Faculty of Electrical and Electronic Engineering Technology

GREENHOUSE HORTICULTURE AUTOMATION WITH CROPS PROTECTION BY USING ARDUINO

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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DECLARATION

I declare that this project report entitled “Greenhouse Horticulture Automation With Crops Protection By Using Arduino” 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.

Signature :

Student Name : CHEE KAI HERN

Date : 10/01/2022

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 Computer Engineering Technology (Computer Systems) with Honours.

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Date : 10/1/2022

DEDICATION

Special thanks to my beloved family member for their unconditional support regarding my studies. Thanks for supervisor who fully guided in the whole journey of my project. I would like to express the sincere appreciation to Universiti Teknikal Malaysia Melaka (UTEM) in providing an opportunity of participation in Bachelor Degree Project (BDP) in this pandemic session. I am sincerely appreciated towards everyone who gave me support and assistance as their contribution had make my final project completed successfully.

ABSTRACT

In Malaysia, sector agriculture has become one of the key factors as income generator which encouraging the economic development for the country. Tropical climate also the sufficient land resources encourage the influence from large plantation suppliers to the small-scale farming owner to demonstrate agriculture practices even in rural areas. But, unpredictable weather condition, natural disaster approaches, unpleasant intruder causes the huge loss of money and reduction of the crop production. The current studies examines that the automation greenhouse enable to control the environmental condition which is prefect for plantation growth. Besides, the intrusion detection system enables to detect the approaches of intruder and gives responses immediate. Implementation of Internet of Things (IOT) in automation greenhouse enable to send the current environment measurement towards the cloud platform and allow the supervision indirectly by using mobile application. Thus, invention of this automation greenhouse system carries out perfect environment to accelerate the growth of plants which increasing the daily productivity also provides protection for crops from being stolen or destroyed.

ABSTRAK

Di Malaysia, sektor pertanian telah menjadi salah satu faktor utama sebagai penjana pendapatan yang menggalakkan pembangunan ekonomi negara. Iklim tropika juga sumber tanah yang mencukupi menggalakkan pengaruh daripada pembekal ladang besar kepada pemilik ladang berskala kecil untuk menunjukkan amalan pertanian walaupun di kawasan luar bandar. Tetapi, keadaan cuaca yang tidak menentu, pendekatan bencana alam, penceroboh yang tidak menyenangkan menyebabkan kerugian besar wang dan pengurangan pengeluaran tanaman. Kajian semasa mengkaji bahawa rumah hijau automasi membolehkan untuk mengawal keadaan persekitaran yang sesuai untuk pertumbuhan ladang. Selain itu, sistem pengesanan pencerobohan membolehkan untuk mengesan pendekatan penceroboh dan memberikan respons segera. Pelaksanaan Internet of Things (IOT) dalam rumah hijau automasi membolehkan untuk menghantar pengukuran persekitaran semasa ke arah platform awan dan membenarkan penyeliaan secara tidak langsung dengan menggunakan aplikasi mudah alih. Oleh itu, penciptaan sistem rumah hijau automasi ini menjalankan persekitaran yang sempurna untuk mempercepatkan pertumbuhan tumbuhan yang meningkatkan produktiviti harian juga memberi perlindungan kepada tanaman daripada dicuri atau dimusnahkan.

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First and foremost, I would like to express my gratitude to my supervisor, Sir Ma Tien Choon for his precious guidance, words of wisdom and patient throughout this project.

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LIST OF SYMBOLS

Ω	-	Ohm
A	-	Amprere

LIST OF ABBREVIATIONS

V	-	Voltage
LDR	-	Light Dependent Resistor
IOT	-	Interet of Things
GSM	-	Global System for Mobile Communications
GUI	-	Graphic User Interface
WIFI/Wi-Fi	-	Wireless Fidelity
LCD	-	Liquid Crystal Display
WSN	-	Wireless Sensor Network
PIR	-	Passive Infrared Resistor
HTUA	-	High-technolgy urban Agriculture
TDS	-	Total Dissolve Sensor
OLED	-	Organic Ligh -Emitting Diode
API	-	Application Interfaces Integration
SMS	-	Short Message Service
RTC	-	Real Time Clcok
LED	-	Light Emitter Diode

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CHAPTER 1

INTRODUCTION

1.1 Background

Agriculture industrial is the one of the important role in the development of economic in Malaysia. In this agriculture sector who has generates nearly about RM 1.2 trillion of national Gross Domestic Product (GDP) in a year. Agriculture sector is profitability and able to support the finances among the stakeholders. Besides, it contributed high employment as creating more requirement of job towards farmer. High demanding of farm crops in domestic and international market has leads implementation of small-scale stakeholders also the large industrial to increase crops productivity to supply the requirement of consumer.

Greenhouse horticulture is a kind of agricultural activity that mostly concentrated in highlands of Cameron Highlands, Pahang Malaysia. Greenhouse defines as a totally encircle structural which isolated the indoor environment inside the greenhouse from external environment to produce a perfect environment condition for plant growth. Usually, it is a framed house that fully covered by transparent cladding which allowed the sunlight rays penetrate inside the greenhouse. Sufficient of sunlight and optimum environment parameters accelerates the speed of plant growth also shorten the harvest duration. Other than that, implementation of greenhouse promotes high productivity also minimize the effects of weather condition, pest or diseases towards the plants [1]. Even though, greenhouse gain the crops yield but the requirement of the high of manpower in management and monitoring during the old time. In the traditional greenhouse, farmer need to always observe the changes inside the greenhouse by naked eyes and depending on own gardening experiences.

Sometimes, this method is not able to get the accurate measurement, if one steps goes wrong, bad result may be consequences.

As the expanding of 4.0 Industry, there are various enhancement which occupying technologies on equipment, gadget or even the remotely system into the greenhouse system in agriculture. IoT based greenhouse system is upgraded with automation which capable to monitor all the desired measurement includes temperature, humidity and soil moisture level in the greenhouse atmosphere by replaced the manual supervision from human. Improvement of advances greenhouse has promoted the efficient the crops production as detecting and managing the environmentally parameters by sensor system with telecommunication technologies support by access of Internet services. Internet of Things will collect data information from sensor system and exchanging the data within the Cloud Computing by network interconnection. Then, the cloud platform will recorded also kept traces these parameters simultaneously when detected by sensor system [2]. The intense agriculture production by emerging the innovation of technology in agriculture sector promotes Netherlands becomes the one of the most food productive in the world. In the big city like Amsterdam practices the high -tech urban agriculture (HTUA) that applying the advance environment controlling system, horticultural lighting used for indoor light source provider and also the growing crops in vertically which is save of spaces. These advances equipment promotes sustainability of crops since the harvesting quantity been maximise within shortest duration. As conclude, Netherlands had considered as the second greatest exporter which relies on exporting the agriculture goods [3].

Nevertheless, there are still existence some risk causes reduction of crops especially the intrusion of wild animals also culprits. Traditional crops protection applying the humanoid scarecrows to deter threat of wild birds and guard crops field. Scarecrow also corn dolly is the earliest method which conducted as the safeguard for the corn filed in ancient

Egypt [4]. However, as time passes, the birds will be familiar to the scarecrow and reduced the scare of scarecrow. Rural agriculture concerns the high possibility of disturbing and feeding by wild animals includes monkeys, deer, birds, mice or even boar. Destruction from wild animals brings up to 50% of loss in finances of farmer. Elephant-human conflict in India shown the intensely intrusion of wild animals which elephants across the human habitats for raid the crops. Both lives and property are been menace within this conflict [5] . Instead of that, there are some unpleasant thefts who will steal valuable crops production from owner and sell it for personal benefits. Sometimes, some farmer owned their armed fire just ready to shoot and warn the intruder just to protect their property. However, armed the gun fire is illegal and only specific to some unusual occupation such as policeman or bodyguard but no for all farmers. Only the one with legal permit can own their imitation or fake gun with bb bullets. Legally own gun is still available to Malaysia, and strictly for someone who own the gun for protection from predators and property. But reminds, with power comes responsibility, if armed shoot at someone purposely will be treats with strict penalty, even worst the death penalty.

Instead of that, some of the farmer applying the fencing around the plantation area with wire netting. Even though there are some sharp wirings and some thorns, but it cannot be stop larger size animal to cross it. After then, invention of the electric fencing which allows the heavy current flow across the fencing to shock the animal once it is approaches. This electric fencing is effective, but it may cause assaulting of animals. Electric fence is high tensile and permanent, but it will consume huge amount of electricity which burden the expenses of farmer. Unfortunately, the electric fencing only can install after approval from government as farmer cannot kill the wild animal simply which may against the wildlife law [6].

1.2 Problem Statement

Traditional conventional agriculture in greenhouse is unable to maintain the ideal temperature during hot weather. High environmental temperature limits the growth of plant also increase the risk of death of plant. Furthermore, as the temperature surrounding increases gradually, the moisture level in soil also effected indirectly. Extreme temperature reduces the humidity in air and decreases the water content in soil which harden the plant to survives. Conventional greenhouse is manually operating which it is not able to obtain the accurate environment parameters to support the plant growth and maximum the crop production. On the other hand, the security of plantation area is not enough to against the attacks from the pests also the criminal. Wild animals may sneak or step into the plantation area and feed the ready harvest crops. As well as there are some culprits may enter the plantation area illegally and steal the crops and sell for money. Some of intruder not only feed or steal the crops while they might causes the harm or killing the young seedling that still growing. In short, the automation greenhouse will be revolute the monitoring and controlling management into technologies. All the parameter of growth of plant will be detected by sensor system and controlling system will working automatically based on the measurement been detected. Hence, automation greenhouse will be the highly security guard with optimum environment condition and avoid the stolen of plantation.

1.3 Project Objective

The main aim of this project as follows:

a) To develop the automation greenhouse system that demonstrates a sustainable environment to increase the crop production.

b) To implement the intrusion detection and prevention system against the wild animals attacks or unpleasant theft in greenhouse.

c) To visualize current environment parameters and interact with on-site greenhouse system by using mobile application.

d) To improve the traditional greenhouse into advanced greenhouse that enable to connect with cloud analytics.

1.4 Scope of Project

The scope of the work is focus on measuring the weather condition and secure the crop within the greenhouse. DHT11 executes temperature and humidity measurement detection in the greenhouse. While the moisture sensor used to detect the moisture level in soil and LDR sensor to measure the light intensity. Apart of that, the laser fence is set up by beaming the laser light source on the LDR module. Once the laser beam is blocked determines the intrusion occurrence, the alarming system invoked. But if the laser beam is unblocked, it will determine no intrusion occurrence. Besides, researcher can check the condition of plant by the mobile application.

The scope of this project to be done as follows:

a) The simulation of the project is done by using the PROTEUS software application to design the electronics circuit.

b) The programming code of the circuit is designed by using the Arduino Integrated Development Environment (IDE) which purposed the editor code for Arduino and NodeMCU hardware.

c) The mobile application using the Blynk Application as monitoring system on user side though connection WiFi.

d) Constructing the hardware prototype for the automation greenhouse system which controlled by Arduino microcontroller.

1.5 Expected Result

Automation greenhouse implementation enable to enhances the crops productivity especially in the agriculture sector. The development of Internet of Things (IOT) in the automation greenhouse helps researcher to monitor and control the environment condition in prefect range. The expected outcome of this project is researcher able to observe greenhouse by using mobile application. Besides, there are installation of the laser fence which used to detect any intrusion into the greenhouse. Once the intruder touched the laser fence, the alarming system will be invoked chase away the intruder and warn to the researcher. Besides, there are automation gate will automatically respond towards the situation meets.

1.6 Summary

The introduction of this project has been studied in Chapter 1. The background of the project mention that the automation greenhouse with technology and the implementation of the Intrusion detection and prevention system has made. This project allows the connection between the software application and hardware prototype. Lastly, the main purpose of this project is to develop automation greenhouse with crops protection which maintain the best environment growth of plants at the same time provides the protection that secure from the intrusion of unpleasant encounter happens that reduce the crop production.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The project is made up of the Arduino microcontroller which is the main component of the circuit. Arduino microcontroller will read the input from various sensor and outputting action towards the peripheral devices. The development of the greenhouse will build up the perfect weather condition for the growth of the crops also guarantees in term of quantity also the quality. The invention of the smart greenhouse the smart gadget like sensors system that measure the real time current condition within the greenhouse. Actuators devices like fan and light source used to control the desired weather condition. Furthermore, the laser surveillance system provides the safeguard towards the crops from damaged by unexpected intrusion happens which carried the bad consequences and damaged to the plant. As really the intrusion happens, audio devices will invoked to scare away the intruder.

2.2 Automation greenhouse based on microcontroller

According to [7], the automated greenhouse is the climate controlling framework also other environment parameters which development technology automatically. As the population increasing gradually, the food production demanding is the most concerned in their sustainability. The automation greenhouse system proposed by states Atmega328 microcontroller as the main control. Besides, the system consists of many sensors such as temperature sensor, soil moisture sensor, humidity sensor also the light sensor. Microcontroller Atmega328 acts as an integrated circuit which read all reading from all the sensor and take control by generated the output in this Arduino based circuit. This microcontroller-based circuit utilizes the innovation framework administer the perfect ecological condition for plant generation. The temperature sensor and humidity sensor decode the digital input from real environment and send towards Atmega328 according to the programming code. Once the desired temperature reading received, the Atmega328 will generates the digital output followed by the threshold value that written in program. Both temperature and humidity parameters will be controlled by heater or the cooler. Then, the soil moisture sensor will detect the digitized reading and send to Atmega328. These reading influences corresponding to the water valves whether to be start up. Furthermore, the light dependent resistors (LDR) will be triggered by emerging the light when necessary.

Microcontroller Atmega328 will receive all the data information from sensor then generates the digital high or low output to handles the situation meets. The output plays role as reducing the effect of the real situation and maintaining all the parameters within the safe range. In short, the implementation of this system can be evaluating the agriculture with technology requirement for plantation also the supply the environmentally condition which suitable for various plantation.

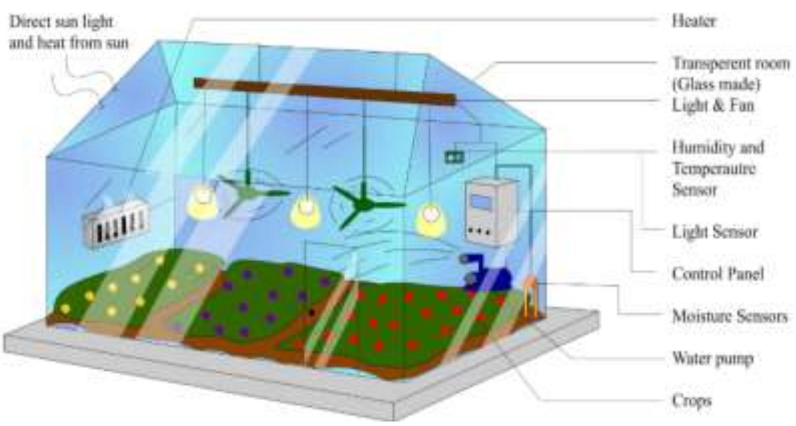

Figure 2.1 The real greenhouse with implementation of sensor nodes.

2.3 Automation Greenhouse with implementation of irrigation system

Based to the studies by [8], which developed the Automatic Watering System based on Arduino. Watering the plant seem easy but it is hard to be controlled. Farmar always aware the precision amount of water to meet the requirement of the particular of plant. The issues turn to be crucial as the manual prediction is not accurate at all the time. Usually, most of the farmer will watering the plant based on their experiences and prediction. However, the prediction brings high risk of wrong decision. Automatic sprinklers using a soil moisture sensor is designed based on Arduino microcontroller technology as the automatic irrigation system will be conducted according to the demand of the growing plant. Soil moisture sensor is used to detect the moisture level in soil which reflects to the respond of the plants condition. Sprinklers system will determine the watering progress based on the received moisture level in land without human-to-human interaction.

Figure 2.2 Irrigation system within the greenhouse.

Likewise, the automation irrigation project will automatically watering system based on the detection values from the soil moisture sensor [9] . The microcontroller Arduino will control all action towards the attached devices. Then, the soil moisture sensor will become the acquisition system which check the soil humidity of a plant. A drip irrigation system encourages efficient use of water where the water is slowly dripped to the roots of the plants through narrow tubes and valves. In addition, this project has been added the Liquid Crystal

Display (LCD) which produce the information with moisture level of soil as user view. Once the output voltage is read by microcontroller, Arduino will send the operation action towards the functional block. Within the functional block, there are water pump which controlled by the relay module by turn ON and OFF. As the moisture level is enough, the relay module will received the low threshold voltage which remains the OFF states of water pump.

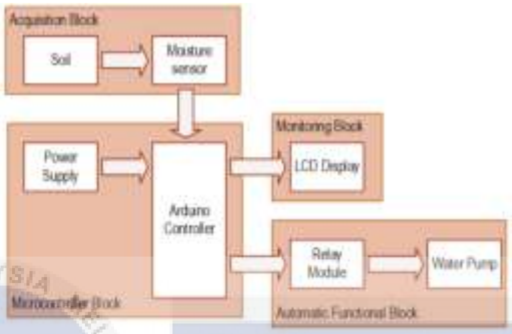

Figure 2.3 Implementation of irrigation system in Greenhouse.

