UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND IMPLEMENTATION OF SMART OBSERVABLE SYSTEM OF INDOOR HYDROPONIC

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automations and Robotics) with Honours

by

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DECLARATION

I hereby, declared this report entitled “Design and Implementation of Smart Observable System of Indoor Hydroponic” is the result of my own research except as cited in references.

Signature :……………………………………………………….

Name :…………………………………………………….

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automations and Robotics) with Honours. The member of the supervisory is as follow:

………………………………

(Project Supervisor)

ABSTRAK

Hydroponik adalah satu kaedah yang jarang didapati atau diketengahkan, serta kaedah yang mudah untuk dijaga tumbuh-tumbuhannya. Bagi menerangkan lagi bahawa kemodenan negara pada masa kini serta peningkatan taraf hidup rakyat, segalanya perlu diletakkan piawaian yang baik untuk sesuatu produk agar is berpotensi untuk dikemas kini dengan mudah dan berteknologi tinggi. Akan tetapi, masih ada lagi sesetengah pihak yang tidak bertanggungjawab menjadikan pembalakan haram sebagai satu aktiviti ekonomikal dan ini menjurus kepada pengurangan tanah untuk bercucuk tanam kerana kawasan pembalakan menjadi tempat untuk aktiviti pembangunan. Oleh itu, keluasan tanah telah berkurang untuk aktiviti pertanian. Hydroponik dengan kepakaran pemerhatian yang canggih, dengan adanya pH meter untuk mengawal nutrisi tumbuhan, sistem pengudaraan dan seterusnya diod pemancar cahaya bagi menggantikan sumber cahaya matahari yang diperlukan oleh tanaman yang dimonitor secara automatik melalui satu aplikasi mudah alih. Keperluan asas hidroponik seperti pam air, lubang perparitan air, serta tangki air diperlukan dan dengan bantuan aplikasi cahaya matahari buatan, nutrisi serta pengudaraan akan terkawal dengan hanya menekan butan yang dipilih. Aplikasi ini sedikit sebanyak membantu tumbuhan mendapat nutrisi yang seimbang. Jika tumbuhan diberikan nutrisi yang seimbang, ia akan tumbuh dengan sihatnya. Ianya adalah sesuatu yang mudah dengan tanaman secara hidroponik berbeza dan jauh lebih sukar dengan penanaman biasa(tanah).

ABSTRACT

As to highlights the pursuit of modernity of a country and living standard of the citizens, everything has to be put up to a standard for a product to be potentially up to date. Somehow, there is certain irresponsible organization discover a place for logging or so called as economic activity. This is where, hydroponic cultivation came in since so many land has been discovered, therefore lack of land that can be used for plantation. Hydroponic cultivation is a great way to grow plants to their full potentials. Hydroponic with smart observable system, precisely are the unintended miracle this is because pH as nutrient level, temperature, ventilation system and as well as Light Emitted Diode (LED) with complete needs of spectrum are monitor automatically through a mobile apps. Basic needs of hydroponic such as water pumps, drain hole, water tank is needed and with mobile apps, artificial sunlight will be switch on, fan as ventilation system to keep the temperature at good state, pH value will be monitor so it keeps balance nutrient for crops. In the end, we can see that hydroponic system is the solution for the on-the-go citizens which allows them to growth plants and monitor the health of the plant at all times on a mobile phones supported with three simple step which is put seeds in pods, sync with apps and then start grow. If you give a plant exactly what it needs, when it needs it, the amount that it needs, the plant will be as healthy as is genetically possible. It’s an easy task with hydroponic; far more difficult in soil.

DEDICATION

Dedicated to my beloved parents, Encik Makbul Shah bin Mirdad Shah and Puan Hasnah binti Hassan.

ACKNOWLEDGEMENT

First of all, I want to thank to Allah S.W.T for the good health and wellbeing as well as chances to complete my Final Year Project successfully just in time. I had to face some challenges and problems throughout these last two semesters in completing this subject such as, lack of knowledge, information and time that fly so fast.

Luckily, my supervisor, En Khalil Azha bin Mohd Annuar guide me throughout this last two semesters until the end and I would like to give my fullest gratitude and thank you to him, En Khalil Azha. Thousands of thanks to him for giving in supports, concerns and a lot more to me when I'm having a problem with either software or hardware by giving me opinions and moral support, until I managed to finish this project smoothly.

I would also like to express my sincere thanks to my senior, Muhammad Hanafi bin Mujtahidin for guidance at the beginning of the project since he has done the same project as mine and let me have a clear and better understanding about the project that I will develop. Not forgetting Ronald Wong Zen Loong and Bong Zhi Yuh who allowed me to visit their hydroponic household here in Bachang, Melacca and gave me a lot of additional information on hydroponic cultivation.

This project consumed huge amount of work, research and dedication. Still, implementation would not have been possible if I did not have a support of many individuals and organizations. Beloved families, classmates and friends for never ending support ever since I step into Universiti Teknikal Malaysia Melaka.

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ACRONYMS AND ABBREVIATIONS

pH	-	Potentials Hydrogen
UV	-	Ultra Violet
IDE	-	Integrated Development Environment
DOP	-	Dwarf Ornamental Peppers
LED	-	Light Emitted Diodes
SMS	-	Short Message Service
PC	-	Personal Computer
WI-FI	-	Wirelessly Fidelity
EDR	-	Enhanced Data Rate
UART	-	Universal Asynchronous Receiver/Transmitter
USB	-	Universal Seriel Bus
GSM	-	Global System for Mobile Communication
PIC	-	Peripheral Interface Controller
I/O	-	Input / Output
EC	-	Electrical Conductivity
3D	-	Three Dimensional
PWM	-	Pulse Width Module
TXD	-	Transmission Data
RXD	-	Receiver Data
BSC	-	Bluetooth Seriel Controller
CO2	-	Carbon Dioxide
H3POH	-	Phosphoric Acid
K3OH	-	Potassium Hydroxide
FHS	-	Floating Hydroponic System
PVC	-	Polyvinyl Chloride
˚C	-	Degree Celsius
˚F	-	Fahrenheit

CHAPTER 1
INTRODUCTION

1.1 Introduction

Plants can be classified as a living organism and as well as exemplified by trees, herbs, ferns, grasses and so on. Hydroponics is fairly recent term used for growing plants without soil and method dates back much earlier. It can be exemplified with the hanging gardens of Babylon, the floating garden of the Aztec of Mexico and Chinese culture which always refer or form a “hydroponic” cultivation. The untimely recorded; plant constituent was in 1600 when Belgian Jan Van Helmont showed in his classic experiment that plants obtain substances from water. The conclusion showed from the research that plants obtain substances for growth from water was correct. In the following years, researchers developed many diverse basic formulae for the study of plant nutrition. Hydroponic literally means “water works“. It can be define as the science of growing plants without the use of the soil but has to grow in a water or nutrient-rich solution without presents of oil.

Theory explained that plant could be grown hydroponically but however in gardening practice, it is usually reserved for exotic plants and culinary herbs. Hydroponics allows plants to be grown in a completely controlled environment, soil-barns-pests-free and free from diseases as well. Delicious product can be obtain without using dangerous herbicides and pesticides by carefully monitoring nutrients, temperature, lights level and nutrient water level or solutions level. For that reason, hydroponics gardening is gaining popularity for both commercial and home gardening application all around the world.

Hydroponics can be exciting and fun. It takes an important place in the classroom. Carrying out hydroponics experiments helps students better in understanding how plants grow. For instance, by withholding certain nutrient from the hydroponics solution, students can observe firsthand how plant growth is affected then overcome the deficiencies. Together with hydroponic provides a hands-on approach to learning and many of the life science educational objectives are reinforced. Whether it's a hobby or a grower or gardener, education is the key for successful growing. This by means, basic plant growth has to be review for better understanding in hydroponics.

A 'little tray' term that is what best explain the water culture system. It used reservoir of nutrient solution in a rectangular tank with a tray of substrate located above the nutrient solution. With the introduction of plastics, small pumps, sensor and drip irrigation supplies, these design will definitely be modifies to operate automatically. Ebb and Flow, known as well as Flood and Drain, when most widely recognized hydroponics system out there. Besides low cost to set up it is absolutely versatile. Easy-alter method so called for your garden, adding or removing plants up to your wish. It has a very basic concept; plants are placed in a tray which periodically filled with nutrient-rich water pumped in and out of a reservoir below. Hydrogen, oxygen and carbon are the first free three essential elements and it comes directly from water and air which are essential for photosynthesis and sugar production. These three elements comprise almost 95% of a plant's dry weight. The other 14 essential elements are minerals and provided in the nutrient solution. The nutrient solution has to be replace for every ten days, or so, preventing the nutrient deficiencies from developing. Those greatest consumptions by the plants including, a critical component of all proteins and enzyme call nitrogen it is important during the vegetative growth state. Phosphorus an energy molecule which essentials for life, Potassium helps in keeping the quality of the fruits high as well as Calcium so plants can easily take up water.

The pH level for plant's nutrient is much important as just adding plant food to the water. pH is basically a measurement of alkalinity and acidity of the nutrient solution which make pH of 7 is neutral, less than 7 is acidic and over 7 is alkaline or basic. While actually, the most suitable pH reading for better nutrient is between 5.8 to 6.4, or slightly acidic. This is to avoid iron and some others metal might be unavailable to the plant and if it is too low, the take-up calcium, magnesium and other macro-element may be hindered.

After explaining the rate plants take up nutrients for environmental regulations conditions, proper lightings is very important to successful hydroponic gardening. There will be two different stage of plant's growing system. Firstly, the vegetative growth stage, which plants in needs of full-spectrum light but with blue end of the spectrum more. Secondly, fruiting and flowering stage, it is preferable to have the red end of spectrum. Plants use mainly the reds and blues where actually so much of the energy of standard lighting is quit wasted. Thus, full-spectrum horticultural lamps have to be chosen when setting up an indoor hydroponic system. A 15W is merely enough for 33.5cm x 27cm area.

Prime factor for hydroponic especially indoor, is the temperature and humidity. Most plants prefer a temperature between 68-78°C. Tropical plants such as tomatoes prefer warmer temperature. The most vital is that, don't ever allow the plant's temperature to go up to 85˚C, it says to inhibit the transpiration process and stress the plant is there is too much heat. Somehow, good air movement can eliminate many problems in a grow room. Usually, for outdoor hydroponic air will definitely is the natural wind but for indoor hydroponic gardening, simple oscillating fans, positioned around garden or house fan is okay just to keep the leaves gently moving and removes much of the excess heat.

1.2 Project Development

The design of indoor hydroponic with smart observable system is exactly the title of this project where the main idea of this project is to use Bluetooth features in an android phone to automatically switch on the grow lamp, fan or thermostat, pump in and out water and nutrient into the tank. The cellphone will be the tool to do all of these including figure out the temperature of the plant. Basically, the temperature sensor will send input data of the current temperature in degrees to Arduino and Arduino then will transfer the data to cellphone with the help of Bluetooth module. The programming of the Arduino is burn by using Arduino IDE Programmer editor and transferred using USB cable from the computer board.

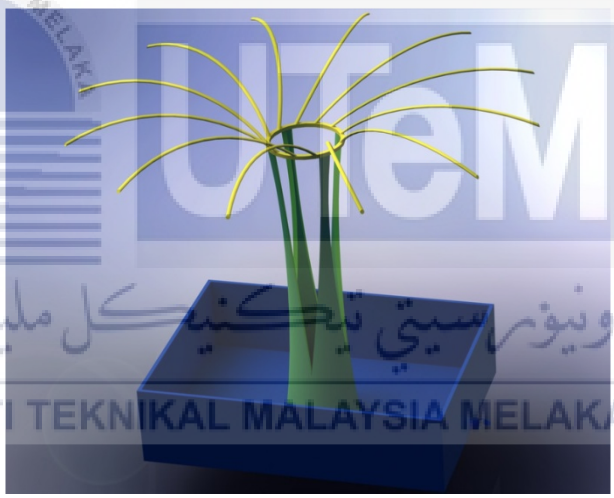

Figure 1.1: Inside of Cart for Indoor Hydroponic System

Figure 1.2: Outer Cart of Indoor Hydroponic System

Table 1.1: Project's Plan Characteristics

ATTRIBUTE	DATA
Number of plants	1
Plant	Vegetables
Dimensions	Width= 35cm, Height= 72cm, Length= 35cm
Operating temperature	10-35celcius
Total lifespan	5-7weeks
Reservoir volume	11L
Sensor measurement	Anytime
Operating voltage	24V
Communications	Bluetooth

1.3 Problem Statement

In the past, hydroponic system required research to setting up, steps for installation as many as well, after all it is required daily monitors to ensure proper growing conditions. When growing, pests and bacteria can significantly affects the health of the plants. It'll definitely involve environmental predators that can cause harm. To avoid this harmful pests, UV light as a grow light is used in indoor hydroponic. However, UV has its own drawback which is harmful to human skin. That's when LED as grow light is the best tools to use as an artificial sunlight.

The biggest problem for today's cultivation is that there are problems of enough land and the alternative cost of feed is quite high. It is also worth nothing that there is a significant reduction when weather is not balance. For soil cultivation, there is a time when draught season when humidity of soil is at substandard or poor. With hydroponics, there will be always a water supply circulating oxygen into the root system of the plants. Hydroponic can also concern or distribute to the issues of food insecurity for poor-food-supply country such as Ecuador and materials for hydroponics are quit cost effective to farme

Figure 1.3: Deforestation

Landslide can be state as one catastrophic event, it can cause human injury including loss of life, economic devastation, construction destroyer and cultural and heritage values. It is usually occurred when the land experience direct hit from the raindrops when raining and surely be one of the land's erosion factors. Without trees, increase in environmental temperature can't be coped. Disappearance of the trees means disappearance of the canopy layer which mainly helps in preventing direct sunlight reaching to the ground. Figure 1.4

Figure 1.4: Landslide

Before that, land discovered has been a widespread problem and this cause the lack of land that can be used for plantation and it puts the limit to the plantation. The drawback of this catastrophic event, price of the raw material will rose-up and due to the limitation of land, it will be not much of plant that can be planted. The most wanted plant or plant that has the most requests from user will be considered important and definitely will be planted widely. While for less-requested plant, price will be high.

