Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF AQUAPONIC SYSTEM WITH IOT

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DEVELOPMENT OF AQUAPONIC SYSTEM WITH IOT

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A project report submitted
in partial fulfillment of the requirements for the degree of
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DECLARATION

I declare that this project report entitled “DEVELOPMENT OF AQUAPONIC SYSTEM WITH IOT” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

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Date :

DEDICATION

To my beloved parents especially my mother, Suhaila Binti Mansor, and my father, Zabidi Bin Awang, that give their full support during my trip to complete this project in mostly term of encouragement and moral until complete my project,

and

To my dearest siblings and my friend that also helps by moral support in term of giving some ideas and opinions to fulfil the requirement to complete this project. Praise to TheGreater who a create the world, Allah S.W.T that I get supportive family and friend thatvery understand and always give me some idea that might help for this project. Thankful for all advised I am blessed.

ABSTRACT

In this era of globalization, the aquaponics system is a method of food production by combines aquaculture with traditional hydroponics in a relationship of symbiotic which facilitates to sustainable system with the necessary inputs because all water and nutrients in it are recirculated to increase land plants and aquatic life. This farming technique may take over other traditional methods if used efficiently. And when traditional Aquaponics meets technology, extraordinary results can be seen. An IoT-based Aquaponic Monitoring System has been carried out for monitoring pH values, level of temperature and level of humidity, water level are using certain sensors and after seeing these values from the sensors, these values are displayed via Liquid Crystal Display (LCD) and similar on the website with the application. Internet of Things. A new technology, Internet of Things has been introduced which bridges the gap between the world of being and the digital world and it starts with things. To connect sensors to the internet, database servers and application servers can be managed so that they can show data overwriting sensors. In order to bring technology to the traditional aquaponics system, the BLNYK APP microcomputer and the Internet of Things have been tried in the system.

ABSTRAK

Dalam era globalisasi ini, sistem akuaponik adalah kaedah penghasilan makanan yang menggabungkan akuakultur dengan hidroponik tradisional dalam hubungan simbiotik yang memfasilitasi kepada sistem yang lestari dengan input yang diperlukan kerana semua air dan nutrien di dalamnya dikitar semula untuk meningkatkan tanaman tanah dan kehidupan akuatik . Cara penternakan ini boleh mengubah kaedah tradisional lama yang digunakan dengan lebih cekap. Dan ketika Aquaponics tradisional memenuhi teknologi, hasil yang luar biasa dapat dilihat. Sistem Pemantauan Aquaponic berasaskan IoT telah dilakukan untuk memantau nilai pH, tahap suhu dan kelembapan, paras air menggunakan sensor tertentu dan setelah melihat nilai ini dari sensor, nilai-nilai ini dipaparkan melalui Liquid Crystal Display (LCD) dan serupa pada laman web dengan aplikasi. Internet Perkara. Teknologi baru, Internet of Things telah diperkenalkan yang merapatkan jurang antara dunia makhluk dengan dunia digital dan bermula dengan perkara-perkara. Untuk menyambungkan sensor ke internet, pelayan pangkalan data dan pelayan aplikasi dapat dikendalikan sehingga mereka dapat menunjukkan sensor penimpaan data. Untuk membawa teknologi ke sistem akuaponik tradisional, komputer mikro BLNYK APP dan Internet of Things telah dicuba dalam sistem ini.

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This project would not have been possible without the invaluable advice and encouragement I received from my supervisor, Encik Mazree Bin Ibrahim.

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Thank you to my parents and other family members for their support and prayers. My supervisor, Encik Mazree Bin Ibrahim, deserves special recognition for his encouragement and patience throughout the process. My friends, I want to thank you for sharing your thoughts and ideas.

Thank you to everyone at UteM who has been helpful and supportive during this process. Special thanks go out to the Faculty of Electrical and Electronic Engineering Technology (FTKEE) and my fellow students and professors.

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LIST OF SYMBOLS

%	-	Percentage
ºC	-	Degree Celcius
I/O	-	Input and Output

LIST OF ABBREVIATIONS

V	-	Voltage
Iot	-	Internet of Things
A	-	Ampere
Gnd	-	Ground
GMS	-	Global Message Service
Cm	-	Centimeter
Kg	-	Kilograms
Mm	-	Milimeter

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CHAPTER 1

INTRODUCTION

1.1 Background

Recently, a unique way of farming has emerged, combining fisheries and agriculture to create a stable ecosystem cycle, namely Aquaponics. Applying the aquaponic cultivation method itself is still relatively new because the rapid population growth causes the lack of land for cultivating these two types of cultivation. The aquaponics system is a food production process that combines traditional hydroponics with aquaculture in a symbiotic relationship that facilitates a long-term system with the necessary inputs because all the water and nutrients in it are recirculated to promote land plant and aquatic life. This farming method may replace existing traditional practices if used efficiently. And when traditional Aquaponics meets technology, extraordinary results can appear.

This project aims to develop the aquaponic system with Arduino's IoT monitoring system. Generally, an aquaponic system that measures and displays parameters like pH level, water level, humidity, temperature, etc., continuously to the user or farmer. Sensors are the hardware components used to acquire information to and from the Internet of Things (IoT). With the application of the Internet of Things (IoT) in Aquaponics systems, it can bring remarkable changes in aquaponic by simply monitoring and maintaining the system parameters for the effective growth of the plants. The use of Wi-Fi of ESP8266 ESP-01Serial wireless WIFI helped to connect the system to read the values of system parameters like pH of water value, the water level in aquarium, temperature and humidity of soil. With the application of the Internet of Things in the Aquaponics Monitoring system, the data from the sensor can display the values of the system parameters and information continuously on a smartphone.

1.2 Problem Statement

Aquarium care and gardening are fun beneficial activities that help relieve stress but aquarium members face some problems to maintain a healthy fish life in the aquarium and also gardeners face some problems to maintain healthy plants.

Changing the aquarium water can be a difficult task because we know it requires a lot of work as much as the gardening need to water the plants as a working person it quite difficult to do. also feeding fish is a messy task for fish keepers during their absence or at any time they vacation.

A combination of these two issue can solve by the system it call aquaponic system. But this old system has face same problems which it still need a person to handle the system by manually and also it quite difficult task to do.

In addition, water temperature and salinity are necessary checked periodically for healthy fish life. Fish suspended particles are necessary removed if it exceeds the limit then the water needs to be changed if it exists in that condition high turbidity.

The system inspired by aquaponics and with little adjustment needs to be developed to control, monitor and feed the fish continuously as well as water the plants all by smartphone.

1.3 Project Objective

Specifically, the objectives are as follows:

a) To design an aquaponic system using Arduino as microcontroller.

b) To develop aquaponic system that allow user to control and monitor by smartphone.

c) To evaluate aquaponic system that a smartphone can monitor and control.

1.4 Scope of Project

The purpose of this project is to control and monitor for aquaponics system with smartphone by using internet. This aquaponics system project is based on Internet of Things (IoT) application that promotes the control and monitoring of aquaponics appliances using the internet. This system uses three loads to demonstrate as water pump, feeding fish and level water tank. IoT is the combination of electronic devices connected with sensors, actuators, software's and a Wi-Fi that allow these objects to exchange information. The project of scope is using Arduino Uno microcontroller work as a brain to control all of activity the components used for this project. Additionally, WIFI module was used for wireless connection between the microcontroller and smartphone developed using the Blynk App. The mobile application based on Blynk App will be developed to control electrical appliance for aquaponics and to monitor water tank level at tank by using smartphone. Aquaponics system has two water pumps for changing water in aquarium or tank, timer for feeding fish and soil moisture sensor by control using smartphone.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the researcher will survey all research about the previous project work that related to project and express and clarify on objective of the project, problem statement of the project and the innovation that have done towards the projects. Other than that, there also will be content of researcher own such as history about system of project and the search databases that can be used for the literature review such as ScienceDirect, Google Scholar and Web searches. “Aquaponics system”, “Iot Technologies”, “Smart aquaponics system”, and “IoT based Aquaponics Monitoring System” are some of search phrases word. In addition, this study is limited to research papers starting in 2013 to 2020 (8 years) only and is also limited to English language only for research papers.

2.2 History of Aquaponics

The history of aquaponics dates back to Asia and South America. It is known that this system dates back to the ancient Aztec civilization that lived in South America. At that time they had the idea to make an island out of mud that was drained by canal water where fish lived. The water and nutrients in the canal water are used to irrigate the plants grown on the artificial island. Not only in South America, the ancient Chinese people were accustomed to simple aquaponic systems although at that time the term had not been invented. They raise ducks on the fish pond and the water of the fish pond will then be used to irrigate the rice fields and vegetable gardens that they plant.

From this simple aquaponic system, researchers in the field of agriculture and science began to research about this planting system. Some of the studies recorded include the following:

In 1969, American scientists John Todd and Nancy founded an institute that later initiated the development of a planting system called the Ark system. The institute that they established, Alchemy institute, further continues to conduct research on fish and vegetable cultivation, especially those that require energy or a continuous supply of electricity. They also built an electrical panel system that used lighting and the needs of fish and plant farming.

In 1971 a researcher from the University of the Virgin Islands discovered difficulties in growing vegetables and fish farming on an island called Semiarid in Australia and then he developed a study on the technique of growing both at once. This research is the basis of commercial aquaponics systems that are currently widely used by farmers who cultivate fish and vegetables. Although researchers' efforts in developing this system still encountered many obstacles, researchers found that the organic elements found in these farms are environmentally friendly and more energy efficient. Because of this, the aquaponic system is suitable to be called organic farming that uses green technology.

In 1980, a student from the University of North Carolina, Mark Mc Murtry and his teacher Professor Doug Sanders began construction of their aquaponic system known as the loop aquaponics system. They grow crops such as tomatoes and cucumbers and then cultivate fish in ponds. The water in the tank used to accommodate the fish is then used to irrigate the plants planted on the sand medium. This sand planting media acts as a filter media or water bio filter which will then be returned to the fish tank. It is this principle of circulation that later became the basis of aquaponic agriculture today.

In the 1990s, two farmers, Paula Speraneo and her Missouri colleague Tom, managed to build a more effective aquaponic system that is used for household scale or small scale aquaponics today. They use planting media in the form of gravel and under the plants they plant, there is a tank containing tilapia whose water is drained to irrigate the plants.

2.3 Internet of Things (IoT)

The Internet of Things (IoT) refers to a technologies that allow various appliance, device, and things to exchange data or collecting data by using internet connection. It has an ability to transfer a data without requiring human to human or human to computer interaction. An ecosystem of an IoT will be consist web enable smart device that use embedded system such as sensor, processor, and hardware to collect information from the environment. In this 21st century IoT become the most important technology in all country around the world. This because the cost of sensor is low, the connectivity is simple and easy, have more availability of cloud services platform, and it has conversational AI technology which make human easy to collect data and process a data.

With that the internet of things (IoT) can minimize the human effort and save every minute of the day by performing a lot of task for us. This can cause this device can complete most of the work without human intervention. Figure 2.1 shows Internet of Things.

Figure 2.1Internet of Things

2.4 Previous aquaponics system with Iot

In this study, several theories and the results of previous research were used, which later became the basis of the work of this research.

2.4.1 Automated Indoor Aquaponic Cultivation Technique

This research was proposed by Saaid, Fadhil, Megat Ali, and Noor in 2013 entitled "Automated Indoor Aquaponic Cultivation Technique". This study discusses a system to maintain the growth and survival rate of fish and plants by monitoring the desired water level; the temperature monitored in the fish tank, the temperature monitored in the plant area and the desired amount of food. At the same time, Arduino functions as a brain used to receive information from sensors and provide a response as feedback [1].