In summary, the paper purpose to design the automation irrigation system without any human control. Water is critically needs for the agriculture as the water wastage will be the crucial impact which destroy the natural environment. Reducing the water wastage with automatic irrigation system by using the modern technology to perform the irrigation management.

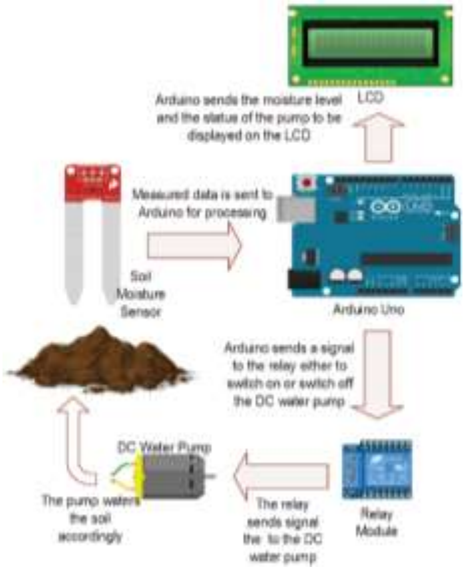

Figure 2.4 Irrigation system with Arduino microcontroller.

2.4 Smart Greenhouse with IOT Based

According to the book by [10] ,designed the Tracking Greenhouses Farming Based on Internet of Technology by Arduino accompanied with the ESP8266 module for the transmission and receiving the data information in the implementation of the Internet of Things. This project is purposed the system that obtain and controls the greenhouse for Aloe Vera crops by sensor and actuators devices. The ESP8266 will contain the Wi-Fi protocol which links the hardware architecture combine with the Blynk application though the Blynk server via cloud computing. Smart farming occupied the Blynk server to collect the environment parameters in greenhouse electronically additionally transferring recorded data within the greenhouse towards the user interfaces. Modern greenhouse has improved by the technology and transforming into the advance monitoring method to user.

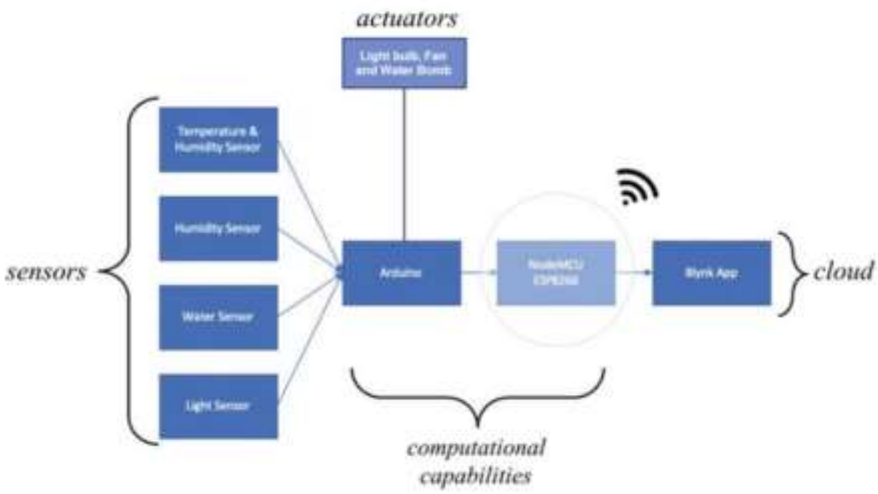

Figure 2.5 The monitoring and actuators in Greenhouse.

According to the system designed, monitoring system will performed by collecting the information of environment parameters inside the greenhouse from data collector through sensors then directed the information to the base station. Base station is essential to the part of controlling the weather condition inside the greenhouse. Further, it also called as the microcontroller the circuit implementation that conduct stabilizing the outrange parameter into the normal range. Typically, the stabilizing process also said to be the controlling system as the base system which always modified the desired growing condition inside the greenhouse. Based on proposal above, the water sensor, humidity sensor, light sensor and the temperature sensor is the data collector while the actuator is controlling system such as pump, light bulb also the fan.

Greenhouse cultivation that accomplished the urban agriculture which purposed valid improvement in microclimate control, the data sharing also the long-term artificial light source with utilized the technology Internet of Things. Advanced greenhouse with precision technology provides optimum environment growth of the plants and increase the productivity [11]. Internet of Things executed the Wireless Sensor Network (WSN) which developed the wireless communication technology for current monitoring and remote controlling. Innovation from the conventional greenhouse applied reading instrumentation, communication device also the mobile application together inside the commercial greenhouse. Network connection supports synchronization monitoring system and the configuration of controlling system. Real time climate parameters detected by the sensor nodes influences the decision support system. Actuators tends to manipulate the output management depend on the decision responses. Distance data measurement in greenhouse combines the physical hardware and software in wireless combination. Data monitoring techniques available the optimization the condition of greenhouse, prediction on the crops condition, and decision-making support system.

Advance microclimate control in greenhouse relies on the various data information which received by the sensor nodes. Mainly, microcontroller system considers the management on the temperature, humidity and light intensity inside the greenhouse. Optimum environment condition encouraged the growth of the plants. Precision irrigation and temperature-humidity control schema is the common controlling system in greenhouse. As an example, the precision irrigation will watering the plants based on its requirements. The sensor node will be attached inside the soil of the plants and measure the moisture level in soil. In this manner, the consistence watering process will be invoked when there is shortage of water situation been measured precisely. Dynamic monitoring system take places in measuring the environment conditions synchronizes the approaches or remains the greenhouse microclimate.

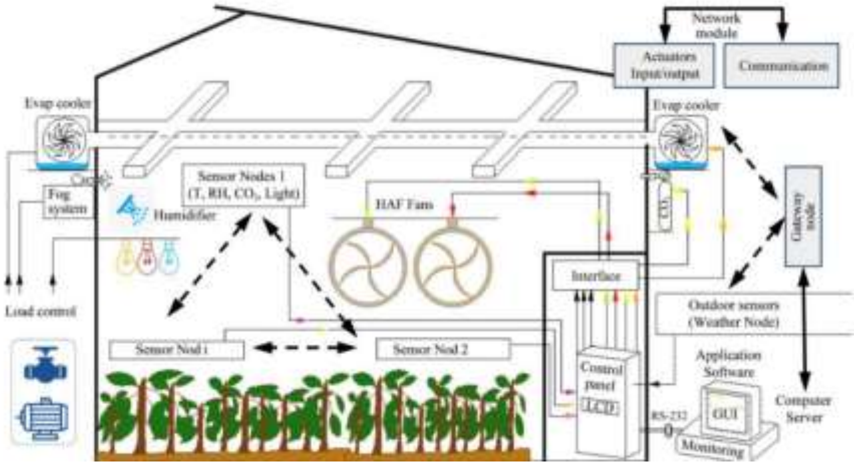

Figure 2.6 The Greenhouse with Internet of Things.

Notwithstanding, it cannot be denied that implementation of Internet of Things created the advances management system within the greenhouse, while there are some considerations should be taken to be functionable. As the network connection might differ in differences location especially there are low network strength in rural area. This might give effect like decreasing in accuracy of information also late respond on system. Moreover, based on the study shows by [12] the Internet of Things in Greenhouse Farming is said to be an alternative and efficient solution towards the food crisis. Enforcement of the greenhouse within the agriculture sector helps maintaining the environment condition which suitable for growth of the plants and far away from the harsh outdoor condition.

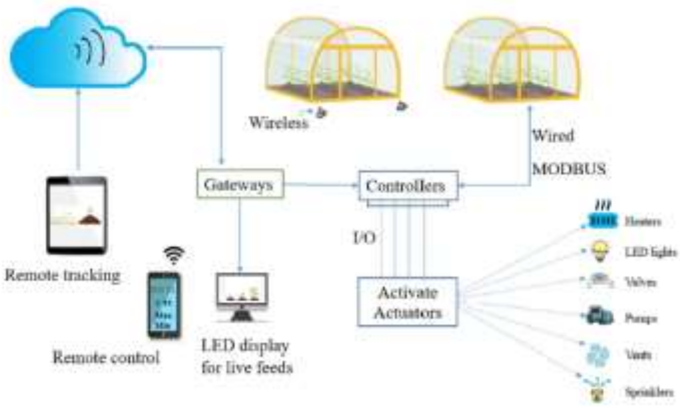

Figure 2.7 Remote Monitoring IOT based Greenhouse.

Integrating Internet of Things technology in greenhouse has change the conventional greenhouse to produce various type of functions and remains the climate control in greenhouse based on the requirement of the crops all the time. Smart greenhouse will activate and takes action without the supervision and manually control by the human. In short, smart greenhouse equipped technology to achieve the optimum condition for increasing the crops and quantity. In the automation climate monitoring system used the sensor technologies which measuring the real-time reading inside the greenhouse with the wireless sensor network. The wireless network module includes the GSM module or the ESP8266 which transmit all the environment measurement toward the cloud server. In traditional farming, the farmer has to make own decision making by experiences based, while the smart farming is undergoing decision by precisely controlled with expert system.

The Wireless Sensor Network (WSN) enable to bind the hardware sensor together with the software application to perform data transformation also the communication. Exchanging the data information resulted integrated decision according to the real time sensor measurement. Accumulate of the data information will send to the cloud to perform analysis at the same time, user side able to observe the environment parameters in the greenhouse with the distance of short period. Cloud computing will carry out data storage of the pervious data information and keeps updated as the reading keeps tacks. Intelligent cloud computing provides the dynamic monitoring and look back the previous data information depend on his requirement. In summary, the “smart” greenhouse carries out the supervision with intelligent action remotely without accessed from human manually.

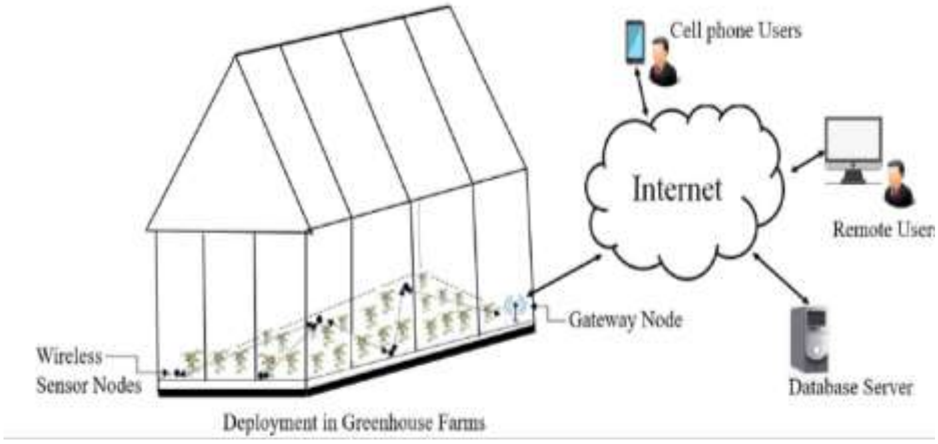

Figure 2.8 Deployment of Greenhouse with Wireless Services Nodes.

2.5 The Smart Greenhouse remote monitoring by Blynk Android Application

Development of the remote monitoring system in greenhouse was designed based on the NodeMCU ESP 8266 Microcontroller will be automatically transmitted the environment parameters inside the greenhouse [13]. The aim of this project maintaining desired environment parameters inside the greenhouse by using the Blynk Application on Android gadget based on transmitter and receiver of NodeMCU ESP8266. There are several functionally components include the DHT11 (Temperature and Humidity), light sensor (BH1750), Total Dissolve Solid (TDS) sensor will build with the Arduino board by supporting programming codes. Development of technology in greenhouse enables the precise environmental condition by replaced the manual monitoring. With internet access within the prototype system, detector will performed as information collector and convey those data information towards web server.

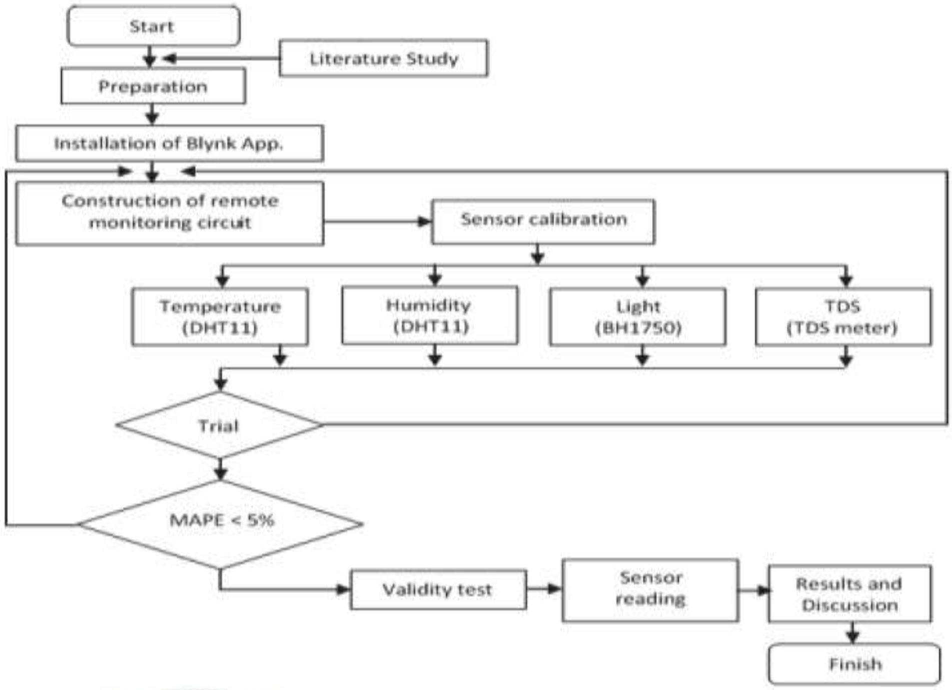

Figure 2.9 The flowchart of the Blynk Application.

The flowchart above shown the process of the simulation in the hardware circuit. The Installation of the Blynk Application on the Android mobile phone and creating the new account. The register of account required the email address, once the account is register successfully, the authentication token will be rewarded. Then, the design of the layout display in the Blynk application depend on the number of sensor system in the greenhouse project. Inside the Blynk application, researcher must design the user interfaces on the Blynk application with some control button. In this manner, all the sensors system will linked on the Arduino board and codded the programming code with the Arduino software IDE. When processing the system started, environment measurement will be taken by the sensor system which allocated on the Arduino board. Sensor calibration will be generated the values by manual sensor system and may takes a quarter of time to display on the Android application on phone.

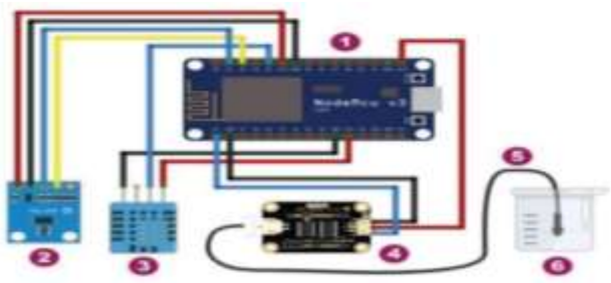

Figure 2.10 The Remote Monitoring System Circuit 1)NodeMCU 2) Light Sensor 3) DHT11 4)TDS Sensor 5) Probe 6) Water reservoir.

The next part which is the Mean Absolute Percentage Error been computed to defines the differences of the real time reading with the prediction measurement. For that result, the accuracy of the sensor has been calculated and defines. At last, the simple implementation of the remote monitoring system using NodeMCU ESP8266 is to manipulate the environment friendly condition which is suitable for the growth of plant. In the end of the research, the remote monitoring system using the NodeMCU has performed well within the greenhouse. In essence, advance greenhouse is designed the remote monitoring system using the NodeMCU via Blynk application on user side.

By the same token, the research from the [14] also appear the dynamic monitoring and remote controlling in greenhouse by using the ESP8266. This system utilized the ESP8266 NodeMCU as the central unit in the circuit. Dynamic monitoring of the greenhouse environment parameters established the interfaces between the Internet of Things database together with the sensor nodes inside the greenhouse. The environment variable consists of the temperature, humidity, light intensity also the moisture level will directly send to cloud computing. All the environmental parameters are adjustable with the help of electronics devices with Internet of Things (IOT) technology. The overview of this project states the dynamic monitoring system also the remote-control system is using the ESP8266 NodeMCU as the central unit to interface the various sensor device and send the accumulate parameters reading towards the IOT cloud. As well, instruction controller will be made as the communication pathway had established between the IOT platform and the user. User side able to operate relay control by sending the instruction towards ESP8266 Wi-Fi Module through IoT platform. Wi-Fi network connection in ESP8266 based on the HTTP protocol with the API (Application Interfaces Integration) keys privately to own data reading.

Figure 2.11 The Greenhouse with ESP8266 as centre in circuit.

Moreover, the monitoring system also implemented on the Organic- Light Emitting Diode OLED module which is the light diode will be emitting that represent each pixel on the display. Thus, all the parameters information will concomitantly with the display data on the android application. Android application Blynk supports the data visualization from greenhouse on the mobile phone, after the registration of the account that links to the project. Internet of Things provides the continuously sending the current greenhouse measurement though NodeMCU so that enable the data display on user side. In conclude, modern technology like Internet of Things evolve the remote control technology which involved the long-distance transmission. Advance technology in agriculture sector helps regulate the desired microclimate in greenhouse for crops growth.