1.4 Objective

To realize this project, the project objectives have been finished in the duration time granted according to the main purpose of this project which to provide smart observable system that can monitored and control pH value as well as the temperature value for the close system as to balance the healthiness of crops with nutrient and its temperature. The improvise that will be make is to use Bluetooth module as a communication bridge between application on android smartphone and sensors with the help of float switch act as a mechanical sensor. This project will offer an alternative way to cope with these problem and helping in providing a clean, healthier and disease-less product in a long run.

1. To establish a smart system that can operate indoor hydroponic for home use.

2. To design the whole electrical system that will combine with hydroponic structure and monitor the pH of the crop.

3. To prove how this system helps in development of better system in agriculture.

The mission of this project is to build an indoor hydroponic which basically will not involve sunlight. I will attempt to dispel some of people common fears associated to make the hydroponic gardening endeavor successful and rewarding. Purpose is to build hydroponic system to lead a better and organize-well life and use all the facilities that technologies has offer us in these era.

Main objectives of carrying out this indoor hydroponic is for reliable condition of anywhere and anytime of food supplying such as vegetables like chilies or bean sprouts. Referring to the economical state to a poor country, hydroponic has it best function to provide good food with high nutrients. Somehow when referring to environmental problem such as landslide, bugs bugging plants, hydroponic will be a solution to grow a plant. Hydroponic is a way of growing plant to reduce runoff and soil erosion cause by regular soil farming. What's make land and water consumption is important nowadays? Seventy- five percent of all fresh water is use for agriculture somehow these fresh water supplies are being over allocated, contaminated and depleted at an alarming rate.

One thing to do, which undeniably an exciting and creative process is that, decorating your home. For many people, decorate a home or office would be so much compelling when choosing the accessories that will decorate the space. From the floor carpet to the candle and the candle holder itself and from vases to houseplants, home accessories is crucial as it personally makes your home to feels like home, enhance and transform positive energy. As to enhance means adding up a little bit of 'mood' no matter at the corner behind the close door, corner under the stairs, or confine spaces used on apartment patios, small backyard, basement and last but not least at the end of the corner of your balcony, this hydroponic indoor for home kits is undeniably suit your home and office. The combination of green plants and cart of 90 centimeter tall will be just perfectly nice to enhance the 'mood' for your home to feels like home.

Hydroponic is a great way to teach a life science. Most schools in Malaysia have their own botanical garden as a form of education in agriculture and living things besides humans. This great-platform educational system that will definitely preserved a good life taught for a better future especially for young kids. Hydroponic will let them know that to keep-clean, go-green, and preserved permanent forest reserved. After all, hydroponic is one simple system that can be carried out by anyone regardless of the age. Ultimately, education starts from home and school, therefore it's an ideal platform to broaden the hydroponic education.

1.5 Scope

A project involves several parts including;

1. **Spaces**

Indoor hydroponics which precisely can be define as a controlled environment agriculture by combining horticulture and engineering techniques that optimize crop production, crop quality , and production efficiency. As it involves indoor garden cultivation, the space needed for this equipment has to be the least but productive. Suitable size of reservoir, plants and the whole equipment will be built to present the art of cultivation in the house. Precisely recover a cabinet of length: 35cm, Width: 35cm and Height: 72cm.

2. **Plants**

Small size of plant will be grow in order to synchronize with the size of the equipment and spaces in the house. It will be Kale due to it has a least and lights roots. There's a lot of great reason to grow Kale as it is very easy to do so. Growing Spinach simply means harvesting delicious and super nutritious plants. It took only 3-6 weeks from sowing seed to harvest time.

Figure 1.5: Baby Spinach

3. **LED Grow Light**

Control Environment Agriculture that combine horticultural and engineering techniques. LED grow light provides artificial lightings for system's plants. LED with white, blue, and red spectrum will give the best crop as they act as an artificial sunlight.

Figure 1.6: LED Strips

4. **Bluetooth Module**

HC-06 Bluetooth Module will be used as it is an excellent interface for communicating with the mobile phones. By interfacing our android mobile phone provided that the Bluetooth is 'on 'with the blue-tooth module as well.

Figure 1.7: HC - 06

5. Android Applications

Bluetooth Serial Controller as the apps that will be uses in this project. It will interface with the entire program in HC-06 Bluetooth Module.

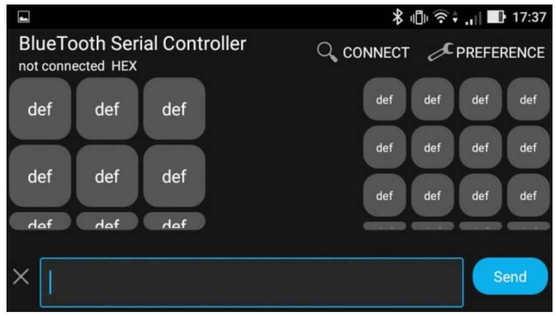

Figure 1.8: Bluetooth Serial Controller Interface

6. pH Sensor

Atlas Scientific pH probe will be use and it helps in reducing or increasing the pH value of the solution so it give sufficient nutrient to crop.

Figure 1.9: AtlasScientific pH Sensor

7. **Float Switch**

Help user to sense the water level in the crop's tank.

Figure 1.10: Float Switch

1.6 Report Outline

There are five chapters included in order to explain the overall of this project in this study's report. Introduction as Chapter 1, shows the general information included in every parts of other chapter, from methodology to conclusions.

While Literature Review for Chapter 2 will share some previous studies that are related to this study, Design and Implementation of Smart Observable System of Indoor Hydroponic. That's including components that were used and any other focuses subject for this paper.

Meanwhile in Chapter 3 will explain procedures from designing and developing the project. This chapter is called Methodology.

Chapter 4, Preliminary Results covered the analysis and discussion of this study, from test conducted, experiment conducted, an observation and to the results and discussions.

Finally, Chapter 5 is the Conclusion discussed about the conclusion that has been made. To emphasize the objective has been achieve and to suggest some other idea in recommendations, and finally project potential to give overview about how far this project can go.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Indoor hydroponic smart observable system is largely based upon empirical studies that investigate how hobbyists often take up hydroponic system to grow their own food but less access to the outdoor space. However there is something in common between indoor and outdoor hydroponic system as sources of sunlight. There is the large volume of published studies describing the role of artificial sunlight which mimics or imitates 4-6 hours direct sun per day and at least 10 hours of " bright light".

This chapter contains explanations regarding the theory as well as basic principle about the indoor hydroponic problem that has been extensively studied by former researcher and it will emphasize on the advantages and additional sources for the success of this project. This including the fundamental and basic information involves theories of the components and equipment for obtaining the data or carrying out the analysis. Lastly, this chapter will make a review on some articles and journals of previous study on similar subject.

2.2 Communications

Torabi, M and Mahlooji, M (2011) invent an apparatus for automated monitoring and controlling a hydroponic installation which measures variety of sensors, controls electrical devices and provides a user with an interface through an apps which accessible anywhere and anytime. According to the inventor, network connectivity or types of communications allows the user to manage the system build remotely and not forgotten to view updates data through just a display on a screen. The inventor related that using a variety of messaging methods, including SMS or email page and initiate control through a reply messages. Last but not least, network access can be provided by Wi-Fi or cellphone with a Bluetooth features.

Mog, L (2015) showed that after a plant cultivating system was built, a smart phone was programmed to control the system as a remote controller. The system consisted of a central monitoring PC, a cultivating equipment control module, a remote control smart phone and a plant cultivating room. The power line communication method was applied for the communication between the monitoring PC and the cultivating equipment control module.

2.2.1 Bluetooth

Bluetooth is a standard short-range wireless interconnection of cellphones, compile and will available at other electronic devices. Basically, it’s built into billions of products on the market today. Instead of wires or cables to connect to a phone or computer, a Bluetooth device uses radio waves. If two devices want to connect with each other via Bluetooth, they need to be pair and Bluetooth communication occurs over a short-range. Most probably, Bluetooth can connect to the door lock, lights which represent some of the applications for Bluetooth even tiny application apply at home base on electrical component including toys. Bluetooth has their own reason why do they are better than other technologies. Firstly first, Bluetooth is everywhere despite which technology you are using or referring, it operates at very low power, easy to use and at a manageable costing. This makes it convenient to connect to each other, among the devices. With Bluetooth, you just have to go to settings, turn on Bluetooth, hit the pairing button and wait for it to start communicating.

2.2.1.1 HC-06

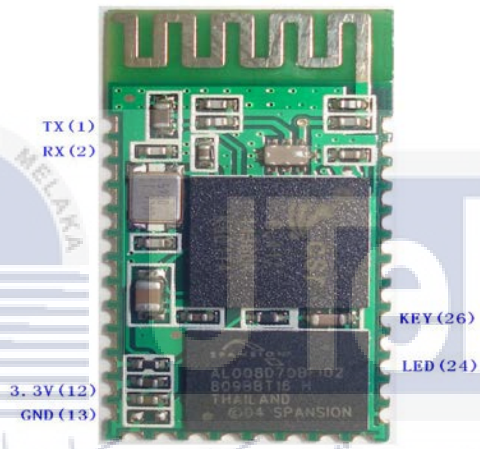

Figure 2.1: HC-06

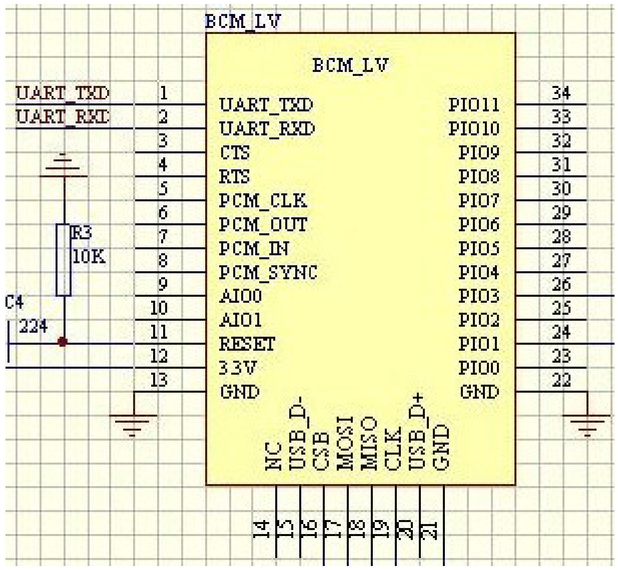

Figure 2.2: HC-06 Schematic

HC-06 is a wireless transceiver which sensitivity can reach to 80dBm. HC-06 is a perfect Bluetooth solution due an EDR module, change rate of modulation depth; 2Mbps-3Mbps. Can work at the low voltage; 3.1V-4.2V while current in pairing is in the range of 30-40mA and 8mA current for communication. UART and USB is HC-06 standard HCI Port. HC-06 has a 24GHz digital wireless transceiver. The size of this Bluetooth module is small, 27mm x 13mm x 2mm. The power consumption is low. Last but not least, it has high-performance wireless trans receiver system and costing to consume this module is low, according to Xin, L (2011).

From Matthew (2014), microcontroller send its data collected from sensors, a communication bridge could be used between the microcontroller of the hydroponic system and the user device such as mobile phone. Another reason why Bluetooth module is proved from Rodrigues, J.R (2015) which stated that this technology was designed to work with low-power consumption. Nowadays, we can find this technology in any devices like smartphones or tablets. The wireless unit will send the sensor data to the user through Bluetooth or Wi-Fi. The goal for the project carried out by Yukech, C (2015) has to produce cost effective sensor that measure pH, nutrient, and temperature.

2.2.2 Mobile Phones

A mobile phone is a device that is used to make a call or receive call from others, it works both ways. Thus, it is important for us nowadays, it is a some kind of devices to communicate to each other's due to their applications which supports variety of services like SMS, MMS, email, access to the internet, Bluetooth, Wi-Fi and photography. Additionally, the user can also shop and directly make payment without any troubles.

2.2.3 Software Specification

There will be two types of software that will be using in this project and Bluetooth Seriel Controller as an application;

i. Arduino IDE as Arduino compiler
ii. Solidwork
iii. Bluetooth Seriel Controller

2.3 Indoor Hydroponic

Donald, J.S (2011) conducted Plant Growing System (PGS). It is convenient and has easy way to grow a high yield plant, vegetable and herbs garden with a limited space, within self- contained watering and fertilizing system. The plant design is to allow plants to get essential and critical nutrients through a cultivating root system. This growing system allows you to grow plants with UV lamps using hydroponic growing methods. UV lamps act as an artificial sunlight. UV lights keep unwanted animals from attacking the plants. The growing system can be imply indoor or restricted to confined areas and use apartment patios, small backyard, basement or small area with 10 times greater and better of that traditional cultivation.

2.3.1 Automated Indoor Hydroponic

A seminal article was published by Loomis, J (2014), two years before, there were a GroBot Evolution. The GroBot Evolution is a growing product contains a bunch of sensors that take data for pH, nutrient level, CO2 level, water level, air and water temperature for the hydroponic growing station or room. Purpose is to keep the growing conditions constant with respect to the hobbyist desired settings. Furthermore, the data needed for the horticulturist displayed conveniently on a web application that can installed onto an android phones. GroBot is to maintain all of the necessary or crucial environment factors of the growing system.

The study of the structural behavior of 'Automated Indoor Hydroponic' was carried out. Instead of frequent daily monitoring to ensure proper growing conditions after all most gardeners find growing soil to be less strenuous and easier than hydroponic gardening. Therefore, project has to be design or create that lets anyone have the ability to grow his or her own hydroponic plant using simple automated system. This will reduce the user from a lengthy setup and daily maintenance. The user will be able to specify the plant that wanting to be grown through a mobile phone's interface which is connected to the microcontroller running the system. The microcontroller can be Arduino UNO. For each sensor calibrated into the microcontroller, the plant specific setting will be loaded and thresholds. This is to eliminate or reduce any research that the user needs to do (Walker et al, 2014)

Crowe, M (2014) stated that what has emerged over the past decade, however, is the utilization of warehouse space in highly dense urban environment, for the purpose of large-scale commercial food production. This is because it believes that hydroponic can hold a large scale of plants. Since whole system is automatically to perform all daily testing necessary, adjust system level for pH, nutrients and water also. Automated hydroponic gardening just as simple as soil gardening but yet able to produce better result. Automated programming or system by means include sensors, power supply and at least one microcontroller and mobile interface for monitoring data by users. This project also keeps in manageable maintenance costing and make sure the plants grow faster than conventional methods. In required that action is needed, user shall be notified via text message or mobile apps notifications.