2.4.2 Temperature, Humidity, and Control System Hydroponic Plant Watering using Blynk Android

This research was conducted by Wahyu Adi Prayitno, Adharul Muttaqin, and Dahnial Syauqy in 2015 entitled “Temperature, Humidity, and Control System Hydroponic Plant Watering using Blynk Android”. This research discusses aquaponics that can be monitored by combining capabilities arduino mega as a data acquisition system equipped with Ethernet shield for delivery data via the internet, DHT22 sensor for real time timing Arduino mega is also connected to a relay to regulate the fault of the sprinkler pump or water circulator [2].

2.4.3 Smart Aquaponics System: Challenges and Opportunities

This research was conducted by Shafeena T in 2016 entitled “Smart Aquaponics System: Challenges and Opportunities”. This study discusses the control system needed for aquaponics to monitor and control a dynamic system using the Arduino Uno microcontroller so that aquaponics performance can be maximized [3].

2.4.4 Smart aquaponics system development

This project proposed by Zulhelman in 2016 et al, where in this system, the IoT principle is run or controlled by two microcontrollers namely Arduino UNO and ESP8266 microcontrollers. For 8 Arduino microcontroller itself is used as a bridge between sensors with a cloud server, while ESP8266 is used as the cloud server which will later distribute the data obtained to the internet to be able to processed by the device or device end-user On the end-user side of the application manager run on an android based platform. There are several sensors that used in his smart aquaponics system, namely the temperature sensor or temperature, ultrasonic sensors, and water pH sensors. Ultrasonic sensor itself serves as a detector of water levels in tanks or ponds so that we can maintain the waterlevel in the pool. In the process the smart aquaponics system run fully automatic, where there are several critical points that will be become a trigger for the actuator in the system, besides that, there is a web page that is used as a center for storing results retrieval of data from sensors. So for the mobile application it will only read the data provided by the web page earlier, and provide input for the speed of response to reading data. Basically the development of this system is more directed to the monitoring process only, with slightly added automation in it, users can not set or manage the actuator manually, but can only adjust the speed reading the data [4].

2.4.5 Real time monitoring of the environmental parameters of an aquaponic system based on Internet of Things

This project proposed by Manju M in 2017, namely an Internet of Things-based aquaponic system which is then carried out Real Time monitoring for the parameters that exist in the aquaponic environment based on the IoT system. In the system there is an Arduino microcontroller which serves as a support for the IoT system. The IoT support system is called the LumisenseIoT board, where later the device will connect various sensors so that it can transmit data over the Internet. There are quite a number of sensors used in this system, with the intention that the system can provide precise data on environmental conditions in the aquaponics ecosystem, some of the sensors used in this system are, air temperature sensors, water pH sensors, sensors for detecting ammonia levels, sensors water level and soil moisture sensor or moisture in the soil, this system can also move automatically to maintain the aquaponic ecosystem. This system is intended to provide convenience in monitoring the condition of the ecosystem in the aquaponic farming system, where in the system a sensor is applied that functions to check the level of ammonia in the pond containing the fish, where these substances are very useful in the rotation of the ecosystem that supports the aquaponics system. So that through this easy assistance, it is hoped that the use of aquaponics will increase, especially for urban areas where the availability of land is quite small and the availability of natural resources such as water is very limited in quantity [5].

2.4.6 Smart Aquaponic with Monitoring and Control System Based On IoT

This project proposed by Wanda Vernandhes, N.S Salahuddin, A. Kowanda, Sri Poernomo Sari in 2017. A smart aquaponic system using the concept of the Internet of Things with the name "Smart Growbox". The system is implemented on the platform Arduino microcontroller which serves as a cloud server for its IoT system, which is then connected to several sensors that become auxiliary tools reading the data, for example the sensors used are, Soil Moisture, Humidity Sensor and LED that can emit a wide spectrum of colors help plants. The system was also connected to a mobile application based on android which will later become the remote controller of the system, so that everything actuator will control all the needs of the plant. This device intended to facilitate the process of plant care through the irrigation system owned by aquaponic, the user can activate or disable automatic mode through the android application, so the system will running and doing the work, typing some points from reading the data reached the tipping point [6].

2.4.7 IoT based Aquaponics Monitoring System

This project proposed by Abhay Dutta, Prayukti Dahal, Rabina Prajapati, Er. Saban Kuma, Pawan Tamang in 2018. This project used raspberry-pi as a control and monitor system via smartphone. This project used a pH sensor, Arduino Nano, ultrasonic sensor, DHT11, soil moisture sensor, LCD, relay, bulb, Raspberry Pi and pump. The result of this project is that the monitoring section was established to detect the water level, pH value, temperature, and humidity of the aquaponic system by using an Ultrasonic sensor, pH sensor module, and (DHT11) respectively. All these sensors were interfaced with the Raspberry Pi microcontroller. The data displayed all the system parameters through LCD and IoT successfully. By applying IoT in this system, it has been possible to view the readings from anywhere in the world. This project is controlled and monitored using RaspController via a smartphone connected with Raspberry Pi. The disadvantage of Raspberry Pi was not running the Windows Operating system, it would cause crash a lot, and there will be many bugs [7].

2.4.8 Smart aquaponics system based Internet of Things

This project proposed by Haryanto, M Ulum, A F Ibadillah, R Alfita, K Aji and R Rizkyandi in 2019. This project used a GSM module as a control and monitor system via smartphone. This project used ultrasonic, pH, temperature, pump, fish feeder, Arduino Uno, GSM, LCD, and Arduino GPRS modules. The result of this project is the growth of plants and fish on the intelligent aquaponics system ranges from 25 degrees to 30 degrees and pond water pH between 7-7.5 with the intensity of fish feeding three times a day, the level of accuracy of the sensors used is relatively high with an average success rate of 99.943% for ultrasonic sensors, pH sensor of 92.353% and temperature of 97.907% and the process of sending and receiving sensor data to an Internet of Things based server runs well using a Wi-Fi connection. This project controls and monitors using messages via a smartphone connected with GSM Module. The disadvantage of the GSM Module was electronic interference that could interfere with certain electronics, such as hearing aids. Such interference is since GSM uses a pulse-transmission technology [8].

2.4.9 IoT Controlled Aquaponics System

This project proposed by Prabha R, Sri Saranish R, Sowndharya S, Santhosh AC, Varsha R, Sumathi K in March 2020. This project used Zigbee as control and monitor system via smartphone. This project used LM35 sensor, LDR, ammonia sensor, co2 sensor, PIC Microcontroller, pH sensor, temperature sensor, pump, fish food model, relay, cooling fan, LCD, Zigbee and Arduino Uno. Result of this project are the framework that uses IoT which is the point and target of this task is implemented effectively, easy to use framework, control and observation of information is done through IoT because system inspection is continuous and this framework helps make 24x7 observation and stay away from manual difficulties seen by individuals. This project control and monitor using Glamox Wireless Zigbee via smartphone that connected with Zigbee. Disadvantage of Zigbee was short range to connect from 10 to 100 meter only [9].

2.4.10 Smart Aquaponics Farming Using Iot & Mobile Computing

This project was proposed by Janavi Chavan, Sonali Patil, Kiran Jangam, Divya Chirayil in April 2020. This project used GSM Module as a control and monitor system via smartphone. This project used IC Atmega 328p, soil moisture sensor, DHT11, Ultrasonic sensor, pH sensor, GSM Module, ESP8266 (WIFI Module), LCD and pump. The result of this project is that farmers will be able to monitor their aquaponic farming from anywhere. The real-time value will be shared with them using message service and through the mobile application; this project has a temperature sensor, pH sensor, soil moisture sensor. The ultrasonic sensor is interfaced with IC 28p. This value is detected from the microcontroller. It is displayed on 16x2 LCD, and this same can be used by the rural area farmer where they can be informed regarding fish and plants through an SMS system. The disadvantage of the GSM Module was electronic interference that could interfere with certain electronics, such as hearing aids. Such interference is since GSM uses a pulse-transmission technology [10].

CHAPTER 3

METHODOLOGY

3.1 Introduction

In general, this chapter describes a full description of methodology that has been used in this project. It is mainly about the hardware and software that are used to make thissystem is convenient for the user. This chapter discusses about the full process and the components that are used to make this project successful.

3.1.1 Project Propose

The research proposes the project IoT based monitoring and control system for the aquaponics system. This project related the Internet of Things (IoT) with an aquaponics system for handling and controlling aquaponics systems via the internet using a device such as a smartphone. This project uses Arduino Uno as a microcontroller, ESP8266 WIFI module, Ultrasonic Sensor, relay, Analog pH sensor, servo motor, Water pump, Soil moister sensor and DHT11 (temp sensor).

The main purpose of this project is to control the water pump and monitor the aquaponics system. This project is proposed to facilitate users for users who are lazy to change the water in the aquarium, who are lazy to watering plant especially as working person and can also save energy for users. This smart aquaponic system based on the aquaponic system makes it easy for users like adults to be controlled and monitored by the aquaponic system at theirs house, this has made it easier for users, safer and more user- friendly.

Users can monitor aquaponics system at home and users can control the water pump by turn ON/OFF also can gives feed for fish by turn ON with instructions given by using smartphone. But for watering plants, it will automatically watering plants when the soil moisture sensor detect our soil are dry and below than our set in Blynk app. For this project are use Blynk App as to connect Arduino Uno and smartphone.

3.2 Materials

Materials are essential elements of this project. In this project, the components must be adequate and no more minor because each component has functions respectively. If one of the components is missing out in the circuit, the circuit can't properly function, and the circuit will be facing a problem because of not enough material. Table 3.1 shows the list of components is used in this project.

Table 3.1 List of components

BIL	Name Of Component	Quantity
1.	Arduino Uno R3	1
2.	WIFI module ESP8266	1
3.	Soil moisture sensor	1
4.	Ultrasonic Sensor	1
5.	Relay	3
6.	Analog pH sensor	1
7.	Servo motor	1
8.	Water pump	3
9.	DHT 11 (Temp Sensor)	1
10.	LCD	1

11.	Breadboard	1
12.	Power supply 9V	1
13.	Jumper wire (female to male)	35
14.	Jumper wire (male to male)	35

3.2.1 Hardware equipment and specification

3.2.1.1 Arduino circuit

This project used Arduino UNO R3 which is work as the brain of the system to control the whole system's features and interfacing all the components in this system. The function of the Arduino is to interface all the components and system.

Arduino Uno can be categorized as microcontroller board which is an open-source electronic broad that used in many prototypes. This board is based on the Atmega328 series microcontroller. Moreover, to writing, compiling, and uploading the coding in the Arduino Uno microcontroller we can use the integrated app which is Arduino IDE. So, the coding language that used in the Arduino is also very easy and basic because it is based on C or C++ programing language. This Arduino have total of 20 input and output pin where 14 of that pins is a digital I/O pin (have six PWM), and another 6 pins is an analog I/O pin for the use of the communication between the electronic component. The example of electronic component is such as sensors, motor, switches and so on. Other than that, the Arduino Uno microcontroller also have 16MHz of ceramic resonant, an external power supply jack/port, USB connection port, reset button, GND pin, and a 5V pin for the supply purpose. The working principle of this Arduino is, first we must design the circuit with using this Arduino microcontroller. Then write the coding with using Arduino IDE software which is very easy to understand. After done on writing the code the Arduino board need to be connected to the computer with using a USB connector. Check whether it is connected in the IDE software and if it is connected then at the top of the menu there will be a command upload where when we press the command it will upload the coding to the board. Done on upload its ready to use. Figure 3.1 shows Arduino Uno R3.