2.6 The database ThingSpeak platform in Smart Greenhouse

According to the studies form [2], the invention Environmental Monitoring System using the Arduino and ThingSpeak which continuously tracking the weather condition within the greenhouse. ThingSpeak is the open-source application which performing the data storage and restore the all the data information from the sensor system and back to the user interfaces. Besides, ThingSpeak is the Internet of Things platform which allow to aggregate and display all live data stream in cloud with network connection. Furthermore, real time data accumulate before able to perform further analysis included interpret in graph or percentage calculation. In summary, ThingSpeak is the middleman that handles the flow of data information between the user interfaces and the software application when there are access of Internet. Functioning sensor will continuously updating the real time data stream as it will act as tracker before transmitting towards IOT platform.

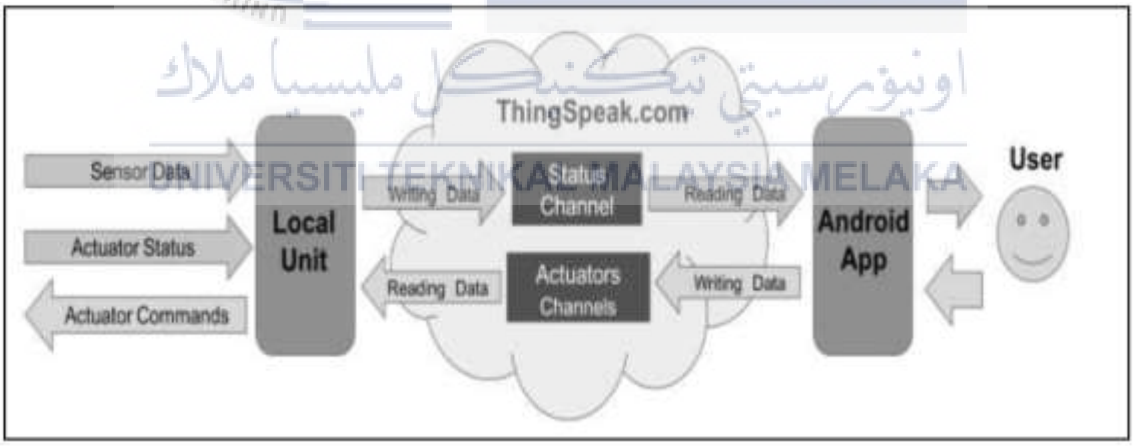

Figure 2.12 The ThingSpeak as centre for integration between Software and Hardware.

The project about the automatic sprinklers in greenhouse based android designed by [15]. The automation sprinklers will be activated by using the soil moisture sensor based on Arduino microcontroller AVR Atmega328. Automatic irrigation system widely be used as the automation watering the plant without manual control. The connection to the

ThingSpeak platform required the established of the network connection. Equivalently, Internet of Things (Iot) will be transferring all the detected data information form the sensors to the ThingSpeak automatically and concurrently once the measurement is detected. Measurement will send to ThingSpeak via cloud computing as the monitoring and controlling progress able to go on without worried on the anywhere or anytime. However, the user had to register a new account then to obtain the channel ID also the Application Programming Interfaces (API) keys to proceed the use of account. At the end, as the sufficient data information is recorded, the analysis of the data will be conducted. Analysis of the data will be shown of the chart graph presentation.

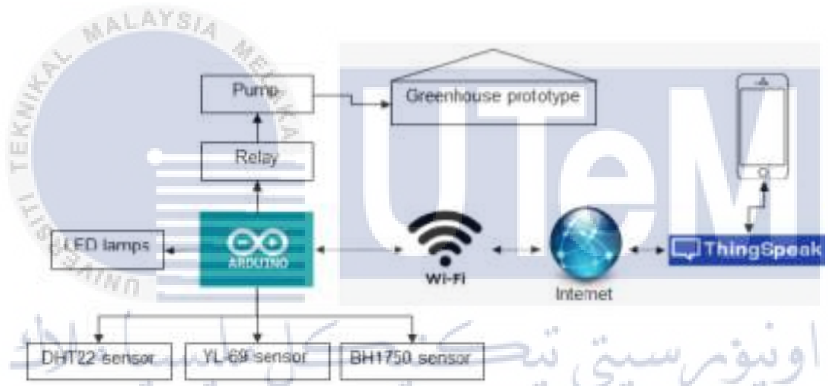

Figure 2.13 All the data information from Arduino will send towards ThingSpeak.

Likewise, the same design purposed by [16] used the IOT platform based on ThingSpeak and Arduino to control the irrigation system. The automation watering system implemented to reduce water consumption and preserve the water usage to avoid water wastage. ThingSpeak create specific channel in cloud platform to this implementation that allows the exchange of data measurement. When the user wants to observing the environment parameters in greenhouse, he will just access through the account by using the same username and passwords when registration of new account for monitor remotely. The project is using the ESP8266 to form a WI-FI module and establish the links between the

Graphic Interface User (GUI) and the database ThingSpeak. In general, the user interface can directly retrieve all the measurement parameters in greenhouse along with android application on electronic gadget. In consequence, the user can visualize the level of soil moisture values with the phone in anytime.

Figure 2.14 Smart Greenhouse with ESP8266 and ThingSpeak Cloud.

Development of automation greenhouse is the one of application of the Internet of Things. At the same time, the ThingSpeak is the Iot analytics platform that investigated the collected data information and serve for decision making. Implementation of ThingSpeak server tends to be a database for aggregation, visualization also the analyze with the live data in greenhouse. Then, observation of the recorded data information will shown on created channel and able to visualize on client side [17]. By referring to the research from [18], the invention of the automation greenhouse carry out the Internet of Things implementation with the Arduino Mega microcontroller, WI-FI module and the cloud platform ThingSpeak. In the function of automation greenhouse has divided into the monitoring system and the control system. Firstly, the monitoring implemented the ThingSpeak web server that updated the all the reading form the sensor as long as there are Internet coverage. Once the data information is uploaded, ThingSpeak will performed the tabulated of the result in greenhouse farming.

Figure 2.15 Computing of ThingSpeak with MATLAB.

Secondly, the microcontroller Arduino Mega will controlling the status of the outputting system which connected to the relay. The three relays will be activated as when receiving the high values from the Arduino mega. Hardware and software interfacing emphasis both monitoring and controlling system. The control system executes the Arduino Mega microcontroller as the main component in controlling control system based on output from sensor system. For instance, the temperature sensor LM35 which is the analog input-output devices which the resolution of the 1024 bits to references 5 V voltage is required to converting the temperature measurement the voltage output. Once the measurement of the temperature reading is higher than 30 $°C$ and below the 25 $°C$, the fan will ON when current temperature is high, while turn OFF when the temperature is lower than 25 $°C$. Similarly, the soil moisture sensor will test the water content in soil. Moisture level is set the 200 values as the threshold value in system. If the water content is low in the soil, the water pump will started spin and pump water but if the moisture level is above 200, the relay will switch off the water pump. Lastly, the condition of the relay on the bulb is modulate by the light intensity. When the value is beyond desired value 500 light intensity, the relay module will switch off the bulb. All the reading parameters from the sensor is checked and resulted the outputting system, thus display all the information on the LCD in ventilate.

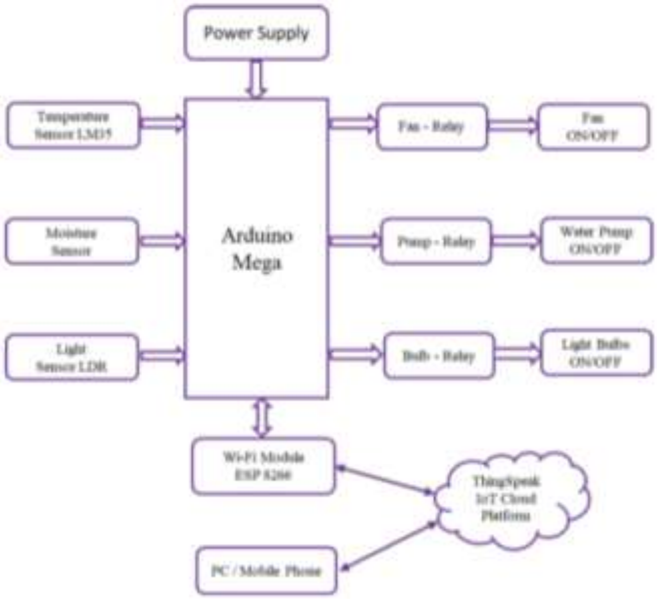

Figure 2.16 Implementation ThingSpeak in Greenhouse with ESP8266

All in all, ThingSpeak is the web service platform which will become the host that collected the all the data from the sensor and resolve into the data tabulation after uploaded by the reading sensor. The automation greenhouse gives advantages to the user to observe real time situation of the greenhouse in the mobile application. Then, ThingSpeak can investigated the data inside the greenhouse also the gave permission to user to access the data information. Advance technology provides high accurate but short time respond output, the only drawback is high consumption of electricity energy.

2.7 Laser Fence towards intrusion in Greenhouse

The research from [19] revealed that the Smart Laser Fence able to reduce the conflict between the wild animals and human. Approaches of the laser fence helps to seriously damage of the wild animals and protected the crop in the effective ways. Before that, some crops guarding method includes chili fences which applying the chemical weapons with strong pungent of smell to deter the animals. Furthermore, some chemical substances like the capsicum which will burn the skin tissues on the animals and irritates the lives animals.

This method is practical, but it is discouraged as the action been taken will causes the dangerous of the animals. Electric fence is another choice for the farmer, but there is not all farmer is affordable to installation of complete electric fence, also high requirement of the electric. High amount electricity flow on fence may stops the threat, while there are still have high risk to damage to human being if it does not handle properly. Therefore, the smart laser fence security system will control the intrusion with laser beam. The laser beam is not harmful to the intrusion as laser emitted will behave like ordinary interaction between light source and living things.

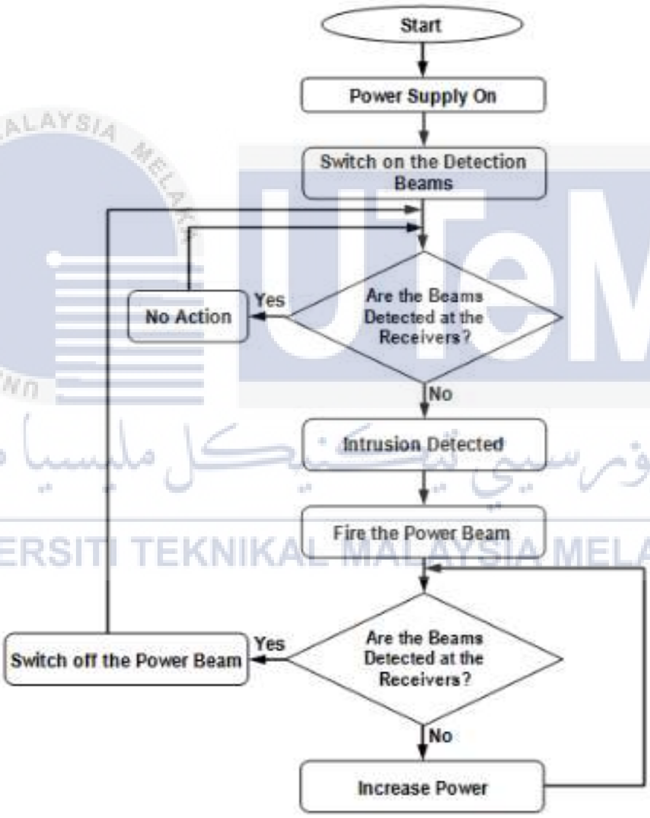

Figure 2.17 Flowchart of Laser Fence.

In addition, this established of laser fence as protection boundary is supported by the [20], the IOT Based Security System (IBSSS) provides the external protection with high accuracy of detection with applied the Internet of Things. The aim of the laser fence used to discover the existence of the animals when the breaching of the laser source been blocked.

On the opposite side of the laser source, there are placed the PIR sensor which build a connection between the laser beams. When the line connection between the laser and the PIR sensor is been break when blocked by the body of wild animals, alarming system activates. This connection considers to be break as the PIR sensor cannot detected the high light intensity values as the beam of laser. Over above of that, the project advocating the automatically laser gun that will pointed to the direction of the intrusion present. Application of the laser gun depend on the ultrasonic sensor that fixed on the servo motor. As the ultrasonic sensor detected the presence of human being, the relay module will be outputting the HIGH threshold values which started the laser gun to fire at the position detected. Hence, some intruder may quick enough to change their heading direction, while the laser gun will follow the position of intruder concurrently.

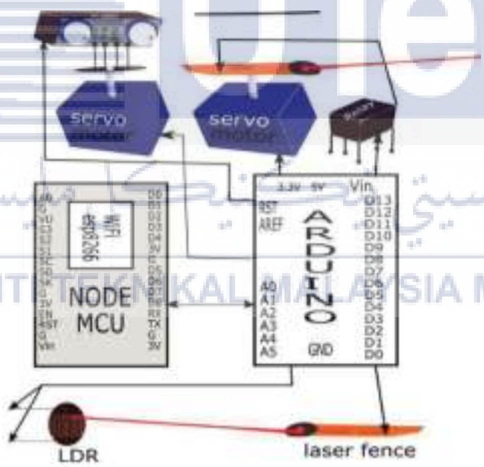

Figure 2.18   Laser Fence control by Servo motor.

Based on the research carry out by [21], an intelligent surveillance security system is been set up by using the laser fence. Advances laser fence has been implemented with the GSM communication system, as the intrusion detection will be sent to user with SMS notification. This project has purposed the energy efficient method which using the LASER beam, LDR and the mirrors to make the purposed system to save money. The concept of total internal reflection of light is performed when two mirrors are placed parallel to each other and receiving the incident light from the laser. The reflection of the laser beam on mirror created the sub-layer with zig zag shape from the inner layer towards the outer layer. There are image monitoring system with camera will be coordinated and recording the intrusion in live stream. Besides, there are the GSM module which will establish the network communication system to notify the user when intrusion occur.

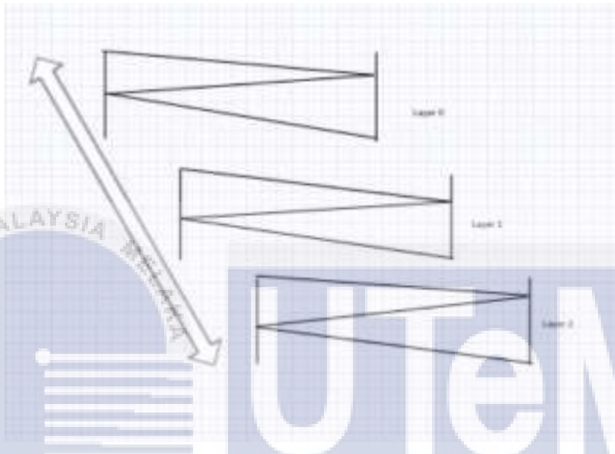

Figure 2.19 The Three Layer Laser Fence.

There are three classification of the threat level includes the false intrusion, threats, and harmful intrusion. The layer of the laser will be tested into three differences threat level in two layer Laser system, three layer Laser system and the four layer Laser system. Firstly, the two layer Laser system using two layer of laser to identify the fake intrusion and send message to user via GSM module. The fake intrusion may the touched by the non-living object or some accident which step on the area. Then, the three layer Laser system used to filter the intrusion as the zeroth layer system will acts to defines whether the correctness of the intrusion. If the wild animals are cross to the zeroth layer but it is not go forward to the next laser system. This intrusion is said to fake intrusion as long as the animals does no go further. Lastly, the four-layer Laser system which extremely high prevention of intrusion system. The zeroth layer will just to be the awareness layering without any notification as the laser fence been disturbed. Next, the first layer will be started the intrusion identification and will classified the Threat. Even more, the second laser layer will be raising the alarm and classified as Harmful Threat. Last, the third laser layer will be activating the alarm and also started to take the image with camera then send to user as the crucial notification.

In summary, there are three differences security system with applied the discrete numbers of the laser layer system. The four-layer laser system is the most energy consumption while with the excellent intrusion filtering system, three-layer laser system is normal rate intrusion filtering and the average resulted in intrusion filtering. On the top of that, two-layer laser system is low consumption of the energy while the intrusion filtering is not efficient.

According to the studies [22], implement of the junction box to prevent the attacks from wild animals intruders. Invention intelligent agriculture system helps the prevention of the intrusion of animals and maintain the productivity of crops. In these studies, the agriculture system works with implementation of the IOT networking system which enable the communication of the component devices by the XBee. In the security part, total implementation of four laser source which placed different direction and pair with the LDR sensor. Each junction box will mount the laser gun also the LDR sensor and surround the crops field, and placed the four corner on field. Not only-but so the practice within the management of the crops also not to be forgotten. The implementation of the precision agriculture includes the smart sensor system to manage the environment condition such as the pH level, temperature, humidity, soil moisture level and light intensity also the watering system with utilized the GSM module to perform transmission of data.

The junction box used the GSM communication to process the data transmission and receiver between the hardware components and the users. If the alarming system is invoked, the alert message will send to the user immediately. Each of junction have the complete circuit which consists of the Arduino microcontroller, the laser transmitter, Real Time Clock (RTC), XBee communication system and LDR sensor. Laser is responsible to build a virtual fence which cover the crops field totally, and the light source of the laser pointed directly to the LDR sensor. The virtual fence will constructing the line of slight together to the other laser. For instances, LDR sensor in each junction box are not used for laser in the same, while it is used for the laser besides. Further, the real time clock is used to track the present day. The RTC used to measure and record time parameters along the occurrence of the detection of intrusion then send it though XBee.

