Furthermore, this automatic plant watering system as shown a drastic rate growth of plant every week. Table 4.4 shows the rate of growth of the plant in manual watering condition. Figure 4.6 shows the graph of the rate of growth of the plant in manual watering condition. The manual watering system has shown a stagnant rate of growth for some weeks, with the slow rate of growth weekly. So this data has proven the sub-irrigation system is more effective than the manual watering method.

Table 4.3: The Rate of the Growth Plant (Automatic)

Week	Automatic Watering Rate of Growth Plant (Kemboja Tree) (cm)
7	7.65
8	7.7
9	7.75
10	7.8
11	7.9
12	8.2
13	8.5

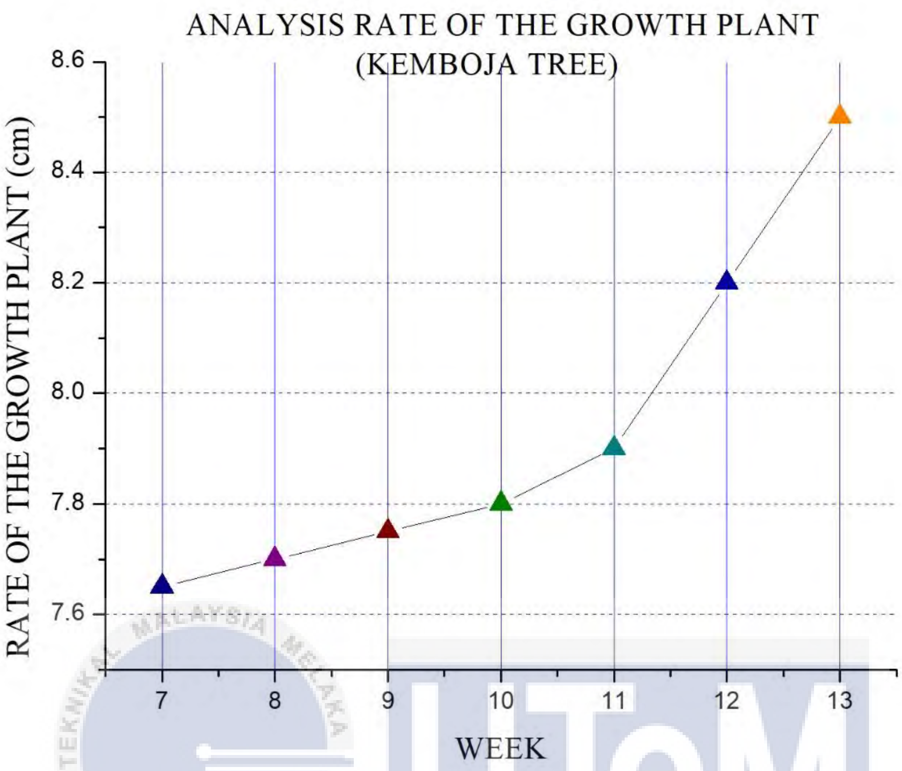

Figure 4.5: Graph of Rate of the Growth Plant versus Time (Automatic)

Table 4.4 : The Rate of the Growth Plant (Manual)

Week	Manual Watering
	Length of Growth Plant (Kemboja Tree) (cm)
7	7.65
8	7.7
9	7.7
10	7.75
11	7.8
12	7.9
13	8