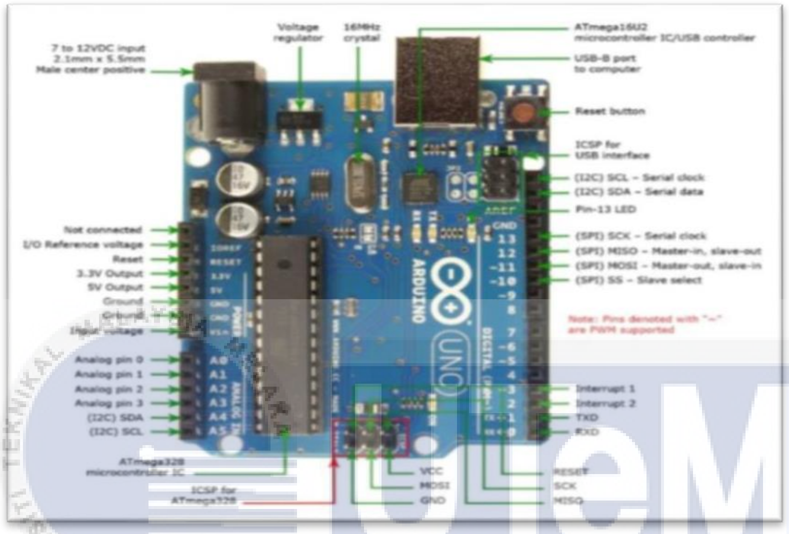

Figure 3.1Arduino Uno R3

3.2.1.2 WIFI module ESP8266

The ESP-01 (ESP8266) is a Wi-Fi module that allows microcontrollers access to a Wi-Fi network The ESP8266 microcontroller is an Wi-Fi enable system on chip (SoC). Espressif Systems which is a multinational company that produces this chip located in Shanghai China. The ESP 8266 microcontroller also can be categorized as the cheapest Wi-Fi microchip which have the full internet protocol suite (TCP/IP) and the capability to be a microcontroller.

This microcontroller is based on 32-bit architecture. In terms of CPU this microcontrolleris using a Tensilica Diamond Standard CPU which have the clock speed of 80 MHz till 160MHz. Besides that, ESP-8266 microcontroller has a memory of 32KB on chip for data and program instruction. It also has very impressive I/0 where it has 10-bit ADC to measure external voltages, have 17 GPIO's programmable pin, Serial peripheral interface (SPI), PWM (Pulse Width Modulation) and so on.

So basically, the ESP8266 chip is very versatile chip that can be used to many IoT project. And when the user uses all this power wisely it can be run on the battery for a very long time because it is battery friendly. Finally, ESP8266 microcontroller also supports Arduino framework where it can be programmed with using Arduino IDE software and it also implies that all the library in Arduino that already exist works well with ESP8266 Microcontroller. Figure 3.2 shows WIFI module ESP8266.

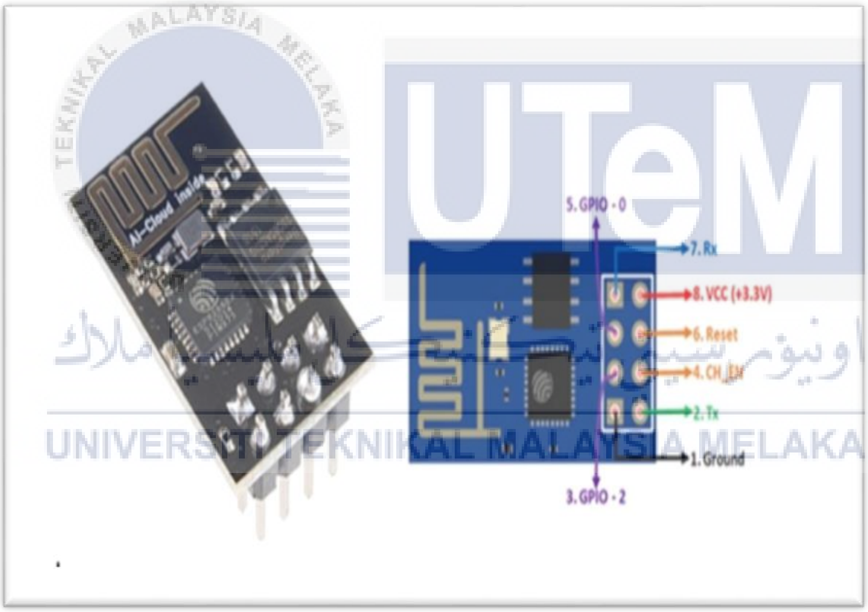

Figure 3.2 WIFI module ESP8266

3.2.1.3 Soil moisture sensor

The moisture sensor allows monitor the water content in the soil. The output can be a digital signal (D0) LOW or HIGH, depending on the water content. If the soil humidity exceeds a certain predefined threshold value, the modules outputs LOW, otherwise it outputs HIGH.

The threshold value for the digital signal can be adjusted using the potentiometer. Soil moisture sensor have 4 pin identification which is A0, D0, Vcc and GND. A0 pin for analog output pin connect to arduino board. D0 pin for digital output pin connect toarduino board. Vcc pin use to connect arduino 5V pin. GND pin are use for ground to arduino board.

The specification of soil moisture sensor, it sensitivity can adjust by the blue digital potentiometer. Next, it operate voltage are between 3.3V and 5V. And also it has module dual output mode which is digital output and analog output giving more accuracy and has pre-drilled hole for easy working for installation.

Small board PCB size(3cm * 1.6cm) easyto handle it. Soil moisture also have a power indicator (red) and digital switching output indicator (green) to give a signal for users. It uses the LM393 comparator chip. Signals and connections of the soil moisture sensor YL-69, FC-28 or HL-69. Figure 3.3 shows soil moisture sensor YL-69 Module.

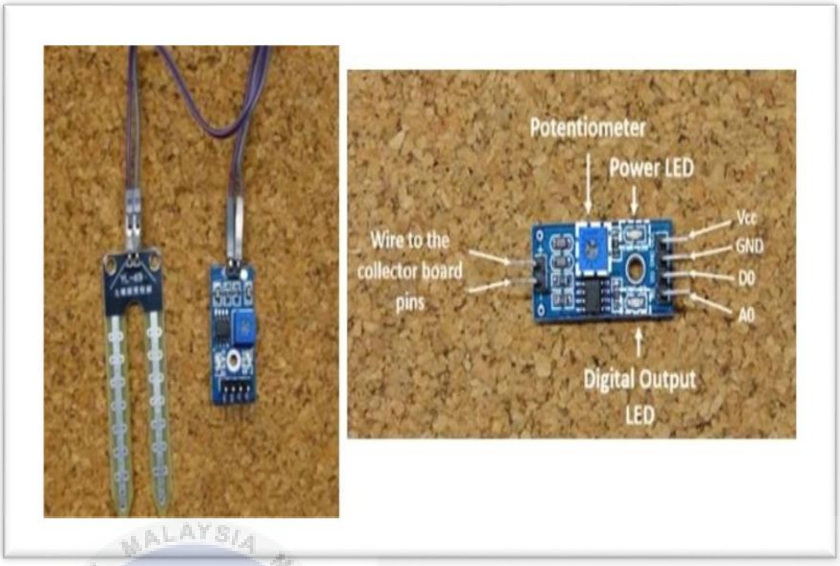

Figure 3.3Soil Moisture Sensor YL_69 Module

3.2.1.4 Ultrasonic Sensor

An ultrasonic sensor is a sensor that serves to convert a physical amount of sound into an electrical amount and vice versa. This sensor works based on the principle of the reflection of a sound wave, where the sensor produces a sound wave that then recaptures with a time difference as the basis of the sensor. The difference in time transmitted and received back is directly proportional to the distance of the object reflecting it.

These ultrasonic sensors are generally used to detect the presence of an object at a certain distance in front of it. Ultrasonic sensors have the ability to detect objects farther away especially for hard objects. On hard objects that have a rough surface this wave will be reflected more strongly than on objects with a soft surface. This ultrasonic sensor consists of an ultrasonic transmitter circuit called a transmitter and an ultrasonic receiver circuit called a receiver. In the planning of this tool used a sensor to help the process of detecting the distance of water to the water tank in the house. Figure 3.4 shows ultrasonic sensor.

Figure 3.4 Ultrasonic sensor

Ultrasonic sensor HC-SR04 are have 4 pin which is pin 1 for Vcc, pin 2 for trigger, pin 3 for echo and pin 4 for ground. Pin 1 act as for powers the sensor 5V. Pin 2 acts as an input pin which is to kept high for 10us to initialize measure by send US wave. Pin 3 acts as outputpin which is this pin goes high for a period of time will be equal by time taken for US waze to return and for pin 4 are connected to the ground of system.

HC-SR04 Sensor have some features. Example HC-SR04 sensor dimension is 45 mm (W) x 20 mm (W) x 15 mm (W). Next , it have operate voltage which is 5V. It can measure distance in theoretical between 2cm to 450cm while for measure distance in pratical are between 2cm to 80cm. Accuracy of HC-SR04 is 3mm. Less than 15° of it covered to measure angle. For operating current and frequency are less than 15mA and 40Hz.

3.2.1.5 Relay

Relay is a switch (switch) that is operated electrically and is an electromechanical component that consists of two main parts, namely the electromagnet (coil) and a set of switch contacts. This relay has a part called a coil that usually has a DC working voltage of 5V, 9V, 12 V or so on and there are also relays that have an AC working voltage. Figure 3.5 shows single channel relay 5V.

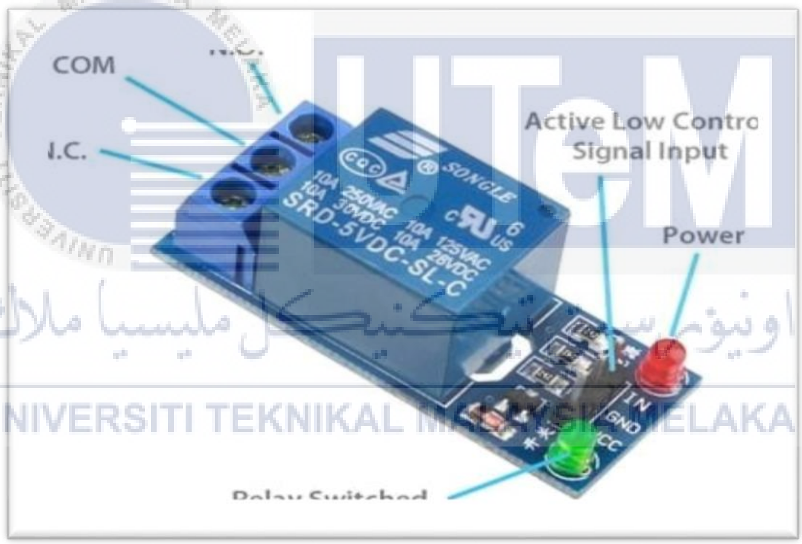

Figure 3.5Single Channel Relay 5V

Single-Channel Relay had 6 pins which is pin 1 for relay trigger, pin 2 for ground, pin 3 for Vcc, pin 4 for normally open, pin 5 for common, and pin 6 for closed. Pin 1 are use for to active the relay, pin 2 are use to connect to the ground system act as reference, pin 3 act as supply input for powering of relay coil, pin 4 act as open terminal for the relay, pin 5 act as common terminal for the relay and pin 6 act as closed contact for the relay.