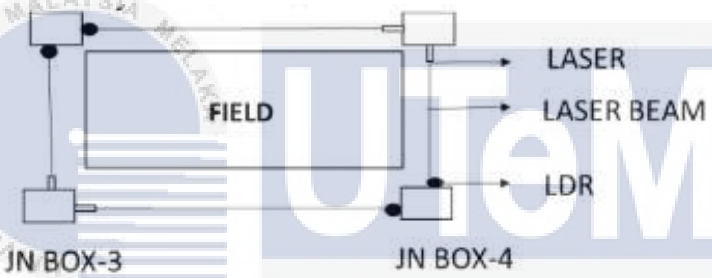

Figure 2.20   Function Box of Laser Fence.

The detection of intrusion in junction box functions by the measurement of the light intensity of the LDR sensor. When intrusion happens, the obstacle will blocked the light pass and break the laser line to LDR sensor. Once the LDR sensor cannot detected of light source, low light intensity will provides the alerting sign and triggering the intrusion message to user. Then, there extra function within this system likes the calculation of the numbers of the intrusion times once the junction box security system activates. Lastly, the implementation of the laser junction box must be straight line and pointed directly to the LDR sensor. Also, the distance between the laser and LDR must not more than 200 meters to strengthen the detection level.

The crop protection to deter the animals intrusion in the agriculture with Wireless Sensor Network purposed [23]. Forming the crop protection equipped with Laser source pair, PIR sensor, XBee, RF module with microcontroller Arduino MEGA. The architecture of this system purposed the closed loop wild animals intrusion detection system which placed the wireless sensor nodes in entrances of the every side of the farm. At the corner there, that sides is installed with the laser emitter as guarding fences sense the detection of animals. Then, the sensor that placed on the nodes will be activates the flasher or the sound devices based on the presence of the animals. Since the application of the sensor nodes is covered the perimeter of the crop field, whenever which direction the animals tried to pass though the crop field their presence still can be detected.

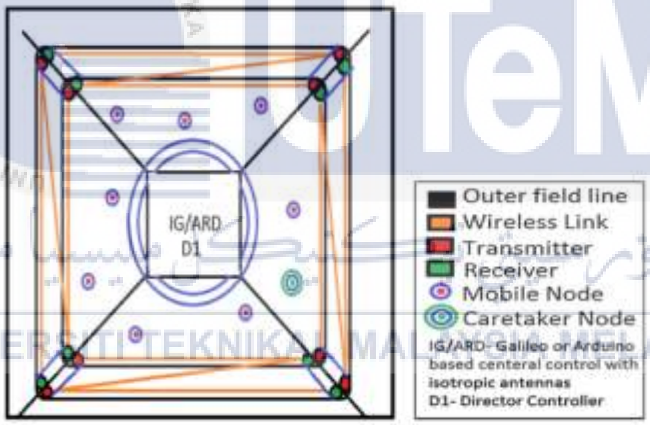

Figure 2.21 Closed loop with Laser Fence.

In this crop protection architecture, the detection of intrusion is automatically. There are central node which managed the other nodes. For this reason, the system will be directly into the wait state when the intrusion does not happen. Hence, once the animals been detected, the central node will activate the mobile nodes depending on the location where the intrusion is detected. Mobile nodes have installed the flashes also the sound device to get rid the presence of the intrusion. Despite that caretaker node will also invoked the LED indication and the buzzer once acknowledge the intrusion. The caretaker will transmit the command to the central node about the location detail of the intrusion. By doing so, the caretaker will be take control the central node to give the stop command. In total, the operation in detection of the states of the intruder with deployment of WSM. As this technique is easily adapted and also without the affected the balance of ecological. The implemented tends to scare away the animals from the crop field and avoiding any hurting towards the animals.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter aims to states the certain steps in methodology this research. In this methodology, researcher has decided the purpose for conducting this project also the procedure to be taken to reach the excepted result. Besides, all the method used, hardware and software will be discussed within this chapter. Furthermore, the research design will be describing all the planning and process flow of research study which necessary for the progress of the entire work.

3.2 Methodology

The progress of the research will be discussed in the flow chart below.

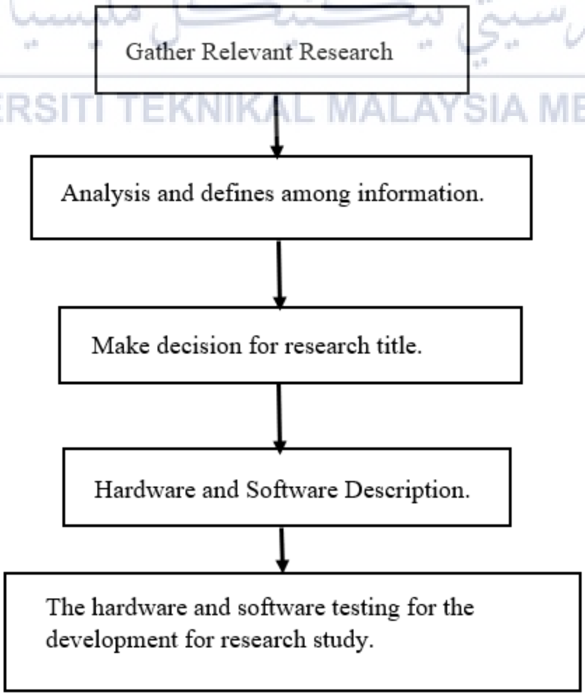

Figure 3.1 The workflow of project.

Firstly, researcher must define the general knowledge and information which about the project title for this research study. Gathering all the genuine and accurate source information for the research from journal, articles, books and even newspaper. Then, researcher has to define the objectives about the project and list down the problem statement that faced in the project. Defines those objectives and problem statement guided the first step as start of the project.

Secondly, the analysis of the information to identify what problem was influenced the project. Source for the information includes like internet source, journals, newspaper, articles also some genuine videos. These sources were investigated and summaries by researcher in the Literature Review section. In the Literature Review section, researcher had listed down the possible method and hardware uses from previous studies. That information is important as a guideline for the researcher in the correctness application used, the type of hardware also implement the innovation when constructing the project. Next, researcher had to make decision within the gather information to define the suitable software and hardware to implement in the project. Researcher had to compare the data information like the resulted data, results and purpose implemented before making the decision. Then, researcher had made the final decision to the specific component for the project.

Besides, researcher also confirm the type of software implemented. Furthermore, the description of the hardware and software discussed further. The detail and function of the hardware and software will be listed down. This is because, this helps more understanding about component that applied in project also maintain the development for the project. Thus, the general knowledge about the hardware component avoids any detrimental on execution.

Lastly, researcher had to continue testing and analyze the running of the project. Modifying within the hardware and software cannot be avoided. The continuously repeating testing the project until achieved the desired result. After then, researcher able to make a conclusion about the project.

3.3 Flowchart

The flow chart above shows the smart greenhouse with the crop protection mechanism. The controlling system in the greenhouse used to measure the temperature, humidity, and moisture level parameters. At the start of the system, the measurement of the temperature and humidity in the greenhouse also the ventilation system will be activated. If the temperature is more 35 Celsius or the humidity is less than 65 percentage, the ventilation system will increase its speed and remains the desired condition. Then, the soil moisture measurement been taken according to the soil condition. There are consist of three condition which is wet, dry or prefect soil condition with different output. The dry condition will switch on the red LED, if wet condition will invoke blue LED while when the soil condition is prefect, the green LED will turn on. Then, intrusion status will detected in greenhouse. When there are intrusion happens in greenhouse, the laser fence will measure the intrusion level occurs. The first intrusion level is indicated the large body size intruder while the second intrusion level is indicated the smaller body size intruder. When first level intrusion happens, the red LED and buzzer will turn on, while second level intrusion will turn on the yellow LED and buzzer. But, if there are no intrusion happens in greenhouse, the statement "Greenhouse is safe" on LCD display. After then, all the environment condition and intrusion statement will displayed on the mobile application.

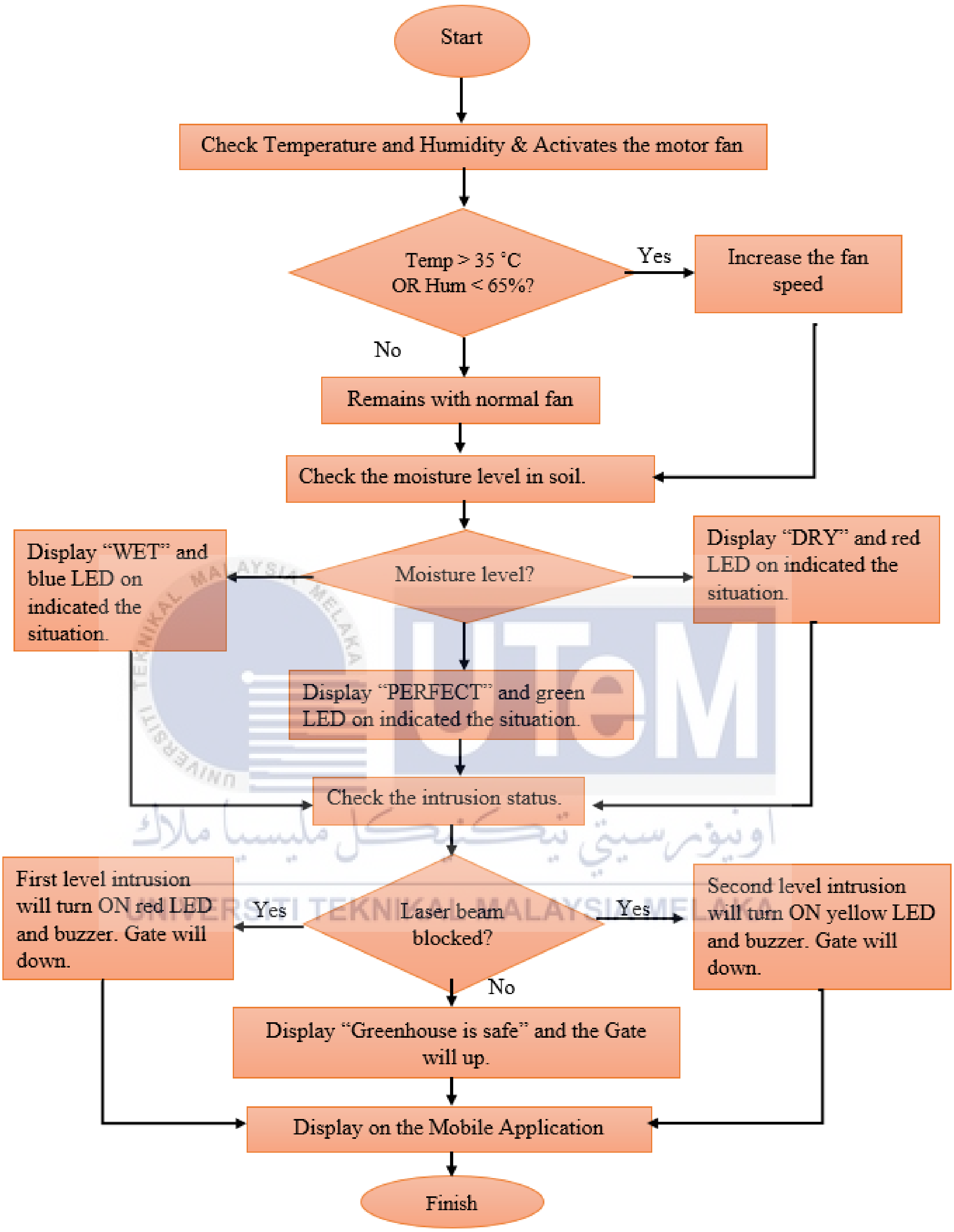

Figure 3.2 The Flowchart in project.

3.4 Block Diagram

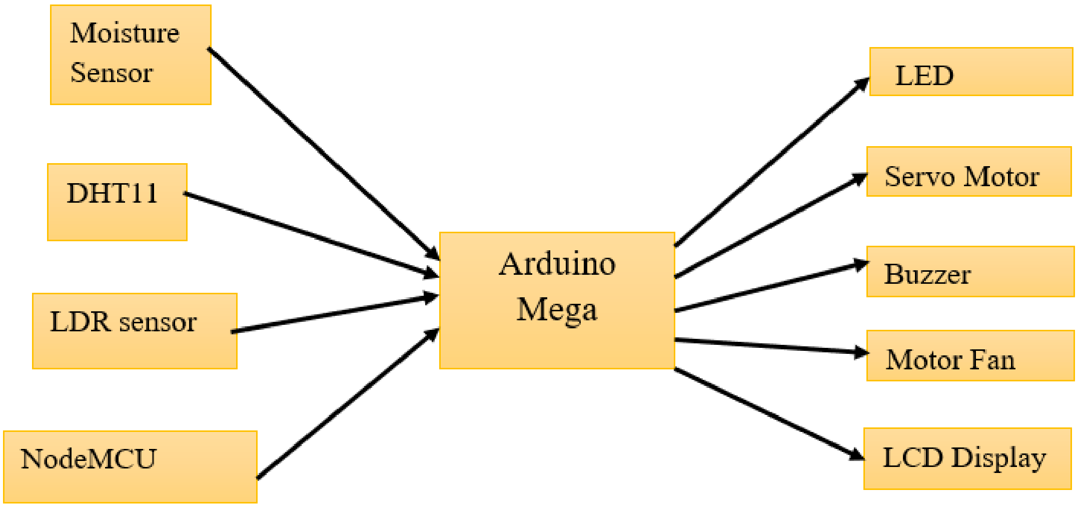

Figure 3.3 The block diagram for the project

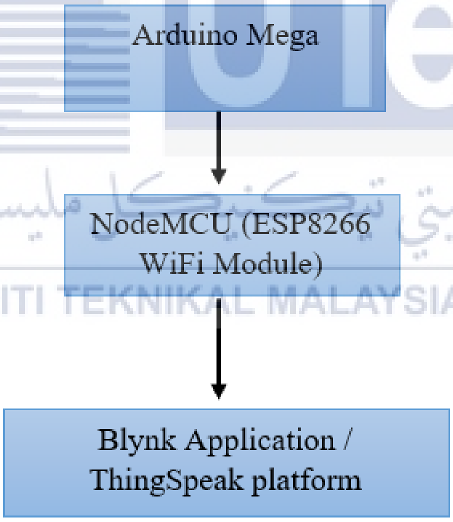

Figure 3.4 The block diagram of transceiver module.

The moisture sensor will place at the soil in the plant to detect the measurement of the moisture level. Besides, the environment parameters like temperature and humidity also measured by DHT11 sensor then moisture sensor will read moisture level in soil. Then, LDR sensor to read the light intensity in greenhouse. All the data information been collected will send to the microcontroller Arduino Mega. The Arduino Mega will classify the measurement value with different solution. The LDR module will detected the first or second level of intrusion. If it is first level intrusion, red LED will light up, while yellow LED will light up if it is second level intrusion then buzzer will turn on for both situations. All these data will be collected and send it the user through the mobile application. The NodeMCU is the transceiver module which allows the microcontroller Arduino Mega to access Wi-Fi.

3.5 Hardware

In the project, researcher is using some hardware component to build the greenhouse system includes the Arduino Mega, NodeMCU Lua V3 ESP8266 WIFI with CH340C, Light Dependent Resistor (LDR), Light Emitter Diode (LED), Buzzer, Temperature and Humidity Sensor (DHT11), Soil Moisture sensor and the laser gun. These components have their own function and specification in the greenhouse system.

Table 3.1 The function and specification of components in greenhouse

Hardware component	Function	Specification
Arduino Mega	The microcontroller board that perform specific operation like taking the data input and performing the output like LED and Buzzer.	Microcontroller of the Arduino is Microchip Atmega2560. It has 54 Digital I/O pins and 16 Analog input pins.
NodeMCU Lua V3 ESP8266 WIFI with CH340C	NodeMCU will connected towards the data cloud. It has firmware that runs ESP8266 WiFi SoC from Espressif System and hardware based on ESP8266 module.	Microcontroller which built-in the System-on-a-Chip (SoC) hardware development ESP8266 Espressif system.

Temperature and Humidity Sensor (DHT11)	The DHT11 calculates relative humidity and temperature by measuring the resistances between the electrodes.	The operating voltage for DHT11 is between 3.5V to 5.5V. Temperature measurement range is from 0°C to 50°C. Humidity measurement range: 20% to 90%.
Soil Moisture sensor	Commonly, it measures the water content in the soil and decided the moisture level as output.	It has operation voltage about 3.3V to 5.0V. It has a LED on board which indicate the output. Besides, it is Analog sensor.
Light Dependent Resistor (LDR)	The LDR works as the variable resistor which keeps changing the resistor value depending on the light intensity detected. LDR is used to detect the light beam from laser.	Passive component which is sensitive to detect the light source which fall on the LDR. Resistance of LDR influences by the light intensity.
Laser diode	It can beam out hte laser ponter by using the GPIO pins. The requirement input voltage is 5V to activated this breakout circuit.	The laser beam is red in colour with wavelenght 652nm. The laser source is in dot shape and outputing the power with 5mW.
Light Emitter Diode (LED)	It is a semiconductor diode which will be emitted when the current is flow. If will light up and blink to show the condition of soil also the intrusion happens.	Convey the specific information by visible light. There are various choice of colours to represent differences visible signal information.
Buzzer	The audio voice will alerting the intrusion happens in greenhouse.	Convey the specific information by audio voice. It is a sound device that requires 5 DC voltage.
DC motor	The DC motor will installed with brush fan and acts as ventilation system in greenhouse.	Convey the specific information by using rotating motor. It can be perform by various speed and rotating direction.
Servo motor	The servo motor rotate will sepcifc angle and acts as the gate to protect the greenhouse.	It is rotary actuator which will receives the control signal and output the desired positon angle.

