AUTONOMOUS HORTICULTURE IRRIGATION SYSTEM

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AUTONOMOUS HORTICULTURE IRRIGATION SYSTEM

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A thesis submitted in fulfilment of the requirements for the
award of the degree of Bachelor of Computer Science
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DEDICATION

Special dedication of this Great Memory
To my beloved parents, thank you for your unconditional loves.
And who always gives me courage and support to finish this project.
To my project supervisor Dr. Syafiq Fauzi Bin Kamarulzaman,
Thank you for the support, advice and sacrificed energy,
Time in helping me to complete this project on time.
To my friends and all the FSKKP lecturers,
Thank you so much of all your kindness
And only God can repay all of you.
I really appreciate it.

May God bless the very all of you.

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To summarize, this chapter discuss about the idea of this project, problem statement, scope and the objective to achieve. The main idea of this project is to develop a system that handle systematic watering activity, hence keep the soil on good moisture and update data condition to the user.

ABSTRACT

Plant need enough water to grow green and healthy. Sometime people cannot maintain their watering activities. Autonomous Horticulture Irrigation System is develop to manage horticulture irrigation activity. It will be based on Internet on Things (IoT) project which user can receive a notification and remotely control the irrigation process. In this system, the sensor will be the input device to read the moisture condition of soil. The system will receive the data and decide if the soil is wet, or dry and need for watering. The system will send notification to remind user for irrigation process. Autonomous Horticulture Irrigation System will handle systematic watering activity, hence keep the soil on good moisture and update data condition to the user. Rapid Application Development methodology is applied as a guideline development of the project. RAD methodology it is an ideal methodology for this project as it is very flexible and adjustable to redesign. As results, the system will produce systematic management to horticulture activity. In conclusion, the proposed system aims to improve the way people managing plants and maintain the moisture of soil needed by a plant.

ABSTRAK

Tumbuhan memerlukan air yang cukup untuk kelihatan sihat dan segar. Manusia kadang-kadang tidak boleh mengekalkan aktiviti penyiraman mereka. “Autonomous Horticulture Irrigation System” dibangunkan untuk menguruskan aktiviti pengairan tanaman. Ia akan berdasarkan “Internet on Things” (IoT) di mana pengguna boleh menerima pemberitahuan dan mengawal proses pengairan. Dalam sistem ini, sensor akan menjadi peranti input untuk membaca keadaan kelembapan tanah. Sistem ini akan menerima data dan membuat keputusan jika tanah itu basah, atau kering dan perlu untuk menyiram. Sistem ini akan menghantar pemberitahuan untuk mengingatkan pengguna untuk proses pengairan. “Autonomous Horticulture Irrigation System” akan mengendalikan aktiviti air secara sistematik, dengan itu dapat mengekalkan tanah pada kelembapan yang baik dan menghatar kemas kini data kepada pengguna. Metodologi “Rapid Application Development” digunakan sebagai garis panduan pembangunan projek. Metodologi RAD ia adalah satu kaedah yang sesuai untuk projek ini kerana ia sangat fleksibel dan boleh laras untuk mereka bentuk semula. Sebagai hasilnya, sistem ini akan menghasilkan pengurusan yang sistematik dengan aktiviti penanaman moden. Kesimpulannya, sistem yang dicadangkan bertujuan untuk meningkatkan cara manusia menguruskan tanaman dan mengekalkan kelembapan tanah yang diperlukan oleh tumbuhan.

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LIST OF ABBREVIATIONS

ABBREVIATION	TITLE
BCN	Bachelor of Computer Network
UMP	Universiti Malaysia Pahang
FSKKP	Fakulti Sistem Komputer dan Kejuruteraan Perisian
IoT	Internet on Things
AHIS	Autonomous Horticulture Irrigation System
Wi-Fi	Wireless Fidelity
HASL	Hot Air Solder Levelling
IDE	Integrated Development Environment
WLAN	Wireless Local Area Network
IEEE	Institute of Electrical and Electronics Engineers
WAP	Wireless Access Point
SoC	System on Chip
TSL	Transport Layer Security
WPA	Wireless Protected Access
WPA2	Wireless Protected Access Version 2
ADC	Analog Digital Converter
LED	Light-emitting diode
LCD	Liquid Crystal Display
SDLC	System Development Life Cycle
RAD	Rapid Application Development
USB	Universal Serial Bus

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Nowadays everything has been innovated. The Internet on Things (IoT) is keep expanding rapidly whereas a lot of things are depending on the internet. In horticulture, people are still using manual process to manage their flowers and plants.

Plant need enough water to grow and frequent watering to maintain a green and healthy. The difficulty is exist when people are busy with their daily work and do not have enough time for watering activity. Besides that, people do not know the exact time and enough volume of water for a good condition of soil in a session of irrigation activity. The problem also occurred when no one is taking good care of the plant when user leave on vacation or spend long periods of time away from home. As we can see, there are several invention on this plant watering activity such as water sprinkler and water jet, but still need human to control the irrigation process manually.

In order to overcome this problem, Autonomous Horticulture Irrigation System is proposed which provide a systematic irrigation activities. User of this system can monitor the plant remotely from anywhere place connected with the internet and view result on the irrigation process. With deployment of this system, the innovation of internet on things applied in horticulture field help to ease human plantation and horticulture irrigation activities. Last but not least, with existing of this system, we can move on from the traditional watering plant.

1.2 PROBLEM STATEMENT

i. People are busy with their daily work and do not have enough time for watering activity to maintain a beautiful and healthy plant.
ii. People do not know the exact time to perform an irrigation activity and the exact amount of water for the best soil condition in a session of irrigation activity.
iii. There is no people will taking good care of a plant when user leave on vacation or spend long periods of time away from home.

1.3 OBJECTIVES

1.3.1 Aim

The Aim of this project is to develop a prototype device for Autonomous Horticulture Irrigation System to handle systematic watering activity, hence keep the soil on good moisture and update data condition to the user.

1.3.2 Objectives

i. To develop automated and computerise plant irrigation system.
ii. To implement the functionality Arduino with combination of soil moisture sensor and solenoid valve to irrigate plants with enough water.
iii. To maintain the irrigation activity for each area of horticulture which perform by Autonomous Horticulture Irrigation System.

1.4 SCOPE OF PROJECT

This project will be conducted in a small garden as the research area, a device as the system and user as the administrator.

1.4.1 Device

The device will execute the irrigation activity systematically based on the moisture of soil read by the soil moisture sensor send the watering data to maintain the plants fertile and healthy.

1.4.2 User

User will manage the entire system and control it remotely by interface through wireless connection. User also can monitor the irrigation activity done by the system.

1.4.3 Target Area

The Autonomous Horticulture Irrigation System will be placed at a mini garden with Wi-Fi connection to support the communication within the area of the garden.

1.5 SUMMARY

To summarize, this chapter discuss about the idea of this project, problem statement, scope and the objective to achieve. The main idea of this project is to develop a system to handle a systematic watering activity, hence keep the soil on good moisture condition. The three main problems are firstly, people do not have enough time to spend for watering activity. Second, people do not know volume of water for a good condition of soil in a session of irrigation activity. The problem also occurred when no one is taking good care of the plant when user leave on vacation. To resolve this problem, the idea to develop The Autonomous Horticulture Irrigation System which provide an automated and systematic irrigation activities. User of this system can monitor their plant condition from anyplace connected with the internet and view result on the watering activity. With the development of Internet on Things (IoT), we can implementing a communication technology to maintain the health of a plant and move on from the traditional watering plant to urban gardening.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this project is to develop a device that allow user to manage their plant irrigation activity. The main components of this project are soil moisture sensor, water solenoid valve and Wi-Fi module which transfer the collected data to the main processing system, communicate between the hardware and user interface. In early process, sensor will detect the moisture of soil. In case the moisture reaches high value, the sensor will send data and alert to the central processing.

The moisture sensor reads value of the soil moisture. Then the captured from the processed into Arduino circuit and transfer to the computer through Wireless Fidelity (Wi-Fi) Module. After command is prompted, the circuit will execute the watering process and provide result to the user through connected device. Report will be generated in value format after the sensors done their processes.

Apart from that, this system will send two types of notification to user. First when the soil moisture reduces, it means water irrigation need to be performed. The system will send a notification to remind user for watering process. The second notification will used to notify user that the watering process is done successfully. The result can be used to observe the irrigation summary and watering activities. The result will be generated to the desktop computer or any devices that use to remote the Autonomous Horticulture Irrigation system.

2.2 OVERVIEW OF SOIL MOISTURE SENSOR

Soil moisture sensor is used to detect amount of moisture present soil and measure water content. With the assist of this soil moisture sensor, it will be realizable in making the plant irrigation system to inform user when the plant need water and display the result. This sensor can read the amount of moisture present in the soil encompassing the area. User will know whether a plant needs water or not by observing the outcomes that the sensor outputs. Although it is a low technology sensor, however it is ideal for observing an urban garden and water amount of a plant. Figure 2.1 shows the figure of soil moisture sensor.

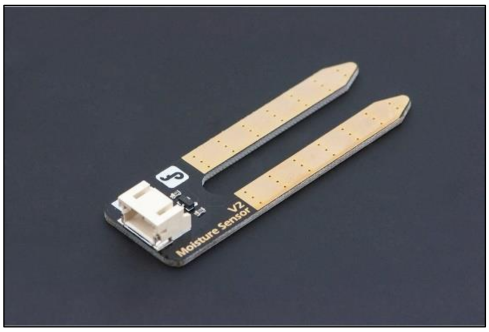

Figure 2.1: Soil Moisture Sensor

The moisture sensor is basically two probes to be embedded into a soil which passing current through the soil by using those probes. This moisture sensor is actually a printed circuit boards utilizes Immersion Gold which shields the nickel from exposed to oxidation. Excessive volume of water will make the soil conducting electricity easily or less resistance, while dry soil conducts the electricity inadequately or more resistance. When the moisture condition of a soil is reducing, the sensor output value will diminish (Demay, 2014).

2.3 OVERVIEW OF WIRELESS MODULE

Nowadays, there are numerous devices are using Wi-Fi for personal computers, cell phones, tablet computers and digital devices. Wi-Fi technology is a wireless module used to connect within devices. Figure 2.2 shows Wi-Fi module.

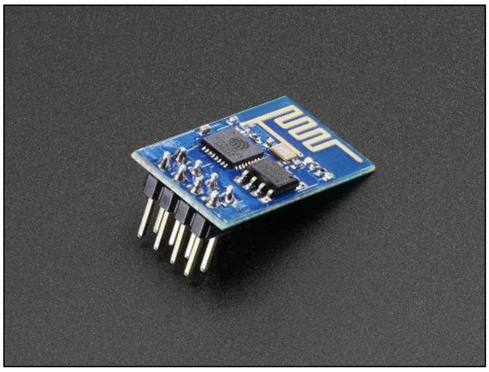

Figure 2.2: ESP8266 Wi-Fi Module

Wireless Fidelity or Wi-Fi is a wireless computer networking technology that permits electronic devices to exchange information through wireless communication by utilizing radio signal over a computer network system and include high speed internet connection (Saddam, 2016). Wi-Fi signal has a range of around 100 meters indoors and a greater range for outdoor. Wi-Fi is a local area network technology which allow electronic devices get connected in a network, fundamentally using 2.4 gigahertz UHF and 5 gigahertz SHF ISM radio bands. With wireless connection, Arduino circuit board can communicate and sending data wirelessly to any devices that used by user to manage and display the system's result, where both compulsory connected to the network, in order to maintain connection.

2.4 OVERVIEW OF 12V WATER SOLENOID VALVE

Solenoid valve is an electronic actuator which is commonly used for water filtration, irrigation, fountains, aquariums, plumbing, and hydroponics plant. A 12V water solenoid valve is controlling water flow by using electricity which consist of a two-way of semi-direct lift valve with a normally closed working position whereas a valve will open when the coil is energized with enough electric power which 12V and permits water to pass through the flow direction (Chris, 2015). Figure 2.3 illustrates the flow of two-way water solenoid valve.

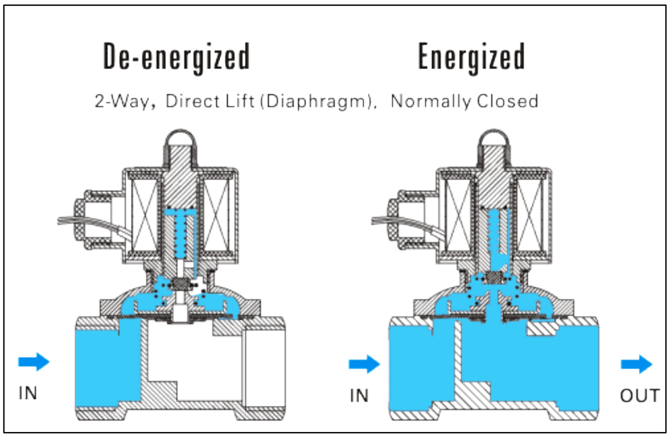

Figure 2.3: 12V DC Water Solenoid Valve

If there is no electrical energy, the coil of solenoid valve will close it and stop the water flow. This liquid valve is suitable in automated watering process. It is cheap and affordable for prototype of an automated irrigation system.

2.5 OVERVIEW OF ARDUINO

Arduino is the popular open source physical computing platform that provide simple input/output on board and implementing programming languages in a development environment. It is one of the best electronic prototyping platform that allow interaction between software and hardware. Arduino is programmed with the Arduino integrated development environment (IDE) which provides development of program and the compiler is compatible with all version of Arduino board.