3.2.1.6 Analog pH Sensor

The main function of a pH meter is to measure the pH or acidity of an object (usually a liquid or soil). These devices are generally composed of a measuring machine that displays the pH level and a measuring electrode (probe). Although basically the pH meter has a similar function, it turns out that this measuring tool also has a variety of types with varied functions as well. There are two type of pH meter which is pH meter analog and digital pH meter.

The first model is an analog pH meter. On an analog pH meter, the pH rate will be indicated by an indicator needle. Once the measuring electrode is inserted into the sample, the needle will move towards the number that represents the pH level. To get precise results, you must be careful when using an analog pH meter. This is because the pointer needle is small.

The digital pH meter is the result of an innovation in the analog pH meter. On a digital pH meter, the pH rate is indicated by a number printed on the measuring machine. This will obviously make it easier for you to get precise results on the sample. Even so, basically the function of analog and digital pH meters remains the same. Figure 3.6 shows analog pH sensor.

Figure 3.6 Analog pH sensor

Among of specification of analog pH sensor are module power which is 5V. Size of module are 43mmx32mm(1.70"x1.26"). it has measure range of pH between 0 until 14 pH and also it had measure temperature between 0 until 60℃. Accuracy of analog pH sensor are ± 0.1pH (25 ℃). Response time less than 1min to react when it have changing. This analog pH sensor are had Industry pH Electrode with BNC Connector and PH2.0 Interface (3-foot patch). And also it had gain adjustment potentiometer and power indicator (LED) for user.

3.2.1.7 Servo motor

Servo Motors are electrical devices used in intelligent industrial machines that function to drive or rotate objects with high precision control in terms of angular position, acceleration and speed, an ability not possessed by ordinary motors. The controller of a servo motor better known as a servo drive is the most important and sophisticated part of a servo motor, because it is designed for such high precision. Figure 3.7 shows servo motor SG90.

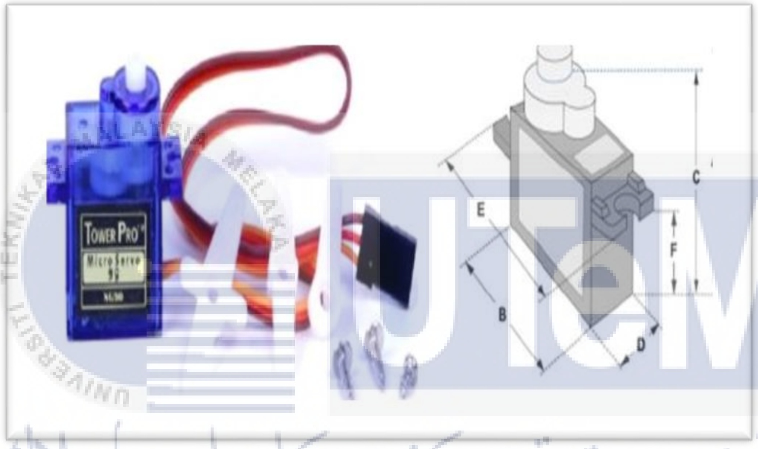

Figure 3.7Servo Motor SG90

Dimensions of servo motor had 6 dimension which is A are 32mm, B are 23mm, C are 28.5mm, D are 12mm, E are 32mm F are 19.5mm. Specification of servo motor SG90 are speed = 0.1sec and torque= 2.5kg-cm. And also it has only weight(14.7g) are to easy for user to handle servo motor and voltage are use for motor 4.8 until 6V.

3.2.1.8 Water pump

Figure 3.8 Water Pump

Specification of mini water pump had operating DC voltage are between 2.5V and 6V. Next, the maximum of water can lift height between 40cm and 110cm (15.75"-43.4"). The flow rate of mini water pump between 80 L/H and 120 L/H. The outer of diameter water outlet are 7.5mm / 0.3" while the inside of diameter water outlet are 5mm / 0.2". Pump diameter approximate 24mm / 0.95", pump length approximate 45mm / 1.8",water pump height approximate 30mm / 1.2"and length of wire water pump are ~13mm cm. Figure 3.8 shows water pump.

3.2.1.9 DHT11 (Temperature Sensor Module)

This is DHT11 is a temperature and humidity sensor module for detect the temperature of the project. Figure 3.9 shows DHT11(Temperature Sensor Module).

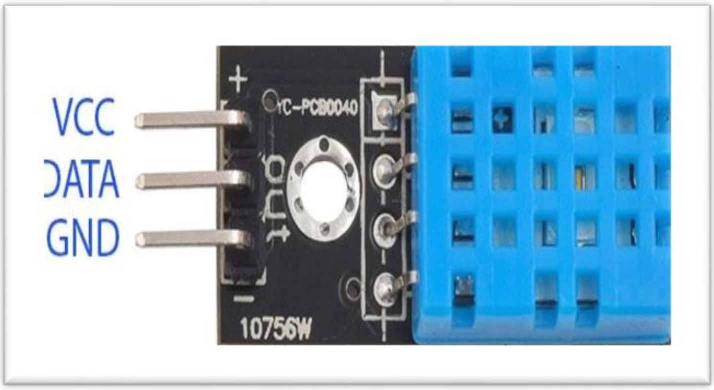

Figure 3.9 DHT11 (Temperature Sensor Module)

Pin identification of DHT11 have 3 pin which Vcc for power supply between 3.5V and 5.5V, DATA for output temperature through serial data and ground for connected to theground of project.

DHT11 of specifications are have operating voltage by 3.5V to 5.5V, operating current by 0.3mA (measuring) 60uA (standby) and output pin have a serial data. DHT11 are had temperature range between 0°C and 50°C and humidity range between 20% to 90%. Resolution of DHT11 temperature and humidity both are 16-bit. Accuracy of DHT11 are ±1°C and ±1%.

3.2.1.10 Liquid Crystal Display (LCD)

This LCD is a module for Liquid Crystal Display to display the project value from the sensor. Figure 3.10 shows liquid crystal display (LCD).

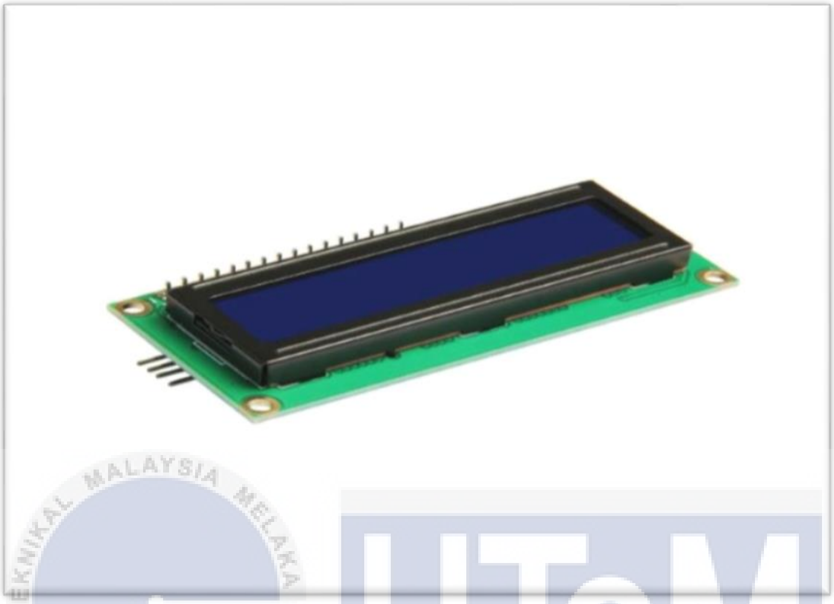

Figure 3.10 Liquid Crystal Display (LCD)

LCD is a device commonly used on calculators, telephones, massage chairs, radios and other electronic devices. Often it displays information in the form of words. LCD is a Liquid Crystal Display or Liquid Crystal Display is a type of display that uses Liquid Crystal as a reflex media. On a color LCD like a monitor there are tens of thousands of pixels. Pixels are the smallest units in an LCD. These tens of thousands of pixels make upa picture100 or words from instructions from a microcontroller found in an electrical appliance. A LCD contains of two lines and each line can display 16 characteristics, which known as 16 x 2 LCD.

The image on an LCD screen is created by a reactive material between two electrodes and the color output on this material can be altered by increasing or decreasing the electric current. The LCD has input and output data pins, voltage control, and display color control.

3.2.1.11 Breadboard

This a breadboard are easy tools was designed for build circuits without requiring the soldering used to prototype electronics or test circuit designs. Breadboard is normally used to make a temporary prototype with designing the circuit with an electronic component. A breadboard is small plastic board which is has many tiny holes. The holes are relating to the strip of metal arranged in rows such as metal is a good conductor of electricity the strip it will function as wire from each component to another component. With these we can easily change the circuit when the connection is wrong without any damage to the component or the board due to without required solder to the component for connection. So, with using the breadboard to design the circuit it will make the process of making circuit to be easy and tidy in terms of less wire usage. Figure 3.11 shows breadboard.

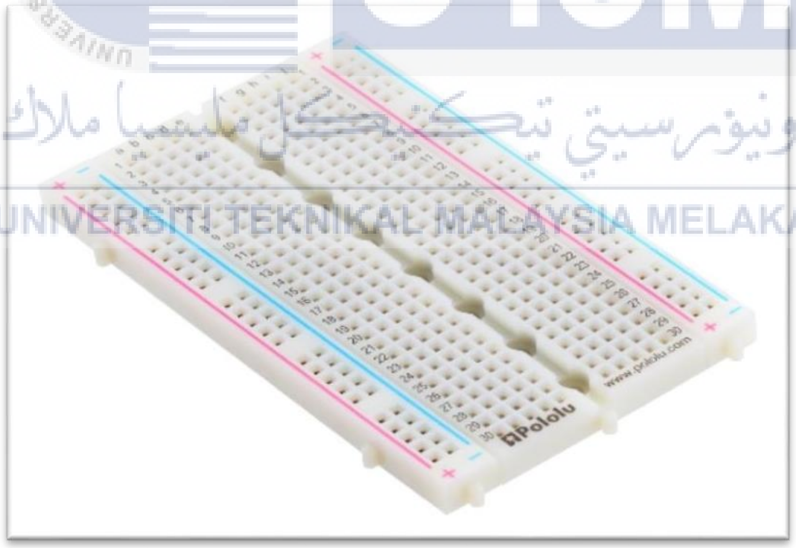

Figure 3.11 Breadboard

3.2.1.12 Rechargeable Battery

Rechargeable battery is designed with one or more electrochemical cell. It can be recharged and discharged many times. It also accumulates and stores the electrical energy through an electrochemical reaction which is reversible. Meanwhile, the cost for a rechargeable battery is higher than the disposal battery or alkaline battery. But still the investment on this battery is better because it has a higher initial value in the market, and it can be reused which will save the cost of buying new battery for the past 5 years.. And the type of rechargeable battery that can be found in the market is such as nickel-cadmium (NiCad), nickel- lithium-ion (Li-ion), lithium-ion polymer (LiPo) and other more. Figure 3.12 shows 3.67V rechargeable battery.

Figure 3.12 3.67V Rechargeable Battery

3.2.1.13 Jumper wire

The jumper wire has 2 type of jumper wire which is jumper wire male to male and Jumper wire female to male. And both are jumper wires are electrical cables that have a connector pin on each end and allow you to connect two components involving an Arduino without the need for soldering. In essence, the use of this jumper cable is as an electrical conductor to connect electrical circuits. Figure 3.13 shows jumper wire male to male. Figure 3.14 shows jumper wire female to male.