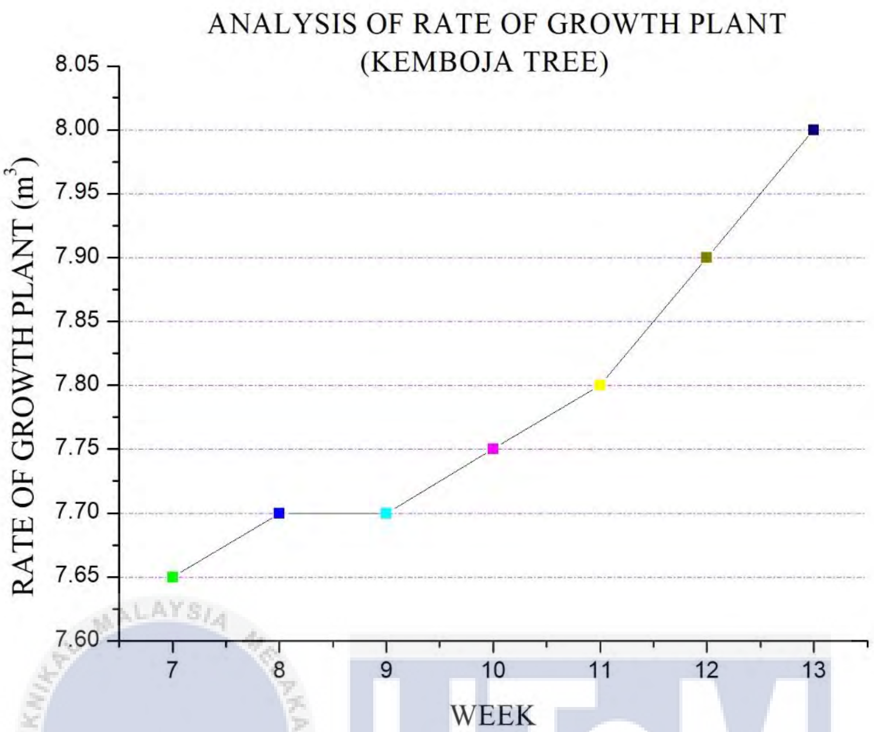

Figure 4.6: Graph of Rate of the Growth Plant

4.4 ANALYSIS OF pH OF THE SOIL

The pH value is considered as a key element in the rate of growth of the plant. The soil needs to be suited to the certainly preferred pH in order for the plant to grow well. All plants have its own preferred pH value. The pH scale is rated between the ranges of 3.5 to 9.0. Most of the plant has the pH value between 6.0 to 7.0, which also known as the neutral pH value. The rate growth of plant will be improper if it does not have the suited pH value. The pH value below 6 is acidic. This may allow pesticides to change the composition of the plant. During this condition, the nutrients in the soil become chemical, which may harm the plant. The pH value was collected in three different times. The automatic plant watering system pH value was compared with manual plant watering system. Table 4.5 shows the automatic plant watering pH value.

Figure 4.7 indicates Graph of pH Value with Three Different Time. At the beginning weeks, the pH value produced was less than 6, which are acidic. As weeks gone, the pH value of the soil become 7, which is the best condition for a plant to grow well. Table 4.6 shows manually plant watering pH value. Figure 4.8 shows the Graph of pH Value with Three Different Time with the manual watering system. The manual watering system takes more days to reach its best pH value, which is 7.

Table 4.5: Result of pH Value with Three Different Time (Automatic)

WEEK	AUTOMATIC		
	MORNING (10am)	EVENING (3pm)	NIGHT (8pm)
7	5.6	5.5	5.8
8	5.8	5.7	5.9
9	5.7	5.6	5.8
10	5.6	6	6
11	6	7	7
12	7	7	7
13	7	7	7