There are variety of Arduino products which have different features and enhancement. The most popular version of Arduino is Arduino Uno. This Arduino Uno is a starter product of Arduino board. It is easy to use for developing your first creative projects. This board is compatible to upgrade with extension modules. Apart from the entry level product, advance version of Arduino board is the Arduino Yún. This version is a product make devices connected easily with Internet on Things (IoT) and expand your creativity into the World Wide Web.

2.5.1 Arduino YÚN

Arduino Yún is the perfect electronic board to use for designing an Internet of Things (IoT) project. “Yún” in Chinese language means cloud as one of the greatest feature of this board to establish an internet connection directly from Arduino. It is the board with enhancement from the previous Arduino, and embedded with Wi-Fi system on chip which is Atheros processor that supports a Linux distribution (Baugues, 2015). Figure 2.4 illustrates the Arduino Yun board

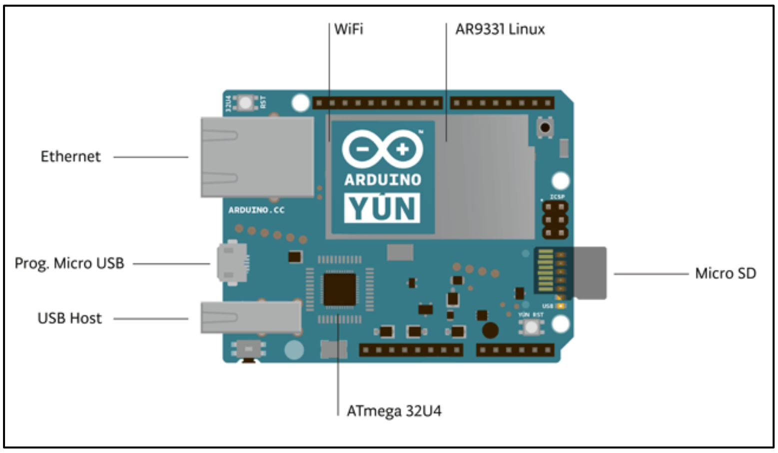

Figure 2.4: Picture of Arduino YÚN

Although Arduino Uno is the simplest and cheaper board than others, but that Arduino Yún is better on the description. We cannot ignore that Arduino Uno is support expansion features by installing extra shield component or modules that not provide by the Arduino Uno. In the end, additional shield like Ethernet shield, Wi-Fi shield and storage module will end up costly to the project. The performance also do not fully optimize since modular parts which not embedded or preinstall with item sometimes not compatible and the connection is not establish. We can see that Arduino Yún provided its advance functionality through embedded or preinstall modules on the board such as Ethernet, Wi-Fi, USB type-A and card reader. This make the Arduino Yún better storage management and allows communication through internet either using wired or wireless. The best feature of this Arduino Yún is embedded Wi-Fi that permits wireless communication which fundamental of Internet on Things (IoT) product. Table 2.1 shows the comparison of the specification and features between Arduino Uno R3 and the Arduino Yún.

Table 2.1: Comparison Arduino board

Specification/Features	Arduino Uno R3	Arduino Yun
Microcontroller	ATmega328	ATmega32U4
Operating Voltage	5V	5V
Input Voltage (recommended)	7-12V	5V
Digital I/O Pins	14 (of which 6 provide PWM output)	20
Analog Input Pins	6	12
DC Current per I/O Pin	40 mA	40 mA
DC Current for 3.3V Pin	50 mA	50 mA
Flash Memory	32 KB ATmega328 of which 0.5 KB used by bootloader	32 KB of which 4 KB is used by bootloader
SRAM	2 KB (ATmega328)	2.5 KB
EEPROM	1 KB (ATmega328)	1 KB
Clock Speed	16 MHz	16 MHz
Ethernet	N/A	IEEE 802.3 10/100 Mbit/s RAM: 64 MB DDR2
Wi-Fi	N/A	IEEE 802.11b/g/n
USB type-A	N/A	2.0 Host/Device
Card reader	N/A	Micro-SD
Additional Feature(s)	Require extension module of additional feature	Linux microprocessor: Processor: Atheros AR9331 Architecture: MIPS @400 MHz Operating voltage: 3.3 V Ethernet: IEEE 802.3 10/100 Mbit/s Wi-Fi: IEEE 802.11b/g/n USB type-A: 2.0 Host/Device Card reader: Micro-SD RAM: 64 MB DDR2 Flash memory: 16 MB PoE compatible 802.3af card support
Manufacturer	Italy	Taiwan

2.6 BENEFITS AND DISADVANTAGES OF USING WIRELESS TECHNOLOGY

Every technologies comes with pro and cons. The main existence of Wi-Fi technology is the flexibility features. Wireless network allows communication beyond boundaries of location. Nowadays, it is not necessary to be in an office or some public telephone in order to send and receive messages (Postscapes, 2015). Technology is expanding rapidly. Wireless communication offer convenience to user which wireless devices like mobile phones that allow to manage something remotely, and permitting every wireless devices to get connected. With Wi-Fi, there is no need to physically intact with anything in passing messages or transfer data. Moreover, Wi-Fi technology is gives cost effectiveness since this communication technology does not require frequent maintenance practices or complex physical infrastructure. This implies any organization to provide wireless communication technology services does not incur a lot of costs and it is able to charge cheaply with regard to customer fees.

In contrast, Wi-Fi is provide less security than wired connection such as Ethernet. It is because an intruder does not need a physical connection to trespassing the wireless connection. We agreed Web pages that use Transport Layer Security (TLS) are secure, but unencrypted internet connection can easily be detected by network intruders. To overcome of this issue, Wi-Fi has applying various encryption methods. The initial encryption is Wired Equivalent Privacy (WEP) has proved easy to break. Higher quality protocols Wi-Fi Protected Access (WPA) and Wi-Fi Protected Access version 2 (WPA2) were added later to enhance the wireless network security. Moreover, wireless networks needs many radio signals to establish the connection. In territories where there is no sufficient signal, bandwidth will be constrained. Wireless communication bandwidth is fairly widespread in modern times, but there are territories that still exist where the possibility of having excessive number of user in a wireless network at once could be an overload issue. To add, we agreed wireless connection do not need a physical intact to send and receive signal, but it performance is depends on the structure of the network and any obstacles there may be weakening the radio signal.

2.7 RELATED SYSTEMS

From the analysis, there are many similar system have been developed and apply around the world. However, those system are expensive and some of them are not exist in Malaysia. If exist that kind of system that meet our climate, it would be extremely expensive.

2.7.1 Soil Moisture Sensor by SparkFun

The SparkFun Soil Moisture Sensor which is really direct when it comes to hook up. One regularly known issue provide by soil moisture sensors are their short lifespan when exposed to a damn environment. To overcome this issue, printed circuit board (PCB) is covered in Gold Finishing (Electroless Nickel Immersion Gold). The sensor consist of two probes operates a variable resistor as more volume of water in the soil means have better conductivity and results in a lower resistance. With an easy setup, the sensor will read and show the water value presence on soil, and let you know if the soil is in wet condition or dry and needs watering. The system is hooked into the soil and connected to the analog port of the soil to send analog value to the RedBoard as central processing of the system which a board made by SparkFun and installed a Serial Enabled LCD Screen to display the outputs (Al-Mutlaq, 2014). Figure 2.5 shows a product of SparkFun Soil Moisture Hookup.

Figure 2.5: SparkFun Soil Moisture Hookup

This small product utilized the usage of soil moisture sensor, which reads soil moisture and combined a motor electronic part to run a self-watering system. Another way include directly put a gear into the water and make a quick rotation to pull the water up and into the plant. It is a simple system that can help user to water a garden. Otherwise, it is only relevant to perform an irrigation in a small area.

2.7.2 Garden Irrigation Sprinkler system

Garden irrigation system is one of a common used product for gardening. This irrigation system are automated by design and make your to stand out from your garden to perform watering activities, reducing the time of gardeners would have usually spent to irrigate their plants. Watering efficiency can be accomplished by using a drip irrigation system instead of using the traditional garden hose. The system helps user with arranging garden watering systems and offer recommendations for particular watering requirements (Devika, 2014).

Figure 2.6: Garden Irrigation Sprinkler system

Larger and complex irrigation systems with multiple zones require something to make controlling them quick, easy and reliable. The irrigation controller acts as the brains of a garden watering system, which then tells the valves when to open and close. Communication between the irrigation controller and the solenoid valves is done via 24V signal cable, so the irrigation controller could be located in the utility room and the solenoid valves is hidden in a valve box buried in the garden.

2.7.3 Automatic Watering by GARDENA

Garden is a place for relaxing and gain a good feeling. To guarantee that plants and lawn remain healthy and green, GARDENA which is expert irrigation company is offering user great solutions for the areas of watering, water transportation, water pumps and automatic watering. There are productive watering solutions for practically every kind of garden. GARDENA offer a better product for user to get connected with a large gardening area (Ramigrafx, 2013). Figure 2.7 shows a Gardena Automatic Watering system.

Figure 2.7: Gardena Automatic Watering

GARDENA provides a comfortable ways to water a lawn, flower or vegetable beds and potted plants easily and comfortably. It offers an extensive variety of watering system which even work automatically when user open the controller. The product is durable and made up from high quality irrigation product. It is suitable for outdoor use and effective in watering large area. By installing the system at the water tap with initial system setup, user can control the irrigation process. This system can completes three time cycle per day with duration of two minutes until one hour process. But still using a timer to control water flow.

2.8 COMPARISON OF TECHNOLOGY

Based on the study of the existing system, a comparison have been made in term of detection method, cost, technology that used, communication tools and covered area. The existing system also being compare with the proposed system to identify the similarities and differences. Table 2.2 shows the comparison among three existing product with the product that are proposed.

Table 2.2: Comparison between existing products and proposed product

Specification	**Products**			
	SparkFun Soil Moisture Sensor	**Garden Irrigation Sprinkler system**	**Automatic Watering by GARDENA**	**Automated Horticulture Irrigation System**
Detection Method	Sensor	Timer	Timer	Sensor
Technology	SparkFun with moisture sensor and motor	Conventional	Conventional	Arduino equipped with solenoid valve and soil moisture sensor
Communication Tools	N/A	Timer	Timer	Wi-Fi
Covered Area	Small	Large	Large	Small ~ Large
Cost	RM404.95	RM896.00	RM1024.35	RM300 ~

2.9 SUMMARY

In chapter 2, explanation will be deeper in literature review of the purposed project. The purpose of this project is to develop a devices that enable user to manage their plant irrigation process. This chapter also made overview of related hardware and the technology used. The main component of this project are soil moisture sensor and solenoid valve. The communication technology for the project is using wireless communication signal. Arduino will be the central processing of the system. Arduino is one of the best electronic prototyping product allows interaction between software and hardware. Here also will be include the comparison of related existing systems. The existing systems also being compare with the proposed system to identify the similarities and differences.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Methodology is the systematic set of techniques and theoretical analysis of the methods applied to a field of study. There are many approaches of methodology in software development process such as Waterfall, System Development Life Cycle (SDLC), Agile Methodology, Rapid Application Development (RAD) spiral and Extreme Programming. In this project, Rapid Application Development (RAD) methodology will be utilized. It will focus on the design, prototype, and research on related software and hardware for the whole development process. All the information of the system in Chapter 1 & 2 are collected and analyzed before implementation phase on Chapter 3.

There are several advantages of using RAD methodology for this project. The methodology is convenient as well as flexible. It is making the system easier to redesign, modify or resolve if any issues of the phases occur. RAD is best used for developing system based on existing prototype. All prototype can be stored in a repository for future use. The reason that a key part to this methodology is to reuse the prototype which increase the speed of the project development process and reduce the duration of development process and testing. Due the reusability, it provide system that offer minimal maintenance cost. Moreover, this methodology encourage the involvement of user in the analysis and design stage also improve the good quality of final product.

3.2 RAPID APPLICATION DEVELOPMENT (RAD) METHODOLOGY

System development methodology is a standard steps used by most organization in developing a system. A methodology can be define as a complete step by step approaches in the development process. The main idea of methodology is to control and guide the progress of developing the system.

Methodology is applied by an organization will be consistent with the general management style. RAD methodology is very flexible and adjustable to redesign. Therefore, it is an ideal for this kind of project since this project need to be accomplished a short span of time. RAD consist of planning phase, analysing phase, design phase, implementation phase and maintenance. Figure 3.1 shows the stages of RAD.