Figure 3.133 Jumper wire male to male

Figure 3.14 Jumper wire female to male

3.3 Software requirement

There are 2 software that we use make this project a successful which is Arduino IDE and Blynk app. Arduino IDE Software, or the full name Arduino Integrated Development Environment (IDE), is software that uses C/C ++ type coding input from the user and translates it to HEX/Binary coding, before uploading the coding into the Arduino Board. Arduino is one of the simplest microcontrollers that we can used to implement the project. Figure 3.15 shows Arduino IDE software.

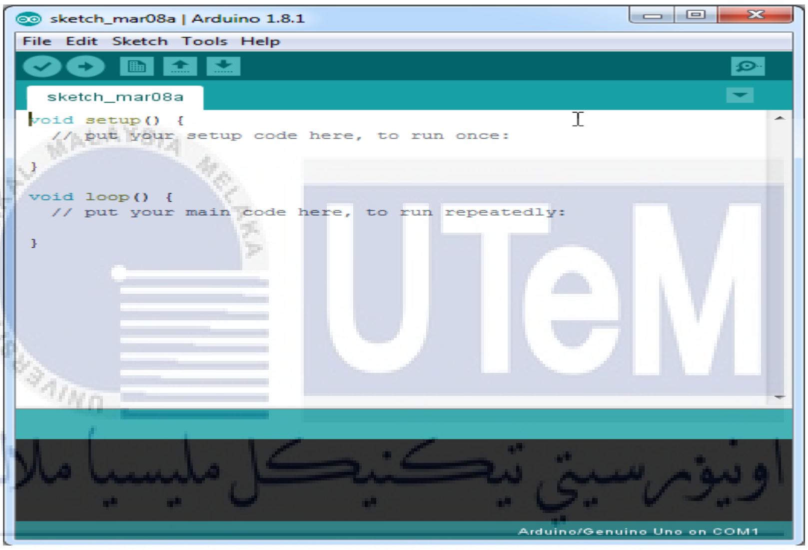

Figure 3.15 Arduino IDE Software

Next, blynk is a smartphone app that allows you to control and monitor a project. The Blynk app is free to download for Android and iOS. Blynk uses a drag and drop widget interface. Blynk can also work via the internet, Bluetooth and USB. You will need to purchase hardware such as the Wifi Module ESP8266 which has a WiFi chip to connect with Blynk Apps. Basically, to run the Blynk app, they will use the Internet platform. To connect Blynk servers need to use with smartphones, Blynk libraries need to be written in coding. It's great because we can get it from the Internet. Figure 3.16 shows Blynk App software.

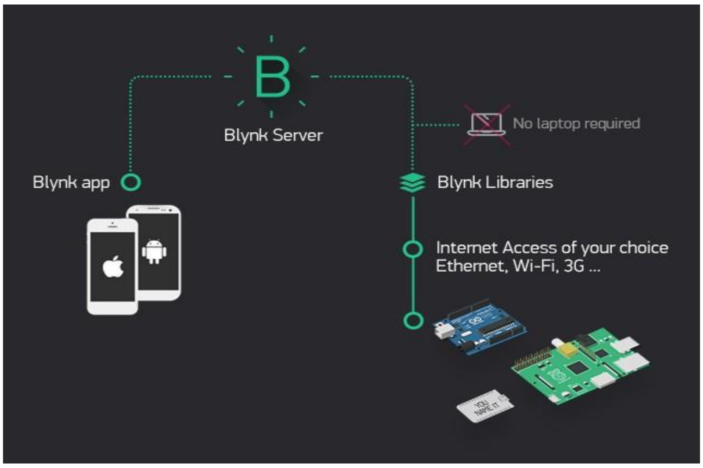

Figure 3.16 Blynk App Software

3.4 Equipment Block Diagram

A block diagram can be categorized as visual explanation of a proposed work/project in terms of input, output, and component used. The function of block diagram is different when compared to the flowchart where it is used to show the workflow of a project, but block diagram is to give a broad view of the component and its part in the project which is easy to understand when designing the project. Below shows a block diagram that represent to the model of Development of Aquaponic System with IOT and its elaboration in a details on the working of the project. Figure 3.17 shows block diagram for the project.

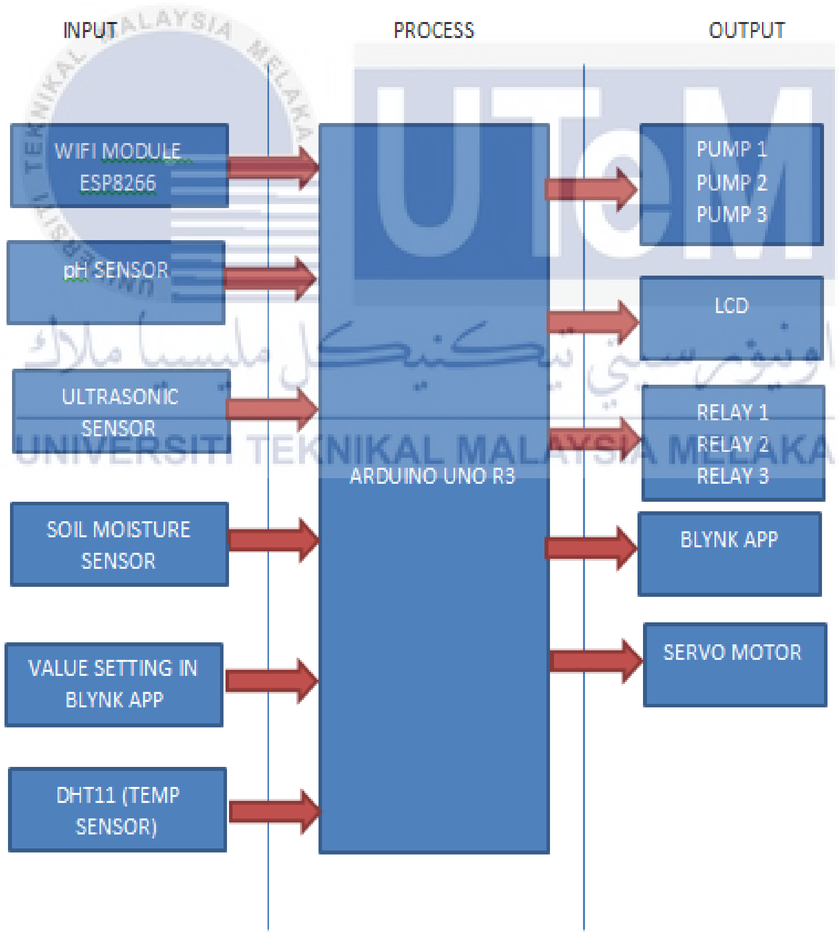

Figure 3.17 Block Diagram

3.5 Flow Chart Project

A flowchart is a diagrammatic representation of what a program should do. A flowchart is made of arrows, shapes, and description. In fact, there were many ways or method can be used to explain the step or process of our project. Among that option flowchart is one of the best ways because the process or step can be explained by using images, shapes, and various other metrics to represent the whole project. Figure 3.17 shows flow chart.

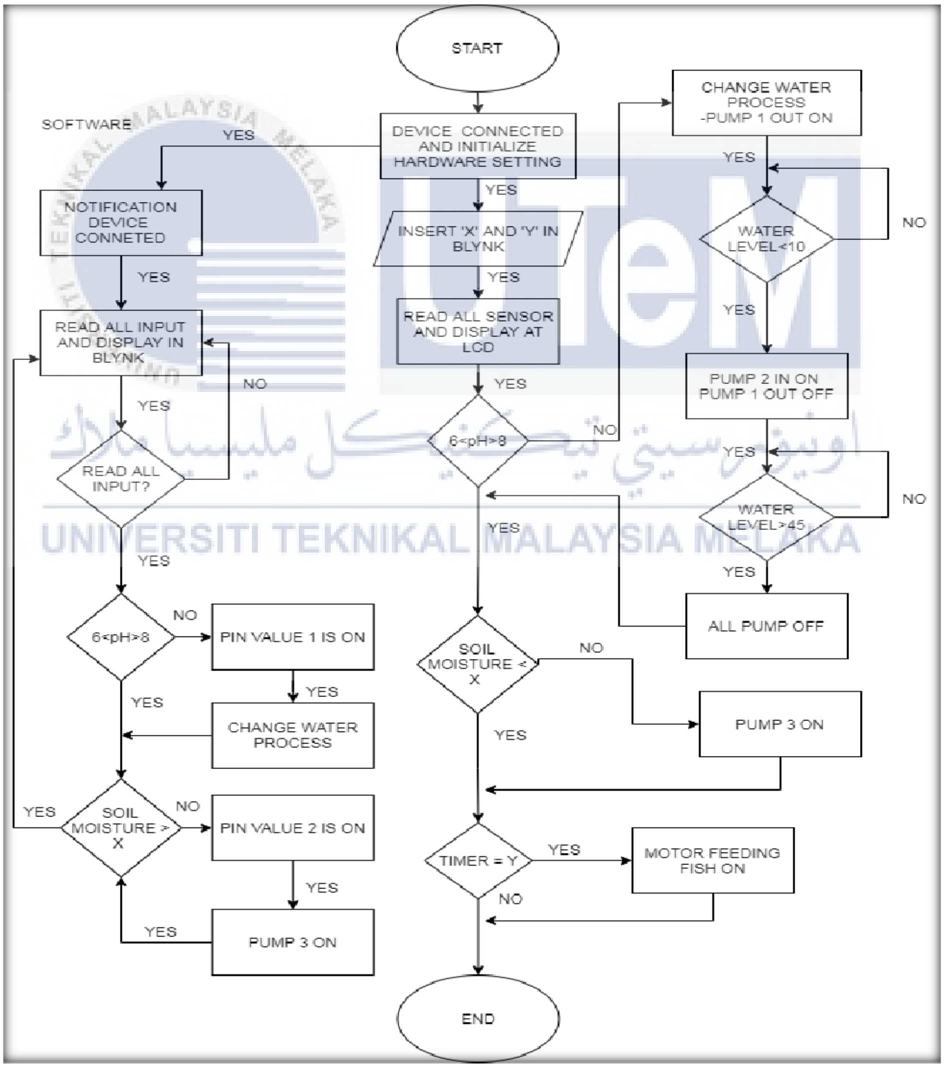

Figure 3.18 Flow Chart Project

When the hardware was turn on, user must to set x which is for soil moisture and set y which is timer for feeder motor in smartphone then the system will reads all sensors data and display on LCD. When pH is not in range 6 < pH > 8, it will trigger changing water process. When soil moisture is below than setting, it trigger water pump 3 to turn on. When timer feeder is equal to setting, it will trigger motor for feeder to turn on. For software which is represent Blynk App, when Blynk app was connected to the system. It will sent notification in smartphone through Blynk App. All data reads form sensor was display in Blynk App. And also user can control water changing process by pressed button in Blynk app. Then user can control timer feeder by pressed button in Blynk App. Lastly when soil moisture below setting, it automatically watering plants. All this process will explained details in Chapter 4.