3.5.1 Arduino Mega

Arduino Mega is an open-source development board with Atmega2560 based 8-bits microcontroller board accompany with 8KB of SRAM and 4KB of EEPROM which can used as read and written with EEPROM library. Besides it has 54 pin digital input/output pin also within 14 pins can be used as PWM output pin (pin 0 to 8) also 4 UARTs pins purpose for hardware serial ports. There are pin for serial communication like 0 (RX) and 1 (TX), 19 (RX) and 18 (TX), 17 (RX) and 16(TX) also 15 (RX) and 14(TX) that enable to receive (RX) and transmit (TX) TTL serial data. But pin 0 and 1 pins will also connect to Atmega16U2 USB-to-TTL Serial chip. Furthermore, for the synchronous serial communication, pins like pin 50 (MISO), pin 51 (MOSI), pin 52 (SCK). These pins able to support the SPI (Serial Peripheral Interface) communication by simulation using SPI library. External Interrupt pins includes pin 2, 3, 18, 19, 20 and 21 that enable to trigger an interrupt on low value, rising or falling edge. Also Then, it has a power jack, ICSP header reset button,16 MHz crystal oscillator and USB connection port. After then, Arduino Mega can powered by USB connection also other power supply. External power supply can be in range of 6 to 20 volts. It requires the Type-B USB connector for power supply and connected to the Arduino Mega 2560 firmware platform using the computer.

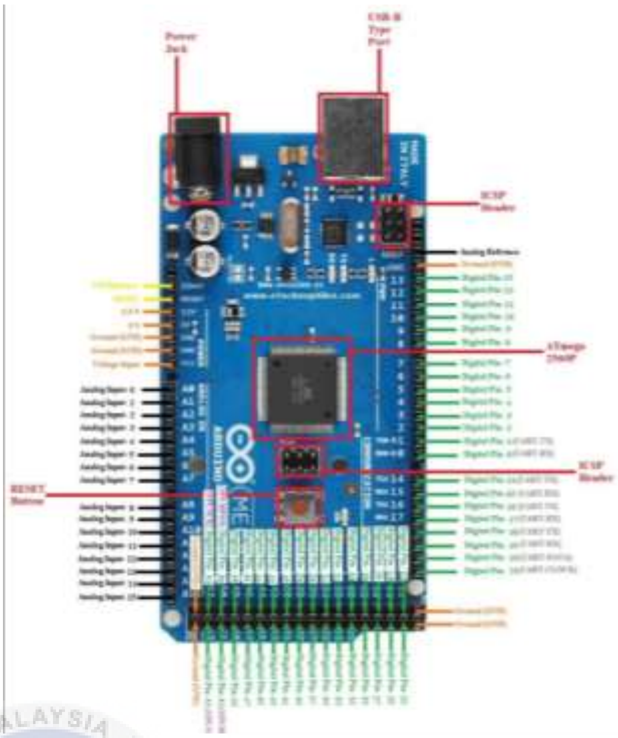

Figure 3.5 Arduino Mega with all pins out.

Table 3.2 The function and specification of components in greenhouse.

Microcontroller	Atmega2560
Operation Voltage	5V
Input Voltage	7-12V
Digital I/O pins	54
Analog Input Pins	16
DC Current per I/O pin	40mA
Flash Memory	256 KB
SRAM	8 KB
EEPROM	4 kB
Clock Speed	16Mhz

3.5.2 NodeMCU Lua V3 ESP8266 WIFI with CH340C

NodeMCU is based in ESP8266 WiFi SoC which is the ESP8266 WiFi module is build-in board. It is the open-source Lua based firmware and development board which specializes to the Internet of Things Application. Besides, NodeMCU has 128KB RAM and 4MB of flash program which used to store data and program. It has high processing in-build Wi-Fi/ Bluetooth also Deep Sleep operating features which makes the ideal IoT project. CH340 USB converter makes the operating system install automatically. NodeMCU hardware has 9 GPIO pins and 1 Analog input pin.

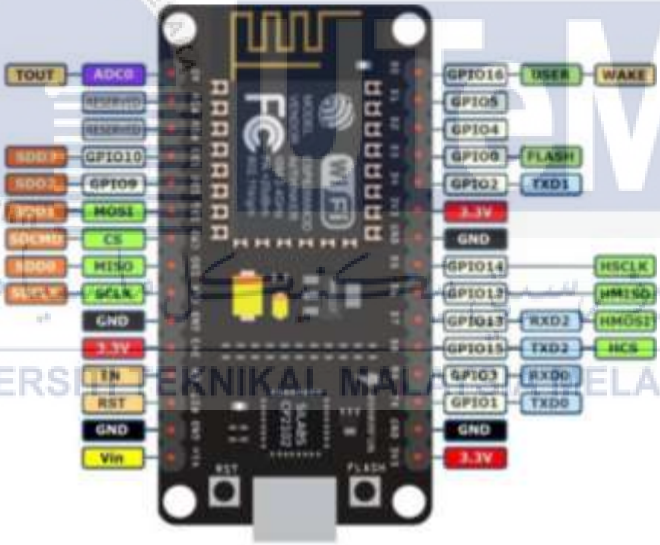

Figure 3.6 The hardware NodeMCU with all function pin out.

Table 3.3 The details of the NodeMCU

Categories	Items	Values
Wi-fi Parameters	Wifi Protocol	802.11 b/g/n
	Frequency Range	2.4GHz – 2.5GHz
Hardware Parameters	Peripheral Bus	I2C/I2S/UART
	Operation Voltage	3.3V
	Operation Current	80mA
	Ambient Temperature Range	Normal Temperature
	USB Connector Port	Micro USB
	Package Size	49mm*26mm*3mm
Software Parameters	Transmission rate	100~460800bps
	Operating modes	STA/AP/STA +AP
	Network Protocols	IPv4, TCP/UDP/HTTP/FTP
	User Configuration	AT Instruction Set, Cloud Server, Android/iOS App

3.5.3 16X 2 Character LCD (Liquid Crystal Display)

The 16X2 LCD has 16 columns with 2 rows which is 32 characters display format. Each position will only store one characters once. Besides, each character will made of by 5x8 pixel dots with cursor which each pixel can displayed as alphabet or numeric. LCD can work with 2 different MPU interfaces modes which is 4-bits modes or 8-bits modes. Then, LCD backlight which is the illumination form that apply in LCD as it cannot produce the light by themselves. The backlight will produce the visible light by using the light-emitting diode (LEDs) that increase the characters visibility during the low light condition. Single power supply requires with 5V voltage input and operating temperature within -10˚C to 60˚C.

Figure 3.7 16X2 LCD Display Module.

Table 3.4 The detail of pin function for LCD Module

Pin Number	Pin Name	Description
1	Vss (Ground)	Connected the LCD to ground source.
2	Vdd (Input Voltage)	Connected the LCD to voltage supply.
3	VE (Contrast V)	Enable to adjust the contrast of the LCD.
4	Register Select	Control pin that toggles the data/command register.
5	Read/Write	Trigger the read/write operation in LCD.
6	Enable	Held the High command to perform the read/write operation.
7 - 14	Data Pin 0-7	Data/Command Pin that enable to send the command and data to LCD display.
15	Led Positive	Backlight LED pin for positive terminal.
16	Led Negative	Backlight LED pin for negative terminal.

3.5.4 Temperature and Humidity Sensor (DHT11)

DHT11 Temperature and Humidity Sensor is the digital signal output sensor with using the digital-signal-acquisition technique to ensure the high reliability and long-term stability. It is small, low power consumption, extremely accurate on humidity calibration and easy 4-pins single row pin package. Operation voltage is among 3.5.V to 5.5 V and the operation current 0.3mA. Temperature range detected among 0˚C to 50˚C and Humidity range among 20% to 90% and resolution of the temperature and humidity in 16 bits. The accuracy for temperature ± 1˚C and humidity ± 1%. It has anti-interference ability and long-distance signal transmission with precise calibration.

Figure 3.8 The DHT11 sensor.

Table 3.5 The pin description in DHT11.

Pin Name	Function
Vcc (1)	Power supply requires 3.5V to 5.5V.
Data (2)	Outputting both Temperature and Humidity through serial Data.
NC (3)	No connection and not be used.
Ground	Connected to ground of circuit.

3.5.5 Moisture Sensor

The moisture sensor can read the moisture level present in the soil by using the two probes to pass the current through the soil. The moisture sensor module which connects to the leaded probe and calculate the volumetric water content inside the soil then gives result as the moisture level. The external will acts as the variable resistor and adjusting the resistor value according to the water content. The module will produce both Analog and Digital output. In the Analog Output (A0) pin, it used to create the output voltage referred to the resistances at probe. Then, the digital Output pin (D0) will digitalize with same resistance value as Analog pin by the LM393 High Precision Comparator on board. The more water content in the soil, the lower the resistance value and gives the low analog voltage reading. But, when the water content is few, the resistance value will become higher and resulted the high analog voltage.

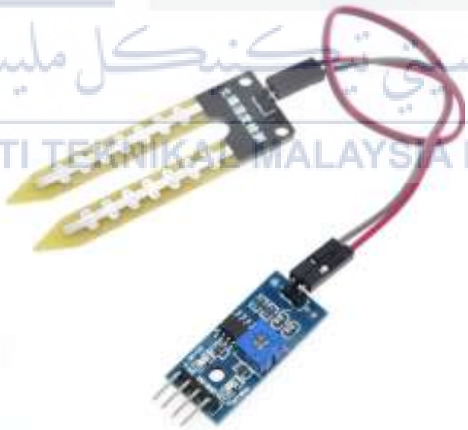

Figure 3.9 The soil moisture sensor with leaded probe and moisture module.

Table 3.6 The pin description in Moisture sensor.

Pin Name	Function
V_{CC}	The pin supplies the power about 3.3V to 5V for the sensor.
GN	The pin provides the ground connection
A0(Analog Output)	The pin function as gives the analog signal between the power value to 0V. This A0 pin will have to connect to the Analog pin on the microcontroller used.
D0(Digital Output)	The pin gives the gives Digital output of internal comparator circuit. This pin must be connected to the digital pin on the microcontroller used.

3.5.6 Light Dependent Resistor (LDR)

The Light Dependent Resistor also called as the photoresistor which will changing the resistances depending on the light intensity detected. It is the light sensing component that absent in the polarity and free to connect in any direction on the board. LDR functions as the Light Sensor will detect the amount of the light and make prediction between the day or the nighttime. The semiconductor material includes Cadmiun sulphide, CdS on the LDR provides the light sensitive properties. Then, it is small size, cheap, and available to fit to different microcontroller. Besides, LDR will wide spectral also wide ambient temperature ranges.

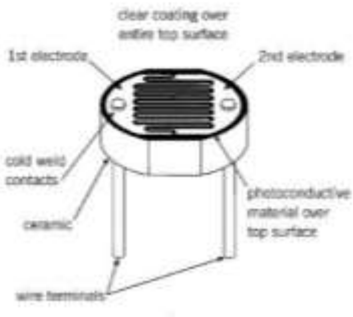

Figure 3.10 The LDR component.

Table 3.7 The specification of LDR sensor

Parameter	Value
Voltage	320V
Current	75mA
Power dissipation at 30˚	250mW
Operation temperature range	-60 ˚ to 75 ˚C

3.5.7 Laser diode

The laser diode is encircled with the electrically isolated case with lead electrical connection. The lens is made up of high reflective index glass to produce the high-quality long-distance beams. Besides, the laser light controlled by using GPIO pin from Arduino board can connect towards the Vcc pin on laser diode. The laser diode requires power input with from 3.3V to 5.0V.

Figure 3.11 The Laser diode.

Table 3.8 Specification on laser diode.

Output Power	5mW
Wavelength	650nm (Red)
Operating Current	Less than 40mA
Laser Shape	Dot Shape
Working Temperature	-10˚C to +40˚C
Dimensions	6.5 X 18nm

3.5.8 Light Emitter Diode (LED)

The Light Emitter Diode is a two-lead semiconductor light sources for excellent readability and dependable performances. It is low power consumption and solid reliability with long time. Then, the LED is light sources with advanced optical-grade eproxy which gives superior high-temperature and moisture-resistance towards the outdoor. Normally, the size in 5mm and various colors with differences wavelength. Operation Temperature within the range -30 ˚ to +85 ˚C. Commonly, the Forward Voltage (V_F) 1.8V to 2.4V and Reverse Voltage with 5V.

Table 3.9 Pin Configuration of LED.

Pin Name	Description
Anode (-)	Positive terminal of LED
Cathode (+)	Negative terminal of LED

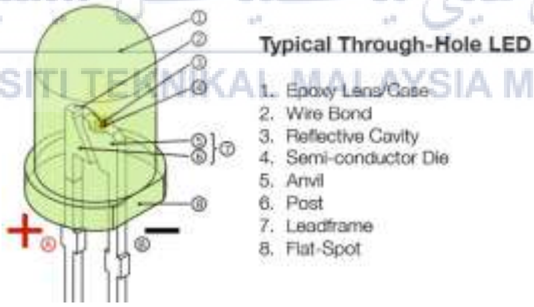

Figure 3.12 The LED with details.

3.5.9 Buzzer

The active passive buzzer is an audio signaling device that used to give out the differences tones and beeping sound. The buzzer is small and breadboard-friendly with compact 2-pin structure. The audio sound generates by buzzer is piercing and noticeable alarm to give respond to some action or event. Besides, the volume of the buzzer can be assigned the frequency value in Hertz like tone(1000); means the buzzer will tone up by 1kHz. Usually, the appearance of the buzzer is black in color with the internal drive circuit. There are 2 pin configurations in buzzer which is positive and negative. The positive pin is represented by (+) symbol and requires powering by 6 DC voltage. The negative pin is represented by (-) symbol and short the buzzer to the ground.

Figure 3.13 The Buzzer with positive and negative terminal.

Table 3.10 Specification in Buzzer.

Parameter	Description
Power Voltage	3~5V DC
Rated Current	≤30mA
Frequency Range	50~14kHz
Operating Temperature	-20˚C to 60˚C
Sound Output	≥85dB

3.5.10 DC Brushed motor

DC motor is a kind of electrical machine that transforming the electrical energy into mechanical energy. The motor will produce a magnetic field in wound rotor that activates the commutator and carbon brush by using electricity current. As the motor is powered, the magnetic field will attract and repels the magnets on motor then this will activate the motor to rotates. It requires 5V input voltage with 0.64 A stall current to activates. Besides, the maximum efficiency speed will be 9602 rpm then the maximum output power will be 0.69W.

Figure 3.14 The DC brushed motor.

3.5.11 Servo motor

Servo motor enable to rotate form 0 degree until maximum 180 degrees due to their gear management. The implementation of servo motor can made by mount the gear on the top of servo motor using a provided screw. There are two type implementation whic is continuous and sweep. Continuous motor can rotates either clockwise or anti-clockwise direction for the specific amount of period. Then, the sweep servo motor will only turn 90 degrees in each direction. There are three hub connection which consist of PWM signal (orange), Vcc power pin (red) and ground pin (brown). The operating speed is 110 RPM and operating voltage from 4.8V to 6V.

Figure 3.15 The servo motor.

3.6 Software

Software is the set of program material which processed by computer system. In this case, software program will perform the modelling the real-time operation without the simulation in actual operation.

3.6.1 Arduino Integrated Development Environment

Arduino Integrated Development Environment (IDE) is an official software which purposed to write, upload, and compiling the code that used on the Arduino Devices. It is an open software that run in JAVA platform to support the C/C++ programming languages also easily available to various operating system. Mainly, IDE environment in Arduino IDE will becomes an editor used for designing the desired code and play role as compiler to compile the code into the Arduino Module. Main code named as a sketch which written in text editor and generates the .ino file extension. Additionally, it also will generate the .hex file which should be uploaded to the board.

3.6.2 ThingSpeak

ThingSpeak is IoT cloud platform which includes the web service (REST API) that allows collect, visualize, and investigate the data information from cloud. Besides, it able to perform the online analysis and visualize the data with MATLAB software. Convert and calculation with built-in-plotted function once the data is transfer into the available channel in ThingSpeak. Other than that, ThingSpeak ensure the device connection between smart hardware and Android application when trigger some reaction or receiving the measuring parameters.

3.6.3 Blynk Application

The Blynk is a platform that designed suited for the Internet of Things. Blynk enable the user interface which allows the user monitoring and controlling the real time hardware remotely. It is a mobile platform allows IOS or Android users to control and visualize the hardware implementation by using graphic interfacing. Besides, the Blynk Server acts as the cloud platform which responsible to establish the communication between the hardware and mobile application via internet connection.

3.7 Summary

In short, the method is going to use in this project has been states in this chapter. The specification and function for each hardware component and software application is explained in detail. Sufficient general knowledge ensures the possibilities to success in the project planning. After the repeatedly testing of the project, the preliminary circuit for the greenhouse has been constructed.