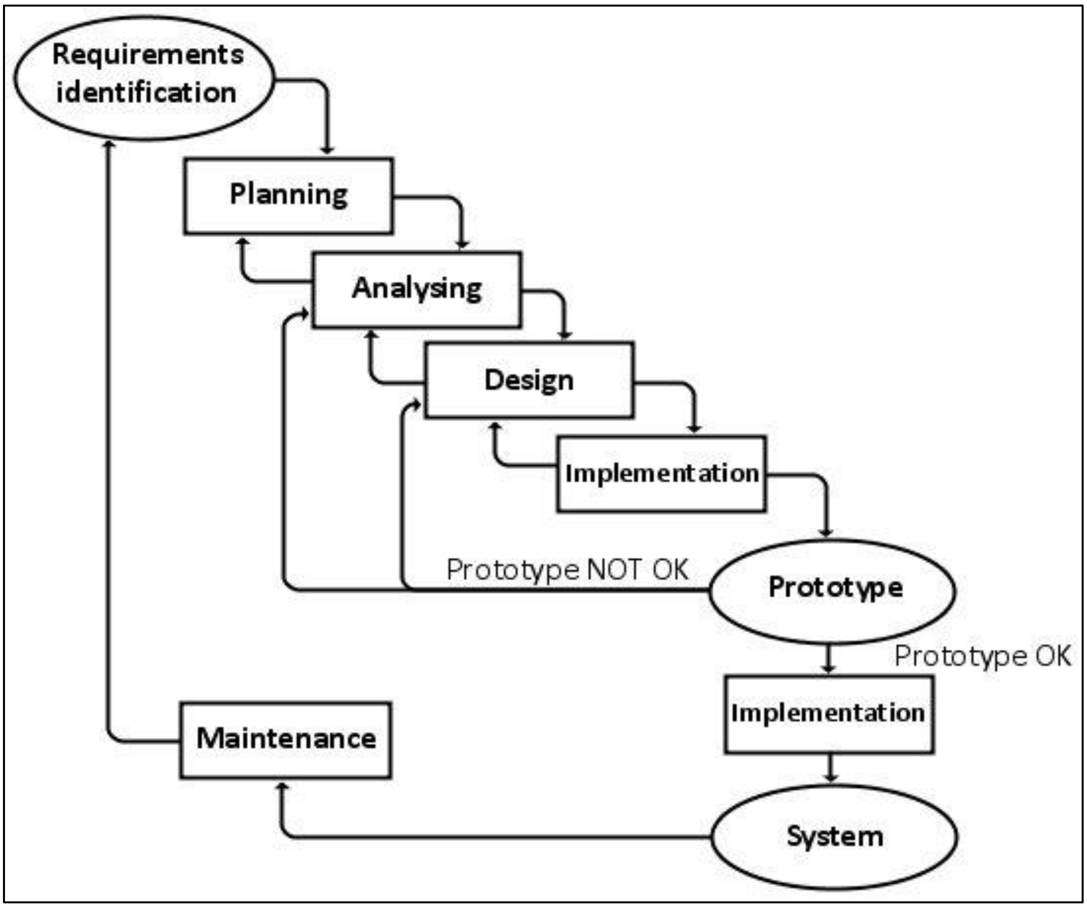

Figure 3.1: Rapid Application Development (RAD) Methodology

3.2.1 Planning

Planning process is take place before the analysis. In this stage, the scopes and objectives of the project are defined. Discussion for the product requirement, potential constraint in functionality and integration are considered. This phase also determine how this project are going to be develop precisely. The requirement planning are going to discuss thoroughly to avoid misconceptions among the person involved with this project. The meeting is conducted to get user requirement about the project should be done in a proper office environment. Meanwhile, the system provider will certainly show the particular part to go into details along with the developers about the existing operating system.

3.2.2 Analysis

The lifecycle of this project is begin. In this stage, the deliverables are broken down from the higher level of project chapter into the more specific business requirements. The analysis stage should discover desired system needs, whether the analysis process will fulfil the system requirements that supports the system outcome. The standard of performance need to be improve to complete the whole process.

In this project, the actual analysis are accomplished to obtain information regarding the plant watering and irrigation system. Analysing requirements is using standard tools to produce a baseline of the requirements. Analysis process also discover issues and problem to obtain information and specific data needs to find out what are the weaknesses related with the current systems. Once the requirements are agreed, the baseline is created and becomes the formal requirement source.

In order to resolve these issues, some systems that use soil moisture sensor and wireless technology for plant irrigation activities has been analysed and explained in Chapter 2. There are several types of plant irrigation systems with various types of technology applied throughout the systems. Although there are vary of technologies have been used, the main focus to achieve the same objective. The research and study about the presence technology that applied in irrigation system were explained in details at the beginning of the chapter.

3.2.2.1 Analysis on the developing system

Further analysis on developing this system are taken place in this section. Here, deeper discussion and explanation are take placed which involve the techniques, tools and materials, and idea enhancement of this system. Moreover, the hardware, software and user requirement also have been analysed. The steps that have been analysed and involved in developing this system are state below.

a) Setup the detection device

The first phase of developing process is Setup the detection device. In the getting start of Arduino board is find all of the Arduino information needed to configure the board. The Arduino software integrated Development Environment (IDE) that used to communicate with the board is an open source software that can be download from www.arduino.cc. Arduino software (IDE) is a compiler of the Arduino code and electronic modules. It can run through multi-platform such as Mac OS X, Windows and Linux. In this step, developer also need to setup the devices driver, by installing the driver and connecting the sensors with Arduino board. Some electronic module need an extension power supply. So batter or DC adapter is need to be included in this project. The most important to avoid the devices from damage is test all of the components and seal them in a waterproof box.

b) Device placement

In this step, device need to be place in higher place to prevent from damage. The exact place of the irrigation system is near the wireless modem and sealed with waterproof box. The area of this irrigation system must be covered with wireless connection to allow the remote function of the system process. Providing an automated system is require the optimized internet connection by the internet service provider and better network modem.

c) Send data to central processing

When the moisture is observed, the data will be send to central processing through the Wi-Fi connection to notification the system for a watering process. The irrigation can be automated or triggered remotely by the administrator of the system.

d) Analyse the data

The data will then be saved into the database. From database, the data will used to predict moisture of soil and the usage of water needed for irrigation, and the watering pattern.

3.2.3 Design

This stage focuses on system design based on associated data analysis along with information which has been collected during the analysis stage. The design include physical and logical design, cost and estimated time until this project is ready to be deployed. It will be included the network, hardware, software, platform, programming, designing of user interfaces and the system interfaces. The proposed design will be tested for performance, and ensuring user requirement is achieved, and set of specification will be use in the next stage.

3.2.3.1 Flowchart

Flowchart is a graphical representation of the program step and flow. Firstly, sensor will detect the soil moisture. Next, the system will calculate and decide the best condition of soil. After that, Arduino will send a notification if the soil is require irrigation process. A condition is offered by the system whether the process is need to open all relay or only certain of it. The process of irrigation will be stop if the sensor sense the soil is get enough water. The data is collected and saved by the system. The data will be analysed and lastly a result will be shown a graph and statistic for a better report. From the statistic use can know the pattern of the watering process. Figure 3.2 illustrates the flowchart of the system. Figure 3.2 shows the flowchart of the system from the beginning until the result is established.

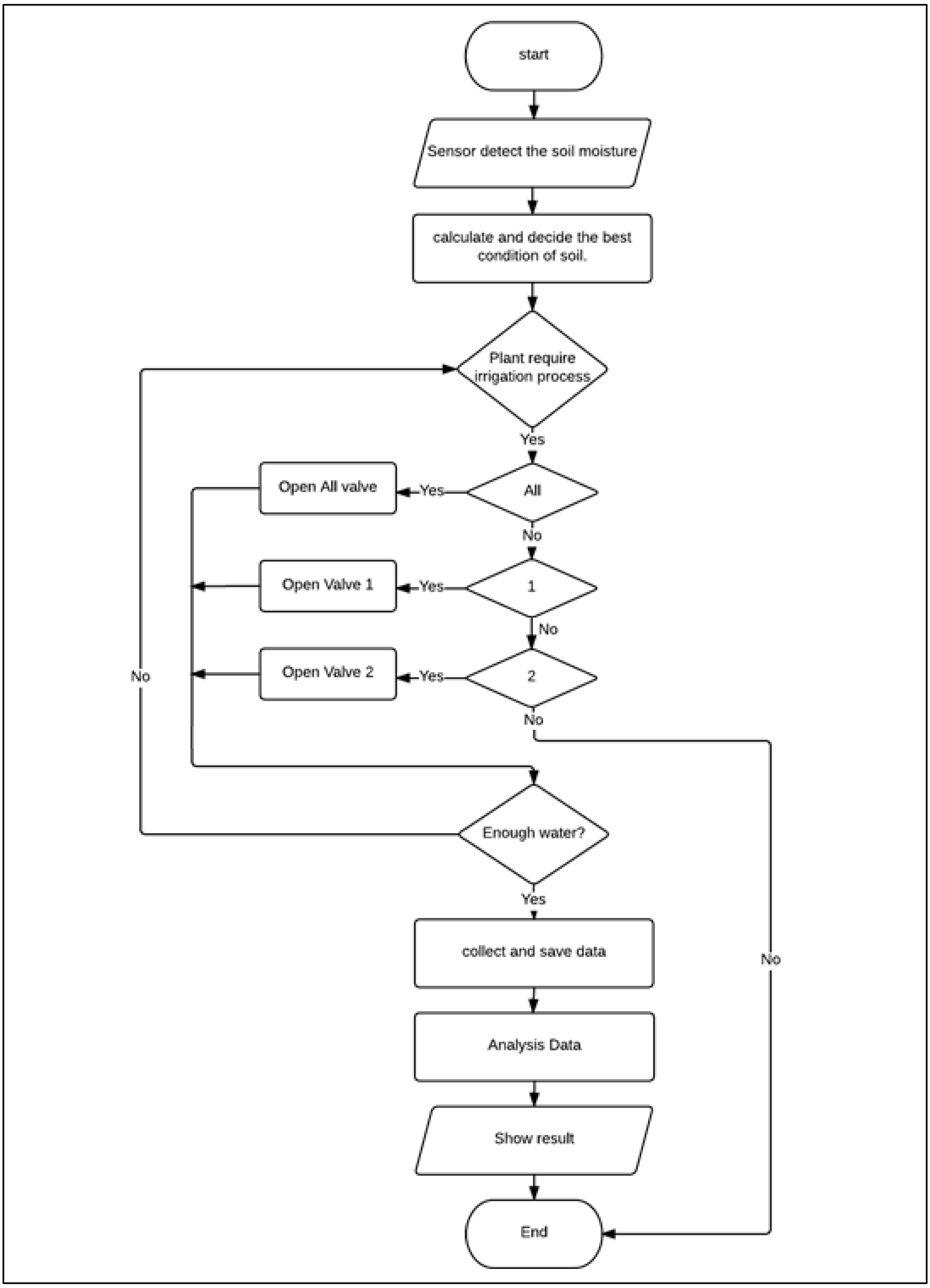

Figure 3.2: Flowchart of Irrigation System

3.2.3.2 Logical Design

Before an actual device is developed, the design must first be structured. The Arduino Ground port will be connected to Ground on terminal on the sensor. Voltage port on the Arduino also will be connected to voltage terminal on the sensor. Five voltage of electric current will be applied on the Arduino modules. The valve will be connected to the circuit using Voltage input (Vin) port which can regulates the voltage because the voltage of solenoid valve is 12V which is higher that the board. Meanwhile data of the irrigation activity will be read to analog signal which is send by the sensor and received on analog output, port 0 on the Arduino board. The resistor are used to lower the current flow in the circuit. In addition, a transistor is used to increase or switch electronic signal and electrical flow. Figure 3.3 show the logical design of the device. The actuator need an external power to supply the 12V while other connected sensor will connected to the 5V Arduino Yun pin port. Relay module also connected to the 5V pin to receive voltage command from the board

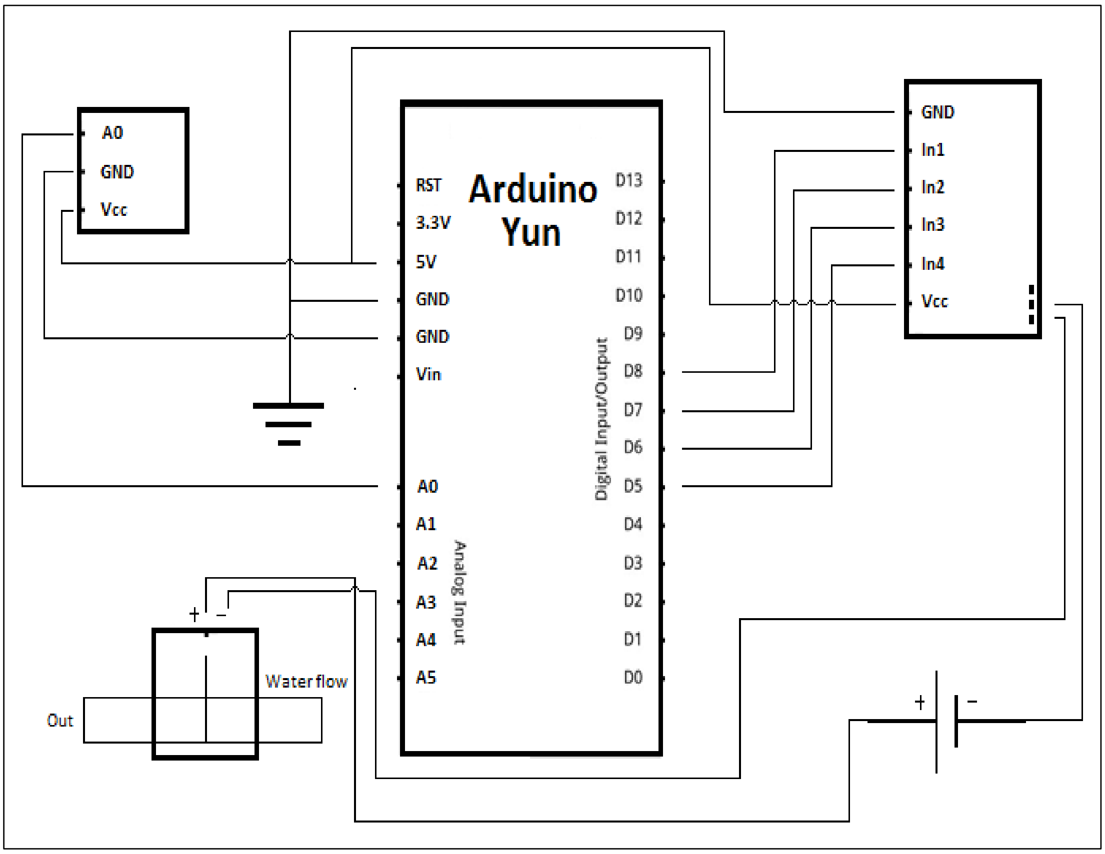

Figure 3.3: Logical Design of hardware component

3.2.3.3 Physical Design

After the logical design is already confirmed, the phase of designing is continue with physical design. The physical design require a complete image of final product. It also give big impact on the performance of final product. Relay will perform a function as an electronic switch that control the electrical energy through the actuators. The design is applied in small are or horticulture as experiment for initial product. Each area will have different actuator and sensor to perform different irrigation activity. Water will supply directly from the connected pipe as a water source. Figure 3.4 show the physical design for this project.