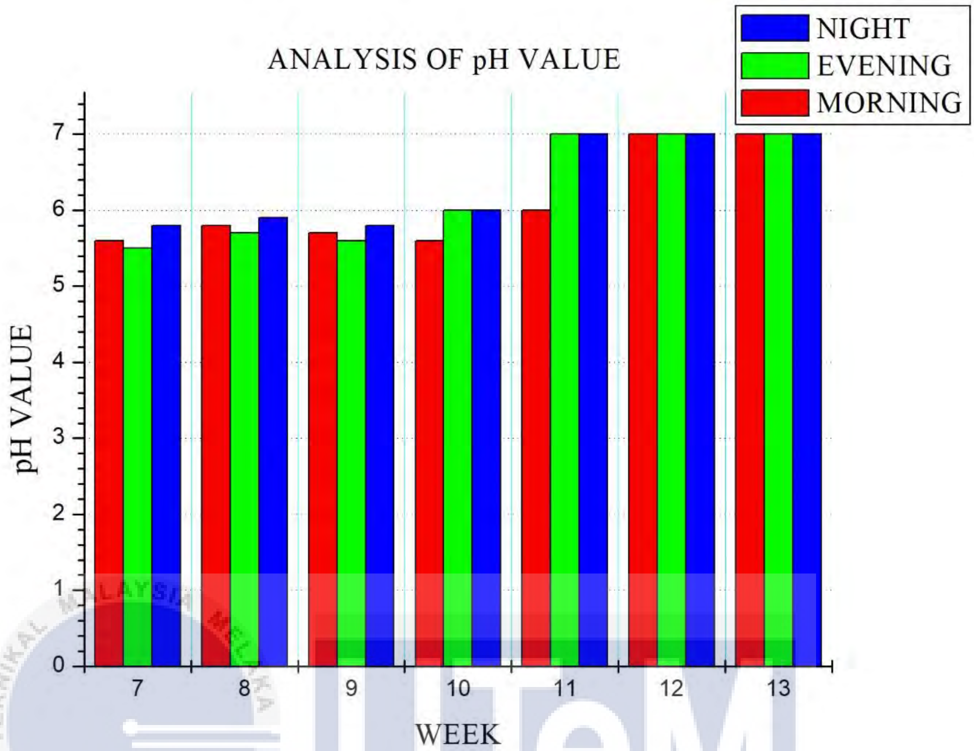

Figure 4.7: Graph of pH Value with Three Different Time (Automatic)

Table 4.6: Result of pH Value with Three Different Time (Manual)

WEEK	MANUAL		
	MORNING (10am)	EVENING (3pm)	NIGHT (8pm)
7	5.6	5.8	5.8
8	5.8	5.7	5.9
9	5.6	5.5	5.7
10	5.5	5.7	5.7
11	6	6	6
12	7	7	7
13	7	7	7

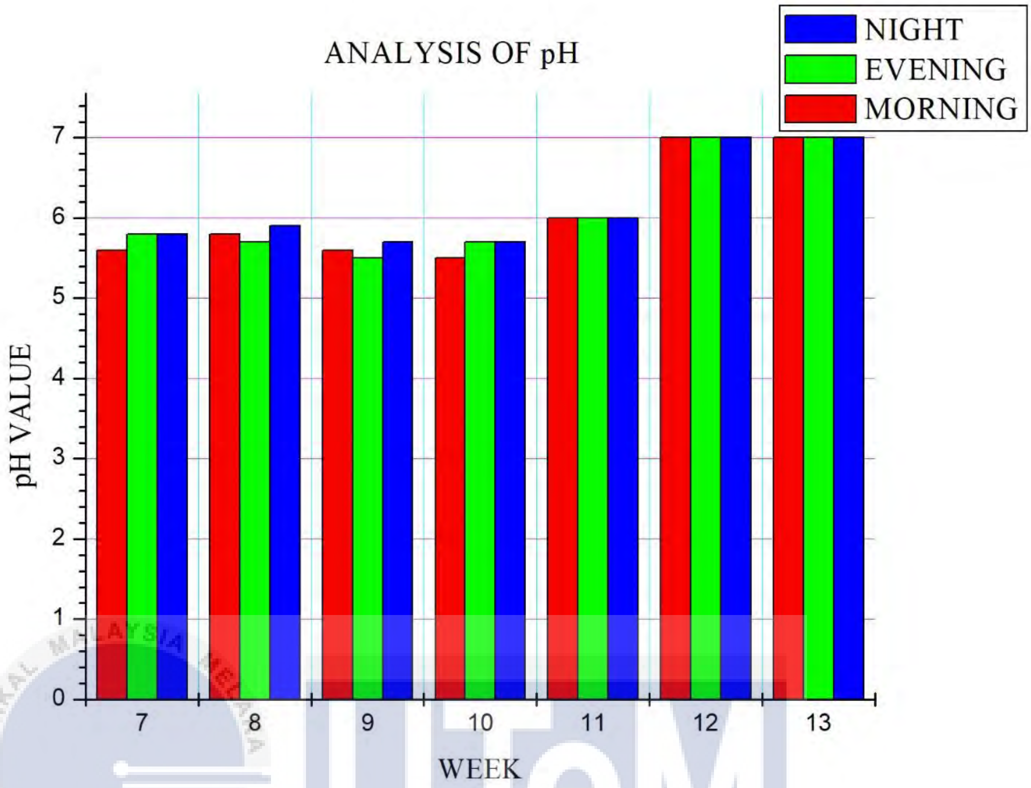

Figure 4.8: Graph of pH Value with Three Different Time (Manual)

4.5 ANALYSIS OF HUMIDITY

Humidity is defined as the moisture in the air, it is important for the plant. Analysis of humidity is similar to soil moisture sensor. During night time, the rate of humidity is usually high compared to the daytime. The watering for the plant also depends on the rate of humidity for the automatic system. The plant will be also watered even though the rate of humidity is high. Table 4.7 shows Result of Percentages of Humidity with Different Time. Figure 4.9 shows Graph of Percentages of Humidity with Different Time. If the rate of the humidity is low the water discharge from the pump would be higher. The highest humidity rate is recorded at 8 am with the reading of 80%. The lowest humidity rate recorded during the evening which is 3 pm to 5 pm with 63 %.