Table 2.1: The Attribution for Hydroponic System

Source: (Matthew, 2014)

ATTRIBUTE	DATA
Battery Life	24hrs
Number of Plants	2-4
Weight	Approx. 20lbs
Dimension	Approx. 4x4x4 ft
Water Consumption	1-15litres daily
Water Volume	30-75litres
Working Temperature	50-105fahrenheit
Working Humidity	10-100%
Sensor Measurement	At least once per hour
Communication	Wi-fi / Bluetooth

2.3.1.1 EBB and FLOW

According to Loomis at el. (2014), basically ebb and flow is where a nutrient with rich solution flooded into a grow tray containing the plants and roots periodically. The solution then drains back out into the main tank or reservoir. Plants lie in plastic small basket that holds it for growing medium. The plants root grows through the medium and protrude out of the bottom of the baskets. The baskets is lie in a grow tray under the basket immerse in for a nutrient solution. Different growing medium required different amount of water over time. Due to this, the flooding frequency determined by the medium used. Flooding cycle begin with a nutrient solution reservoir located underneath the grow tray. Water pump in the reservoir is used to pumps the solution into the grow tray above. During this water pumping, roots and medium are exposed to the nutrient solution. Before the pump is turned off, the solution stays in the grow tray only for few minutes. The solution then flows back into the reservoir tank by gravity. New oxygen is filled in the grow tray during the draining cycle giving the roots plenty to intake.

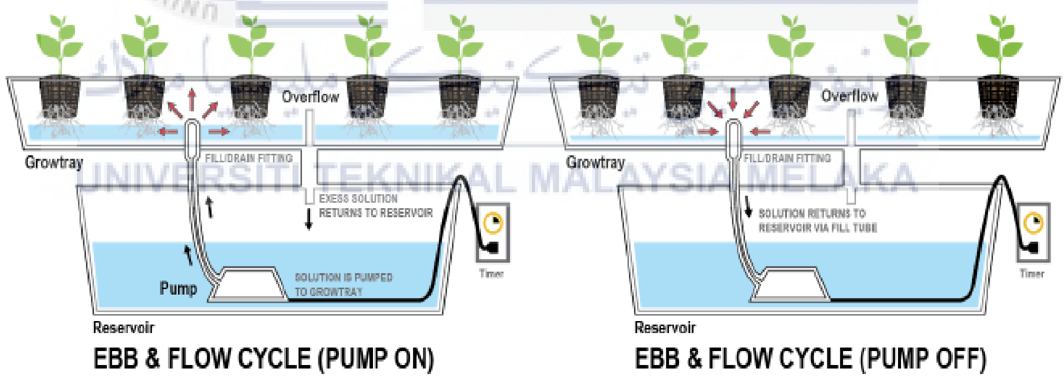

Figure 2.3: Figure of Ebb & Flow Cycle

Source (Christina, 2014)

Rodrigues, J.R (2015) reviewed that instead of a drop-wise irrigation system is a flood system. That is, the platform where the plants are located in flooded with the solution containing nutrients during a certain time interval. At the end of this time the solution is removed, the system often used gravity to perform this step. Finally leaving the roots oxygenized and nourish.

2.4 Microcontroller

Hydroponic is a new technology which evolves rapidly since its inception 70 years ago. From research to its utilization in industrial and government, hydroponic has found many new applications. Besides a versatile technology, it is appropriate for all developing countries. Hydroponic knows no boundaries when they can generate food efficiently from barren desert sand, ocean water, mountainous regions, cities rooftops, on the concrete walls and schoolyard. Hydroponic tends to move forward higher-technology, in fact suitable for automation with many helps over associated technologies such as artificial lightings, microcontroller and plastics. These definitely help in increase crop yields and reduce cost production. It has been proposed antenna could be embedded into the glass house to receive energy radiation, at the same time facilitate hydroponic crop production. The development and use of controlled environment of hydroponic has enhance the economics (Anita, 2014)

A recent study regarding using a microcontroller for automated hydroponic is where to conduct of a series of experiment on the hydroponic system using pH value and electrical conductivity, (Pabiana et. al, 2011). The program for the module Programmable Interface Controller (PLC) microcontroller were created and compiled in PIC BASIC (Beginner’s All- purpose Symbolic Instruction Code). As to create the hex file, the programs were compiled using Proton PICBASIC. PICKIT 2 programmer was used to import the hex file and burned it to the microcontroller. PIC Microcontroller was used to receive the pH and conductivity level’s reading from the output for the corresponding meters. GSM will then receive the reading meters. GSM will then receive the readings which were forwarded before to microcontroller and then to the system software that handle processing of data for output to personal computer.

2.4.1 Arduino

Nowadays, Arduino has become a thing because it is easier to use due to the simplified version of programming language, C++ and the ready-made Arduino microcontroller which easy programmed, to erase and to end programmed, this is according to Badamasi, 2014.

Furthermore, Alessandro D' Ausilion, 2011 stated that concept in which Arduino brings has a critical advantage which related to open-source community. Such as forums, mailing lists, schematic of the hardware and code freely available for many projects. After all it is an open-source. Thus, many interesting project can be readily updated.

The power of Arduino is the ability to interact through input-output (I/O) pins. Arduino has 14 digital I/O labeled 0 to 13 which can be used to the motors and lights on and off, referred to W. Durfee, 20011.

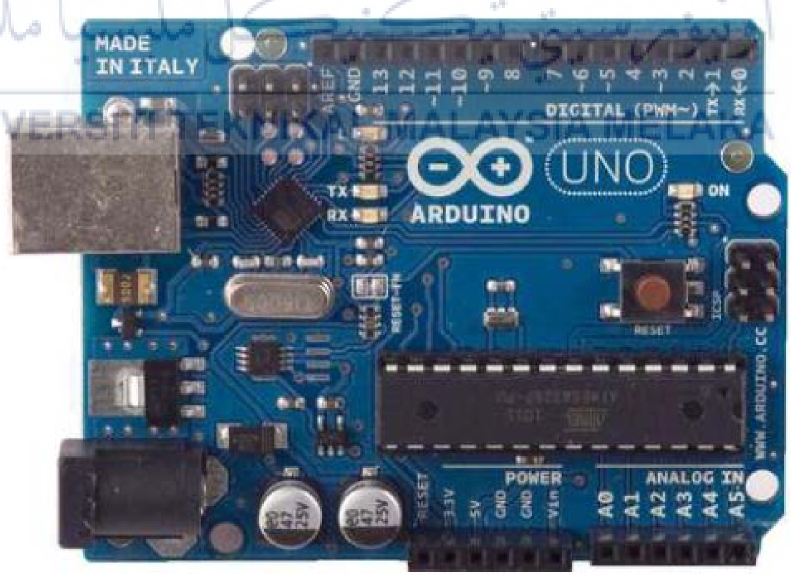

Figure 2.4: Arduino UNO Board

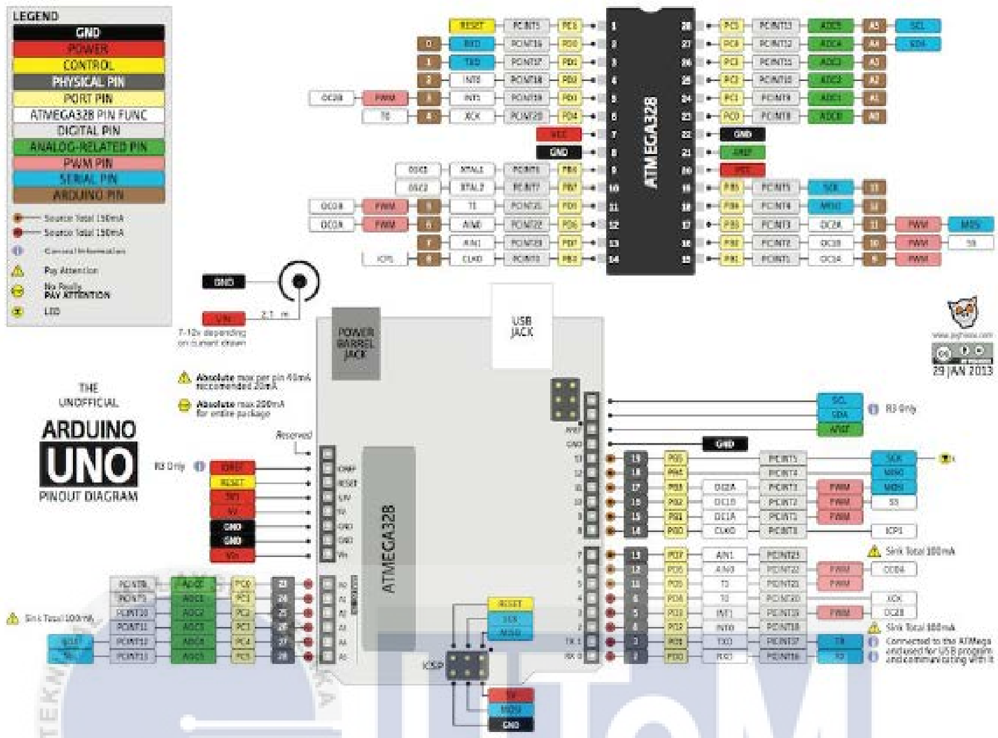

Figure 2.5: Arduino UNO Board Pin Directory

2.5 Sensors

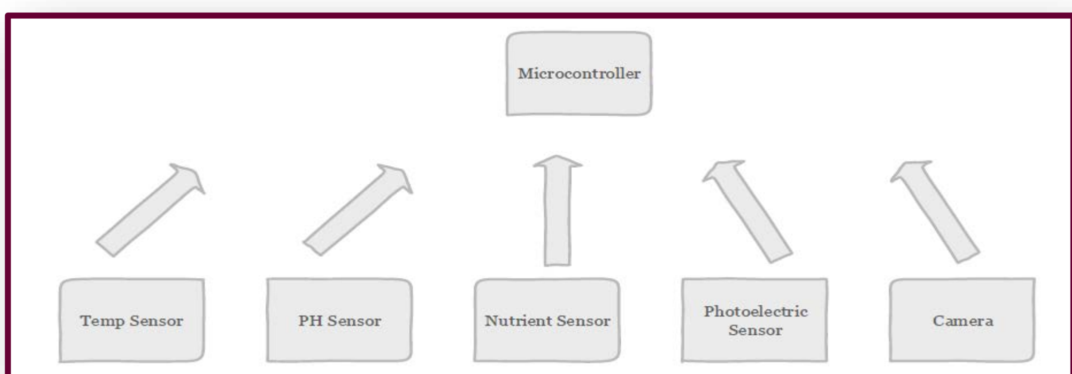

Figure 2.6: Types of Sensors Involve

Source (Loomis, 2014)

According to Chappell, (2013) identified sensor for improved efficiency of irrigation in greenhouse and nursery production, sensors provide quantitative information to guide and automate the decision-making process for irrigation. Given an overview on the most common sensor, that can be used for such purpose. Sensor includes the sensor which can be used for any weather stations, or water status and irrigation system troubleshooting. Even though, collecting data with sensors are relatively easy, data are only useful is the sensor are used correctly and understanding of the sensor limitations is applied. By optimizing the value of the collected data, selecting the best sensor(s) for a particular purposed is required, determining the optimal number of sensor to be utilize and assuring that the collected data are as accurate and precise as possible. Proper use of sensor can attain a result in large increases in irrigation on efficiency and as well as improve the profitability of ornamental production in greenhouse and nursery.

Here is to another research carried on by Walker, (2014), it says that the power supply will give power that will house the microcontroller board that will be using for this project. The date will be sent to the microcontroller via many sensors located through system. The microcontroller will control the pH level of the nutrient from the data gained and adding few chemicals or more nutrients if needed. Not only pH sensors are crucial, water pumps as well.

2.5.1 Temperature Sensor

For past few project carried out by Miss Komal (2014), emphasize on temperature and humidity controlling. Diode sensor is used which is generally a silicon diode and act as a temperature measurement transducer and temperature sensor silicon is a diode specifically designed and optimized for this function which can be seen widely used for temperature sensing application, in an automotive industrial and consumer products, where manageable costing and high accuracy are important.

It says, temperature of water is a very important parameter to measure as to obtain accurate EC (electric conductivity) meter readings. It is crucial to know that the overall system temperature is not getting excessively hot or cold so that the electronic sensors' work correctly and the plant will grow healthily. Warm season vegetables and flowers grow best between 60°F and 80°F.

Two main types of temperature were highlight, contact sensor which brings the sensor into direct contact with the substance that it is measuring, and the other one is non-contact sensor such as infrared sensor that measure temperature by sensing the infrared radiation emition from a substance. Somehow, contact sensors are more appropriate for this hydroponic system due to its simplicity of installation and low cost. Varying voltage signals is use by thermocouple, devices, or the derivation resistance value from input voltage and current, line thermistors or resistance wires. (Loomis, 2014)

2.5.1.1 Thermistor

Thermistor is thermally sensitive transistor. The resistor of the transistor decrease as the temperature increase at a known rate, therefore it works by predicting resistance value for given temperature. Resistance wire detector work in a similar way, the resistance across the junction increases as the temperature increase at known rate.

2.5.1.2 Thermocouple

Junction were create with two different material that responds in the temperature change, thus creating a voltage potential different.

2.5.2 pH Sensor

In 2013, Smith H.N explained; in order for insure optimal utilization by the plant, pH measurement for both acidity and alkalinity of nutrient solution should be monitored daily. A pH of 7 is basic, more than 7 is alkaline or basic and below 7 is acidic. 5.8 to 6.4 is the ideal pH value for absorbing nutrient by the plant roots, or slightly acidic. To avoid from iron or some of the other metals deficiencies, pH is not allowed to be so high and if the pH is too low, calcium, magnesium and of the macro element may be hindered.