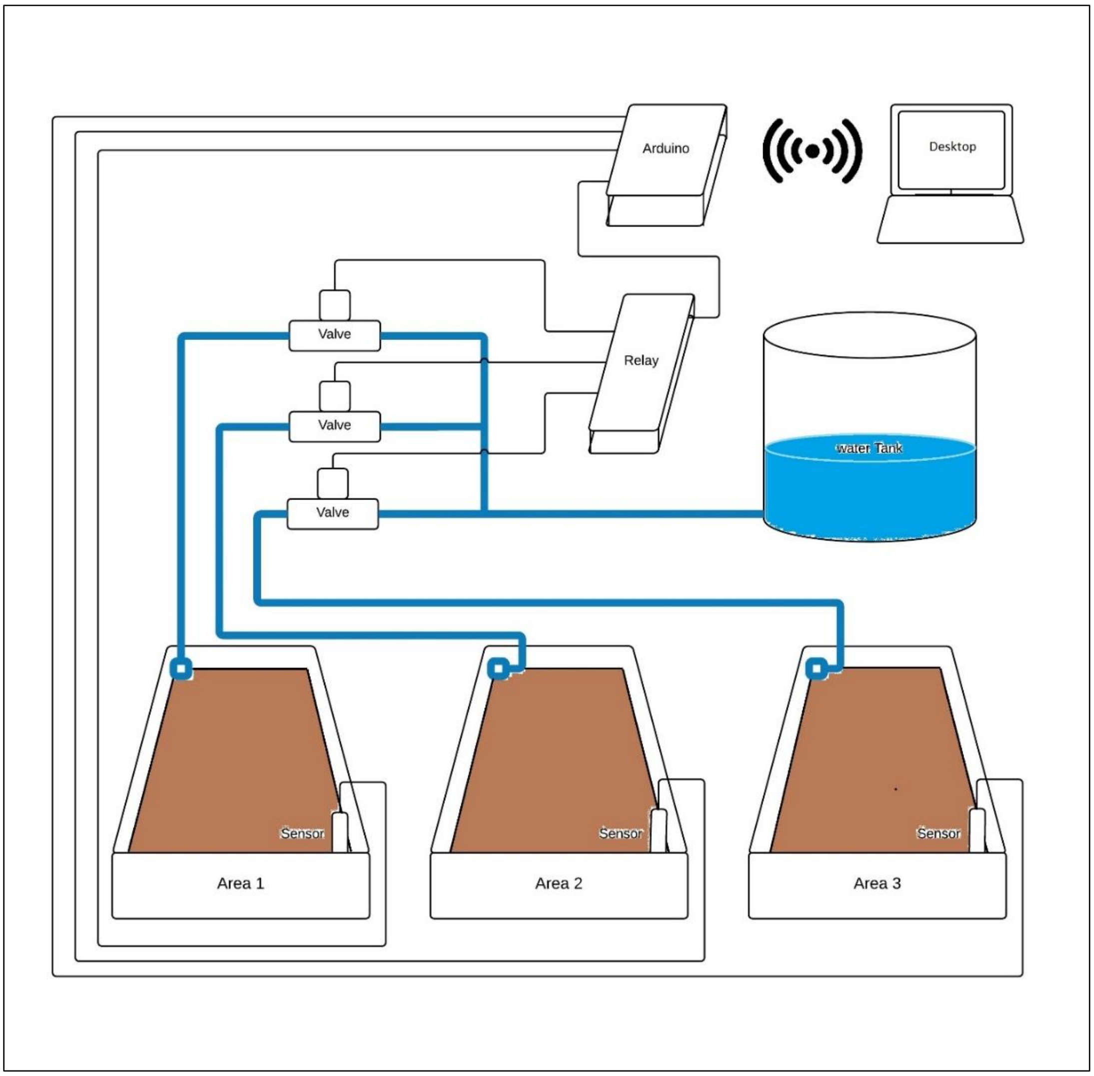

Figure 3.4: Physical Design of Proposed System

3.2.3.4 System Architecture

The system will start its process with the sensor detecting the soil moisture. Figure 3.5 shows how this system interacts and communicate with each other to get the data from the device and perform and irrigation process to water plant.

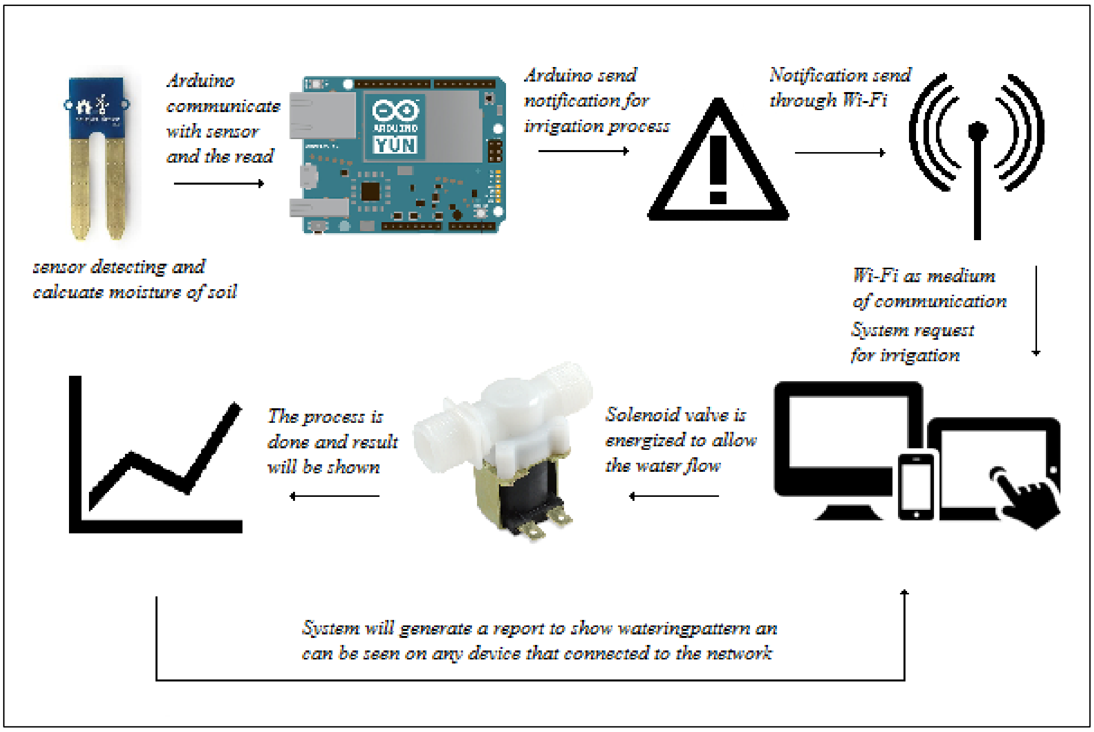

Figure 3.5: System Architecture

Based on the system architecture on figure 3.5, the board connected with wireless connection, then sensor will firstly detect the presence of water in a soil. It will observe the moisture of soil before starts the irrigation process. After the data gained, the device will send notification to the system to trigger the irrigation process. The system will perform the watering activity automatically or the user can trigger the irrigation process remotely through desktop computer or any devices that connected with the internet. After the irrigation process happened, the central processing will receive the message transmitted from the Arduino and transfer the message to the database. Lastly, the data will be use to show the irrigation report in statistical and analyse the watering pattern.

3.2.3.5 Context Diagram

Context diagram is a diagram used to define the boundaries between the system and their environment. In this case, the contact diagram show how the sensor will interact with Arduino board as the main processing system to generate full result. Figure 3.6 shows the context diagram for this system.

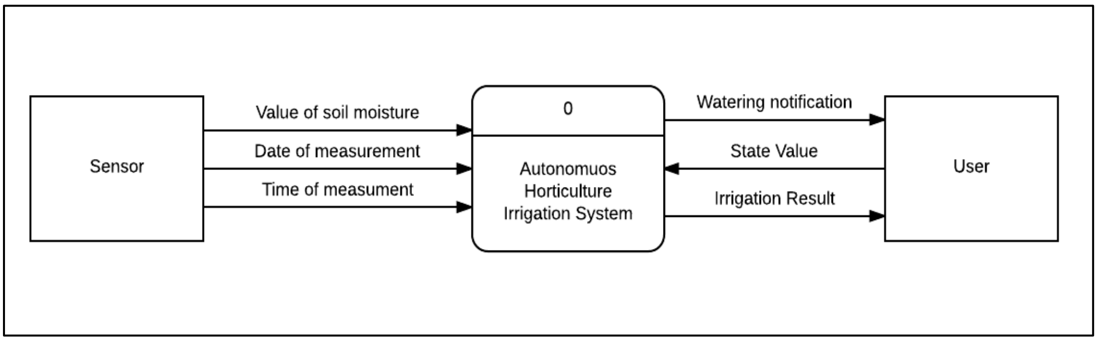

Figure 3.6: Context Diagram of the Entire system

From the context diagram above, it shows that the sensor will calculates soil moisture, date and time and also the condition of the soil. The main system or the central processing will send a notification to perform an irrigation process. After the process is done, the user will receive a notification from the system. System will generate a graph based on the watering process occurred to show the pattern of the irrigation system. The Autonomous Horticulture Irrigation system also will notify user the latest condition of the soil.

3.2.3.6 Data Flow Diagram

Data flow diagram (DFD) is define a flow of a system represented by the graphical modelling. The DFD can be said as the expansion of context diagram. Figure 3.7 shows the system flow of Autonomous Horticulture Irrigation System in term of Data Flow Diagram.

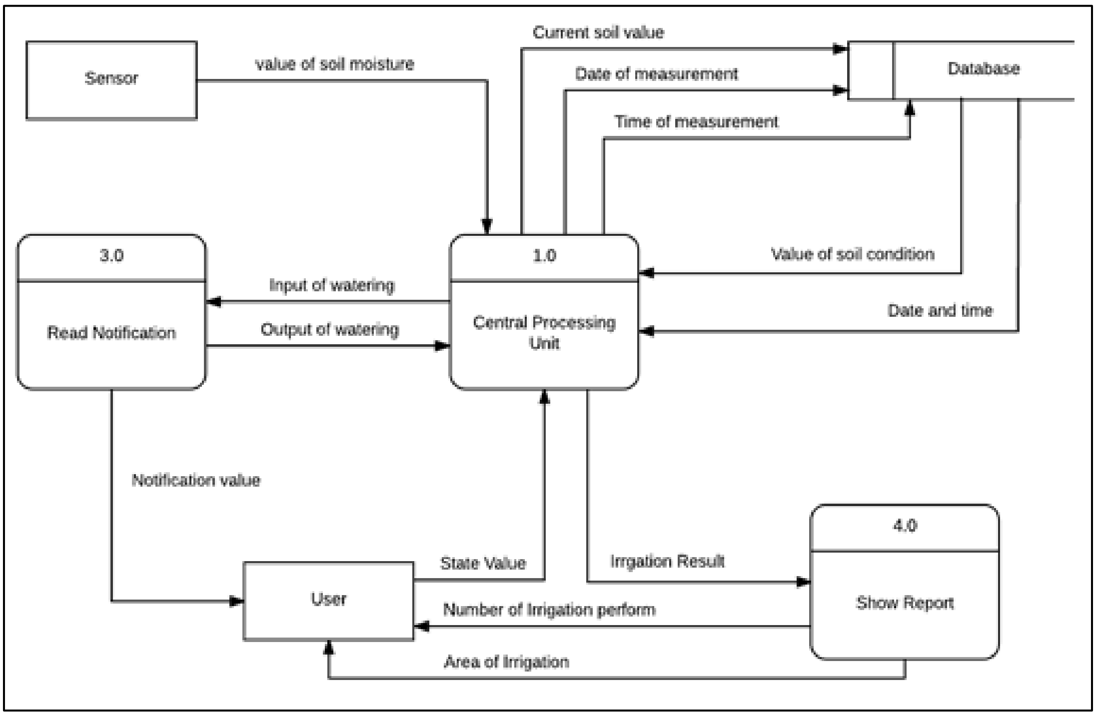

Figure 3.7: Data Flow Diagram

The DFD shows a complete system flow of the system. The sensor calculate the presence of water in soil and will send the moisture condition to the detection mechanism which is Arduino. The Arduino will notify user from any installed devices which are connected with wireless connection to perform an irrigation process. After notification is done, the system will open the valve to allow the process of the horticulture irrigation process.

Detection mechanism will send the data it received from sensor as well as time and date of the data collected into the database. From the database, all data will be used by central processing to predict the irrigation pattern for user. Central processing also generating graph for further review and systematic watering process.

3.2.3.7 Use case Diagram

Use case diagram will be act a representation between user interaction and developing system in the simplest form. It will explain which user is involved in the system process. Figure 3.8 show the user-system interaction for this system.