Table 4.7: Result of Percentages of Humidity with Different Time

Time	Percentage of the Humidity (%)
8am	81
9am	80
10am	78
11am	75
12pm	69
1pm	65
2pm	65
3pm	63
4pm	63
5pm	63
6pm	75
7pm	78
8pm	80

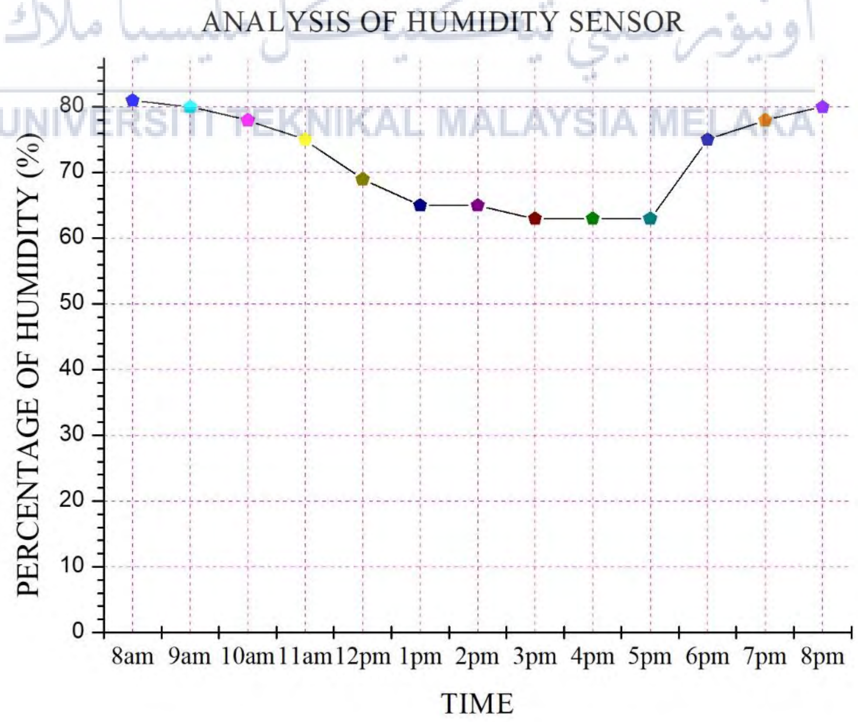

Figure 4.9: Graph of Percentages of Humidity with Different Time

4.6 ANALYSIS OF SOLAR

One of the main advantages of this system in the capability of self-powered. For the purpose, the energy usage of all the device must be known. This is to calculate the duration at which the system can last. In reality application at the field, it must be able to sustain long-term usage unless circuit error in which maintenance will be needed. Otherwise, the system must be able to operate for long term such as half-year without a problem. The prototype that was created for Final Year Project (FYP) is only for small scale which can suitable for house garden and thus its sustainability is also less. The Table 4.8 shows that the total current consumption of all equipment that used for this system. Each value of current is the maximum of the operation current output of each equipment. Total maximum operation of this system is 2.1775A.

Table 4.8: Total Current Consumption of the System

NO.	EQUIPMENT	MAX CURRENT OUTPUT
1	ARDUINO UNO	40mA
2	SOIL MOISTURE SENSOR	35mA
3	HUMIDITY AND TEMPERATURE SENSOR(DHT11)	2.5mA
4	12DC SOLENOID VALVE	400mA
5	12 DC SUMERSIBLE PUMP	0.5A
6	MOTOR DRIVER (L298N)	1.2A
TOTAL CURRENT		2.1775A

The second important consideration on this system is the charging capability of the PV panel on the battery. The time taken off the charging the battery was obtained from calculation method by referencing certain formula.

The formula below for the time take to charge the battery:

$$= \frac{(Vbattery)(Cappacity\ battery)}{Power\ pv} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(1)}$$

$$\frac{(12v)(7AH)}{5W} \quad \boxed{= 16.8 \text{ hours at full output}}$$

❖ Therefore 5W of solar panel would take 16.8 hours of full output to fully charge the 12V 7Ah battery.

The third important consideration on this system is the capacity of the power storage system and how long the system can stand last.