3.6 Gantt chart Bachelor Degree Project 1

Table 3.2 Gantt Chart BDP 1

NAME:		MOHAMMAD IDHAM BIN ZABIDI															
PROJECT TITLE:		DEVELOPMENT OF AQUAPONIC SYSTEM WITH IOT SYSTEM															
COURSE CODE:		BACHELOR DEGREE PROJECT 1															
CLASS:		3 BEEY S1/1															
FACULTY:		FACULTY OF ELECTRICAL AND ELECTRONIC															
	ACTIVITY	MARCH				APRIL				MAY				JUNE			
BIL	WEEK	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	BRIEFING ABOUT PROJECT																
2	SUPERVISOR CHOOSING																
3	SELECT PROJECT TITLE																
4	IDENTIFY THAT EQUIPMENT USE IN THE																
5	STUDY ABOUT PROJECT EQUIPMENT																
6	COMPLETING INTRODUCTION PROJECT																
7	RESEARCH PREVIOUS PROJECT																
8	COMPLETING LITERATURE REVIEW																
9	COMPLETING THE METHODOLOGY REPORT																
10	PROJECT REPORT CHECKED BY SUPERVISOR																
11	SUBMIT REPORT TO THE PANEL																
12	PRESENTATION TO THE PANEL																

3.7 Gantt chart Bachelor Degree Project 2

Table 3.3 Gantt Chart BDP 2

NAME:		MOHAMMAD IDHAM BIN ZABIDI															
PROJECT TITLE:		DEVELOPMENT OF AQUAPONIC SYSTEM WITH IOT SYSTEM															
COURSE CODE:		BACHELOR DEGREE PROJECT 2															
CLASS:		4 BEEY S1/1															
FACULTY:		FACULTY OF ELECTRICAL AND ELECTRONIC															
	ACTIVITY	OCTOBER				NOVEMBER				DECEMBER				JANUARY			
BIL	WEEK	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	BRIEFING ABOUT DESIGN PROJECT																
2	DESIGN SIMULATION PROJECT																
3	PROCEED WITH CODING																
4	PERFORMING AN ANALYSIS ON PROJECT DESIGN																
5	PROCEED WITH HARDWARE																
6	IMPLEMENTATION																
7	OBSERVE AND COLLECT THE RESULT																
8	CONCLUDE THE RESULT																
9	PROGRESS WITH REPORT																
10	COMPLETE A REPORT																
11	SUBMIT REPORT TO SUPERVISOR																
12	ORAL PRESENTATION TO THE PANEL																

3.8 Cost implementations

The costs used by the researcher are listed as follow:

Table 3.4 Cost implementation

BIL	Name Of Component	Quantity	Price (RM)
1.	Arduino Uno R3	1	88.90
2.	WIFI module ESP8266	1	7.90
3.	Soil moisture sensor	1	3.90
4.	Ultrasonic Sensor	1	8.50
5.	Relay	3	13.50
6.	Analog pH sensor	1	325.00
7.	Servo motor	1	11.90
8.	Water pump	3	63.00
9.	DHT 11 (Temp Sensor)	1	5.72
10.	LCD	1	8.00
11.	Breadboard	1	4.50
12.	Power supply 9V	1	20.06
13.	Jumper wire (female to male)	35	4.50
14.	Jumper wire (female to male)	35	4.50
	Total		569.86

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

In this chapter, it will discuss on the results that have been gained through an implementation of a project which is entitled as “Development aquaponic system with Iot”. After the project has been completed, the effectiveness of the system was ready to be tested in term of software and hardware.

4.2 Software Design

From the previous chapter, software are used to design this project are Blynk Application, Arduino IDE and Proteus. All the components used in this project are programmed via Arduino IDE. The coding is then uploaded into Proteus to test the workability and the functionality of the coding.

4.2.1 Blynk Application

Figure 4.1 shows the design of Blynk application that have been choose for the purpose of monitoring and controlling in the aquaponic system. The title given for this project in the Blynk application is “IRRIGATION SYSTEM” and it can be seen on the top of the app when the Blynk app is opened. So, in the app there will be five function which is the aquaponic system status, the feeder button, pump in button, pump out button and soil moisture setting.

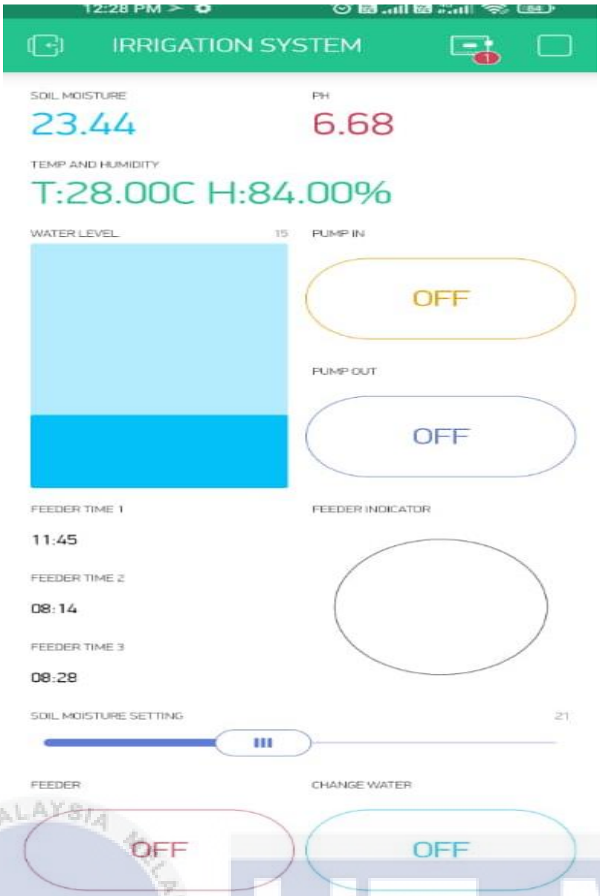

Figure 4.1 Blynk Application

4.2.2 Arduino IDE

Figure 4.2 shows a coding for Arduino to control sensor while Figure 4.3 shows a coding for Wifi to connect to Blynk App. A full coding for these two can be refer at appendix.


```
#include <Wire.h>  // Coding for Arduino
#include <dht.h>
#include <Servo.h>
#include <LiquidCrystal.h>
LiquidCrystal lcd(A5, A4, A3, 2, 3, 4);
// Include the libraries we need

#define DHT11_PIN 11    //Sambung ke pin A1
#define WPUMP 8
#define PumpIn 9
#define PumpOut 10
#define trigPin1 7
#define echoPin1 6

Servo myservo;
dht DHT;

String Temp1x="";
String PHxx="";
String Temp2x="";
String Temp1y="";
String PHy="";
String Temp2y="";
String Temp3y="";
String Temp3x="";
String Temp4y="";
String Temp4x="";
```

Figure 4.2 Coding for Arduino

```
//coding for wifi
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>
#include <BlynkSimpleStream.h>
#include <TimeLib.h>

#include <WidgetRTC.h>
// Your WiFi credentials.
// Set password to "" for open networks.
const char* ssid = "MyAqua";
const char* pass = "12345678";

// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "0yRwLiDr024xtE7VNXt5_W0d3Xgs6JSz";
char server[] = "139.59.206.133";

int Start=0;
String B0x;
int B1x=0, B2x=0;
int U1=0, U2=0;
int T1x=0, T2x=0;
int M1x=0, M2x=0;
int X0x=0, X1x=0, X2x=0;
```

Figure 4.3 Coding for wifi

4.2.3 Proteus

Figure 4.4 shows a final circuit design for this project in proteus.

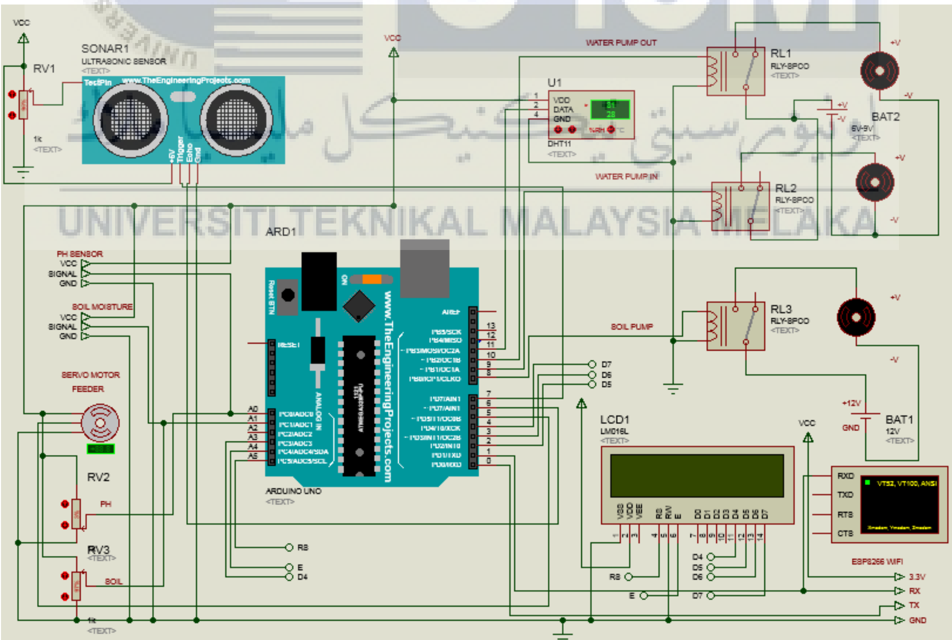

Figure 4.4 Final Circuit Design

4.3 Hardware Design

In the Figure 4.5 and Figure 4.6 below show the full design of the prototype and the hardware construction of Arduino for this project.

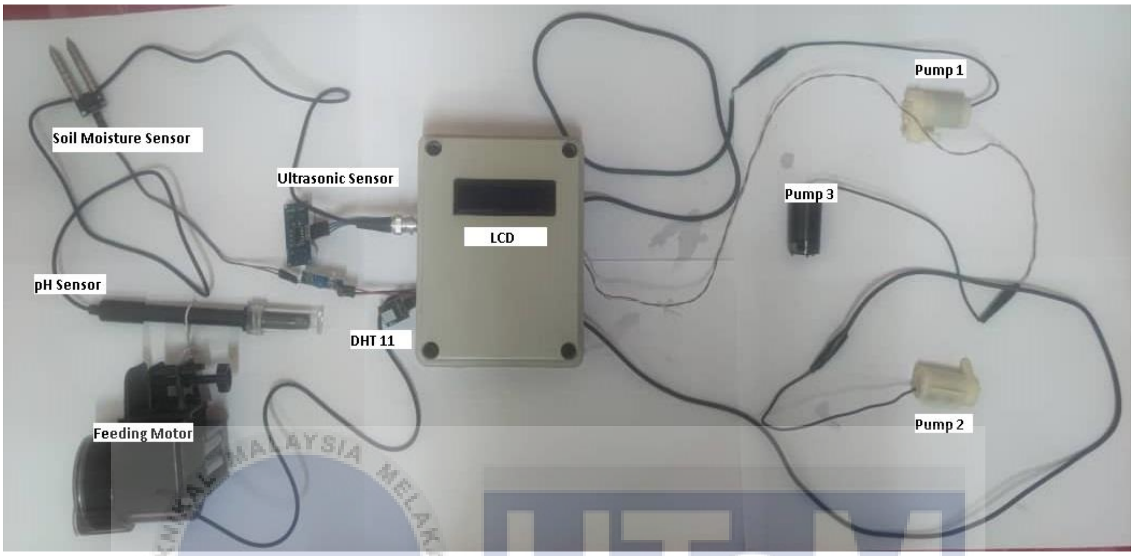

Figure 4.5 Full components before installation

Figure 4.6 Full components after installation

From Figure 4.6 shows it has two containers which was label ‘A’ and ‘B’. Container A was a function for when the water exchange process occurs; pump one will transfer the water in the aquarium into container A. Then, this water is used to water the plant, and container B was a function for the storage of clean water to be channelled to the aquarium when water exchange takes place in the aquarium.