To adjust or to control pH in hydroponic is easy. By adding a little dilute acid such as phosphoric acid, it will quickly bring the pH level, down. Vice versa, adding a base such as potassium hydroxide will bring it back up. For most plants, a pH balance of 6.0 is an ideal target. In fact, in my own project, ideal pH for spinach itself is from 6.0-7.5. For another experimental carried out on 2014 by Komal, AT89S52 microcontroller were used and C language to develop precisely with nutrient flow meter sense the level of nutrient in the plant vessel and in comparison with reservoir.

Stefan, (2014) highlighted that the most crucial criterion is pH. The pH depends on the water and the nutrient solution in used to dissolve in water. The pH of the result will determine which nutrients are absorbedly by the plants of each substance. For better result, pH needs to be check daily. There’s inexpensive pH test kit specifically desired for hydroponic. It can be done by take a small water sample in a test tube and few drops of pH indicator solution. Color chart will tell you the pH when the color sample change.

2.5.3 Float Switch

Water level is minor parameters that hydroponic system can measure and notify the user in case of a problem. In any culture of hydroponic system, water supply is crucial to reaches the top of the water reservoir. In order for this to happen, valve or some sort of water pump can be used with a pipe hose connecting to a secondary water reservoir.

To ensure that water will enter the reservoir as to keep it full, water valve would bypass all of the electronics of the hydroponic system entirely and instead a mechanical system can be used. The most common use of this application is in the most homes bathrooms, keeping the toilets water supply full yet not overflowing. Accomplished with the use of a float valve, the float valve taking advantage of the buoyant force of water to close the valve that is filling in the reservoir. In this way, water fills itself up and seals out any excess water create balance system of water flowing.

One thing need to be consider is that an excessive water level in a hydroponic system gain from the rain water or water that gets into the reservoir through outside must be deal with overflow prevention. To solve this, drain holes at the higher level of the reservoir allow any excess water to escape without ruining the electronic devices or ruining the plants. (Loomis, 2014)

CHAPTER 3
METHODOLOGY

3.1 Introduction

Chapter 3 will explain the steps and the process that has to be taken in order to achieve the objective stated in Chapter 1. There are several acts or steps required to be taken orderly to achieve those objectives as stated in Chapter 1. Parts of the ideas are extracted from Chapter 2 as well which is called Literature Review. The chronology of method and procedures that need to be taken is important as it can save time and organize the work or objective for the research. This means, it involves both analysis for hardware and software.

3.2 Principle of Methodology

Flowchart below address that the methodology of project involve hardware and software. The project expected to be completed once the combination of hardware and software part is completed. The flowchart is as shown in Figure 3.0 below.

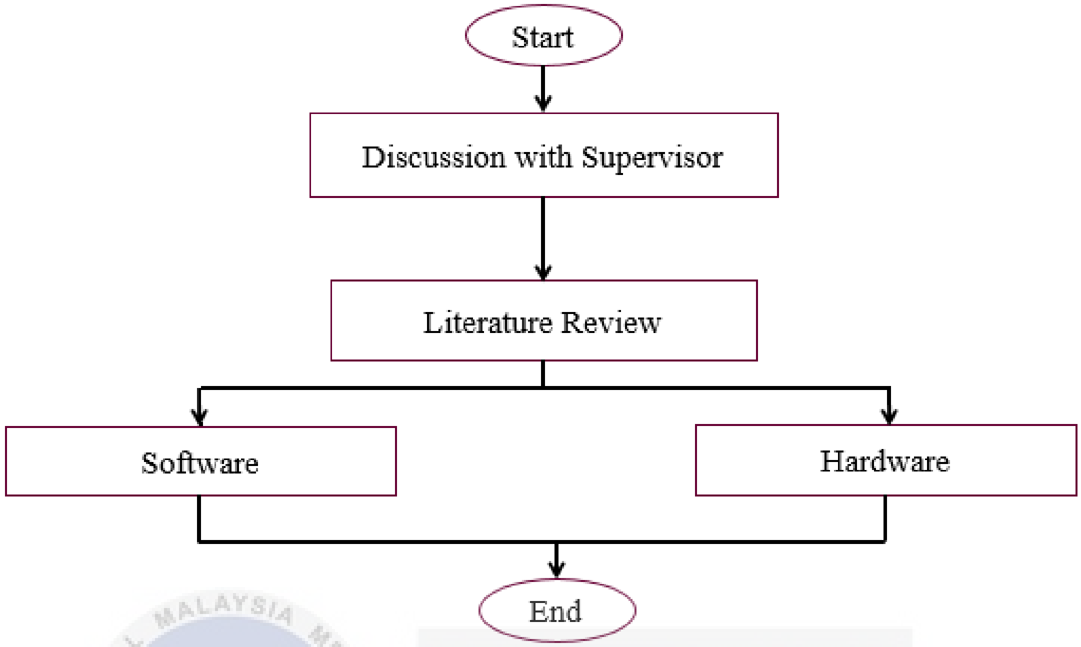

Figure 3.1: Flowchart of the Project

The first step to begin with this project is to meet supervisor to discuss about the title and project's flow. With the guide from the supervisor, the project flow will be easier to understand and plan. As have been mentioned, some of the idea or planning in methodology is extracted from chapter literature review so further step will be taken then. Previous work related to this project has to be study first as they can be references to this project and helps in improving if there's any necessary change is needed. Scope that has to be focus on previous chapter will be software, hardware, design, concept and lots of theoretical value or knowledge. Then, project planning can begin.

According to previous study, the review doesn't involve software that much. Hydroponic can just be done with a tank of water and seeds. Software will only be involves whenever automated hydroponic is build. According to my previous study, nowadays hydroponic that have been commercial is all about automated hydroponic which requires interface and few sensors.

3.3 Structure of System Design

Before we proceed to what we known as hardware development, the system need to be design to address the flow of how the system operates. Refer to figure 3.1 below.

Figure 3.2: Idea of Linking Microcontroller to System

The block diagram of the indoor hydroponic system shows the system operates, which is which the inputs and outputs. It consists of the heart of the system which is Arduino UNO as the microcontroller. Bluetooth module provides a wireless communication link between the Arduino and android smartphones. Sensors helps in detecting any changes or command so that, the most crucial hardware involve which is LED as an artificial sunlight can light up and ventilation system can balance the temperature inside the cubicle of the crop.

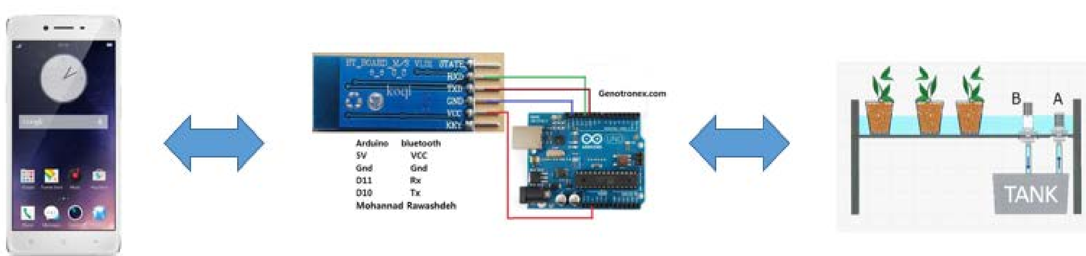

Figure 3.3: Example of Process in the System

3.4 Software Development

To explain much more about this project, there's a few software that will be use. Such as Arduino IDE, SolidWork and Proteus. Basically Arduino IDE is the programming console helps in program all of the project in 3D drawing. Proteus is where circuit's drawing is for. It is kind of LabCenter for Electronics. It is unique in offering ability to co-simulate both high and low-level micro-controller. Below is the system operation for software.

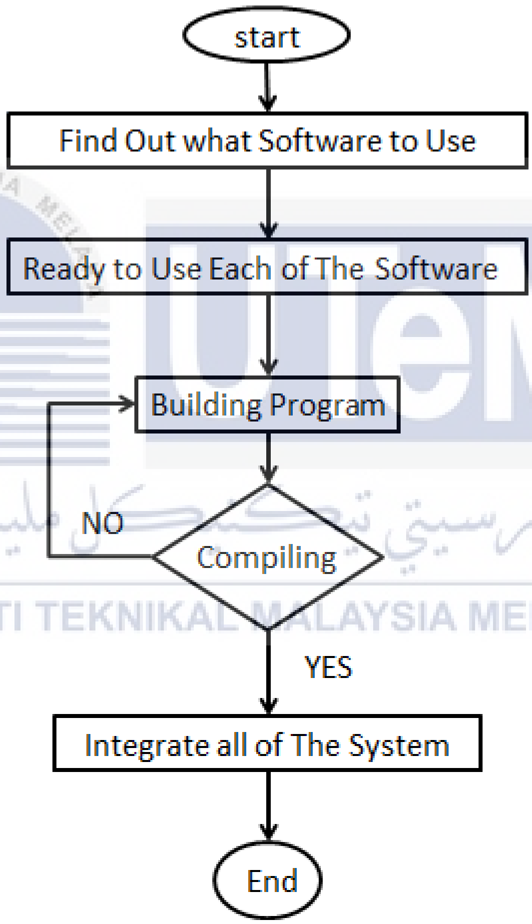

Figure 3.4: Flowchart of Software Processes

Before start the programming operation, microcontroller has to be chosen. The program will be design base on the project's operation and flow. Programming usually take time as it has to be adjusts with the inputs and outputs and project operations from beginning till the end. The coding must then be tested until it can be compiles. If not, recheck and make sure it can be finalize and integrate with the whole system of the project.

3.5 Hardware Development

As to complete this project, besides software, hardware has to be develops successfully. Flowchart below shows the flowing of the developments of the hardware according to the project planning. Once the hardware part is done, it will be then integrate with the whole system including software. There will be a troubleshooting and rechecking or testing for the hardware involves. The testing and troubleshooting processing will be on repeats until it reach its target. Figure 3.3 below shows the hardware development of Bluetooth module.

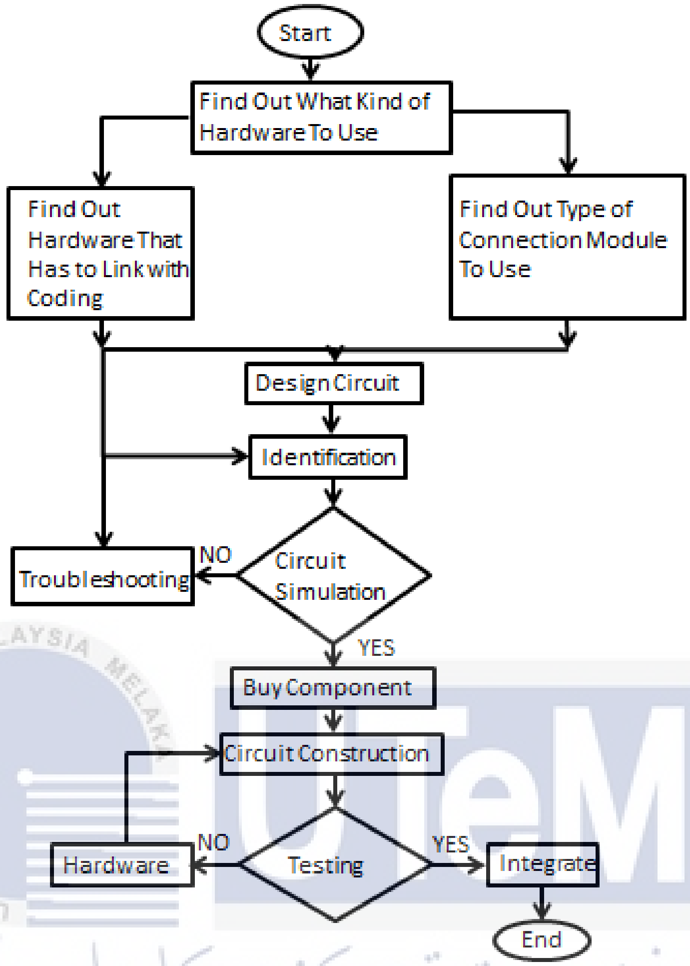

Figure 3.5: Flowchart of Hardware Processes

The first step for hardware development is to determine all of the components that will be use. There are some procedures that need to be taken on in order to complete or carried out the purposes of this project. The most important is that, all of the component used need to be specifies either the criteria or the specification so that it will be compatible with the project. Once the components have been finalized, the circuit needs to be constructs. To be exact, the heart of the project is Arduino as the microcontroller itself. For this, we have to determine which pin of Arduino set up for which component. Before that, Arduino that will be use is Arduino UNO. Since it has 14 digital inputs and outputs pins of which six of PWM outputs and Arduino contain six analog inputs as well. For example, pH sensor will use one analog pin and floating switch will be using one digital pin. Other than that, HC-06 of Bluetooth module will connect to TXD and RXD pin of Arduino UNO. Somehow, after all the components and the microcontroller has been compatible and confirmed, we can proceed with buying the components. If it is not, it is time to compare or troubleshoot until it is compatible with the circuit design on software call Proteus.

Then, after all components are enough, it is time to construct the circuit according to the simulation made before. Soon, the circuit can then be test either it is suitable to use in hardware or it does not. If it is not, then the construction of the circuit has to be done again and again until the integration between software and hardware can be proceed.

3.6 Overall Development

The project is said to be complete once the whole program development is completed as shown in figure 3.4. Prototyping part will definitely depends on the project design on software. Prototyping involves both part from hardware and software, which means includes all of the electrical parts and programming. The flowchart is as below.