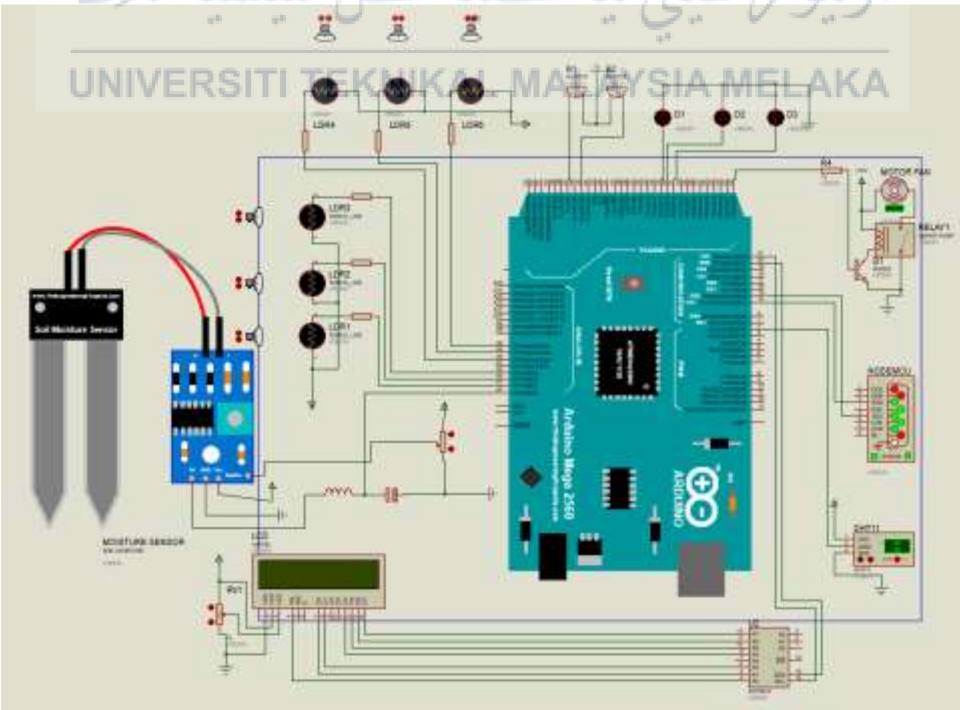

Figure 3.16 The software design of project.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This project will simulate the testing running of the hardware implementation to measure the environment parameters and the detection of the intrusion in greenhouse. This chapter is aimed to discuss the design and hardware implementation for the Greenhouse automation system. The performance of Greenhouse is observed when the sensor device detects the current weather measurement for plant growth, the LDR sensor to detect the intrusion happens once the laser source is blocked also the gate will automatically closed and prevent the intruder step into greenhouse further.

4.2 The Development of Greenhouse automation

The design of the automation greenhouse with crop protection is discussed in this section. The Figure 4.1 show the prototype in the greenhouse automation with implementation of the laser fence. The laser fence is installed three direction of greenhouse which is from left, middle to right side in Figure 4.2. The main microcontroller applied is Arduino Mega that enable to receive all data information from sensor devices DHT11, moisture sensor and LDR sensor. Then, the NodeMCU is the communication devices that integrating the hardware implementation with the cloud service ThingSpeak and mobile application. All the real time measurement and warning information will display synchronized on LCD display also mobile application.

Initially, the statement "CHEE KAI HERN_ GREENHOUSE" will displayed on the LCD like Figure 4.4 when the greenhouse system started. Then, the greenhouse will measure the environment parameters such as temperature, humidity, soil moisture and light intensity of the greenhouse which will displayed on mobile application and LCD display at the same time. Blynk application consist of gauge widget to monitor the measurement value for the environmental parameters also virtual button to control the artificial light in greenhouse. After then, greenhouse system will investigate the intrusion event from the laser fence. If the intrusion happens, the notification will displayed on the LCD also displayed the mobile application together with intrusion level and intrusion location details like Figure 4.3. The details information in LCD display and Blynk application will explained and demonstrates below part. Lastly, all the data information will aggregate and displayed in graph form on ThingSpeak cloud platform like Figure 4.5.

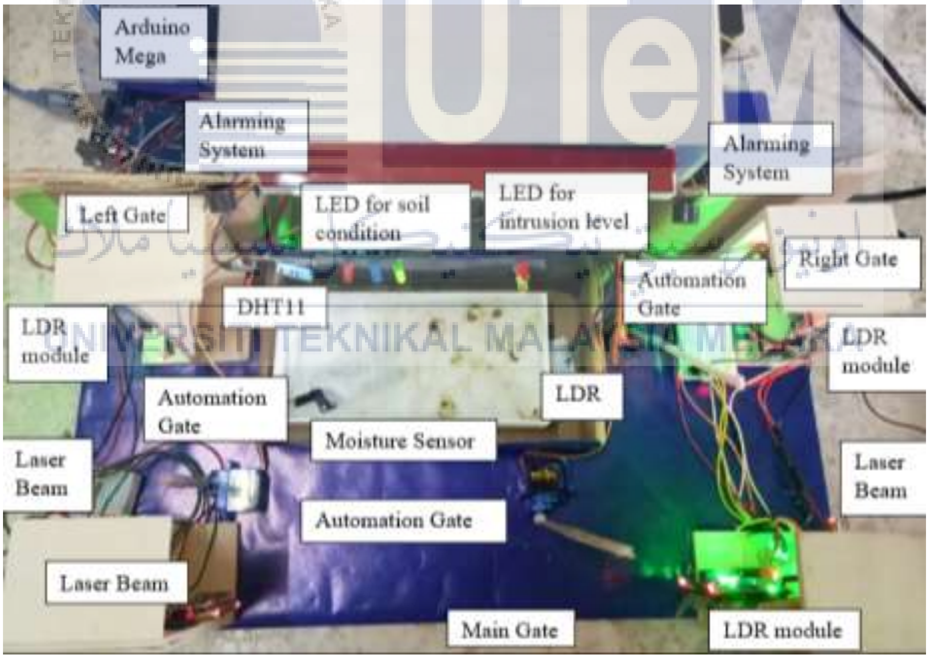

Figure 4.1 The phototype of the Greenhouse.

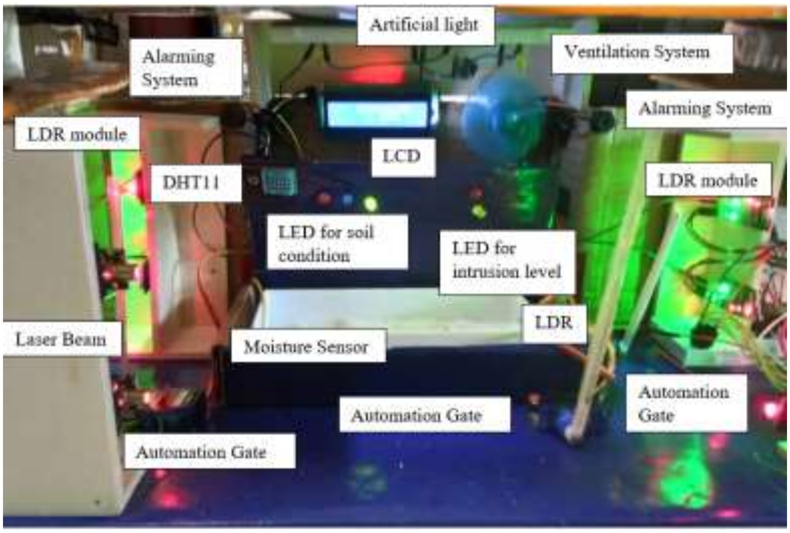

Figure 4.2 The front view of greenhouse.

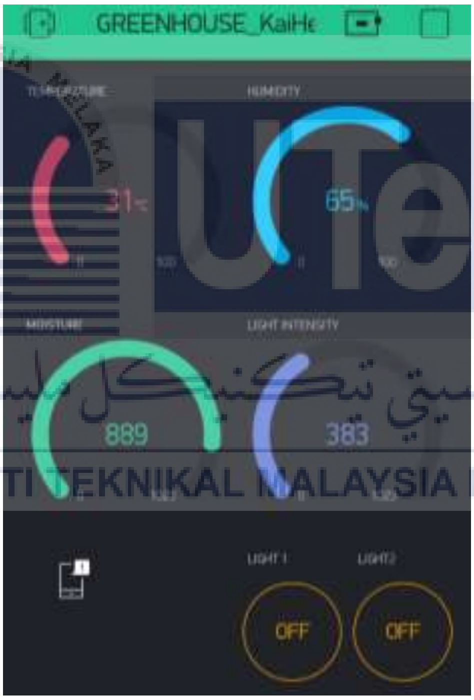

Figure 4.3 The display page on the Blynk mobile application.

Figure 4.4 The display statement when the greenhouse is start.

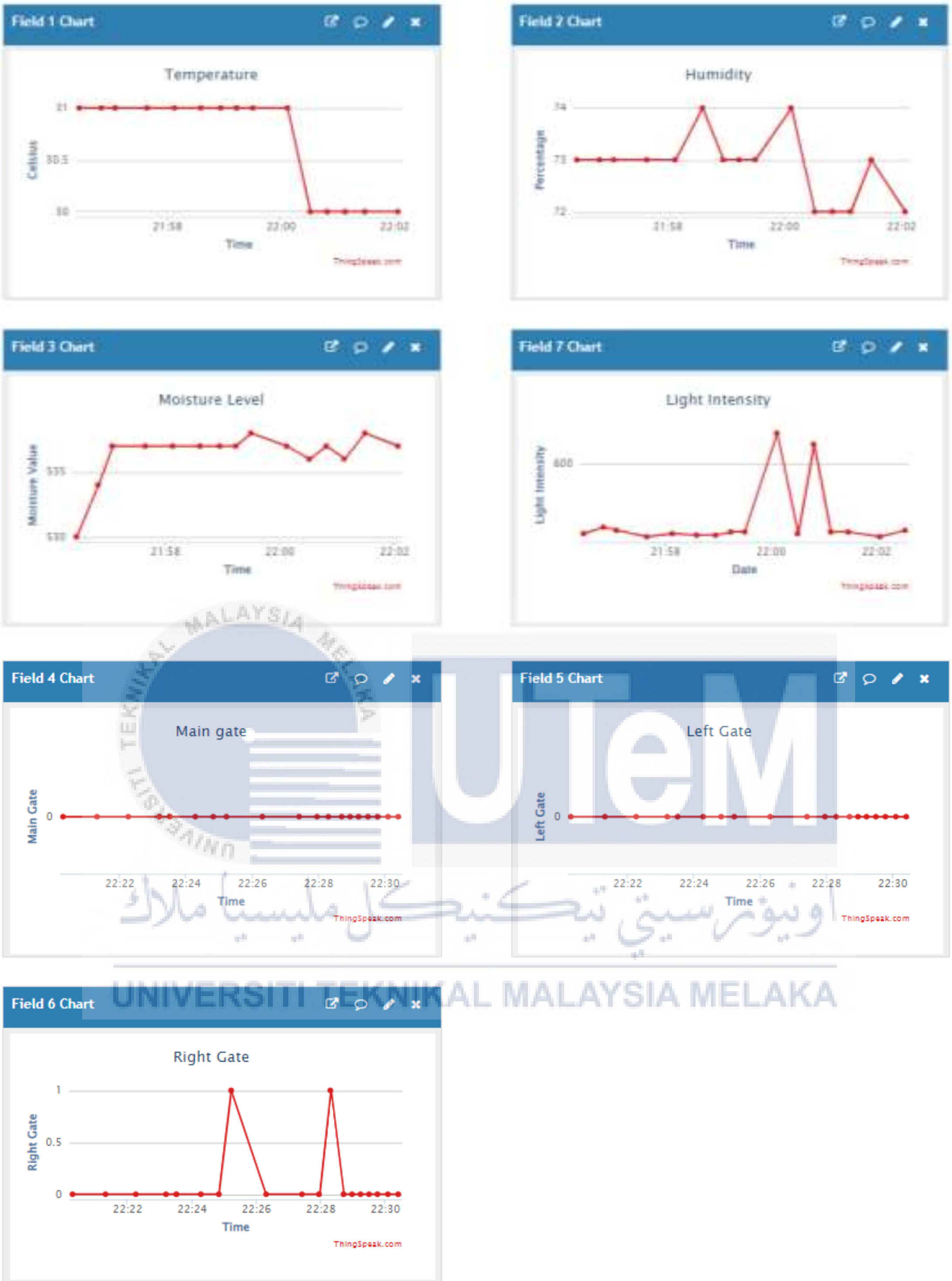

Figure 4.5 Data visualisation in ThingSpeak

4.3 Result Analysis

4.3.1 Environment parameters for plantation in Greenhouse System

In this part, data information about the environmental condition is recorded a tabulated in the table below. The data analysis is done by measuring the parameters includes the temperature, humidity, soil moisture value and light intensity in greenhouse with time changes.

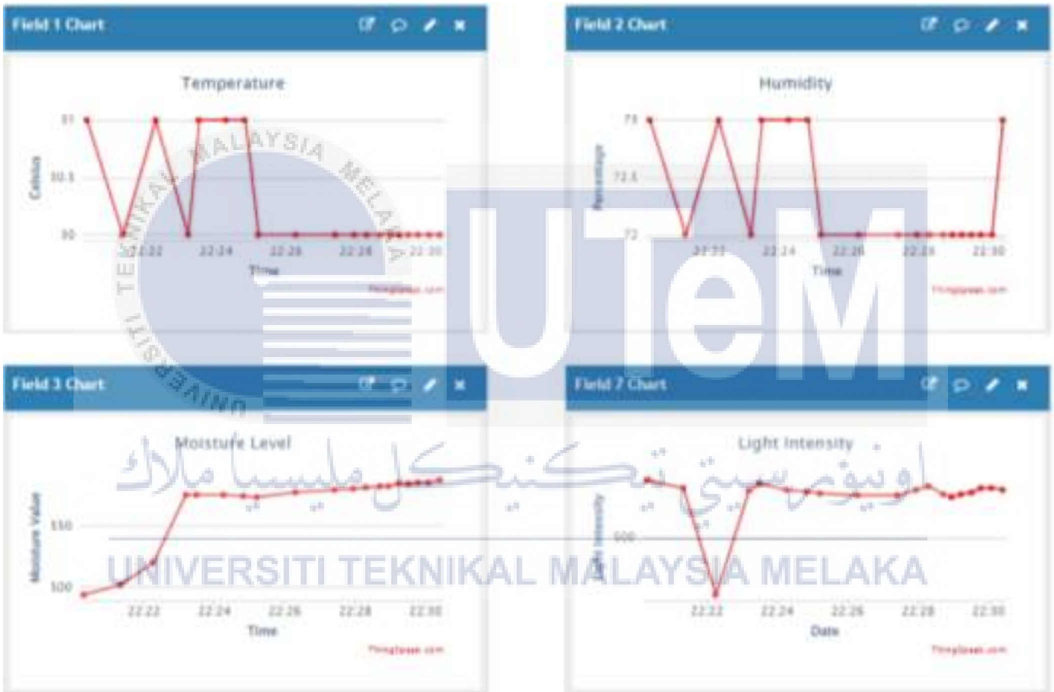

Figure 4.6 The selected parameters in greenhouse.

Table 4.1 The Average measurement of selected parameters of greenhouse.

Selected Environment Parameter	Average measurement
Temperature	31° **C**
Humidity	73 %
Soil moisture	569
Light intensity	547

Based on the Figure 4.6, the data visualization about the selected environmental parameters of greenhouse is appear in each specific channel on ThingSpeak cloud service along the time period. According to the Table 4.1, the average temperature of greenhouse is 31 degrees Celsius and the average of humidity of greenhouse is around 73 percentage. Besides, the average analog measurement for the soil moisture which is 569 values also the light intensity with 547 values.

4.3.2 Internet speed

This section will be measuring the performance of the greenhouse system. The time taken for greenhouse system had observed by comparing the internet speed and time responses for NodeMCU to receive an instruction. Internet speed like 10.1 Mbps, 20.0 Mbps, 45.7 Mbps and 98.9 Mbps has been selected for this testing section.

Figure 4.7 The internet speed tested results

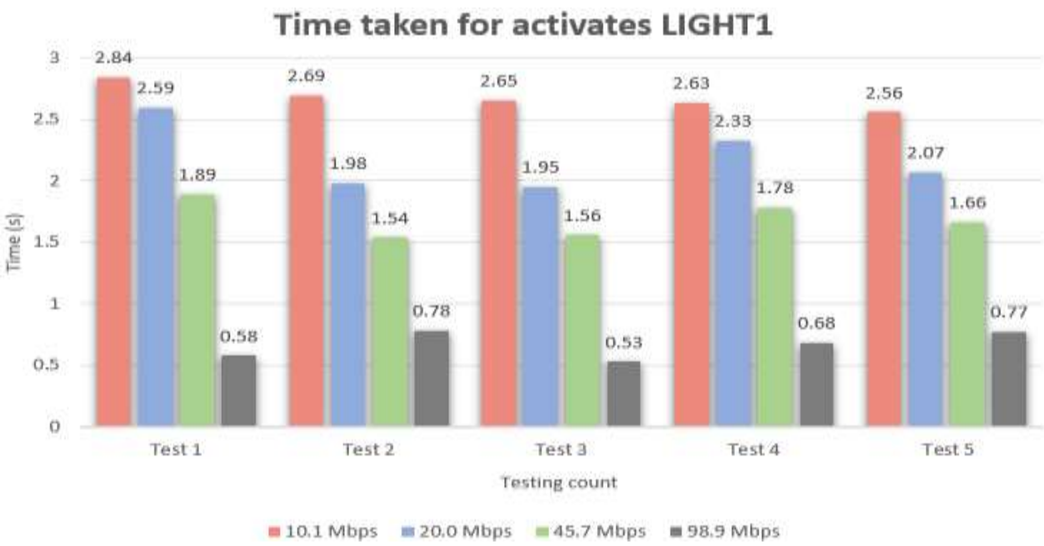

Figure 4.8 The time taken for activates LIGHT1.