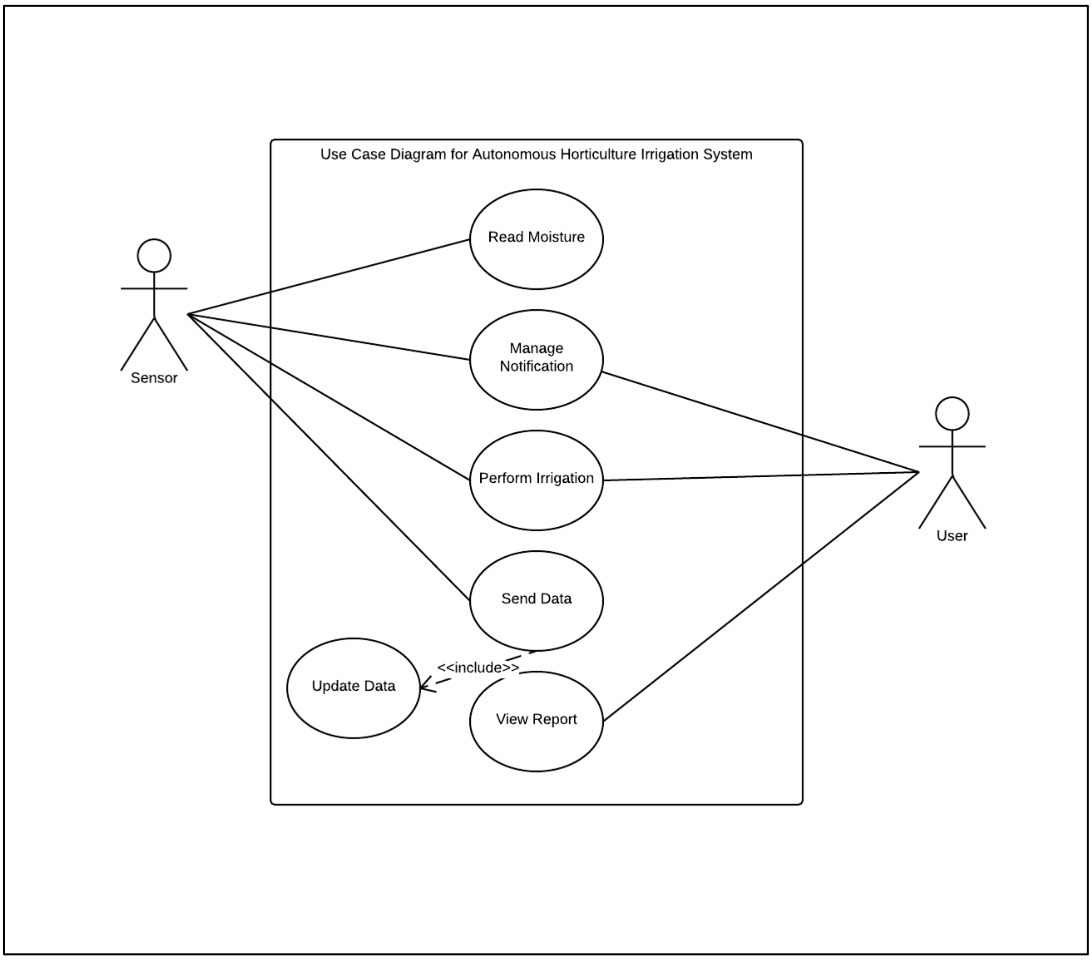

Figure 3.8: Use case Diagram

Use case diagram explain about the interaction between the user and the system. Sensor and user act as the objects of this system. Sensor will interact directly with the system. The sensor will open the valves to release water for irrigation process if according to the systematic process. Report will be generated by the system and user will use the data provided by the system to be observed and analysed the watering pattern.

3.3 HARDWARE & SOFTWARE

In the process to actualize this system, a suitable hardware and software are required. The hardware and software requirements also very important ensure the system can be run as planned. The following subtopic will discuss about the hardware and software necessary for the development stage.

3.3.1 Hardware requirements

In the developing of process, the requirement hardware are Arduino Uno/Yun board, electronic breadboard, electronic components such as resistor, transistor, LED and diode; soil moisture sensor, relay module, alarm module and PVC clear pipe or hose. Soil is also needed as observation for the project. Table below shows the hardware that used in this project with specification and description. It is also state the function of each hardware to be used in the system.

Table 3.1: Hardware and its description

Hardware	Description
Arduino Yun	- To communicate with electronic modules and the sensors. - Provide Wi-Fi connection to allow remote control of a system
Jumper wire	- To connect the Arduino to board, breadboard and the components
Solderless Breadboard	- To place an actual electronic components and test the component connectivity
Adapter	- Intended for connection between the software and hardware
Battery	- Provide electrical power to and act as power supply for the device.
Battery holder	- A chamber to hold a battery.

Resistor	- To support and optimize electricity in the circuit
Darlington TIP120 transistor	- To switch electronic signal and electrical power.
1/2″ Clear PVC vinyl Tubing	- Allow water flow to distribute and release water from tank.
Water Solenoid Valve – 12V – 1/2″ Nominal	- Automatic control valve. Control the water for irrigation process
Water sprinkler	- Release the water and drip irrigation systems
Soil Moisture Sensor	- To measure the moisture of soil
4-Channel module	- Control the switches appliances on the circuit.
1N4001 Diode Rectifier 1A 50V	- Control flow of electric current and protect against reversed polarity in a circuit.
LED	- Indicator and show the system status on the board

3.3.2 Software requirements

Software that required in developing the system are mostly open source software and some of it are preinstalled in the devices which include platform, compilers, drivers, document viewer and editing software. Software that will be used in this project are Windows 10, Arduino Software Integrate Development Environment (IDE), Java, Notepad++, Microsoft Office which including Microsoft Word, Microsoft Access, Microsoft Power Point, Microsoft Project and Microsoft Visio; Adobe software which are Adobe Reader, Adobe Illustrator and Adobe Photoshop; modules driver and Xampp. Table below shows the software that will be used to program this system and software have been use to complete the thesis.

Table 3.2: Software and description

Software	Description
Windows 10	• To run the software and the platform for this system • Used to developed system
Arduino Integrate Development Environment (IDE)	• An open project written, debugged, and supported by Arduino.cc and the Arduino community worldwide. • Run, uploading and allow to write code for Arduino using C and Java
Java	• To write the code to generate report from the data collected
Notepad++	• Write various language that applied in the system
Microsoft Office • Microsoft Word • Microsoft Project • Microsoft Power Point • Microsoft Visio • Microsoft Access	 • To prepare the documentation • To prepare the Gantt Chart • For the presentation slides • To design the diagrams and draw charts • For the data repository of the system
Adobe Reader Adobe Illustrator Adobe Photoshop	• To read related articles to this project • To design the model figure • To design and create related images for the system
Modules driver	• Use to run detect module of electronic parts
Xampp	• To create a database using preinstall MySQL and local web for testing and deployment purposes.

3.3.3 User requirement

Comparison between the planned projects with the existing system is one of the technique in user requirement that applied to develop the system to avoid developing same features with the existed system. On the other hand, observation of the particular process in manual system also help to get the user requirement. This is because, we can create a system that can help user to simplify their work. In addition, to communicate with the system, user just need in interface of a system that connected with wireless network to control and monitor the system.

3.4 GANTT CHARTS AND TASKS

In order to reach the milestone, Gantt chart has been construct to keep the track of the system flow. It is very important to ensure the duration of the project to be completed and reach the objective. The Gantt chart starts from session 1 until deployment at session 2. The milestone of this project is 206 days starting from 18th February 2016 until 30th of November 2016. Gantt chart will be a guideline in the process in completing each task to meet the requirement of the project.

3.4.1 Gantt Chart for Overall Project

The overall project will be run from February 2016 to November 2016 (206 days). Figure 3.9 shows the main process which is planning, analysis, design, implementation and testing. The maintenance phase are not included in the Gantt chart because it takes longer period of time to proceed.

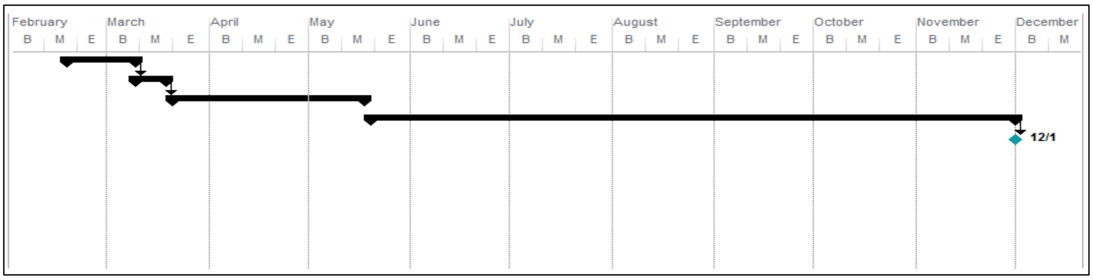

Figure 3.9: Gantt chart for overall project

3.4.2 Task and Duration for Overall Project

This section will show the tasks and duration of the whole project in general. Figure 3.10 gives a better picture of task for the project.

	Task Name	Duration	Start	Finish	Predecessors
	System Planning	17 days	Thu 2/18/16	Wed 3/9/16	
	Requirements Analysis	7 days	Thu 3/10/16	Fri 3/18/16	1
	System Design	43 days	Mon 3/21/16	Tue 5/17/16	7
	Implementation	139 days	Fri 5/20/16	Wed 11/30/16	
	Maintanance	0 days	Thu 12/1/16	Thu 12/1/16	33

Figure 3.10: task and duration for overall project

3.4.3 Gantt Chart for Session 1 (PSM 1)

PSM 1 require the step by step process to complete the first session of the project. The task and duration for PSM 1 are defined in the Gantt chart compiled in following Appendix A.

3.4.4 Task and Duration Session 1 (PSM 1)

	Task Name	Duration	Start	Finish	Predecessors
1	**System Planning**	**17 days**	**Thu 2/18/16**	**Wed 3/9/16**	
2	First Meeting with supervisor	1 day	Thu 2/18/16	Thu 2/18/16	
3	Discuss and contain idea of project	3 days	Sat 2/20/16	Tue 2/23/16	2
4	Chapter 1 & 2 progress research software & hardware	5 days	Wed 2/24/16	Tue 3/1/16	3
5	Second meeting with supervisor . The progress of chapter 1 & 2	1 day	Wed 3/2/16	Wed 3/2/16	4
6	Submit chapter 1 to supervisor and review existing product	6 days	Thu 3/3/16	Wed 3/9/16	5
7	**Requirements Analysis**	**7 days**	**Thu 3/10/16**	**Fri 3/18/16**	**1**
8	3rd meeting with supervisor, discuss hardware to use. Checked chapter 1 &	1 day	Thu 3/10/16	Thu 3/10/16	6
9	Research on hardware to use	1 day	Fri 3/11/16	Fri 3/11/16	8
10	4th meeting with supervisor and brainstorm on the project	1 day	Mon 3/14/16	Mon 3/14/16	9
11	Work on system physical design	2 days	Tue 3/15/16	Wed 3/16/16	10
12	5th meeting show system design. Decided the sensor used for project	1 day	Thu 3/17/16	Thu 3/17/16	11
13	Continue with design, research on hardware prices used in the project	1 day	Fri 3/18/16	Fri 3/18/16	12
14	Submit chapter 2	1 day	Fri 3/18/16	Fri 3/18/16	
15	**System Design**	**43 days**	**Mon 3/21/16**	**Tue 5/17/16**	**7**
16	Identify requirement, methodology and software & hardware to use	2 days	Mon 3/21/16	Tue 3/22/16	14
17	Buy and get device	1 day	Wed 3/23/16	Wed 3/23/16	16
18	Learn and try to use device	3 days	Thu 3/24/16	Sat 3/26/16	17
19	6th meeting with supervisor	1 day	Mon 3/28/16	Mon 3/28/16	18
20	Finishing chapter 3	12 days	Tue 3/29/16	Wed 4/13/16	19
21	Submit chapter 3	1 day	Thu 4/14/16	Thu 4/14/16	20
22	Learn to use device	3 days	Fri 4/15/16	Tue 4/19/16	21
23	Test device and sensor	4 days	Wed 4/20/16	Mon 4/25/16	22
24	Test do it all software and hardware	4 days	Tue 4/26/16	Fri 4/29/16	23
25	Submit presentation approval to faculty and do turnitin report	2 days	Mon 5/2/16	Tue 5/3/16	24
26	Do correction on report	1 day	Wed 5/4/16	Wed 5/4/16	25
27	Meet supervisor and finalise report	1 day	Thu 5/5/16	Thu 5/5/16	26
28	Do correction and turnitin	1 day	Fri 5/6/16	Fri 5/6/16	27
29	Send copies and report turnitin report and logbook to faculty	1 day	Mon 5/9/16	Mon 5/9/16	28
30	Setup all nesessary presentation	3 days	Tue 5/10/16	Thu 5/12/16	29
31	Prepare for PSM 1 seminar	2 days	Fri 5/13/16	Mon 5/16/16	30
32	PSM 1 seminar	1 day	Tue 5/17/16	Tue 5/17/16	31

Figure 3.11: task and duration for PSM 1

3.4.5 Gantt Chart for Session 2 (PSM 2)

Task that need to accomplish are development of the system, documentation for the project and deployment phase. The milestone of PSM 2 is shown in figure 3.12.