4.3.1 Hardware Testing

As hardware testing was a test that produce actual context of that product. This testing is totally opposed to a laboratory testing or testing a product in its development environment. And the reason on pursuing this test on newly made product is to identify its working ability and problem that will be occur when used in real situation. So, to identify the project ability and problem it has been performed with field testing in my house at Kampung Banggol, Penang.

Firstly, when the system turn on then connect to wifi to connect our smartphone via Blynk App. All the sensor will read a data and display on LCD and Blynk App. In LCD will show W represent water level in aquarium, S represent soil moisture, PH represent pH sensor, T represent temperature and H represent humidity same like for Blynk App as shown in Figure 4.7. Next step, the researcher or user need to set soil moisture setting in Blynk App as shown in Figure 4.8. If the pH sensor detected pH of water is out of range 7<pH>7, notification will sent into Blynk App as shown in Figure 4.9.

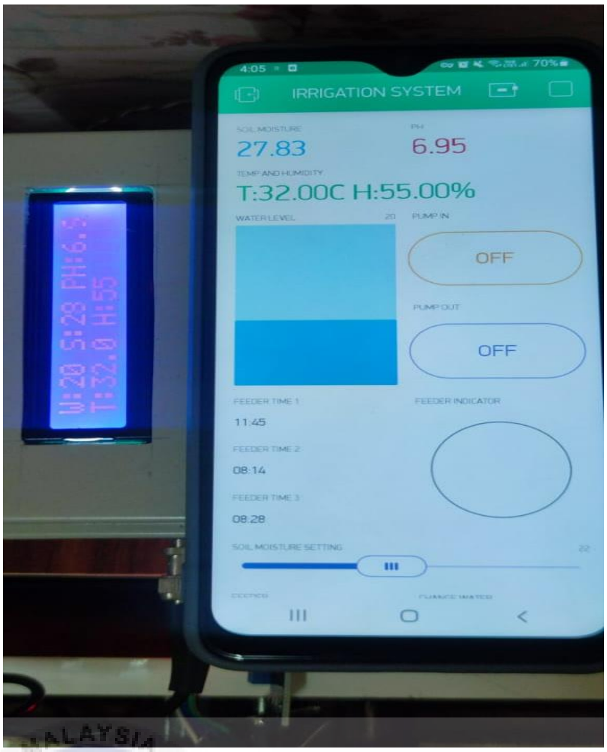

Figure 4.7 Reads all sensor display

Figure 4.8 Soil Moisture Setting in Blynk App

Figure 4.9 Notification in Blynk App

4.3.2 Changing Water Process

For process water changing, the researcher or user must press a button for the pump in to turn on in Blynk App, and it will trigger water pump 1 to drain water out from the aquarium to container A while in LCD will display ‘PUMP IN = ON’as shown in Figure 4.10. Then when to stop that process the researcher or user must press a button for the pump in to turn off in Blynk App, and it will trigger water pump 1 to stop drain water out from the aquarium to container A while in LCD will display ‘PUMP IN = OFF’as shown in Figure 4.11.

Next process to transfer new water into the aquarium from container B, the researcher or user must press a button for the pump out to turn on in Blynk App. It will trigger water pump 2 to drain water out from container B to the aquarium while in LCD will display 'PUMP OUT = ON'as shown in Figure 4.12. Then when to stop that process, the researcher or user must press a button for the pump out to turn off in Blynk App, and it will trigger water pump 2 to stop drain water out from the container B to the aquarium while in LCD will display 'PUMP OUT = OFF'as shown in Figure 4.13.

Figure 4.10 PUMP IN = ON

Figure 4.11 PUMP IN = OFF

Figure 4.12 PUMP OUT = ON

Figure 4.13 PUMP OUT = OFF

4.3.3 Feeding fish and watering plants

Next, for feeding fish, the researcher or user need to press the button feeder in Blynk App then the feeding motor will work as shown in Figure 4.14. Lastly, the watering plant will automatically water the plant if the soil moisture sensor is lower than the setting in Blynk App, as shown in Figure 4.15.

Figure 4.14 Feeding Fish

Figure 4.15 Automatically watering plants

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter will cover about the overall of the implementation of the "Development of Aquaponic System with Iot" projects. This chapter would clarify some recommendations and potential work that can be used to develop the project.

5.2 Conclusion

As the final results in implementing the project that known as "DEVELOPMENT AQUAPONIC SYSTEM WITH IOT" with using Arduino, ESP8266 and Blynk application was successfully designed and tested. The Blynk application is successfully calibrated till it connected to the aquaponic system to make the project to be success in monitoring by smartphone. Other than that, both sensor which is ultrasonic sensor work very efficiently to detect water level in aquarium and soil sensor work very efficiently to detect the soil are not too dry than our setting in our smartphone that make the project to achieve its functions without any problems. With implementing this project with Iot, the system can be maintained well, can save our energy and time especially for working person. Finally, by using these aquaponics systems and Blynk applications, overall maintenance work can be reduced and it is easier to identify problems related to current and old system deficiencies with reference to inefficient manual work. So, the conclusion is with these projects and the objectives were successfully achieved.

5.3 Future Works

For future improvements, results could be enhanced as follows:

i) The usage of the LDR in this project is to detect the light intensity to turn on the light automatically. For the example when the light intensity that fall onto the sensor is low then the light will turned on automatically otherwise it will remain off.

ii) The water pump will turned on automatically when the humidity sensor detect the temperature of the enviroment is rised.

iii) For the future upgrade we can make this system work as this,where for now the water tank is using a manual refill system to refill the water so in future we can consider it to work fully automated where a water pump is built in the water tank to pump the water in when it detect the water level of the tank below 50%.

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APPENDICES

Appendix A Coding Arduino

```
#include <Wire.h>  // Coding for Arduino
#include <dht.h>
#include <Servo.h>
#include <LiquidCrystal.h>
LiquidCrystal lcd(A5, A4, A3, 2, 3, 4);
// Include the libraries we need

#define DHT11_PIN 11   //continue pin A1
#define WPUMP 8
#define PumpIn 9
#define PumpOut 10
#define trigPin1 7
#define echoPin1 6

Servo myservo;
dht DHT;

String Temp1x="";
String PHxx="";
String Temp2x="";
String Temp1y="";
String PHy="";
String Temp2y="";
String Temp3y="";
String Temp3x="";
String Temp4y="";
String Temp4x="";

int Maxx=45;

int Maxy=45;
int DataIn=0;
int Counter=0;
float Hum,Temp;
float LevelMax=20;
float Level=0,Soil, Sens1;

int MODE=0;
float Turbidity;
float Sens2=0;
float PHx=0;
int pump = 10;       // the pin where pump is
int Count=0;
float Active=0;
```

```
float PH=0;
float Sens3=0,Movement=0;
float OldSens3=0;
const int phSensorPin  = A0;
float Vo             = 0;
int ALM1=0;

void setup()
{
   lcd.begin(16, 2);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("   WELCOME");
  lcd.setCursor(0,1);
  lcd.print("..............");
Serial.begin(9600);
  myservo.attach(5);
pinMode(trigPin1, OUTPUT);
  pinMode(echoPin1, INPUT);




 pinMode(PumpIn, OUTPUT);
 digitalWrite(PumpIn,LOW);
  pinMode(PumpOut, OUTPUT);
 digitalWrite(PumpOut,LOW);

  pinMode(WPUMP, OUTPUT);
 digitalWrite(WPUMP,LOW);


 delay(2000);
 myservo.write(0);

}


void loop()
{

 long duration1x, distance1, duration2x, distance2, duration3x, distance3, duration4x,
distance4, duration5x, distance5; // for ultrasonic sensor
  digitalWrite(trigPin1, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin1, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin1, LOW);
  duration1x = pulseIn(echoPin1, HIGH);
```

```
  distance1 = ((duration1x/2) / 29.1); //* 0.26;
  Level=1100-distance1;

  /*
  if (distance1>20){
    Level=20;
  }

  if (distance1<=20){
  Level=LevelMax-distance1;

  }

*/
Counter++;


  delay(100);
Count++;



if (Count>15){
  Serial.print("*");// lcd declare
Serial.print(Level);
Serial.print("*");
Serial.print(PH);
Serial.print("*");
Serial.print(Temp);
Serial.print("*");
Serial.print(Hum);
Serial.print("*");
Serial.print(Soil);
Serial.println("#");


   Count=0;
}

    Sens1 = analogRead(A1);          //read the value from the sensor
  Soil= (5.0 * Sens1)/1024.0;  //convert the analog data reading to moisture level
Soil=100-((Soil/5)*100.0);

    Sens2 = analogRead(A0);
  PH= (5.0 * Sens1)/1024.0;
PH=((PH/5)*14.0);

int chk = DHT.read11(DHT11_PIN);
  switch (chk)
  {
```

```
    case DHTLIB_OK:
    break;
    case DHTLIB_ERROR_CHECKSUM:
    break;
    case DHTLIB_ERROR_TIMEOUT:
    break;
    case DHTLIB_ERROR_CONNECT:
        break;
    case DHTLIB_ERROR_ACK_L:
        break;
    case DHTLIB_ERROR_ACK_H:
        break;
    default:
    break;
  }


  Temp=DHT.temperature ;// for soil moisture sensor
  Hum=DHT.humidity;

if (Soil<10){
  digitalWrite(WPUMP,HIGH);
}

if (Soil>=10){
  digitalWrite(WPUMP,LOW);
}


if (PH> 8 || PH<5){
  MODE=1;
}

if (MODE==1){
  digitalWrite(PumpOut,HIGH);// for pH sensor
  if (Level<5){
    digitalWrite(PumpOut,LOW);
    delay(2000);
    digitalWrite(PumpIn,HIGH);
    MODE=2;
  }
}

if (MODE==2){
  if (Level>20){

    digitalWrite(PumpIn,LOW);
    digitalWrite(PumpOut,LOW);
    delay(2000);
    MODE=0;
```

```
  }
}

lcd.clear(); // lcd declare
  lcd.setCursor(0,0);
  lcd.print("W:");
  lcd.print(Level,0);
  lcd.print(" S:");
  lcd.print(Soil,0);
   lcd.print(" PH:");
  lcd.print(PH,0);
  lcd.setCursor(0,1);
  lcd.print("T:");
  lcd.print(Temp,1);
  lcd.print("H:");
  lcd.print(Hum,0);



}

void serialEvent() {
  while (Serial.available()) {

    char inChar1 = (char)Serial.read();

    if (inChar1 == 'A') {

      myservo.write(90);
      delay(1500);
       myservo.write(0);
    }
       if (inChar1 == 'B') {
      myservo.write(90);

    }
          if (inChar1 == 'C') {
      myservo.write(0);

    }


  if (inChar1 == '*') {
     DataIn++;

    }


    while (DataIn > 0){
       while (Serial.available()) {
```

```
    char inChar = (char)Serial.read();
    if (inChar == '*') {
      DataIn++;

    }
    if (inChar != '*' && inChar != '#' && DataIn==1) {
      Temp1x+=inChar;

    }
    if (inChar != '*' && inChar != '#' && DataIn==2) {
      Temp2x+=inChar;

    }
    if (inChar != '*' && inChar != '#' && DataIn==3) {
      Temp3x+=inChar;

    }
     if (inChar != '*' && inChar != '#' && DataIn==4) {
      Temp4x+=inChar;

    }


    if (inChar == '#') {
      DataIn=0;
     Temp1y=Temp1x;   PHy=PHx;     Temp2y=Temp2x;  Temp3y=Temp3x;
Temp4y=Temp4x;
     Temp1x="";
     PHxx="";   Temp2x=""; Temp3x="";
     Maxx=Temp1y.toInt();
     Maxy=Temp2y.toInt();

    }
        }

    }


  }
}
```