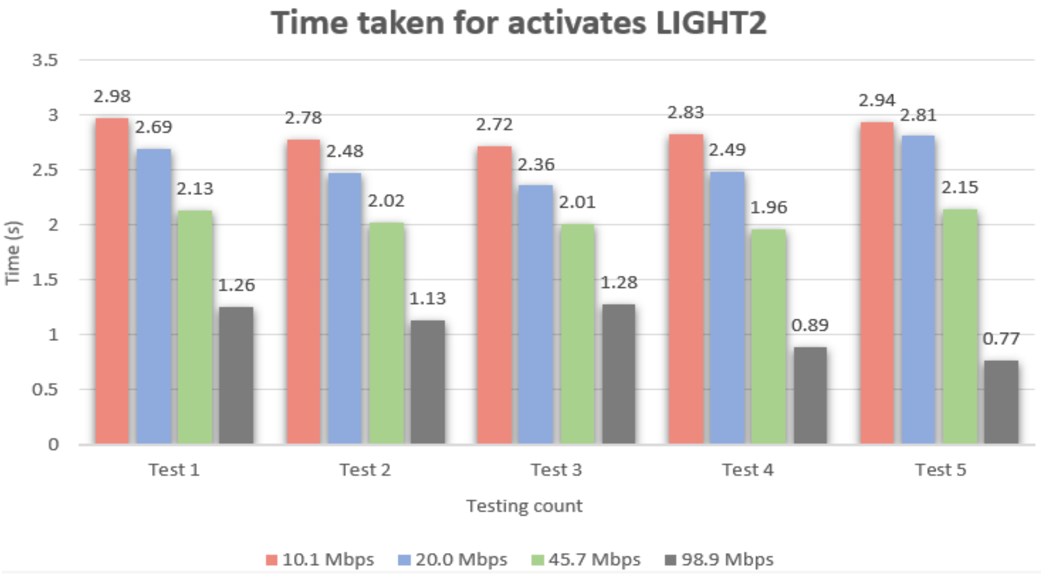

Figure 4.9 The time taken for activates LIGHT2.

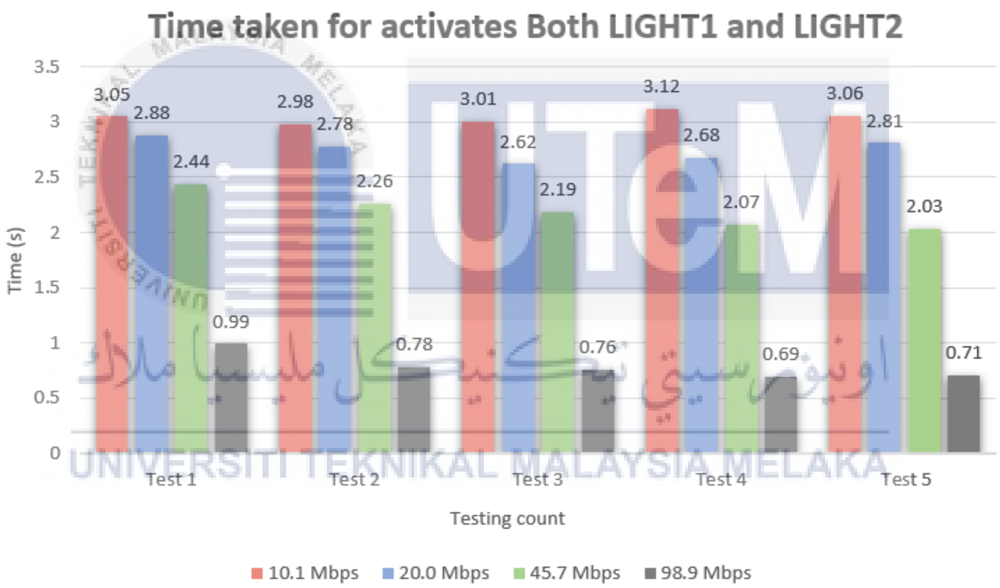

Figure 4.10 The time taken for activates both LIGHT1 and LIGHT2.

Table 4.2 Average time taken for activates LIGHT1.

Internet Speed (Mbps)	Average time response (s)
10.1	2.67
20.0	2.18
45.7	1.69
98.9	0.67

Table 4.3 Average time taken for activates LIGHT2.

Internet Speed (Mbps)	Average time response (s)
10.1	2.85
20.0	2.57
45.7	2.10
98.9	1.10

Table 4.4 Average time taken for activates both LIGHT1 and LIGHT2.

Internet Speed (Mbps)	Average time response (s)
10.1	3.04
20.0	2.75
45.7	2.20
98.9	0.79

According to the Figures 4.8, 4.9 and 4.10 shown the time taken response NodeMCU to receive a signal against with internet speed. There are 5 testing has been done by three different situations with different internet speed. From the resulted obtained, the average of response time for internet speed 10.1 Mbps, 20.0 Mbps, 42.7 Mbps, and 98.9 Mbps is calculated and recorded on Table 4.2, 4.3 and 4.4 following to the situation event. From the table 4.2 states the average time response for activates only the LIGHT1 is highest with internet speed 10.1 Mbps which requires 2.67 seconds, followed by internet speed 20.0 Mbps with 2.18 seconds, internet speed 45.7 Mbps with 1.69 seconds and internet speed 98.9 Mbps takes the lowest time response with 0.67 seconds. Then, average time response from Table 4.3 shown the shortest time response in internet speed 98.9 Mbps with 1.01 seconds and followed by internet speed 10.1 Mbps with 2.85 seconds, internet speed 20.0 Mbps with 2.57 seconds and internet speed 45.7 Mbps with 2.01 seconds. Other than that, the average time taken to activates both LIGHT1 and LIGHT2 is shown on the Table 4.4 which the internet speed 98.9 Mbps reaches the shortest time taken with 0.79 seconds followed by 10.1 Mbps with 3.04 seconds, internet speed 20.0 Mbps with 2.75 seconds and internet speed 45.7 Mbps with 2.20 seconds. Thus, the finding in graphs and table provides evidence that the higher of internet speed the shorter time taken to response.

4.3.3 Comparison between result on-site and result in Blynk Application

This section will be discussing the comparison between the on-site result with the Blynk Application at the same time. LDR sensor will measure the intrusion event while the NodeMCU will transmit the intrusion event to Blynk Application that enable to display the notification details about the intrusion level and location. There are three situations tested to determine whether it is simultaneously with notification of Blynk mobile application.

Figure 4.11 First Test in main gate.

Figure 4.12 Second Test in main gate.

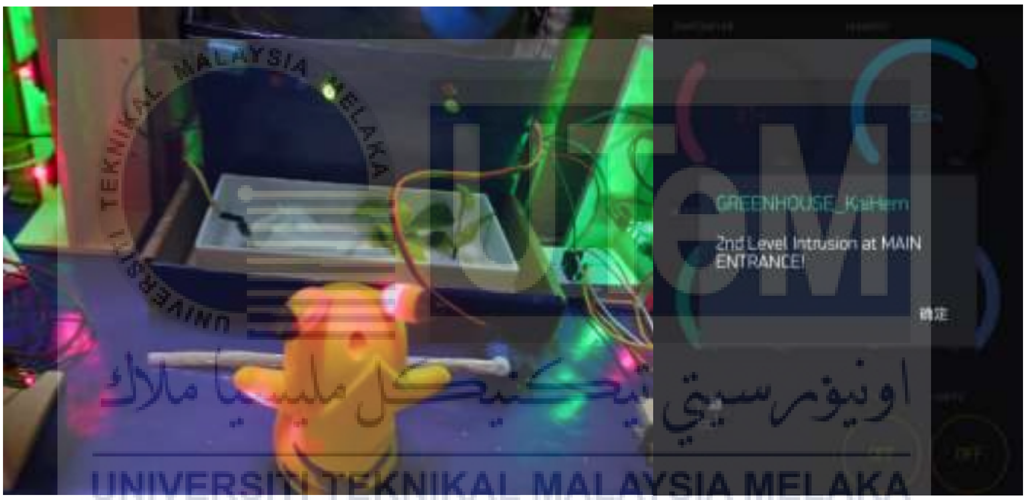

Figure 4.13 Third Test in main gate.

Table 4.5 Comparision result based on intrusion event and Blynk Application displayed.

Laser Fence at Main Gate	Situation		Notification details displayed on Blynk Application
	First Intrusion Level	Second Intrusion Level	
First Test	No	No	No
Second Test	Yes	No	Yes
Third Test	No	Yes	Yes

Table 4.6 Comparisation result based on intrusion event and automation gate status.

Laser Fence at Main Gate	Situation		Automation Gate turning down.
	First Intrusion Level	Second Intrusion Level	
First Test	No	No	No
Second Test	Yes	No	Yes
Third Test	No	Yes	Yes

By referring to Figure 4.11 which shown there are not intrusion event happens in greenhouse and the notification does not display on Blynk application. While Figure 4.12 and 4.13 shown there are intrusion happens in greenhouse, but first intrusion level happens in second test also second intrusion level happens in third test. In the Table 4.5 explained the occurrence of intrusion event with Blynk application notification. Then, Table 4.6 shown the intrusion event intrusion event happens status with status of automation gate. Thus, the comparison between the on-site intrusion event and result notification on Blynk Application displayed concurrently with right information details about real time intrusion event happens.

4.4 Display Result

4.4.1 Environment measurement and ventilation system in Greenhouse system

Figure 4.14 LCD Display with ventilation system in Greenhouse.

Figure 4.15 The measurement shown on Blynk Application.

Figure 4.16 The fan is speed up when temperature is overange or humidity is underange.

Figure 4.17 Measurement on Blynk Application after measurement is changed.

Figure 4.18   LDR sensor in Greenhouse.

Just as Figure 4.14, the LCD display shown the temperature, humidity, moisture, and light intensity reading from greenhouse, which the symbol “T” represented temperature, “H” represented humidity, “M” represented soil moisture value and “L” is the light intensity. Ventilation system is made up of motor fan which spinning continuously to enhance the air quantity inside the Greenhouse. Since the temperature not more than 32 ˚C also the humidity not less than 65%, the ventilation system is operates with normal speed with duty cycle 55%. Then, Figure 4.15 shown the environment measurement will displayed on mobile application at the same time.

However, the LCD display on Figure 4.16 shown the temperature reading with 33 ˚C which is more than 32 ˚C and humidity 57% which is less than desired humidity 65%. So, the ventilation system will increase the motor speed until duty cycle 82%. Figure 4.17 shown the environmental reading will appear the same reading in Blynk Application. Furthermore, the electronic device LDR sensor on Figure 4.18 function as measuring the light intensity in greenhouse system.

4.4.2 Moisture status in soil for plant growth

In order to measure the soil condition in greenhouse, the moisture sensor will drip or out from the container. There are three soil condition occurs like dry, wet and prefect soil condition depends on moisture value. The analog measurement from 0 to 1023 which less than 500 value assume to be wet condition and more than value 800 will be assigned to dry condition. Yet, the analog measurement between 501 and 799 will be assigned as prefect condition. Moisture sensor enable to measure the accurate measurement for soil and ensure the correct amount of irrigation supplement for maximize the crop productivity.

4.4.2.1 Dry soil condition

Figure 4.19 The red LED light up when soil is dry.

Figure 4.20 The LCD display “Plant is too DRY”.

Figure 4.21 Blynk application shown the mositure value is more than 800.

In Figure 4.19 shown dry soil condition is demonstrated by remove the sensor probe out from soil. The red LED that allocated above the moisture probe is turn on which represented the dry soil condition. Besides, the LCD display will show out the statement information about “Plant is too DRY” once dry soil condition is detected like Figure 4.20. As stated in Figure 4.21, the moisture measurement detected 889 value is indicated as dry soil condition since the value is more than desired dry soil reading 800. There is lack of water content in dry soil condition which reduce plant growth and decrease photosynthesis process of plants.

4.4.2.2 Wet soil condition

Figure 4.22 The Blue LED light up when soil is wet.

Figure 4.23 The LCD display “Plant is too WET”.

Figure 4.24 Blynk application shown the mositure value is less than 500.

In Figure 4.22 shown the wet soil condition is detected when the moisture probe is drip into the soil. The blue LED which located besides of red LED is turn on when wet soil condition is detected. Additionally, the LCD display will show out the statement information about "Plant is too WET" which represented wet soil condition like Figure 4.23. Therefore, since the analog moisture measurement detected 436 in Figure 4.24 is less than desired value 500, the reading will be assigned as wet soil condition. Excess moisture in soil which will bring bad impact like decrease the oxygen present for and resulted root rot.

4.4.2.3 Prefect soil condition

Figure 4.25 The Green LED will light up when the soil is prefect for plant.

Figure 4.26 The LCD display statement "Soil is PREFECT !!"

Figure 4.27 The prefect moisture value is display on Blynk Application.

In Figure 4.25 shown the prefect soil condition is detected when the moisture probe is drip into the soil. The green LED which located besides of blue LED is turn on when prefect soil condition is detected. Additionally, the LCD display will show out the statement information about "Soil is PREFECT !!" which represented prefect soil condition like Figure 4.26. Likewise, since the analog moisture measurement detected 797 in Figure 4.27 which in the range between 501 to 800 analog measurements, thus it is assumed to be prefect soil condition. Prefect soil condition is ensuring the proper amount mineral and nutrients which is essential for plant growth.

4.4.3 Artificial light source for greenhouse.

Figure 4.28 The artificial light is installed on the top part of greenhouse.

Figure 4.29 The artificial light button LIGHT1 and LIGHT2.

There are two artificial lights installed at top of greenhouse which left and right each a side like Figure 4.28. The Blynk Application like Figure 4.29 have two widget buttons act as switch to control the artificial light that LIGHT1 represented the left artificial light while LIGHT2 represented the right artificial light. Virtual button in Blynk Application will be interactive with hardware implemented to switch on or off according to the user’s decision.

4.4.3.1 Left artificial light source in greenhouse

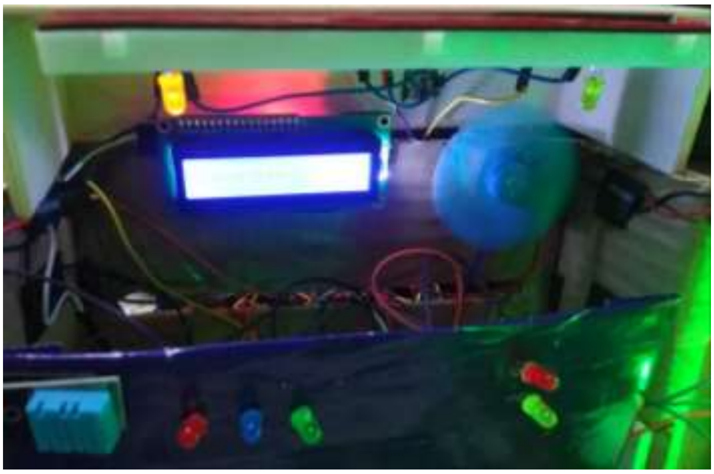

Figure 4.30 The left artificial light is turn on.

Figure 4.31 The left button is pressed in mobile application.

In Figure 4.30 shown the left artificial light source yellow LED is turn on and it is located on the top of the LCD display. The artificial light source is light up when the left button LIGHT1 on mobile application been pressed, also the button will displayed on-states shown in Figure 4.31. While button LIGHT2 show off-states and off in real time.

4.4.3.2 Right artifical light source in greenhouse

Figure 4.32 The right artificial light is light up.

Figure 4.33 The right button is pressed in mobile application.

In Figure 4.32 shown the right artificial light source yellow LED is turn on and it is located above the ventilation system. The artificial light source is light up when the right button LIGHT2 and show on-states on mobile application has been pressed shown in Figure 4.33 while LIGHT1 button in off-states and turn off in real time.

4.4.3.3 Activates both artifical light

Figure 4.34 Both artificial light source is turn on.

Figure 4.35 Both of button is pressed in mobile application.

In Figure 4.34 show that both artificial light source is turn on concurrently. Both yellow LED will turn on when both button LIGHT1 and LIGHT2 on mobile application is pressed as Figure. Based on the Figure 4.35 shown both button is on-states when the two artificial light is turn on in current greenhouse.

4.4.4 Intrusion detection system

Figure 4.36 The laser fence position left gate, main gate and right gate (from left to right).

Figure 4.37 The display statement when the Greenhouse is free from intruder.