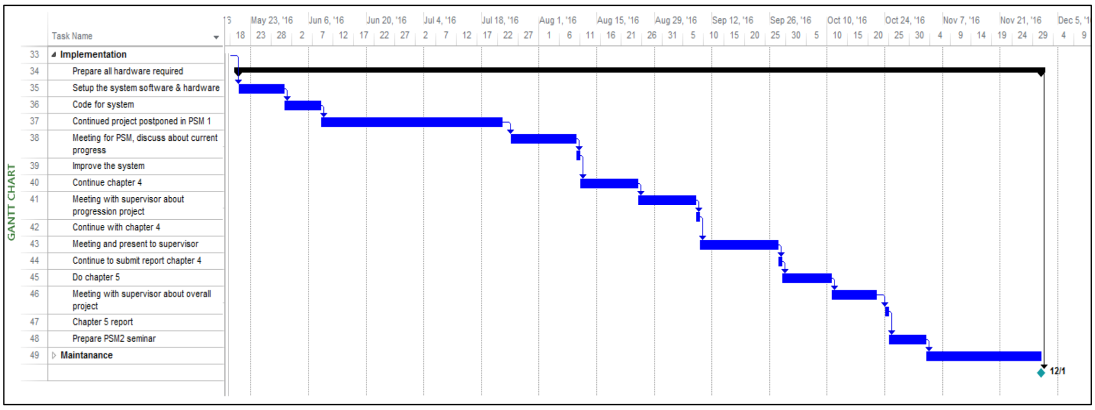

Figure 3.12: Gantt chart for PSM 2

3.4.6 Task and Duration Session 2 (PSM 2)

Figure 3.13 shows the task and duration for PSM 2 which takes place from 8/9/2016 until 30/11/2016.

	Task Name	Duration	Start	Finish	Predecessors
33	**Implementation**	**139 days**	**Fri 5/20/16**	**Wed 11/30/16**	
34	Prepare all hardware required	7 days	Fri 5/20/16	Mon 5/30/16	32
35	Setup the system software & hardware	7 days	Tue 5/31/16	Wed 6/8/16	34
36	Code for system	32 days	Thu 6/9/16	Fri 7/22/16	35
37	Continued project postponed in PSM 1	12 days	Mon 7/25/16	Tue 8/9/16	36
38	Meeting for PSM, discuss about current progress	1 day	Wed 8/10/16	Wed 8/10/16	37
39	Improve the system	10 days	Thu 8/11/16	Wed 8/24/16	38
40	Continue chapter 4	10 days	Thu 8/25/16	Wed 9/7/16	39
41	Meeting with supervisor about progression project	1 day	Thu 9/8/16	Thu 9/8/16	40
42	Continue with chapter 4	13 days	Fri 9/9/16	Tue 9/27/16	41
43	Meeting and present to supervisor	1 day	Wed 9/28/16	Wed 9/28/16	42
44	Continue to submit report chapter 4	8 days	Thu 9/29/16	Mon 10/10/16	43
45	Do chapter 5	9 days	Tue 10/11/16	Fri 10/21/16	44
46	Meeting with supervisor about overall project	1 day	Mon 10/24/16	Mon 10/24/16	45
47	Chapter 5 report	7 days	Tue 10/25/16	Wed 11/2/16	46
48	Prepare PSM2 seminar	20 days	Thu 11/3/16	Wed 11/30/16	47
49	**Maintanance**	**0 days**	**Thu 12/1/16**	**Thu 12/1/16**	33

Figure 3.13: Task and duration for PSM 2

3.5 IMPLEMENTATION

This phase also known as a deployment phase. Clear objective should be developed and deliverables need to be documented together with the project scope. The scope can be redefined during this initialization process. In this process, all programming code and command will be implement to the device. Tool that will be use in this process are Arduino IDE and Notepad++. The design developed in the previous phases will be actualize. The process will be focus on each phases to figure out the best way in developing the system. At this stage, developers will be tested and enforcing the system in order to gain the best result.

3.5.1 Hardware Implementation

The hardware required for this system are Arduino Yun, Soil Moisture Sensors, Temperature and Humidity Sensor, Relay Module and 12V Water Solenoid Valve. Firstly, Configure the Wi-Fi feature embedded on Arduino Yun to initiate any wireless connection. The process is enter the configuration interface 192.168.1.1 with default username and password. Any network configuration and authentication setting will appear at the Arduino Yun Interface. Figure 3.14 shows Arduino Yun configuration.

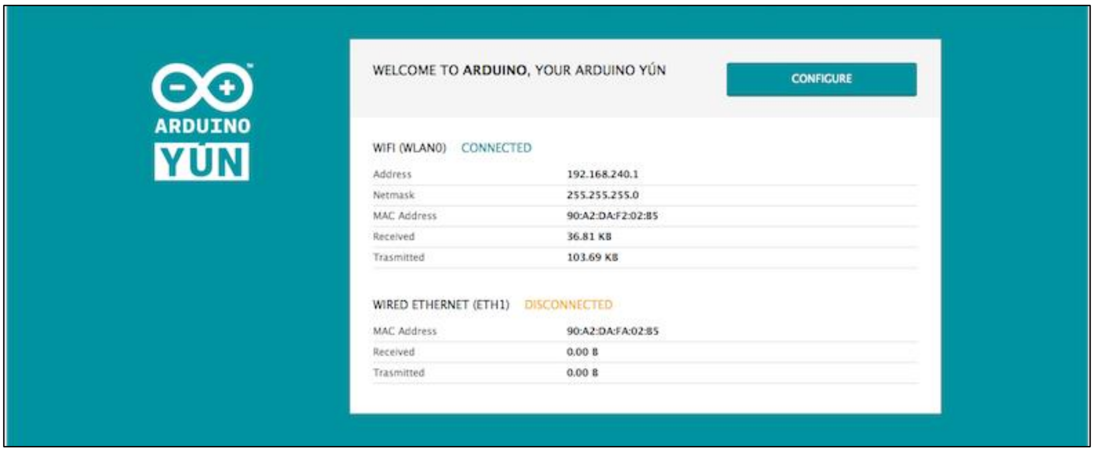

Figure 3.14: Arduino YUN configuration

Next, All sensors have three (3) wires attached to it. The VCC is a voltage label which is the power pin, GND indicate ground label and V/D which is a signal label for input and output digital and analog to send and receive signals. Breadboard is use to extend pin to enable sensor connections. LED is put into Yun built-in digital pin 13. All components must be correctly connected to prevent short-circuit event occur. Safety precaution should be apply in this project such as using anti-static mattress and container to prevent from short-circuit that can cause component become malfunction. Figure 3.15 show the connection of hardware components onto the Arduino board.

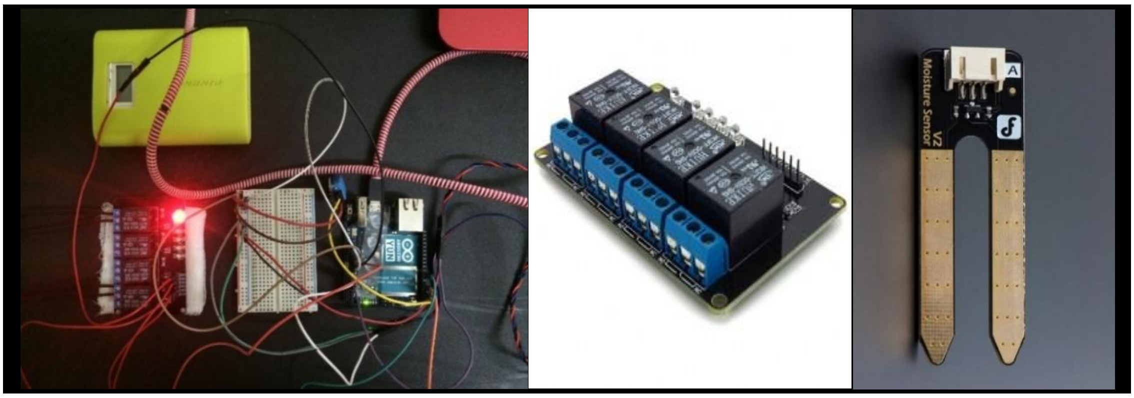

Figure 3.15: Connection of Hardware components

After connection of hardware between laptop and module of Arduino Yun is set, use Arduino IDE (Integrated Development Environment) compiler to activate the sensor and the board. Figure 3.16 show board testing with initial declaration. After that, declare variables for analog and digital pins that used in this project as shown at figure 3.17.

```
int ledPin = 13;

void setup() {
  // put your setup code here, to run once:
    pinMode(ledPin, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(13, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);              // wait for a second
}
```

Figure 3.16: Board testing

```
#include <CayenneYun.h>
#include <dht11.h>
#include <math.h>

#define CAYENNE_PRINT Serial    // Comment this out to disable prints and save

#define VIRTUAL_HUMI V0 //Humidity
#define VIRTUAL_TEMP V1 //Temperature
#define VIRTUAL_PIN3 V2 //Soil moisture 1
#define VIRTUAL_PIN4 V3 //Soil moisture 2

#define VIRTUAL_PIN1 V4 //Relay Switch 1
#define VIRTUAL_PIN2 V5 //Relay Switch 2

#define READ_ANALOG_A0 A0 //Analog Pin
#define READ_ANALOG_A1 A1 //Analog Pin

dht11 DHT11;
#define DHT11PIN 2  //Digital Pin Temperature

#define RELAY_DIGITAL_PIN1 4  //Digital Pin Relay Switch 1
#define RELAY_DIGITAL_PIN2 7  //Digital Pin Relay Switch 2
```

Figure 3.17: Hardware Configuration code on Arduino IDE

Virtual pin is apply to connect a component that will send and receive value to the application. The virtual pins declaration are shown in figure 3.18 and figure 3.19.

```
CAYENNE_IN(VIRTUAL_PIN1)
{
  // get value sent from dashboard

  int currentValue = 0;

 currentValue = getValue.asInt(); // 0 to 1

  // assuming you wire your relay as normally open
  if (currentValue == 1) {
    digitalWrite(RELAY_DIGITAL_PIN1, HIGH);
    //Serial.println("relay 1 is ON");
  } else {
    digitalWrite(RELAY_DIGITAL_PIN1, LOW);
    //Serial.println("relay 1 is OFF");
  }

}
```

Figure 3.18: Hardware Configuration code on Arduino IDE

```
float humi = DHT11.humidity;
float temp = DHT11.temperature;

float convertCelcius = (temp - 32) * .5556; //temperature conversion

Cayenne.virtualWrite(VIRTUAL_HUMI, humi);
Cayenne.virtualWrite(VIRTUAL_TEMP, convertCelcius);

int MOISTURE_VALUE1 = analogRead(READ_ANALOG_A0);
int MOISTURE_VALUE2 = analogRead(READ_ANALOG_A1);

MOISTURE_VALUE1 = map (MOISTURE_VALUE1, 0, 1023, 0, 100);
MOISTURE_VALUE2 = map (MOISTURE_VALUE2, 0, 1023, 0, 100);

Serial.print(MOISTURE_VALUE1);
Serial.print(" | ");
Serial.println(analogRead(READ_ANALOG_A0));

Serial.println("\n");

Serial.print(MOISTURE_VALUE2);
Serial.print(" | ");
Serial.println(analogRead(READ_ANALOG_A1));

Cayenne.virtualWrite(VIRTUAL_PIN3, MOISTURE_VALUE1);
Cayenne.virtualWrite(VIRTUAL_PIN4, MOISTURE_VALUE2);
```

Figure 3.9: Hardware Configuration code on Arduino IDE

After the hardware configuration is done in IDE, the next step is connection of actuator of the system which is water solenoid valve. The ground wire should be connected in with the relay to break the electric current, while the power wire should connected directly to the valve. The connection is as shown on figure 3.20.

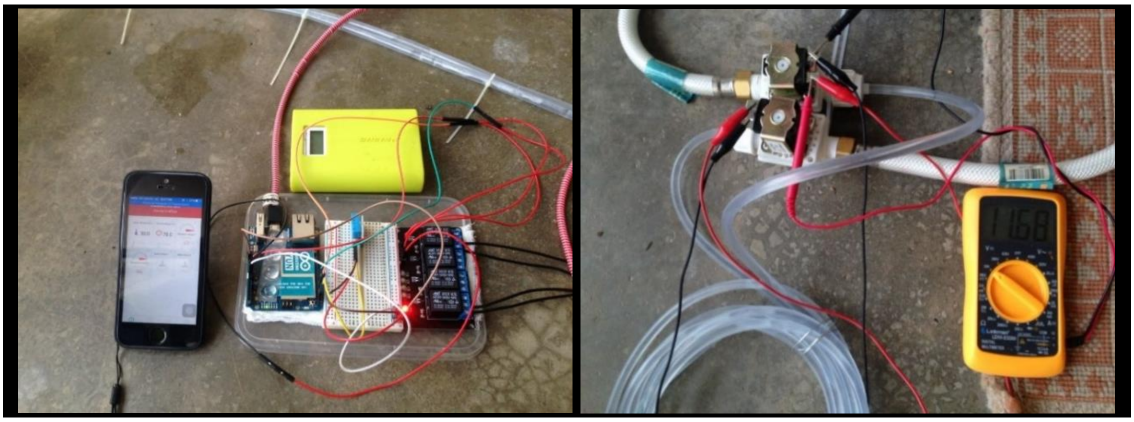

Figure 3.20: Connection of Hardware components

3.5.2 Software Implementation

The second stage is software implementation. User need to register a valid email account into Cayenne application for authentication as shown in figure 3.21. After successfully login, user require to choose a board which is Arduino Yun. Setup will need the application to synchronize with Arduino Yun board. The cayenne library need to be included in the Arduino IDE. Next, select board and port of connected Arduino.