Appendix B Coding Wifi

```
// coding for wifi
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>
#include <BlynkSimpleStream.h>
#include <TimeLib.h>

#include <WidgetRTC.h>

// setting password 4 Blynk app
const char* ssid = "MyAqua";
const char* pass = "12345678";

char auth[] = "0yRwLiDr024xtE7VNXt5_W0d3Xgs6JSz";
char server[] = "139.59.206.133";

int Start=0;
String B0x;
int B1x=0, B2x=0;
int U1=0, U2=0;
int T1x=0, T2x=0;
int M1x=0, M2x=0;
int X0x=0, X1x=0, X2x=0;

String DATA="";
int P1=0, P2=0, P3=0, P4=0;
int Rly1=0, Rly2=0, Rly3=0, Rly4=0, Rly5=0, Rly6=0,  Rly7=0,  Rly8=0;
int led1x=0,led2x=0,led3x=0,led4x=0;
int TotalUse=0;
int TotalAvai=0;
int Px=0;
float Temp1=30.1423;
float PH=7;
float Temp2=30.2;
String Flat;
String Flon;
String Temp1x="";
String PHx="";
String Temp2x="";
String Temp1y="";
String PHy="";
String Temp2y="";
String Temp3y="";
String Temp3x="";
String Temp4y="";
String Temp4x="";
String Temp5y="";
```

```
String Temp5x="";
String Command="0";
int Timer=0;
int Tx=0, Rx=0;
long startTimeInSecs;
long startTimeInSecs2;
long startTimeInSecs3;
long startTimeInSecs4;
long startTimeInSecs5;
int SH1=10,SM1=10;
int SH2=10,SM2=11;
int SH3=10,SM3=12;
String T1,T2,T3,T4,T5,TN;
int Mode=0;
int DataIn=0;
int ALERT=0;
int S1=0,S2=0,S3=0,S4=0;
int Alarm=100;
String currentTime,CT;
int Alm1=0;
int Alm2=0;
int Alm3=0;
int Alm4=0;
int Alm5=0;
int Alm6=0;
String currentDate;
int Hour=0;

WiFiClient wifiClient;

{
  wifiClient.stop();
BLYNK_DEFAULT_PORT);
  return wifiClient.connect(server, BLYNK_DEFAULT_PORT);
}

{
  Serial.print("Connecting to ");
  Serial.println(ssid);

  if (pass && strlen(pass)) {
    WiFi.begin((char*)ssid, (char*)pass);
  } else {
    WiFi.begin((char*)ssid);
  }

  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
```

```
}

//---------------------- virtual pin susun--------------------------
BLYNK_WRITE(V33)
{
  Max=param.asInt();
}
BLYNK_WRITE(V34)
{
  May=param.asInt();
}

BLYNK_WRITE(V20)
{
  X0x=param.asInt();
}
BLYNK_WRITE(V21)
{
 X1x=param.asInt();

}
BLYNK_WRITE(V22)
{
 X2x=param.asInt();

}


BLYNK_WRITE(V0)
{
 Command=param.asStr();

}

BLYNK_WRITE(V30)
{
 T1=param.asStr();
    // startTimeInSecs= param[0].asLong();
    // int rh=startTimeInSecs/3600;
    // int secr=startTimeInSecs%3600;
    // int rm=secr/60;
    // T1=String(rh) + ":" + String(rm);

}
BLYNK_WRITE(V31)
{
 T2=param.asStr();
// startTimeInSecs2= param[0].asLong();
  //    int rh2=startTimeInSecs2/3600;
  //    int secr2=startTimeInSecs2%3600;
```

```
 //    int rm2=secr2/60;
 //    T2=String(rh2) + ":" + String(rm2);

}
BLYNK_WRITE(V32)
{
 T3=param.asStr();
 //startTimeInSecs3= param[0].asLong();
 //    int rh3=startTimeInSecs3/3600;
 //    int secr3=startTimeInSecs3%3600;
 //    int rm3=secr3/60;
 //    T3=String(rh3) + ":" + String(rm3);

}

BLYNK_WRITE(V6)
{
 TN=param.asStr();


}

BLYNK_WRITE(V10)
{
  int pinValue = param.asInt();
  Rly1=pinValue;

}
BLYNK_WRITE(V11)
{
  int pinValue1 = param.asInt();
  Rly2=pinValue1;

}

BLYNK_WRITE(V12)
{
  int pinValue3 = param.asInt();
  Rly3=pinValue3;
  // process received value
}

BLYNK_WRITE(V13)
{
  int pinValue4 = param.asInt();

  Rly4=pinValue4;
}
BLYNK_WRITE(V14)
{
```

```
  int pinValue5 = param.asInt();

  Rly5=pinValue5;
}

BLYNK_WRITE(V15)
{
  int pinValue6 = param.asInt();
  Rly6=pinValue6;
}

BLYNK_WRITE(V16)
{
  int pinValue7 = param.asInt();

  Rly7=pinValue7;
}

BLYNK_WRITE(V17)
{
  int pinValue8 = param.asInt();

  Rly8=pinValue8;
}
BlynkTimer timer;

WidgetRTC rtc;



// Digital clock display of the time

void clockDisplay()

{

   Blynk.syncVirtual(V30);
  Blynk.syncVirtual(V31);
  Blynk.syncVirtual(V32);
  Blynk.syncVirtual(V33);
  Blynk.syncVirtual(V34);




     Serial.print("*");
    Serial.print(Max);
     Serial.print("*");
    Serial.print(May);
```

```
   Serial.println("#");

WidgetLED led1(V7);
//WidgetLED led2(V8);
//WidgetLED led3(V9);
Hour=(hour());
  currentTime = String(hour()) + ":" + minute() + ":" + second();
Tx=hour();
Rx=minute();
 currentDate = String(day()) + "/" + month() + "/" + year();

CT= String(hour()) + ":" + minute();
 // Serial.print(currentDate);

  //Serial.println();



  // Send time to the App

  //Blynk.virtualWrite(V0, currentTime);
  // Blynk.virtualWrite(V6, CT);


  // Send date to the App
/*
  Serial.print(TN);
  Serial.print("  ");
  Serial.print(T1);
  Serial.print("  ");
  Serial.print(T2);
  Serial.print("  ");
  Serial.println(T3);

*/

//---------------------------------------------------------------
  if (Mode==0){
if (CT==T1 && Alm1==0){
  Alm1=1;
Serial.println("A");
  led1.on();
}
if (CT!=T1){
  Alm1=0;


}

if (CT==T2 && Alm2==0){
```

```
Serial.println("A");
  Alm2=1;   led1.on();
}

if (CT!=T2){
 Alm2=0;
}

if (CT==T3 && Alm3==0){
Serial.println("A");
  Alm3=1;   led1.on();
}

if (CT!=T3){
 Alm3=0;
}
if (CT!=T2 && CT!=T1 && CT!=T3){
 led1.off();

}

//-------------LIGHT
if (CT==T4 && Alm4==0){
Serial.println("D");
Alm4=1;

}
if (CT!=T4){
 Alm4=0;
}
if (CT==T5 && Alm5==0){
Serial.println("E");
Alm5=1;
}
if (CT!=T5){
 Alm5=0;
}

if (Command =="A" && Alm6==0){
  Serial.println("A");
  delay(1000);
  Alm6=1;
  Blynk.virtualWrite(V0, "0");
}
if (Command =="B" && Alm6==0){
  Serial.println("B");
  delay(1000);
  Alm6=1;
  Blynk.virtualWrite(V0, "0");
}
```

```
if (Command =="C" && Alm6==0){
  Serial.println("C");
  delay(1000);
  Alm6=1;
  Blynk.virtualWrite(V0, "0");
}
if (Command =="D" && Alm6==0){
  Serial.println("D");
  delay(1000);
  Alm6=1;
  Blynk.virtualWrite(V0, "0");
}
if (Command =="E" && Alm6==0){
  Serial.println("E");
  delay(1000);
  Alm6=1;
  Blynk.virtualWrite(V0, "0");
}
if (Command =="1" && Alm6==0){
  Serial.println("1");
  delay(1000);
  Alm6=1;
  Blynk.virtualWrite(V0, "0");
}
if (Command =="2" && Alm6==0){
  Serial.println("2");
  delay(1000);
  Alm6=1;
  Blynk.virtualWrite(V0, "0");
}
if (Command =="3" && Alm6==0){
  Serial.println("3");
  delay(1000);
  Alm6=1;
  Blynk.virtualWrite(V0, "0");
}
if (Command =="4" && Alm6==0){
  Serial.println("4");
  delay(1000);
  Alm6=1;
  Blynk.virtualWrite(V0, "0");
}
if (Command == "0" && Alm6==1){
  Alm6=0;
}


}

//----------------------------------------------------------------
```

```
}


//-------------------------------------------------------------------

void setup()
{

  Serial.begin(9600);

  connectWiFi();

  connectBlynk();

  Blynk.begin(wifiClient, auth);

  setSyncInterval(10 * 60);


  timer.setInterval(2000L, clockDisplay);

 rtc.begin();
 Blynk.virtualWrite(V0, "0");
}

void loop()
{


/*
T1=String(SH1) + ":" + String(SM1) +  "00";
T2=String(SH2) + ":" + String(SM2) + "00";
T3=String(SH3) + ":" + String(SM3) + "00";
*/

  // WiFi was reconnect
  if (WiFi.status() != WL_CONNECTED) {
    connectWiFi();
    return;
  }

  // Reconnect to Blynk Cloud
  if (!wifiClient.connected()) {
    connectBlynk();
```

```
    return;
  }


  Blynk.run();
  timer.run();


while (Serial.available()) {

    // get the new byte:
    char inChar1 = (char)Serial.read();


 if (inChar1 == '*') {
      DataIn++;

    }


    while (DataIn > 0){
        while (Serial.available()) {
    // get the new byte:
    char inChar = (char)Serial.read();
    if (inChar == '*') {
      DataIn++;

    }

    if (inChar != '*' && inChar != '#' && DataIn==1) {
      Temp1x+=inChar;

    }
    if (inChar != '*' && inChar != '#' && DataIn==2) {
      Temp2x+=inChar;

    }
    if (inChar != '*' && inChar != '#' && DataIn==3) {
      Temp3x+=inChar;

    }
     if (inChar != '*' && inChar != '#' && DataIn==4) {
      Temp4x+=inChar;

    }
    if (inChar != '*' && inChar != '#' && DataIn==5) {
      Temp5x+=inChar;

    }
```

```
    if (inChar == '#') {
      DataIn=0;
     Temp1y=Temp1x;   PHy=PHx;      Temp2y=Temp2x;  Temp3y=Temp3x;
Temp4y=Temp4x;  Temp5y=Temp5x;
     Temp1x="";
     PHx="";   Temp2x=""; Temp3x="";
       Blynk.virtualWrite(V0, Temp5y);
       Blynk.virtualWrite(V3, Temp3y);
       Blynk.virtualWrite(V2, Temp4y);
       Blynk.virtualWrite(V4, Temp1y);
       Blynk.virtualWrite(V1, Temp2y);



    }
       }

    }


}
```