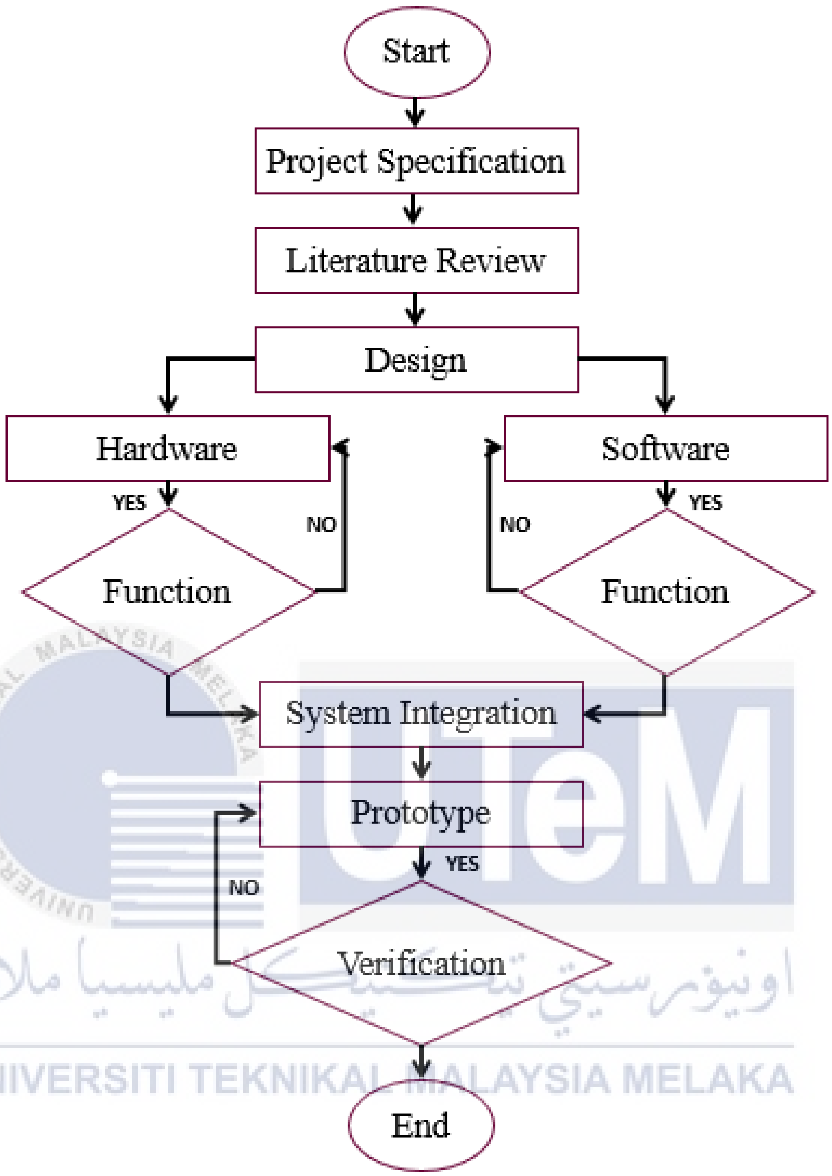

Figure 3.6: Flowchart of Overall Processes

3.6.1 Parts that Linked to Microcontroller

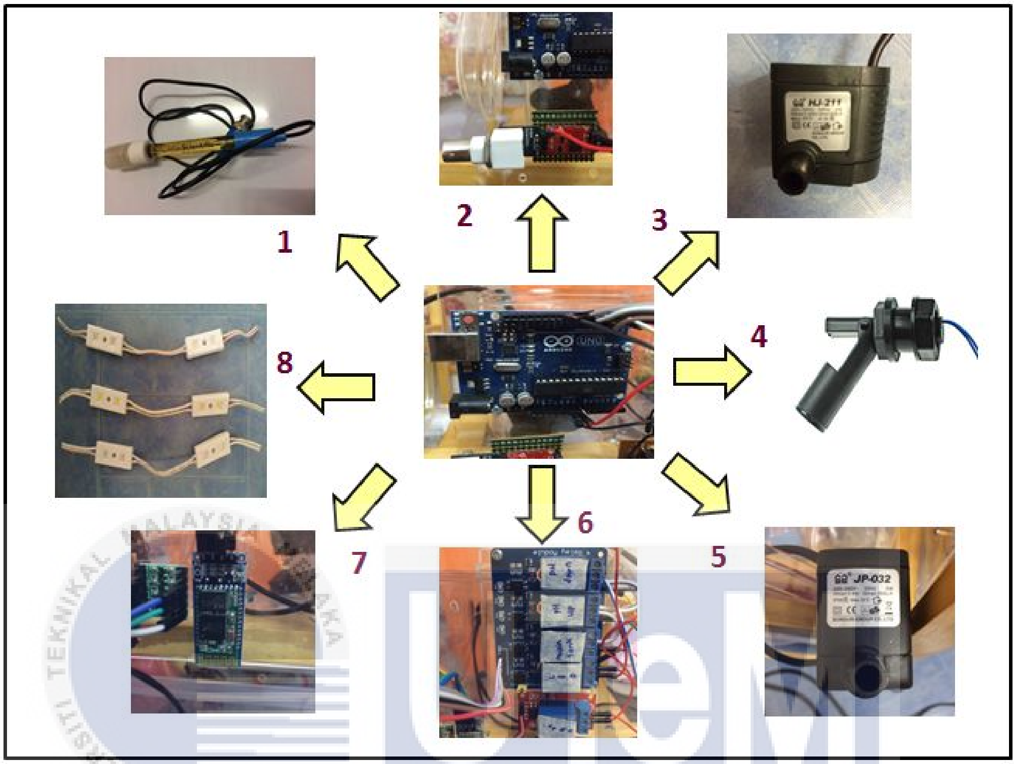

Figure 3.7: Parts That Linked with Arduino Uno

1. pH Sensor
2. pH Shield
3. Water pump for both Soluble Fertilizer
4. Float Switch
5. Water pump for Main Tank
6. Relay Board
7. HC – 06 Bluetooth Module
8. Light Emitted Diode (LED)

3.7 System Design

3.7.1 Cart Design

Figure 3.8: Cart

Figure 3.9: Process of Designing Cart

Figure 3.10: Cart in SolidWork

Figure of 3.8 shows that cart that not yet being assemble. This cart is consisting of three tiers. Tier that holds the vase is the second tier. Perspex was attached to it so it can patch the vase and hold up to 100g weight of both vase and plant.

3.7.2 Hardware Involves

Figure 3.11: 1m Transparent PVC Host

This PVC host helps in linking the fertilizer's container and vase. So that, the water could flow in and flow out. It is consists of 1m long.

Figure 3.12: Soluble Fertilizers Container, Caster Wheel and Hand phone's Holder

The caster helps in moving the cart. It is consists of four to complete all of four leg of the cart. Meanwhile, the phone’s holder is just an additional component to put on the smart phone.

Figure 3.13: Main Tank

This reservoir consists of 11L box that can store water. It is enough for operating one plant. By using this, refill of the water has to do for every two to three days. This is where the main water pump is store. On its lid, two holes were drilled so that it allow PVC pipe for flowing purposes.

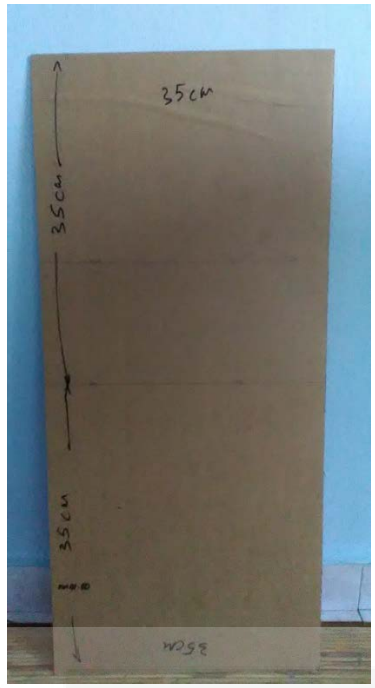

Figure 3.14: Perspex

3.7.3 Water and Vase Design

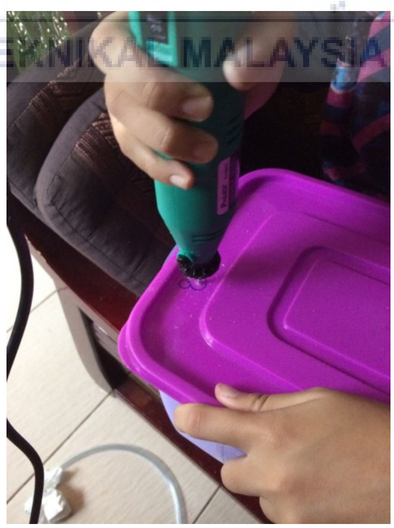

Figure 3.15: Process of Designing Water Tank and Vase

Figure 3.16: Process of Installing Float Switch in Vase

Figure 3.15 shows that drilling of holes for water in and out of the main tank is going on and while Figure 3.16 shows that the drilling of holes for water, pH solution as well as for float switch and pH probe on the vase.

3.7.4 Water Pump Placement

Figure 3.17: Process of Installing Water Pump in Tanks

As the requirement of water pump is to pumping in water and soluble fertilizer, the designing of those water pump has to be design as in Figure 3.13. Two pumps were attached to a container of 8 cm X 15 cm because of its role, the container and water pump has to be attached closely to the vase and then, there is a host that links the vase and the container so then the soluble fertilizer could pass into the vase and flooded the roots of the crop.

3.8 pH and Fertilizers

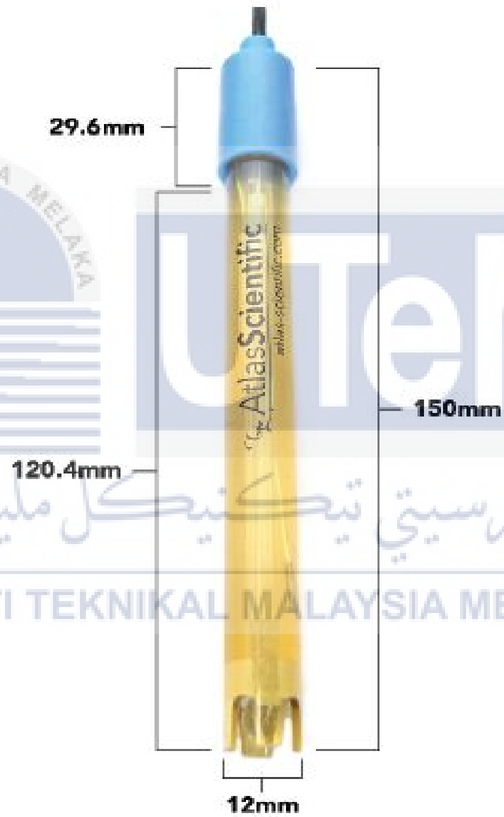

Figure 3.18: pH Sensor

A pH electrode is a passive device that detects a current generated from hydrogen ion activity. This current (which can be positive or negative) is very weak and cannot be detected with a multi-meter, or an analog to digital converter. A proper care should be taken by using proper connectors and cables. This pH probe is Atlas Scientific and it can be fully submerged up to the BNC connector indefinitely.

Table 3.1: Specification of Atlas Scientific pH Probe

pH Range	**0 – 14**
Temperature Range	1˚C to 99˚C
Max Pressure	690 kPa (100PSI)
Weight	49 gram
Cable Length	1 meter
Dimensions	12 mm X 150 mm
Resolution	Limited to only by the device reading it.

This pH probe comes with three solutions that help in probe's calibration. Consist of three bottles. One with the red labels indicates 4.00 pH reading, the yellow label indicates 7.00 pH reading and the white is for storage purposes.

Figure 3.19: Calibration Solutions

Figure 3.20: A Visit to Hydroponic Household

On 24th of November, a visit has been made to a household of two Chinese men who carry out a business on hydroponic cultivation. It was really a good company and visited to the garden and so much of knowledge gained on Hydroponic and Fertigation System (HFS) including a book and little soluble fertilizer, here in Bachang, Melacca.

Figure 3.21: A Visit to Agro Bazaar at MAHA 2016, Serdang.

MAHA 2016, which stands for Malaysia Agriculture, Horticulture & Agro-tourism and it is the leading agriculture show of its kind in Mlaysia and indeed in the region. MAHA brings out the best theme for this year which is “Our Food Our Future“. It is brilliant because, we are what we eat. This time, the theme is focusing on food security and sovereignty. There are a lots of exhibitions for public, kids and for professional in agro sectors businesses. It is still an event for everyone.

On the 3rd of November 2016, a visit has been made to MAHA 2016, Serdang, Selangor. There a lot of benefits, some of it were encouraging young and future entrepreneur in promoting the agro industry and what is more efficient was MAgIS 2016, Malaysia Agricultural Innovation Challenges and Agro IT in showcasing the latest IT innovations and technologies advancement in agriculture. With these kind of exhibitions, it is believes that smart system of hydroponic can go beyond industries. MAHA 2016 is the way to the future of agriculture.

Figure 3.22: Brand A

Figure 3.23: Brand B

These are called soluble fertilizer. These fertilizers help in increasing and decreasing pH. Instead of using KOH and H3POH as a chemical fertilizer, let's keep the plant organic. Soluble fertilizer of Brand A gives reading between 3 and 6 only, it helps in decreasing pH value if it happened to exceed 6.8. While Brand B helps in increasing the pH reading up to 6 to 6.8. Those reading are approximate and suitable for the plant. Soluble fertilizers were gained from the previous visited at a household of hydroponic business given by Mr. Ronald and Mr. Bong.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Introduction

In this chapter, we will be discussing about result which is the result after completing this project additionally with objective achievements. Final result explained how this project expected to be operating from the beginning to the end of the operation. As to do so, to make it works there are few steps involves.

4.2 Project Operation

4.2.1 First Step

The first step on how this project will be working is that user must send a command to the controller through mobile application with the help of Bluetooth module and the Bluetooth features on the mobile phone has to be turned on at first.

This steps might involves turning on the small fan, LED strip lights, as well as checking out the water level for the tank if it’s empty or less. Not to forget that through this first step, we can figure out the nutrient status for the solution.

Noted that the user received a feedback from the microcontroller, the next step is optional for them.