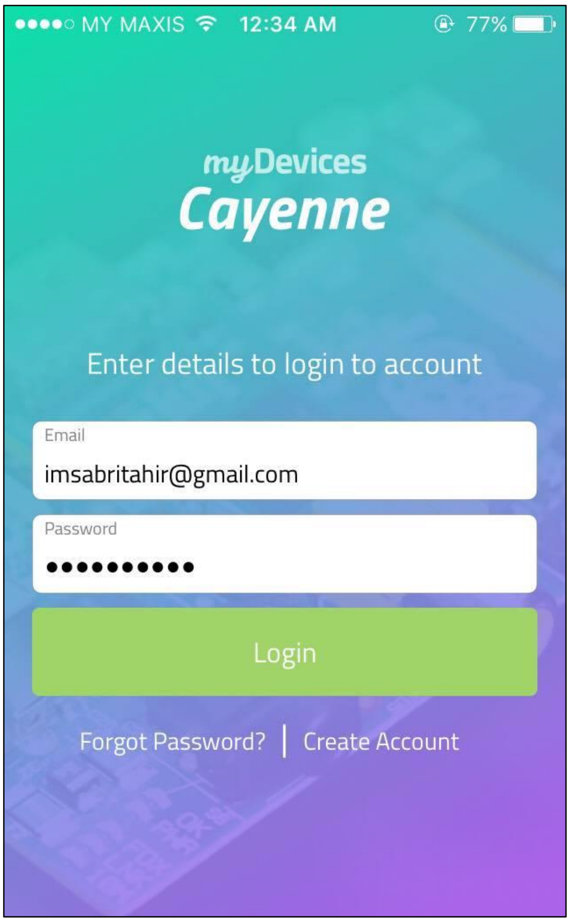

Figure 3.21: Login interface

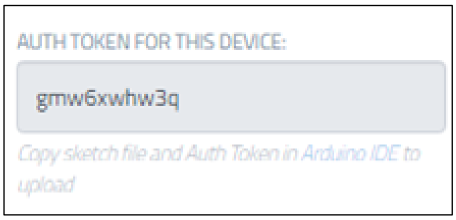

Figure 3.22: Authentication token

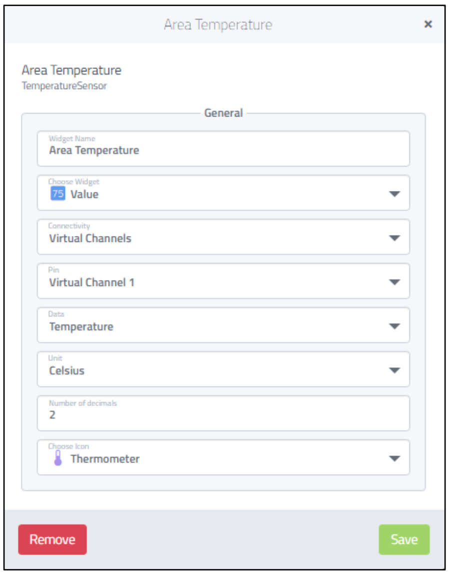

Figure 3.23: Widget configuration

The cayenne application will generate an authentication token as shown in figure 3.22. The token is a unique ID used by is a small hardware device that the owner carries to authorize access to a network service. After successfully connected between the Arduino Yun and the cayenne server. In this part, all setup of virtual pin will be applied into the software configuration. Digital and analog pin of the system will be convert to virtual pins to enable Arduino Yun send data on those pin to the cayenne server. As in figure 3.23, user will configure the sensor’s widget that suitable with the cases. Communication of sending and receiving data will be successful if virtual pins are synchronize between the Arduino IDE and cayenne application.

3.6 Testing

In order to cope with the requirement needs, the system will be tested to make sure it running without any error. The system also will be debug to eliminate any existing error. The system only can be deploy after it is free from error. Testing phase also require to redesign and make enhancement for the system. After the deliverable of acceptance and objectives is achieved, the system will be installed properly. System testing and User acceptance test will be conducted in this phase and the system will be documented.

3.7 MAINTENANCE

Maintenance is the final phase of the methodology. Maintenance phase take place when the project is deployed. In this phase, the developer team will give support to the user. Any changes of the software and the hardware will be subjected in this phase. The changes may error recovery, system modifications or updates required by the system. The team will monitor the performance of the system, bugs and manage the errors that exist after the deployment of the project. The key to this phase are to make sure to keep the system alive, to maintain the code is running and to keep update the software and hardware whenever required.

3.8 EXPECTED RESULT

After design the devices and the application control the irrigation process and managing the system, this is the expected outcome from the project. The device will be able to detect the moisture condition of a soil.

- To develop automated and computerize plant watering system, interact with user via Wi-Fi connection from any devices with system notify the irrigation and user decide the irrigation process to happen.

- System that able to detect moisture of soil, read the analog input and perform a process distribute water for a plant.

- To maintain the irrigation activity for each area of horticulture perform by Autonomous Horticulture Irrigation System. The data of irrigation activity will be shown in on the display interface.

Figure 3.24 shows the expected data collected from the device in moisture category details which are dry soil, ideal soil condition or wet soil.

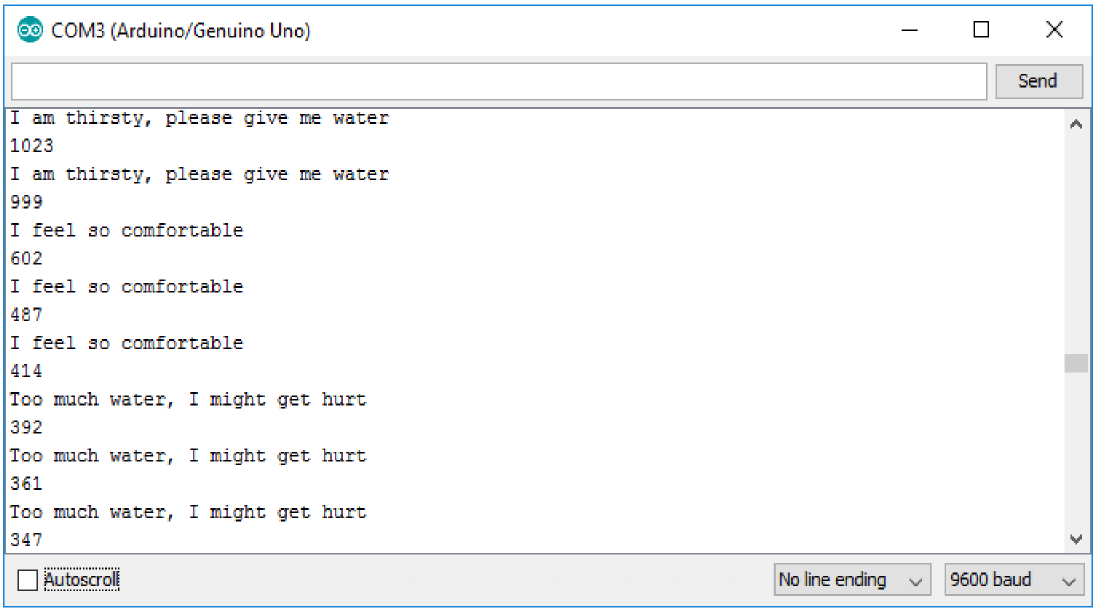

Figure 3.24: Expected data collected from the device in detail

3.9 SUMMARY

Rapid Application Development (RAD) methodology was chosen due to its flexibilities and adaptabilities. By using this methodology, the system can be updated easily from time to time. The previous phase can be redo to make improvement and enhancement for the project. This RAD methodology allow refinement and redesign the prototype to achieve the objective. Moreover, this methodology is very suitable for small system that require a brief developing period.

In order to develop the system, the logical design process is one of the important phase to illustrate how the result of the project. The physical design is concentrate in choosing the best and reliable hardware and software to be listed and to be used in for this project. The procedure of choosing the best software and hardware are very important to ensure meets the requirement of the system design. The process of choosing the best software and hardware are include the boundaries such as the cost and functionality of the software and hardware required by the system.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

In this chapter, the process of implementation will be discuss further in details. It will include the documentation of process in the project development. This chapter will also cover the implementation of the project which are using Arduino Yun, Soil Moisture Sensor, Temperature and humidity sensor, Relay Module, 12V Water Solenoid Valve and also the debug and documentation. The interaction between Arduino and sensors are using the code programmed to Arduino using Integrated Development Environment (IDE). This will make the module running easier to write the code and control sensor on Arduino board.

Furthermore, in this chapter will also discuss about the Arduino Yun project which is will send and receive the data through Wi-Fi module embedded to Arduino board, and directly send notification to the interface using Wi-Fi connection. So, sensors current value can be viewed by the user by looking on the interface through website or mobile phone

4.2 TESTING AND RESULT DISCUSSION

Testing process is very important during the development process. As the last phase before deployment, this process ensure the system will not having any problem in the future. All the error detected is solved so that the system works perfectly. In addition, a system testing have been conducted to prove that this project is reliable, user friendly, have no error and data is accuracy and effectiveness.

4.2.1 Testing Report and System Testing Approval

Testing report is outline to evaluate the process of the system. Approval of this testing implies that the reviewers are confident that the following execution of the test plan, the resulting system will be considered fully tested and eligible for implementation. Refer Appendix B for system testing report.

4.2.2 Result of system testing

The main target of this system is to test the new innovation in irrigation system that can give a benefits for the users and also attraction users in used in any size of garden especially indoor and data interaction through Wireless connection. This is a prototype that still need enhancements.

The system is started when the moisture of a soil is detected by the moisture sensor. If there is no moisture present, the value will remain to print value 0. Once the sensor is attach into the soil it will read the soil current status. That a moisture value will be print on serial monitor on Arduino IDE and cayenne application interface.

The value will send to cayenne server and display the value on the widget display. The value will send and receive data in real time since no delay is set and exact value as print by the serial monitor. In other situation, this system also been tested by configuring the same interface in a different account. Previous token should be replace and synchronize with the current account and Arduino IDE.

The actuator will execute command to trigger a process to release water through the water solenoid valve when the system meet the ideal situation to perform task which set on the sensor value from the board. User also can perform irrigation process manually using actuator widget. The actuator widget is configured to synchronize between the device, IDE and the cayenne application to receive and send a trigger value through the virtual pin. Once it meet the specification, water will be released through the solenoid valve. Figure 4.1 shows the application display.

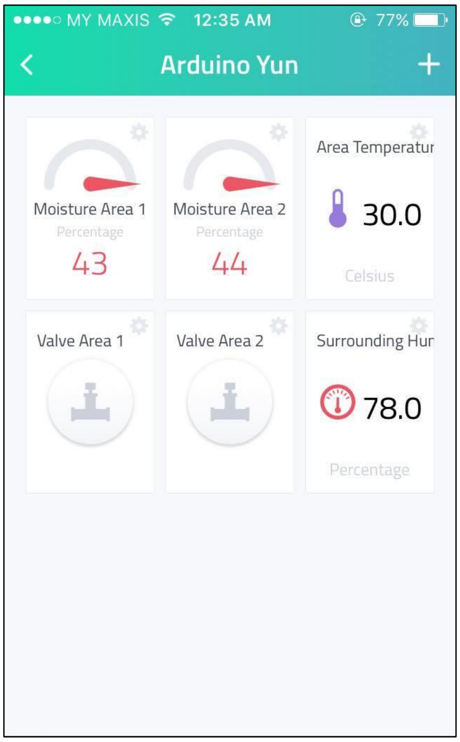

Figure 4.1: Application Display

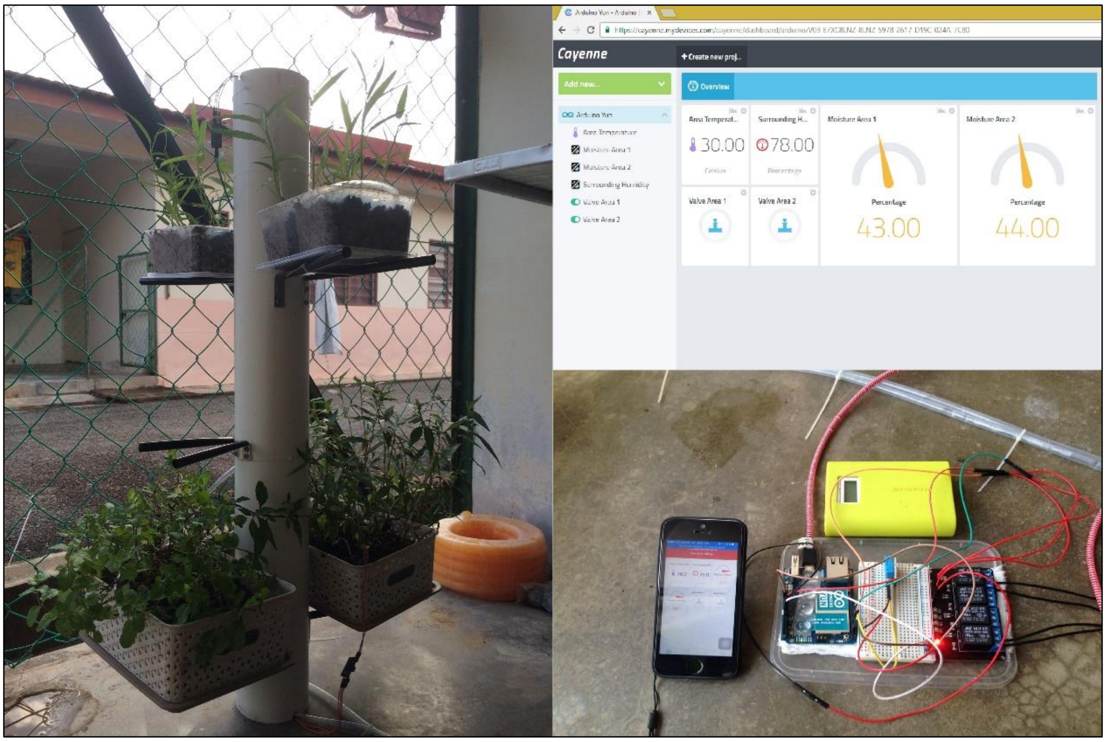

Figure 4.2: Output of the system

The figure 4.2 shows the system output. When the value is ideal for irrigation process, the system will activate the actuator and release the water from the pipe through the solenoid valve. It will stop the watering activity after it meets the well drain of soil condition.