- Since 7A last for 1 hour, then 2.1775A which is the total current of the system will last for X hours.
- X stand for the time taken for discharge the battery.
- The formula below for the time take to discharge the battery:

$$X = \frac{Capacity\ battery}{\max imum\ output\ curren} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

X= (7Ah/2.1775A)
= 3.2 hours

Therefore, the battery lasts only 3 hours but that was the assumption of the both DC submersible pump and solenoid valve was running continuously. This is because the DC submersible pump and solenoid valve absorb more current if continuously running. In this application, the real run-time of both is as below for this project:

- Daily the 12V DC submersible pump trigger twice at the initial trigger stage, the water will flow through the pump around 15-20 seconds from the duration time 8.00AM to 6.00PM.
- Daily the 12V DC solenoid valve trigger twice when soil moisture level is high at the initial trigger stage, the water will drain through the valve around 30-50 seconds from the duration time 8.00AM to 6.00PM.

Therefore, with the real run-time as above, the time taken for the discharging the rechargeable is increase which is around 6-7 hours.

4.7 DISCUSSION

Based on the data collected and a graph plotted this experiment is to test the performance and capability of the soil moisture in order it to work in well in all conditions. Thus, this help to increase the rate of the growth of plant faster than the manual plant watering method Thus, this help to increase the rate of the growth of plant faster than the manual plant watering method. However, it has a lot of variation between the repeatability of its measured data for each condition. after that, the automatic plant watering system supplies water direct to the root of the plant which the plant even more refreshing than the manual method. Furthermore, this automatic plant watering system as shown a drastic rate growth of plant every week. In addition, from the analysis of pH, the pH value of the soil which is the automatic become 7 faster, which is the best condition for a plant to grow well. Furthermore, the watering from plan also depends on the rate of humidity for the automatic system. If the rate of the humidity is low the water discharge from the pump would be higher. Finally, the analysis of solar is to calculate the time taken of charging and discharging the battery by using formula and also in real run-time. The more the capacity of energy device, the more the system can stand longer.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

As a conclusion, the solar-powered automatic irrigation system has been achieved by refer to the objective of this project. The solar-powered automation sub-irrigation system by using Arduino is designed to be a green technology which is capable of performing irrigation to the growth of the plant based on the level of the moisture, temperature and the humidity with the combination of Arduino Uno. This system optimizes the usage of water by reducing wastage of the water and reduce human intervention. In addition, it can save cost on the entire system because the whole system runs by using solar energy. Therefore, it can be said as a standalone unit which no additional require powers to work this system. The system also requires low maintenance. In conclusion, the objective of Final Year Project (FYP) was accomplished with lots of knowledge gained regarding many different aspects and software tool used by engineers. The main aim of this project is in the agriculture sector, house garden area and hopefully in the future technologized like this will be implemented worldwide.

5.2 RECOMMENDATION

As a recommendation, the prototype can be improvised by implementing larger capacity of energy storage device that can sustain the system much longer and establish the objective of self-powered. After that, included a GSM module because the user can control the system via smartphone. Other than that, use python software with webcam and raspberry pi for this project to determining the rate growth of the plant. In addition, solar tracker using LDR for efficient working of the system which can enable the solar panel to automatically get placed itself in the appropriate path where the solar energy is maximum. Finally, include the image processing technique to monitor the growth and predict the yield.

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APPENDIXES

APPENDIXES A

The Arduino Coding For Soil Moisture Sensor

```
int sensorPin = 0;

int sensorValue = 0;

void setup() {

  // declare the ledPin as an OUTPUT:

   Serial.begin(9600);

}

void loop() {

  // read the value from the sensor:

  sensorValue = analogRead(sensorPin);

  delay(1000);

  Serial.print("sensor = " );

  Serial.println(sensorValue);

}
```

The Arduino Coding For the Pump

```
int IN1 = 5;
int IN2 = 6;
int button1 = 7;
void setup() {
pinMode(IN1, OUTPUT);
pinMode(IN2, OUTPUT);
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
pinMode(button1, INPUT);
digitalWrite(button1, HIGH);
}void loop() {
int statebutton = digitalRead(button1);
if (statebutton == 0)
  {
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  }
else {
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, LOW);
  }
```