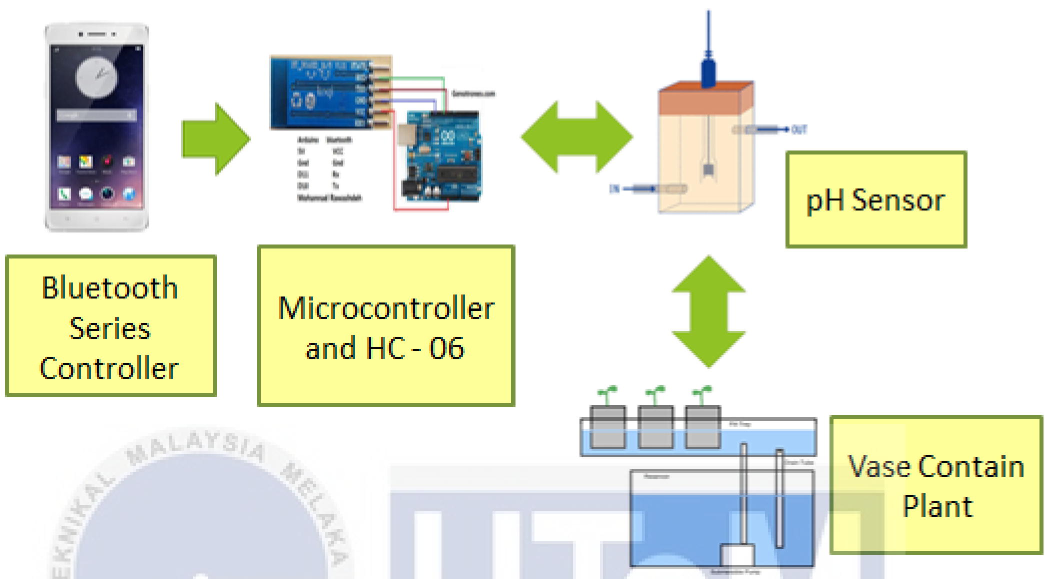

Figure 4.1: First Step Visual Flow

4.2.2 Second Step

Once the user has been received the status of the plants for example pH level or temperature of the plants, and let's take pH as an example, the first thing to do is either to increase the pH value, or decrease the pH value or else, to do nothing about it. It is depending on the status of the nutrient of the solution.

To increase the pH value, Potassium Hydroxide has to be pump in into the solution that will run through the plant roots or else, Phosphoric Acid helps in decreasing the pH value. Since the tank that holds the plant is small, to make it a productive system, there will be two small special tank that holds or fill with these chemicals and water pump out these chemical into main tank according to the command from the user.

For example, if the user tend to increase the pH value, the user need to click a button that sets to give command to Arduino microcontroller and then the water pump will operate about few second and pump out the Potassium Hydroxide into the main tank and leave the roots oxygenize and nourish with nutrient.

Same goes to decreasing the pH level of the nutrient solution, the user needs to click a different button that sets to decrease the pH level of the nutrient which will be pumping in Phosphoric Acid.

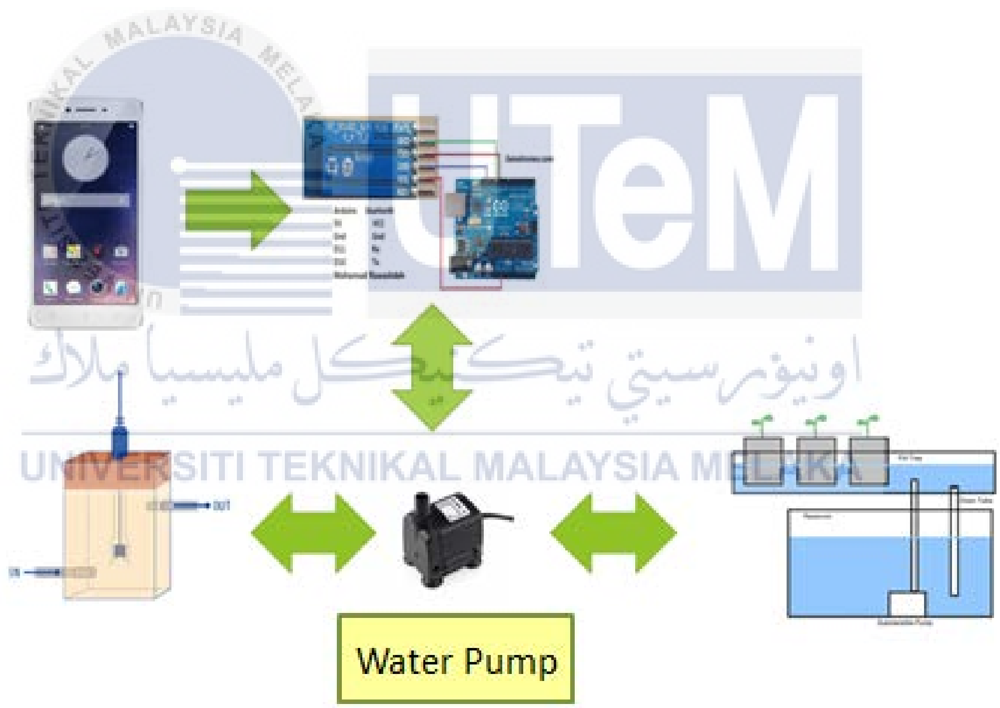

Figure 4.2: Second Step Visual Flow

4.3 Part of the Hardware

4.3.1 Overall Layer of Hardware and Electrical

This outer layer basically a cart that will cover the inner part that containing whole of the hydroponic system. The expected result would be a cart with width of 35cm and height of 40cm lastly, length is 35cm and it would be a see through material such as Perspex. As for inner layer, the tank would be half of the outer layer so that there's enough spread of lights, air and so plants can grow to its maximum height after 3 to 4 weeks before harvesting.

Figure 4.3: Front View

Figure 4.4: Back View

4.4 Experimental Set Up

4.4.1 Experiment on Brand A and brand B

There's few step were taken to carry out an experiment on pH conditions which involves few equipment. First and foremost, pH meter, powder form of Brand A and Brand B soluble fertilizer and then calibration solutions showed in chapter 3.

Figure 4.5: Brand A and B in Powder Form before Dissolved with Water

Figure 4.6: Brand A and B after Dissolved in Water and both pH Value Respectively

This is proven that soluble fertilizer used is suitable for controlling the pH that is sufficient for the plant. Brand A consists of high acidity level while Brand B is basic. Best pH reading for vegetable is always between 5.8 and 6.5. The mixture and right reading for pH are as below

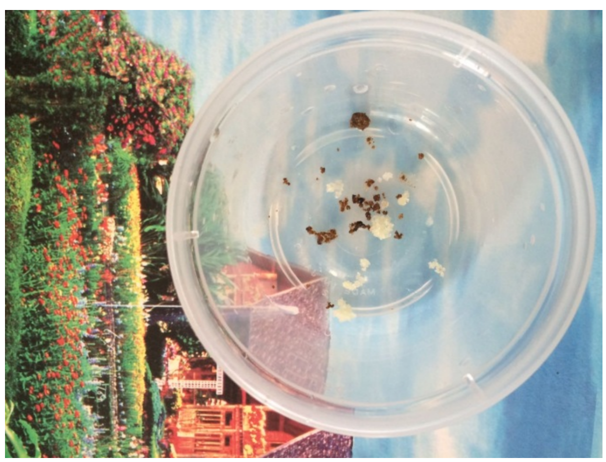

Figure 4.7: Mixture of Powder Form of Soluble Fertilizer

Figure 4.8: The pH Reading that Shows Appropriate Value for The Crop

4.4.2 Calibration on pH Calibration Solution

4.4.2.1 pH Test on Basic Solution

Figure 4.9: Calibration Solution

Figure 4.9 shows that these three solution helps in calibration of pH sensor Atlas Scientific. As to start further experiment, at first I have to calibrate the pH sensor and has to start with pH solution that is equal to 7.

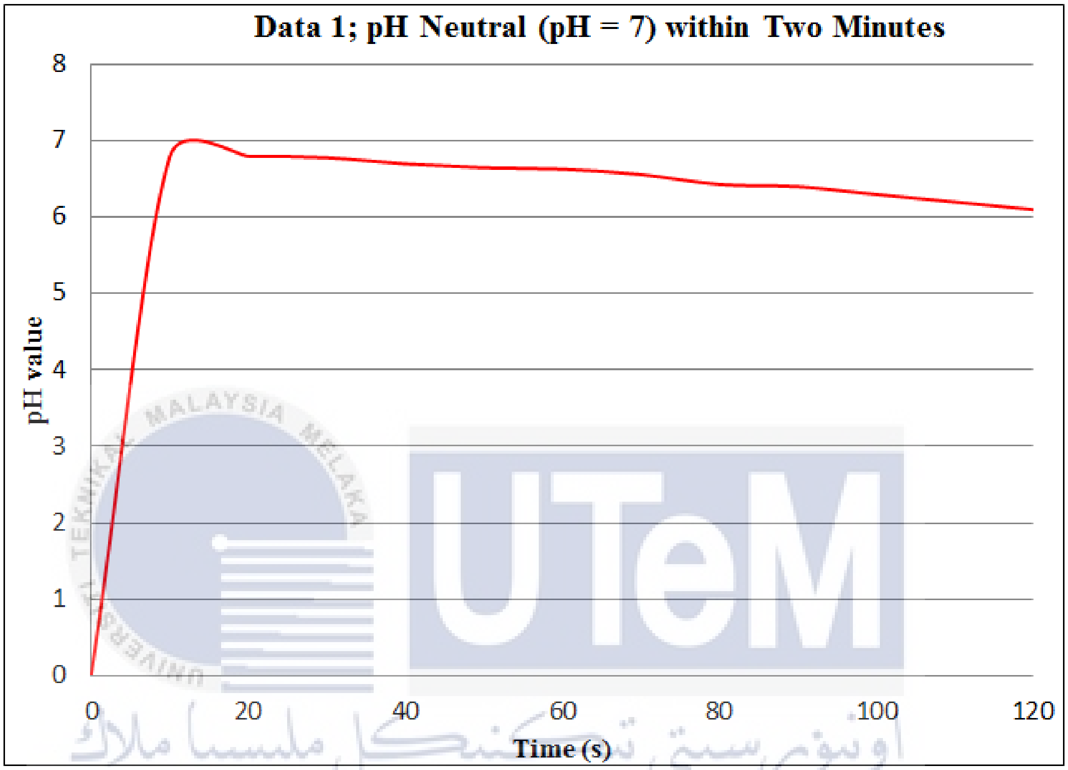

Figure 4.10: Data and Graph of pH=7

At room temperature, the pH of pure water is very close to 7. Water is considered to be neutral. It is neither an acid nor a base, but is the reference point for acids and bases. The chemical formula for water contains charged hydrogen ion that is bonded to a negatively charged hydroxide ion. This means, water has properties of both acids and bases. Where the properties essentially cancel each other's out. As time increase, temperature also decrease and hydrogen ion tend to lose, therefore pH value 7 tend to decrease to acidic.

4.4.2.2 pH Test on Acidic Solution

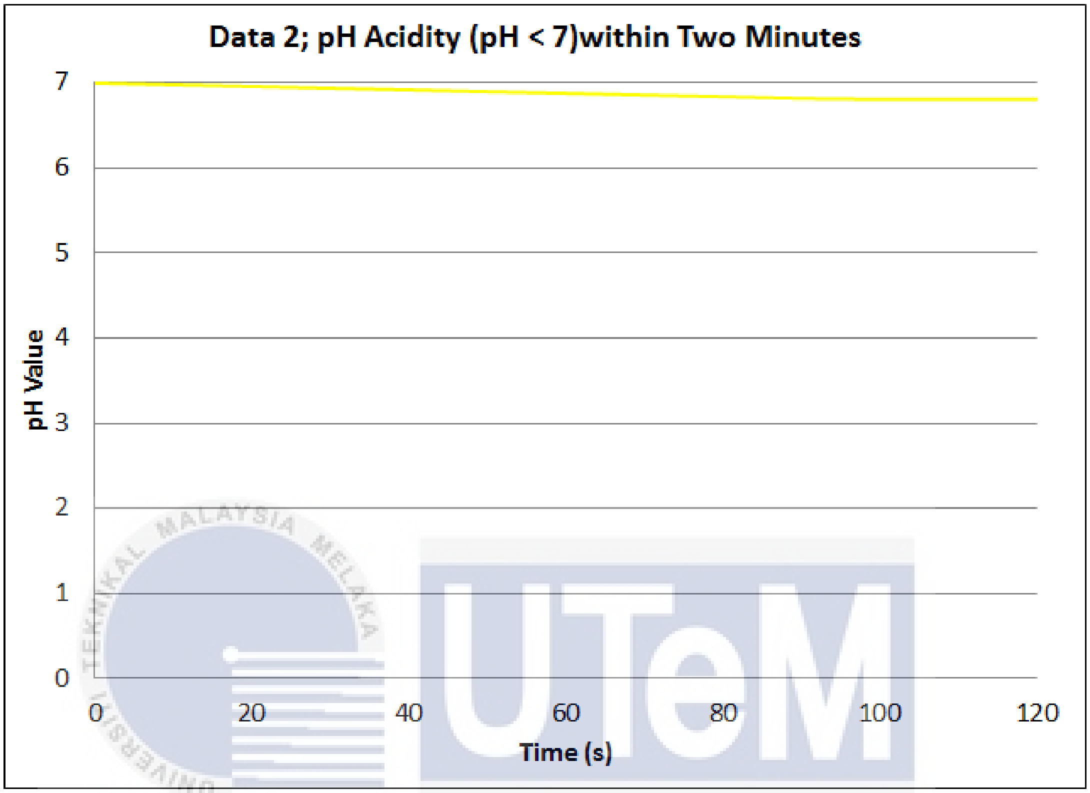

Figure 4.11: Data and Graph of pH < 7

4.4.2.3 pH Test on Alkaline Solution

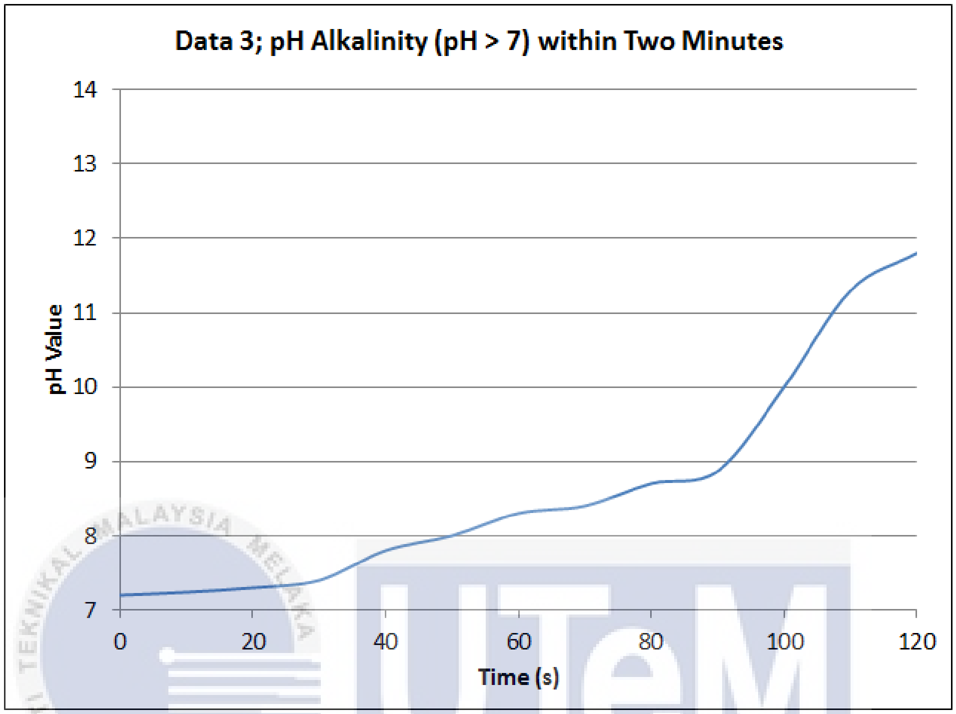

Figure 4.12: Data and Graph of pH > 7

Alkalinity consists of ions that incorporate acid protons into their molecules so that they are not available as a free acid that can lower the pH. This is known as buffering.