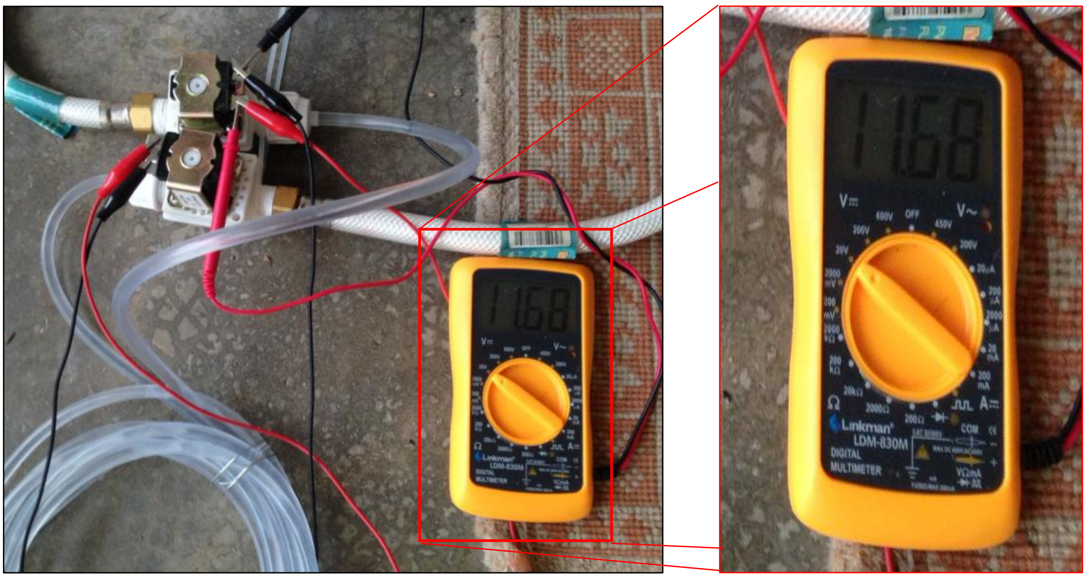

Figure 4.3: Voltage Flow through the valves

Figure 4.3 shows current voltage received by the actuator. The current status of an active actuator will receive ~12V of output voltage to allow the solenoid valve to normally open state. If the soil achieve the ideal moisture, the solenoid valve will be closed. Manually pushing the button also will make the electricity to activate the actuator. Refer Appendix C1 and Appendix C2 for overall system and result of project implementation.

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

This chapter discussing and summarize all content of whole project including summary of literature review, describe the achievements of the objectives and the effectiveness of the methodology applied. In this particular chapter, also discuss the details regarding constraints and ways to overcome, and also future works for future enhancement of the project.

Integrating Cayenne Application with Arduino is one of the prototype that allow communication between the systems and sensors. By connecting Arduino Yun to router with available internet access, user can use Cayenne application from anyplace and anywhere to display current data read by the sensors. This prototype is user friendly as everyone know nowadays, Internet Of Things (IoT) application such as cayenne has become most useful platform for integrate the Arduino with internet and can be access at anytime and anywhere. Any smartphone or laptop that can run Cayenne platform is needed to get this prototype successful run. It provides cloud storage for display real time data as the cayenne server will manage all the running data.

To perform this project, user need to create a cayenne account for configuration access. Cayenne is a free platform to build an IoT project which provide cayenne application to setup and control IoT projects, a cayenne cloud responsible for processing and storage, and cayenne agent to enable communication between the hardware and the server for implementing incoming and outgoing commands and actions. This is one of the best platform to allow people to get involve in Internet of Things (IoT) development project. By using a platform like cayenne, it is now possible to make human connected with machines. So this prototype is one step to improve horticulture on the new era of internet of things.

5.1.1 Summary of Literature Review

In literature review, we know more details about problem statement, scope and current system comparison as this information could help student in this project. Based on the problem faced by currently available system, student will select around three systems that can be compare and see their both advantages and disadvantages. Each comparison will be review by supervisor to see if the system has any connection between this project and the information of the existing system will be documented and analysis. The purpose of the analysis and comparison of the existing system is to find the most suitable technology and method that can help to improve this project.

5.1.2 Summary of Methodology

Methodology is important to project as it will determine on how the project is going to be done. For this project, we use Rapid Application Development (RAD) methodology and try to improve the project based on the situation to help me finish this project. This method has several advantages such as flexible in time, reduce project risk which is can resolve if any issues of the stages happen, and additionally the quality of the project will be increase. A lot of studies need to be done in order to develop this prototype. This projects have a short time to be finish and this methodology is flexible to any changes that need to be made.

5.2 RESEARCH CONSTRAINT

In completing this project, many of limitations exist. In term of hardware, the budget is the biggest issue. The hardware used is limited up to make the device functional. There are many function have to cut off to satisfy the budget such as, presence of rain sensor as additional variable will make the system to be more variability and can perform task more accurate in real life situation. Next, solar power sources are not included in this prototype system. When it comes to larger area, backup power source need to be place in this system to allow scheduled irrigation activities even when the main power is shut down and the usage of solar power as one of greenhouse technology.

For overall process, it is working properly, if other sensors are included in this prototype system, it will offer a good functionality to replace the manually process of irrigation system. In term of the hardware configuration, electronic field is new for myself. I need to learn electronic knowledge to make the electronic parts receive correct output, and avoid short circuit event from occurs. In addition, Internet of things facts and the code for Arduino IDE itself, it is new to me. So, I have to learn on how to use it from internet even it has open source code and learn the know knowledge from video tutorials and reading materials.

5.3 FUTURE WORK

Although the objectives are achieved, the enhancement are still necessary. The future system should include the following criteria:

i. Connect a portable power source instead of directly from wall plug power source like solar power in implement wireless power source.
ii. Flow rate sensor used to measure water flowing through a solenoid valve to calculate daily used the amount of water used to water your plants.
iii. Rain sensors are used for the detection of water beyond what a humidity sensor can detect.

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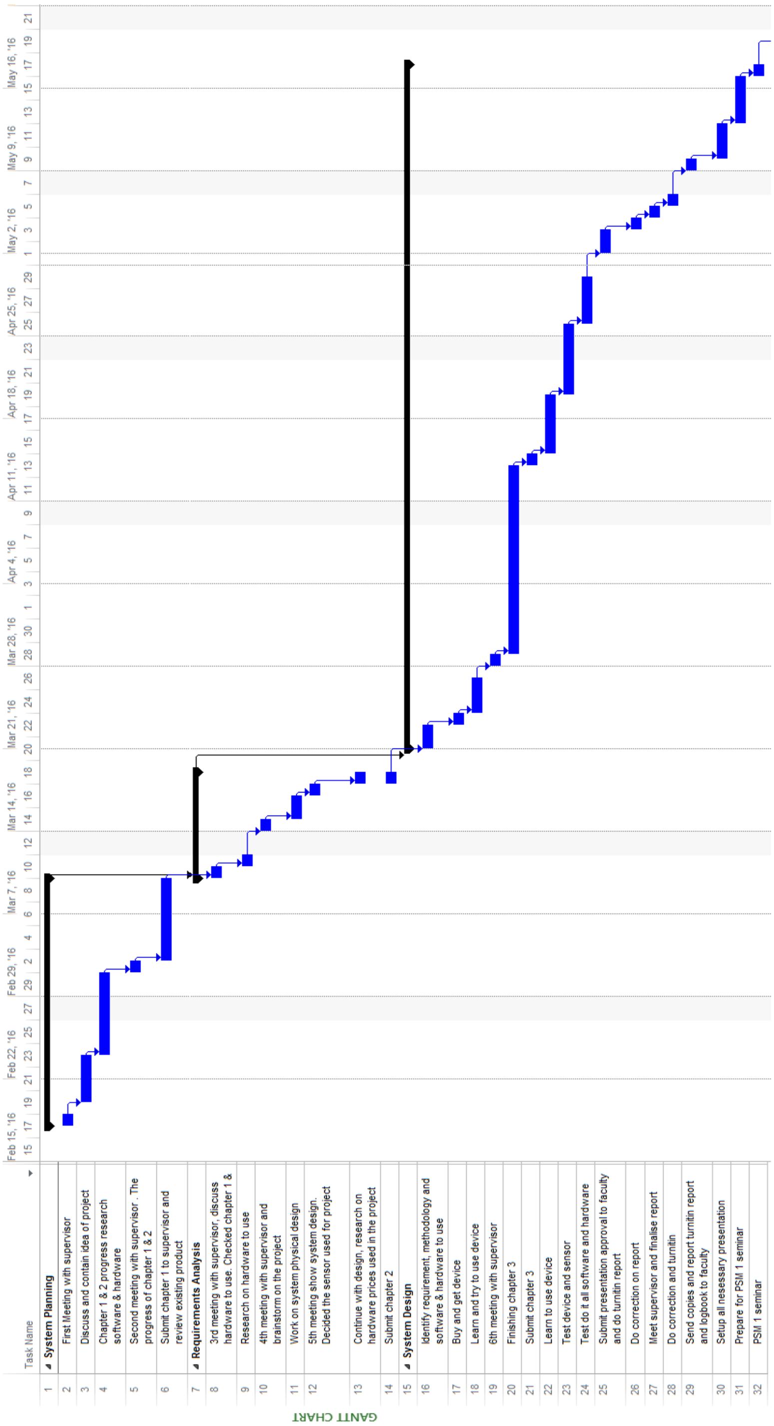
APPENDIX A



Appendix A: Gantt Chart for Session 1 (PSM 1)

APPENDIX B

1.0 TESTING REPORT

1.1 Case Number 1

No.	1
Test Case	Sensor detection (no value captured) Test the sensor either the value is captured or not. If no value printed on the serial monitor, it means that no connection detected. Once detected, serial monitor will print the moisture value.
Description	Prerequisite: 1. Code the sensor to function. 2. Leave the sensor on normal condition.
Test Step	1. Detach the sensor from soil. 2. Check the type Arduino used and connected port at IDE toolbar. Make sure the pin is correctly connected
Expected Result	1. Once a sensor reading value, the LED light will blink three times. 2. Serial monitor will print connection ready as the successful status 3. Sensor is reading value and print value on serial monitor
Result (Pass or Fail)	

1.2 Case Number 3

No.	3
Test Case	Sensor detection display with cayenne application through WIFI connection. Attach the sensor onto the soil. Once detected, the sensors will capture values and print on the Arduino IDE. Then the Arduino will send the real time value captured

	to the cayenne function and display it on the cayenne application.
Description	Prerequisite: 1. User make a connection for Arduino Yun to internet access and login to Cayenne application interface. 2. System has been configures to synchronize with Arduino and cayenne account.
Test Step	1. Connect the sensor with Arduino and attach the sensors into the soil 2. Sensor will keep capturing moisture value of the soil. 3. Activate the widget on the Cayenne application and integrate the function in Arduino to display the value.
Expected Result	1. Soil moisture value is received by Arduino and display the data on the IDE and cayenne application on by using widget display on real time data.
Result (Pass or Fail)	

1.3 Case Number 4

No.	4
Test Case	Activate actuator (relay and water solenoid valve) Sensor while a movement detected. Once detected, LED will blink three times and capture an image. An image locally stored in MicroSD card embedded in Arduino Yun. Directly, image will be upload to another Dropbox account.
Description	Prerequisite: 1. User make a connection for Arduino Yun to internet access. 2. Define the actuator virtual pins 3. Configure button on cayenne interface 4. Connect actuator, 5. Attach into soil, moist
Test Step	1. Test the if else condition 2. Check the virtual pin connection

	3. Check voltage flow on the actuator
Expected Result	1. Actuator button on the interface will turn to active 2. Water will be release through the water solenoid valve.
Result (Pass or Fail)	

1.4 Case Number 2

No.	2
Test Case	Connection between Arduino IDE and Cayenne application through WIFI. Test the Arduino connection with cloud Cayenne application through WIFI. If connect the Arduino IDE will print the status connection ready.
Description	Prerequisite: 1. Arduino Yun must connect to the internet by using its WIFI module.
Test Step	1. Configure connection from Arduino to Cayenne. 2. Check connection on both Arduino IDE and Cayenne setting and synchronize it virtual pin configuration. 3. It will print connection ready on Arduino and Cayenne.
Expected Result	1. Serial monitor will print connection ready as the successful wireless status on IDE 2. Last seen on cayenne interface will turn online/available.
Result (Pass or Fail)	

2.0 SYSTEM TESTING APPROVAL FORM

	Name	Date
Verified by: ____________________ Developer		
Approved by: ____________________ User		

Appendix B: Testing Report

APPENDIX C1

Early Implementation

This is initial picture of project implementation.

The irrigation area is divided into two which are bottom and top.

The actuator which is valve is triggered to perform irrigation activity by using specific moisture value set in the system.

After 3 Weeks

This is the result of the project implementation.

The irrigation areas received water through two different solenoid valve to watered different areas which are bottom and top.

The bottom were received more quantity of water than the top area depend on their needs.

Appendix C1: Project Result

APPENDIX C2

Appendix C2: Project Result