The Arduino Coding For DHT11

```
#include "DHT.

#define DHTPIN 4    // what digital pin we're connected to

#define DHTTYPE DHT11   // DHT 11

DHT dht(DHTPIN, DHTTYPE);

void setup() {

  Serial.begin(9600);

  Serial.println("DHTxx test!");

  dht.begin();

}

void loop() {

  delay(2000);

  float h = dht.readHumidity();

  float t = dht.readTemperature();

  float f = dht.readTemperature(true);

  if (isnan(h) || isnan(t) || isnan(f)) {

    Serial.println("Failed to read from DHT sensor!");

    return;

  }

  float hif = dht.computeHeatIndex(f, h);

  float hic = dht.computeHeatIndex(t, h, false);

  Serial.print("Humidity: ");
```

```
Serial.print(h);
Serial.print(" %\t");
Serial.print("Temperature: ");
Serial.print(t);
Serial.print(" *C ");
Serial.print(f);
Serial.print(" *F\t");
Serial.print("Heat index: ");
Serial.print(hic);
Serial.print(" *C ");
Serial.print(hif);
Serial.println(" *F");
}
```

The Arduino Coding For LCD Display

```
#include <Wire.h>  // Comes with Arduino IDE
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x3F, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE);  // Set the LCD I2C
address
void setup() {
Serial.begin(9600);
lcd.begin(16,2);
lcd.backlight();
lcd.setCursor(0,0);
lcd.print(" Subirrigation  ");
lcd.setCursor(0,1);
lcd.print("  Auto System  ");
delay(3000);
lcd.clear();
}
void loop() {
 }
```

The coding of integration of all modules

```
#include <Wire.h>  // Comes with Arduino IDE
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE);
int analogsoilpin = A2;
int digitalsoilpin = A1;
int IN1 = 5;
int IN2 = 6;
int IN3 = 8;
int IN4 = 9;
int button1 = 7;
#include "DHT.h"
#define DHTPIN 4
#define DHTTYPE DHT11   // DHT 11
DHT dht(DHTPIN, DHTTYPE);
void setup() {
Serial.begin(9600);
dht.begin();
pinMode(analogsoilpin, INPUT);
pinMode(digitalsoilpin, INPUT);
pinMode(IN1, OUTPUT);
pinMode(IN2, OUTPUT);
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
pinMode(button1, INPUT);
digitalWrite(button1, HIGH);
lcd.begin(16,2);
lcd.backlight();
```

```
lcd.setCursor(0,0);
lcd.print(" Subirrigation  ");
lcd.setCursor(0,1);
lcd.print("  Auto System  ");
delay(3000);
lcd.clear();
}
void loop() {
int analogsoil = analogRead(analogsoilpin);
int digitalsoil = digitalRead(digitalsoilpin);
int h = dht.readHumidity();
int t = dht.readTemperature();
lcd.setCursor(0,0);
lcd.print("Hum:");
lcd.print(h);
lcd.print("% ");
lcd.print("Temp:");
lcd.print(t);
lcd.print("C");
Serial.print(analogsoil);
Serial.print(",  ");
Serial.println(digitalsoil);
delay(300);
lcd.setCursor(0,1);
lcd.print("Soil Hum:");
int soilhumid =  analogsoil;
lcd.print(soilhumid);
int statebutton = digitalRead(button1);
if (digitalsoil == 1)
  {
```

```
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, LOW);
  digitalWrite(IN4, LOW);
  }
else if (statebutton == 0)
  {
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  }
else
  {
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);
  }
 }
```

APPENDIXES B

GANTT CHART FYP 1

FINAL YEAR PROJECT 1	SEMESTER 1													
	WEEK													
PROJECT ACTIVITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14
MEET PROJECT SUPERVISOR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CONFIRMATION OF FYP TITLE	X	X												
FIND THE ARTICLE RELATED		X	X	X										
LITERATURE REVIEW		X	X	X	X									
PROBLEM IDENTIFICATION			X	X										
CONSTRUCT DESIGN						X	X	X						
SELECTION OF DESIGN								X	X					
COMPONENT SELECTION									X	X				
TESTING SENSOR										X	X	X		
REPORT WRITING (FYP1)											X	X	X	
PRESENTATION (FYP1)											X			
SUBMISSION REPORT (FYP1)														X

GANTT CHART OF FYP2

Final Year Project 2	Semester 2														
	Week														
Project Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Meet Project Supervisor	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Literature Review	■														
Fabrication Hardware		■													
ProblemIdentification			■												
Do Programming Arduino			■	■											
Testing Electric Circuit					■	■	■								
Experiment Analysis							■	■	■						
Modification							■	■	■	■					
FinalAnalysis										■	■	■			
Report Writing (FYP2)												■	■	■	
Presentation (FYP2)															■
Submission Report(FYP2)															■