4.4.3 Increasing and Decreasing of pH Reading

Figure 4.13: Soluble Fertilizer Brand A and B

Brand B increasing the pH value because it contains lesser nitrogen in the substances compare to soluble fertilizer in the Brand A. Nitrogen helps in increasing the soil or water acidity and that is why Brand A maintain its pH from 5 – 6 only compare to Brand B.

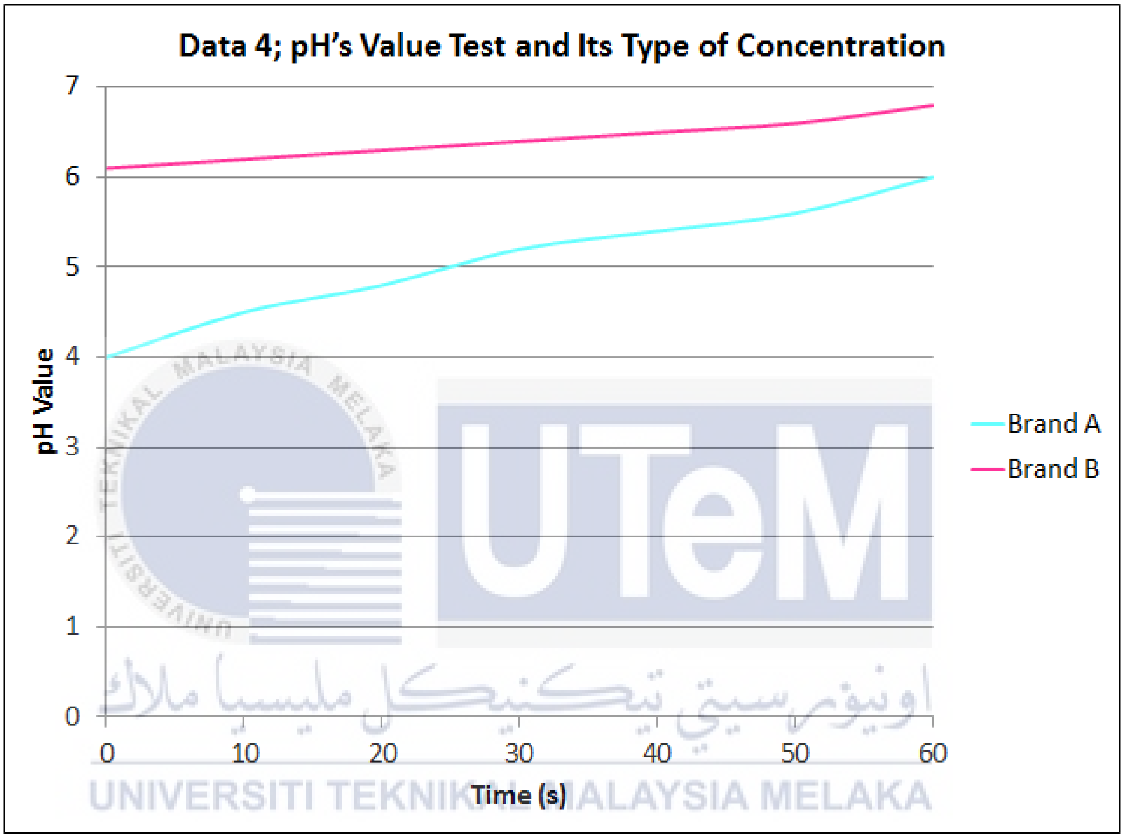

Figure 4.14: Comparison between pH Value of Brand A and Brand B

4.5 Settings for Water Nutrition, pH and Its Concentration.

Concentration of nutrition and pH has to be monitored periodically. If water level happened to be less, water has to be pump in into the vase as soon as possible so that the plant will get sufficient needs and grow healthily. But, in this system, once the float switch has triggered the less of the water contain, pump will automatically pumping in water and will flooded the plant again and again in a circulation system as long as the water keep on touching the roots of the plant and keep the substance that holds the crop in a moist condition. The concentration of nutrition has to be balance when the pH is at the sufficient value depends on the type of the plant itself.

4.5.1 Suitable pH for a Suitable Plant

How do pH values affect the crop of the plant? pH (power of hydrogen) is one of the most vital system in hydroponic. The acidity of the solution measured the concentration of hydrogen's ions in the solution. It is acidic if pH responds on monitoring application on smartphone, indicates lower than 7.0 and said to be alkaline if it's more than 7.0, while 7.0 considered being neutral. Each type of the plant has its own suitable range of pH. Content of pH could be change as if in the morning, pH is 6.5 but during the evening, pH change to 8. This is important as its effect the crop's root in absorbing nutrition. If the pH content is not suitable or right, the crops will happen to grow slow and has its own impact on the color of the leaves and soon, it will die.

In cultivating a plant hydroponically, the quality of concentration of the water is crucial and has to be monitor periodically, as I were saying. The component that is important for this part, monitoring the concentration of water with pH, is by using Atlas Scientific pH sensor. Below is the table of pH range according to its vegetables and herbs.

Table 4.1: Specification of pH's Value on Specific Vegetables

Source (Bayu Widhi, 2013)

VEGETABLES	pH
Garlic	6.0
Spinach	5.8 – 7.0
Kale	5.8
Broccoli	5.8 – 6.8
Sweet Corn	6.0
Cabbage	6.5 – 7.0
Carrots	6.0 – 7.0
Brinjal	6.0
Tomatoes	6.0 – 6.5
Potatoes	6.0

Table 4.2: Specification of pH's Value on Specific Herbs

Source (Bayu Widhi, 2013)

HERBS	pH
Basil	5.5 – 6.5
Chicory	5.5 – 6.0
Leek (Daun Bawang)	6.0 – 6.5
Lavender	6.4 – 6.8
Mint	5.5 – 6.0
Rosemary	5.5 – 6.0

4.6 System Testing

4.6.1 System Testing on Application

For Design and Implementation of Smart Observable System of Indoor Hydroponic, the application used was Bluetooth Serial Controller (BSC). This app gained from Google Play Store for Android Smart Phone and App Store for IOS Smart Phone. It is easy to design our own controller buttons and features which require few steps only. As shown in Figure 4.15, 4.16 and 4.17.

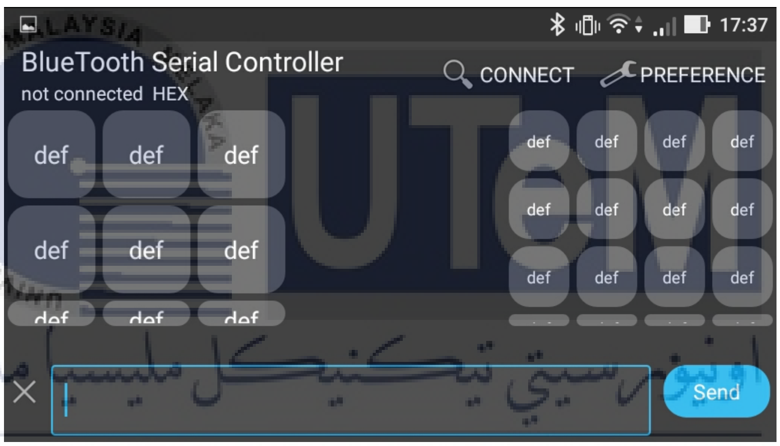

Figure 4.15: Interface of BSC

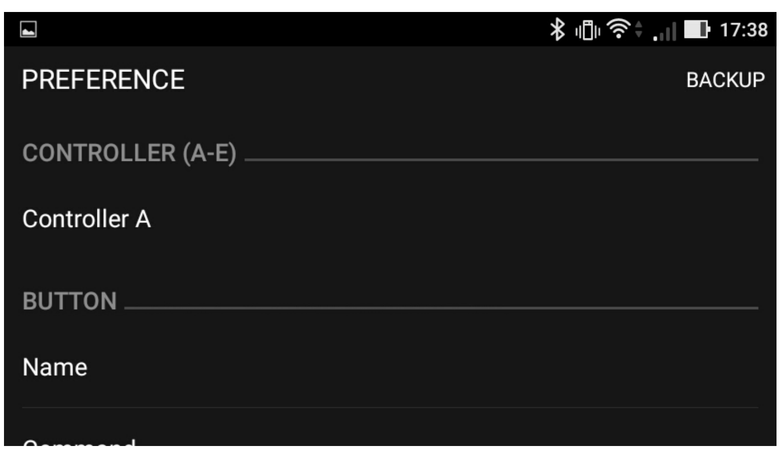

Figure 4.16: Preference inside of BSC

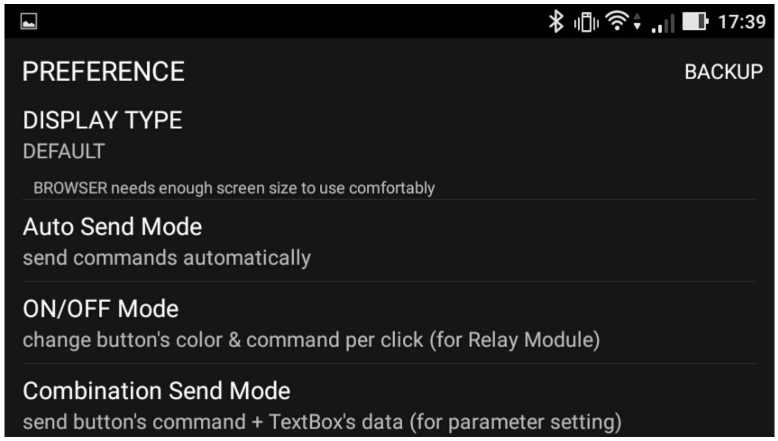

Figure 4.17: Some Other Settings in BSC

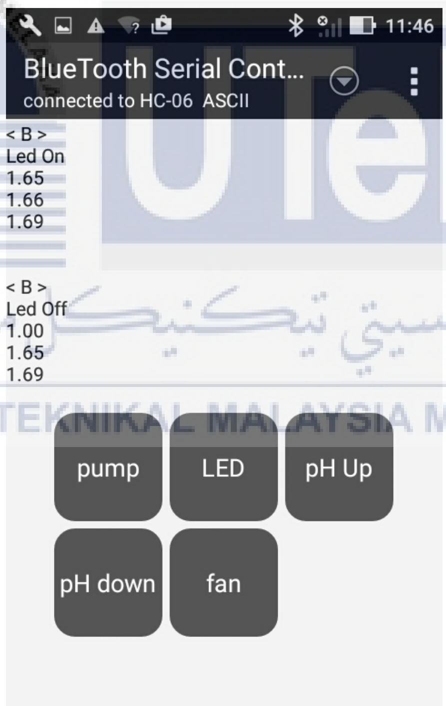

Figure 4.18: System Testing on On and Off of LED

To gain this type of observation is to choose LED button and command name will appeared as soon as certain button were click. As in Figure 4.18, button chosen was

LED. For first click, LED will turn on, and if LED need to be turn off, LED's button need to be click once again and command name "Led Off" will appeared.

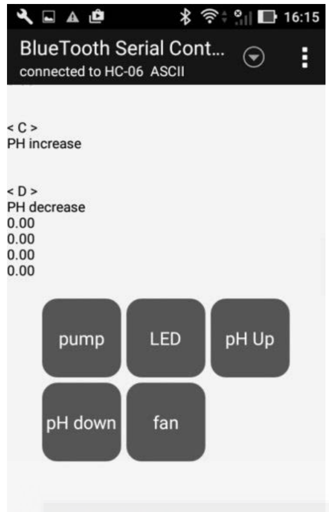

Figure 4.19: System Testing on Increasing and Decreasing of pH Values

Figure 4.19 shows that how it looks like if pH Up and pH down were click. Command name for pH Up is PH increase and pH down is PH decrease. The numbers display indicates the pH reading of the plant. There were no changing in pH's reading because pH sensor wasn't dipped in any solution.

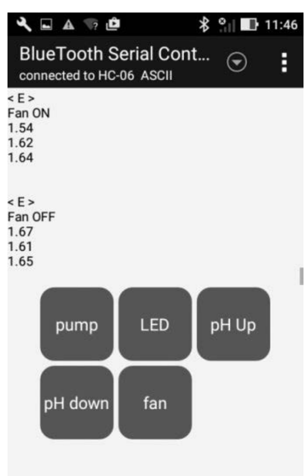

Figure 4.20: System Testing on On and Off of Fan

4.6.2 System Testing on Bluetooth Module

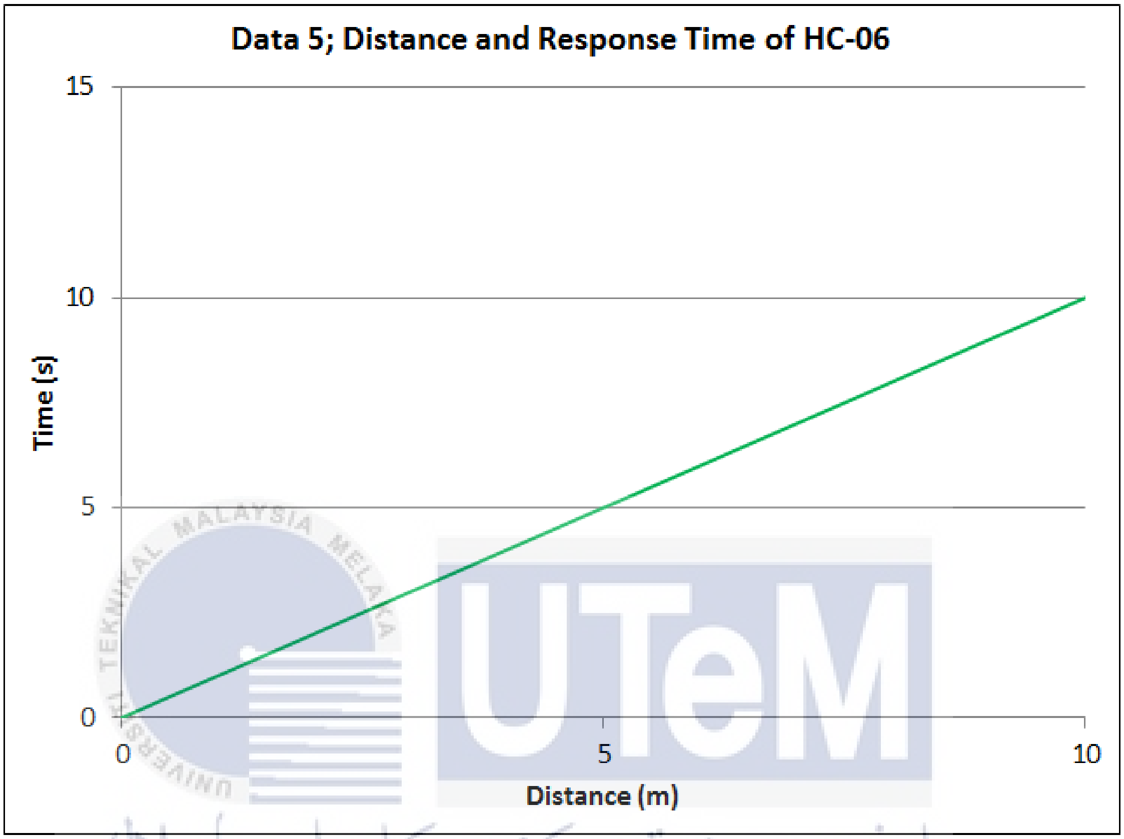

Figure 4.21: Data of Number of Weeks and HC – 06 Responded Time

As shown in graph of Data 5, the overall time required for this system was 10 minutes approximately. Since Bluetooth module can reach up to 10m, the system testing was tested up to 10m of distance. The test required the user to go over 1m at a time to see and record the time responded from the system that were keep in a bedroom. The user went to a distance of 10m maximum and it happened to be that after 10m, HC-06 and application were disconnected. As shown in 4.21 the time respond is directly proportional to the distance apart.

4.6.3 System Testing on Leave’s Length along The Weeks.

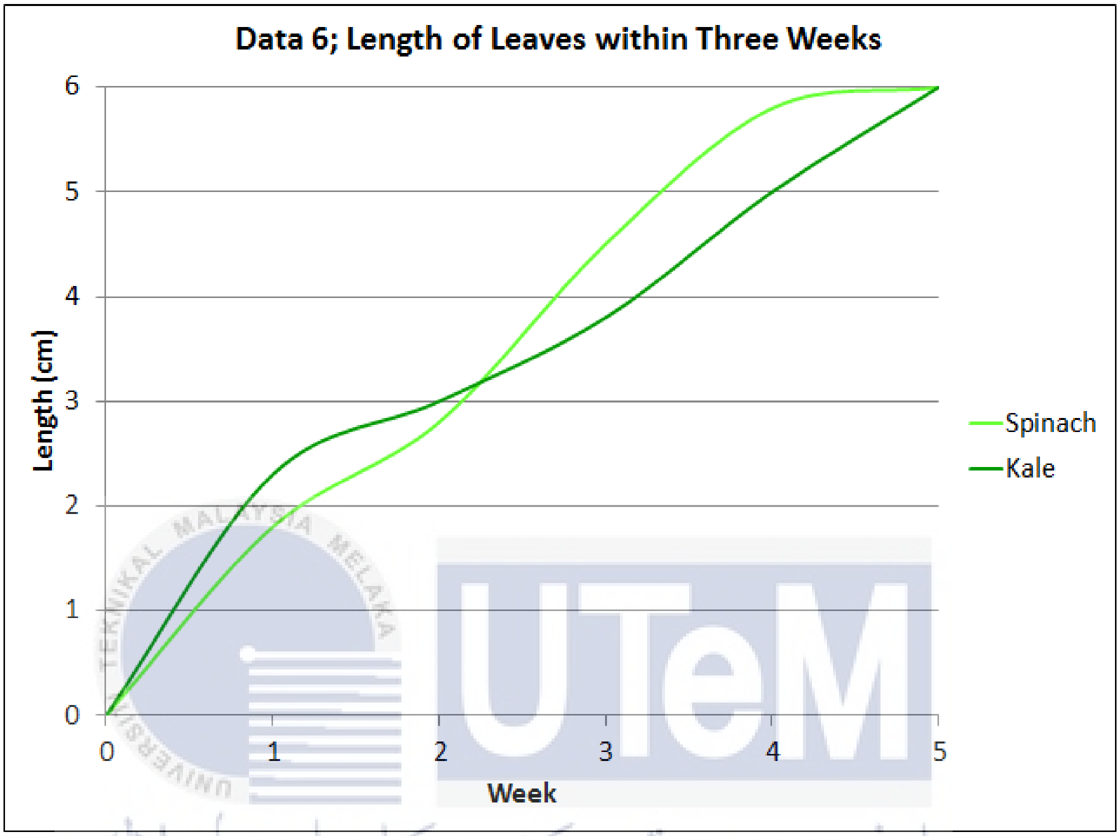

Figure 4.22: Data of Number of Weeks and Length of Leaves

The system testing was done by involving two different types of vegetables. One is spinach and the other one was kale (bayam). At some point the length of the leaves reaches its limit and can be observes on week 3 and week 4. To grow both spinach and kale, it took at least three weeks respectively. The leaves will grow 1cm or 2cm every week.

4.6.4 System Testing on Crop's Roots

Table 4.3: Roots in Different Concentration

Root 1	Root 2	Root 3
Brand A	**Brand B**	**Brand A and B (mix)**
		

For this experiment set up, three roots were planted or immerse in three different substances. Root 1 were immersed in Brand A soluble fertilizer, which contain lots of Nitrogen content compare to soluble fertilizer of Brand B which were immersed with root number 2. However, root 3 was immersed in both fertilizer, Brand A and Brand B. For previous analysis, showed that, the mixture of soluble fertilizer would gave the best value for crops because sufficient nutrient were given to the crop according to the sufficient pH value for a plant especially for kale.

What's more vital to plant productivity rather than the root growth itself? Plant's requirement for growth is the same in both soil and hydroponic cultivation which is water, oxygen and nutrients but in hydroponic, plants gain a frequent rate of replenishment of the plant's needs. As to compare with hydroponic, soil cultivation gave a large root volume to grow but less root density in most soil-based system. With water, nutrient and oxygen able to delivered directly to the root surface and plants don't need to expand as much energy on growing roots for long distance foraging.

For Brand A, in contains more nitrogen than Brand B, but give pH reading around 4 to 5. That’s mean, there’s still less nutrient in the substance, that is why the observation of root immersed in Brand A are as shown in Table 4.3 under root 1. Even though Brand B contain lesser nitrogen, which helps in photosynthesis of the plant but it contains lots of potassium, trace element which stimulate plant metabolic processes and lots more. It gave better response to the roots growing system as shown in Table 4.3 under root 2.

Last but not least, the mixture of both fertilizers gives a balance and almost perfect nutrient demand by plants. With a mixture of nitrogen from Brand A fertilizer, and lots of advantages from Brand B fertilizer, it gave perfect pH reading for plant which is 5.8. These ensure that plants will grow healthily with sufficient nutrient suck into the root system as shown in Table 4.3 under root number 3.

CHAPTER 5
CONCLUSION

5.1 Introduction

In this final chapter, where all of the conclusions have to be made, explained and proved that all of the objectives have been achieved. It will explained briefly about what are the objective's achieved, some recommendations to make better system of hydroponic and finally, project potential which believes to go far beyond than what we have in this era.

5.2 Conclusions

Indoor hydroponic system is a very interesting home furnishing that many people have put eyes on and starting to show some interest at. It is complete with some technology or electrical system that brings the comforts of having a growing plant in or outside of your home.

Even there is much different within the developed technology of hydroponic nowadays, hydroponic still promise to provide a better, bigger and healthier yield or crops. The better technology such as sensors and components that helps in regulates the air and acts as an artificial sunlight for the plants, the better and healthier the plant will grow.

In order to ensure that these technologies give their best service to their user, the user has to provide the needs of the plants efficiently and with a moderate monitoring session. This whole project is all about managing and monitoring which promise a better yield when it is a harvesting time. As to accomplish the objectives, users need tools to communicate with the system and helps in nourishing the plants day by day.

The whole idea has been presented in this Final Year Project 1, and it is accepted and as well as Final Year Project 2. It turned out to give good responses, analysis and result. For whatever risk and challenges appeared while completing FYP 2, it still managed to be done and achieved its objective, where smart system that can operate indoor hydroponic for home use has been implemented with electrical monitoring system including pH of the crop. It has been proven also that this system helps in development of better system.

5.3 Recommendations

This study focus on the indoor hydroponic system by using Ebb and Flow technique because it is the easiest technique to use and almost all growers of hydroponic system used this technique. Somehow, there is so much more type of technique that could use less startup modal and better for crop yield such as Floating Hydroponic System (FHS). There is not much different from Ebb and Flow but in FHS, the crop get sufficient oxygen and air so that the crop's root will grow maximally and the optimally.

For a better monitoring system, these whole products have to be in automatically state. Which means, the way user need to monitor the system has to be automatic from pumping in water and automatically receive a message about the condition of the crop and then, it reacts on its own for whatever the condition is. For example, if the crop is less in pH value, the user would receive a message and then, water pump in the solution that helps in increasing the sufficient pH need to pumping in the solution into the vase that hold up the vegetables or crop.

It is recommended that to use more sensors. Such as sensor to sense the electrical conductivity (EC) of the crop. This is due to, many growers, especially beginners, tend to concentrate more on their feed solution, the root zone solution will always have a different nutrient balance to the feed and usually a different EC and pH. Typically for Ebb & Flow or Flood & Drain Systems, if you have both automatic EC and pH control, then these obviously controlled. What is not controlled is the nutrient balance of the recirculating solution. If the EC gets too high, plants will suffer and eventually die. It is safe to add EC meter or sensor.

Last but not least, it is recommended as well that this hydroponic system is spread around the globe and it will educate young children about a simple and basic form of electronic system, sensors and as well as preserves your own food which is interesting.

5.4 Project Potentials

Food, water and living space are the human's requirement to survive. These things do not exist in endless abundance and are derived both from abiotic and biotic sources, where optimization of land area and the preservation of biodiversity makes humans inherently dependent upon them. To emphasize these matters, the affluence of the world is increasing, meaning feature's consumers will demand higher.

First and foremost, world's land area and substantial quantities of fresh water and fossil fuels are being devoted to the production of food in a massive portion which fails to meet humanity's basic dietary needs. Hydroponic is a system of agriculture that utilizes water rather than soil for crop's nourishment. Hydroponic presents people who are living in arid regions with a means to grow food for them and for profit because in order to be effective, it does not require natural precipitations or fertile land.

Some of the advantages are, in drought prone areas or deserts hydroponic still can be develop because water can be recycled. With hydroponic, excessive richness of nutrients in a lake frequently due to run off from the land, which is the main causes of dense growth of plant life and animal's life from lack of oxygen. After all, as to achieve concrete results through hydroponic technique which is easy and does not require any prior knowledge at all can be helping.

The use of advance hydroponic can be cheaper in a long run. The potentials of this smart observable system for indoor hydroponic wins over the drawback of the indoor hydroponic. This is because it can go beyond home-startup-hydroponic-system. According to it sizes, it only can hold one or two type of vegetables in the vase but somehow, it still can give you profit by providing your own food and this system can be sell due to its applicable monitoring system including pH, duplicate sources of sunlight, and ventilation system. There is so many ways in build up this system from easy to complex and you would still meet the same quality and benefits.

If we're about to find out basic science project at school is that, hydroponic will always the best project beginner at school and home. Hydroponic is a fancy-sounding word, but believe it or not it can go beyond than just a basic school's science project. For example, Seawater Greenhouses which joint power planted greenhouses facilities in arid locations, serving as sources of fresh water for the purpose of irrigation and human consumption, as centers of food development and repositories for solar energy.

The companion technologies interact in order to create a self-sustaining operation including light tracking reflectors turns turbine to produce electricity as a continuous operation for the power plant, seawater that helps in humidifies the air within the greenhouses, a fresh water that form for continuous irrigation and drinking and of course the resultant crops that feeds human.

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