The intrusion detection mechanism is built by using a laser light and beam the light onto the light detector sensor, LDR sensor like Figure 4.36. Each of the laser fence consists of the laser beam accordance with the LDR sensor that located at opposite side. When the greenhouse system is free from the intrusion event, the LCD display will shown statement “GREENHOUSE IS SAFE !” like Figure 4.37. Then, there are consists of two intrusion level such as first and second intrusion level which will assigned according to the body size of intruder. Intrusion level will become estimation about the crisis occurrences when present of unexpected encounter. Over and above that, each laser fence will place the automation gate that enable to stop intruder to step into the greenhouse further. Once the intrusion event is detected from laser fence, the automation will turn down together with high-decibel alarming system for both first or second intrusion level. However, once the laser fence is free from intrusion event, the buzzer will off and automation gate will automatically turn up.

4.4.4.1 Main entrance laser fence

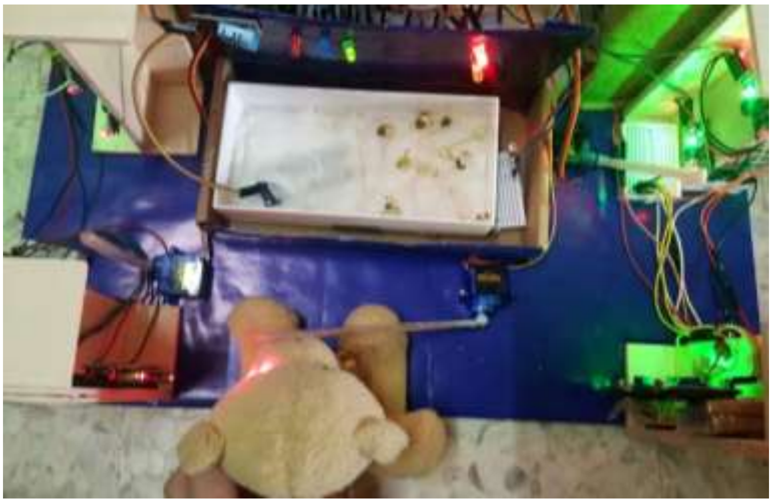

Figure 4.38 The big body size intruder approaches in main gate.

Figure 4.39 Blynk notification when First intrusion level happen in Main gate.

Figure 4.40 The display statement when first intrusion level happens in main gate.

Figure 4.41 The smaller size intruder approaches in main gate.

Figure 4.42 Blynk notification when Second intrusion level happen in Main gate.

Figure 4.43 The display statement when Second intrusion level approaches in main gate.

Figure 4.44 The data visualisation for Main gate in ThingSpeak.

By referring to Figure 4.38, there is big body size of intruder which indicated the first level intrusion happens in main gate. When first intrusion level approaches, the red LED and alarming system buzzer will activated also the automation gate will turn down. The notification about the intrusion level with location details states “1st Level Intrusion at MAIN ENTRANCE!” will displayed on Blynk Application like Figure 4.39 together with LCD display will display information “BIG INTRUDER IN MAIN GATE” like Figure 4.40. After then, Figure 4.41 resulted the second intrusion level happens when encounter from smaller body size intruder in main gate. The yellow LED will turn on also the alarming buzzer will be invoked together with the turning down automation gate. Next, the Blynk Application will notify the user with statement “2nd Level Intrusion at MAIN ENTRANCE!” like Figure 4.42. At the same time, the LCD display will show information “INTRUDER IN MAIN GATE” when intrusion approaches like Figure 4.43. Lastly, the intrusion event for both first and second intrusion level that happens in main gate will be recorded on ThingSpeak cloud service like Figure 4.44. Based on the Figure 4.44, the intrusion status “1” means intrusion event happens in main gate while intrusion status “0” means main gate is free from intrusion event.

4.4.4.2 Left Fence Laser Fence

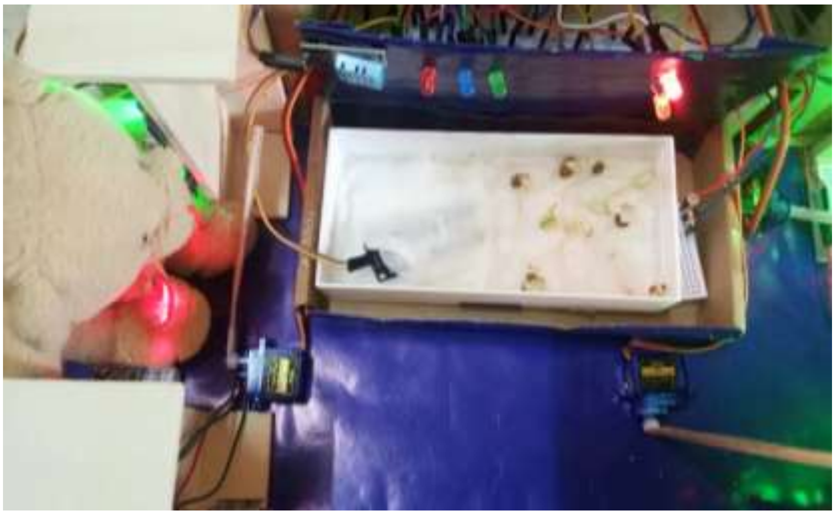

Figure 4.45 The big body size intruder approaches in left gate.

Figure 4.46 Blynk notification when First intrusion level happen in Left gate.

Figure 4.47 The display statement when First intrusion level in Left gate.

Figure 4.48 The smaller size intruder approaches in left gate.

Figure 4.49 Blynk notification when Second intrusion level in Left gate.

Figure 4.50 The display statement when Second intrusion level in Left gate.

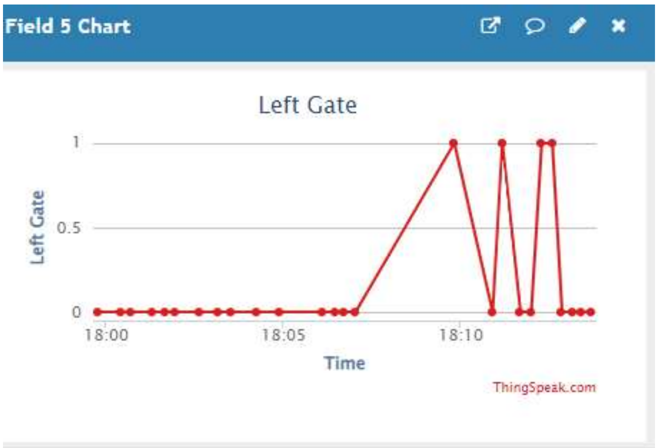

Figure 4.51 The data visualisation for Left gate in ThingSpeak.

As mentioned on Figure 4.45 shown the first intrusion level happens in left gate when big body size intruder approaches. The red LED is turn on and activates the alarming system buzzer together turning down the automation gate in front of left laser fence. Besides, the Figure 4.46 shown the notification about "1st Level Intrusion at LEFT FENCE!" on Blynk Application at the same time LCD display will results the statement "BIG INTRUDER IN LEFT GATE" like Figure 4.47. In addition, the Figure 4.48 shown the second intrusion level when the smaller body size intruder tried to step into greenhouse from left gate. The yellow LED and alarming system buzzer will trigger concurrently the automation gate will turning down to block the intruder step further. Also, the Blynk application will show out the notification statement "2nd Level Intrusion at LEFT FENCE!" like Figure 4.49, and the LCD display will resulted statement "INTRUDER IN LEFT GATE" on Figure 4.50. Hence, all the intrusion events include first and second intrusion level from left gate will recorded in ThingSpeak cloud platform like Figure 4.52. As the intrusion status "1" meaning the intrusion event happens while intrusion status "0" meaning the left gate is free from intrusion.

4.4.4.3 Right Gate Laser Fence

Figure 4.52 The big body size intruder approaches in right gate.

Figure 4.53 Blynk notification when First intrusion level happen in right gate.

Figure 4.54 The display statement Second intrusion level in right gate.

Figure 4.55   The smaller size intruder approaches in right gate.

Figure 4.56   Blynk notification when Second intrusion level happen in Right gate.

Figure 4.57   The display statement Second intrusion level in Right gate.

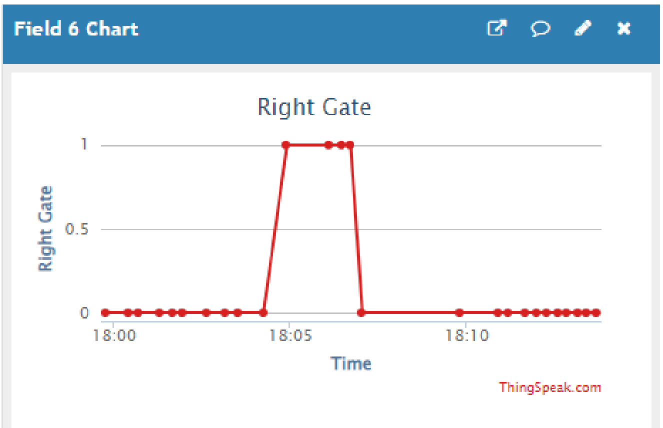

Figure 4.58 The data visualisation for Right gate in ThingSpeak.

As observation from Figure 4.52 states the first intrusion level occurs in right gate when big body size intruder encounters the laser fence. The result will start up the red LED with alarming system buzzer together with turning down the automation gate in front of right gate. Then, Figure 4.53 show the Blynk application notify the user with statement "1st Level Intrusion at RIGHT FENCE!" simultaneously LCD display will be outputting the statement "BIG INTRUDER IN RIGHT GATE" like Figure 4.54. Moreover, Figure 4.55 shown the second intrusion level happens when there are smaller body size intruder approaches. Second intrusion level will causes the yellow LED and alarming system buzzer to turn on together with the turning down automation gates. In the same way, the notification statement "2nd Level Intrusion at LEFT FENCE!" like Figure 4.56, at the same time display statement details as "INTRUDER IN RIGHT GATE" on LCD display shown on Figure 4.57. Accordingly, the intrusion event from right gate will be recorded and displayed with graph visualization on ThingSpeak like Figure 4.58. Based on the graph, the intrusion status "1" represented the intrusion event includes first and second intrusion level then intrusion status "0" represented the right fence is free from intrusion event.

4.5 Summary

Earlier from this chapter, the prototype of the automation greenhouse with laser fence has shown for each side with labelled. Moreover, the analysis of the automation greenhouse is obtained by calculated the average environmental parameters in greenhouse, calculated the time taken for communication device with different internet speed and comparison between the result on-site and Blynk Application. From the analysis, the average environment parameters like temperature, humidity, moisture value and light intensity is recorded and tabulated. Moreover, the analysis result proven the higher of internet speed, the lower time taken response. This testing has point out the shorter time taken in exchange the date, increase the performance of greenhouse system. Also, when there are intrusion event encounters the laser fence, the intrusion status will notify the user though Blynk application and update towards ThingSpeak cloud service at the same time. Initially, the greenhouse system will measure and automatically control the weather condition and display on LCD display also update towards Blynk Application and ThingSpeak concurrently. Since greenhouse is free from intrusion event, the alarming system will not activates and automation gate is allow to be pass. But when the intrusion event detected from laser fence, the alarming system buzzer with led light will also activates the automation gate will turning down to prevent the intruder go ahead further. Red light indicated the first intrusion level while yellow light indicated second intrusion level exists on laser fence. At the same time, user will be receiving the intrusion notification together with intrusion level and location approaches details. Furthermore, user can switch on or off the artificial light by using the virtual button on mobile application. As conclude, user can monitoring and controlling the environmental measurement in greenhouse also receive and estimate the danger level of intrusion based intrusion notification though Blynk Application besides the greenhouse system will be prevent the unauthorized entry automatically.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter will discuss the results, analysis, demonstration, and future work for automation greenhouse system. The performance of automation greenhouse has determined and suggestion of future work will addressed in this section.

5.2 Conclusion

This project consists of both hardware and software testing to construct the implementation of the greenhouse automation with crops protection. The hardware implementation works to measure and delivery the information about the environmental parameters and intrusion notification to enhance the plant growth and security for crops. Blynk application is mobile application for user then the ThingSpeak is the cloud database to collect all the data information. Automation greenhouse shown the real-time situation like greenhouse which functions to maintain the suitable environmental condition automatically. Besides, the users enable to preview, control, and receive intrusion information remotely only from Blynk Application. The protection mechanism for this automation greenhouse is laser fence, alarming system also the automation gate. Laser fence works to detect the unauthorized encounter also undergoing the estimation about the body size and danger level approaches. Once the intrusion events is detected, the alarming system buzzer activates and automation gate will be turning down. Triggered alarm used to scare away the unpleasant intruder also alerting the appropriate authorities threatening intrusion situation happens. The automation gate will be turning down and prevent the intruder enter the plantation area in greenhouse. Besides, the user will receive the notification with intrusion level and exact location happens in greenhouse.

Furthermore, the weather condition in automation greenhouse had been analyzed, calculated, and tabulated the average results. After then, the performance of the greenhouse had tested by comparing the average time taken with different internet speed. The result indicated the higher internet speed will shorter the time response and increase the accuracy. As well as the performance of laser fence is investigated here. The accuracy of the laser fence is proven when notification details on Blynk application is exactly same with on-site situation. As conclusion, all objectives of project had achieved successfully.

5.3 Future Works

There are some suggestion and improvement can be applied based on this project. Firstly, the amount of the laser fence set up can be enlarge. This is because users might enclose the whole area of greenhouse rather than just installed on left, right and main entrances of greenhouse. Besides, the requirement of the power input in the greenhouse is high as large amount of the connected components on hardware. On the hardware Arduino board, it only can supply amount of 5V and maximum current 500mA. The lack of the power supply in hardware circuit may consequences the performances of whole greenhouse to be unstable and not consistency. The external power supply like power jack may become the solution of this problem. Furthermore, the laser fence can detect the intrusion but cannot recognize the type of intrusion accurately. Suggestion for this problem is to apply the camera which able to capture and recorded the actual situation when intrusion happens. Besides, it also can become evidence as the intrusion happens illegally.

5.4 Project Potential

The greenhouse automation system with crops protection may be commercialized in the agriculture section and even the floral industry. Both of those industry requires to produce the high amount of harvest with prefect good condition. Automation greenhouse construction enables to save of money and reduces the human power for supervision while give fully protection on quality and quantity of harvest. This project intended to maximize the crop productivity and improve the income of agriculture industry.

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APPENDICES

Appendix 1 Arduino Mega coding

```
#include <DHT.h>
#include <SoftwareSerial.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <Servo.h>
SoftwareSerial ArduinoMega(10, 11);
LiquidCrystal_I2C lcd(0x27,16,2);

#define DHTPIN 2
#define DHTTYPE DHT11
DHT dht(DHTPIN,DHTTYPE);
#define WET 500
#define DRY 800
#define POWER 5
#define moisturePin A0
Servo servo1;
Servo servo2;
Servo servo3;

String cdata="";
int LDR = A1;
int LDR2 = A2;
int LDR3 = A3;
int LDR4 = A4;
int LDR5 = A5;
int LDR6 = A6;
int LIGHT_LDR = A10;
int LED_RED = 22;
int LED_YEL = 23;
int BUZZER = 46;
int BUZZER2 = 47;
int LED_WET = 26;
int LED_DRY = 27;
int LED_PRE = 28;
int enA = 37;
int in1 = 38;
int in2 = 39;
int servo1Pin = 6;
int servo2Pin = 7;
int servo3Pin = 8;

void setup()
{
```

```
Serial.begin(9600);
ArduinoMega.begin(9600);
dht.begin();
lcd.init();
lcd.clear();
lcd.backlight();
lcd.setCursor(2,0);
lcd.print("CHEE KAI HERN");
lcd.setCursor(2,1);
lcd.print("__GREENHOUSE__");
delay(1000);
lcd.clear();
pinMode(2, OUTPUT);
pinMode(LDR, INPUT);
pinMode(LDR2, INPUT);
pinMode(LDR3, INPUT);
pinMode(LDR4, INPUT);
pinMode(LDR5, INPUT);
pinMode(LDR6, INPUT);
pinMode(LIGHT_LDR, INPUT);
pinMode(LED_RED, OUTPUT);
pinMode(LED_YEL, OUTPUT);
pinMode(LED_WET, OUTPUT);
pinMode(LED_DRY, OUTPUT);
pinMode(LED_PRE, OUTPUT);
pinMode(BUZZER, OUTPUT);
pinMode(BUZZER2, OUTPUT);
pinMode(enA, OUTPUT);
pinMode(in1, OUTPUT);
pinMode(in2, OUTPUT);
digitalWrite(2, HIGH);
digitalWrite(POWER, LOW);
digitalWrite(in1, LOW);
digitalWrite(in2, LOW);
servo1.attach(servo1Pin);
servo2.attach(servo2Pin);
servo3.attach(servo3Pin);
}

void loop()
{
  analogWrite(enA,140);
  digitalWrite(in1, HIGH);
  digitalWrite(in2, LOW);

  int h = dht.readHumidity();
  int t = dht.readTemperature();
  int light = analogRead(LIGHT_LDR);
  int moisture = readMoisture();
```

```
 if (isnan(h) || isnan(t)) {
   Serial.println("Failed to read from DHT sensor!");
   return; }

   lcd.setCursor(0,0); lcd.print("T:");
   lcd.print(t); lcd.print(" C");
   lcd.setCursor(7,0);  lcd.print("L:");
   lcd.print(light); lcd.print(" ");
   lcd.setCursor(0,1);  lcd.print("H:  ");
   lcd.print(h); lcd.print(" %");
   lcd.setCursor(7,1); lcd.print("M:");
   lcd.print(moisture);lcd.print(" ");
   delay(1000);
   lcd.clear();

   if(t> 32 || h < 65)
   {
   analogWrite(enA,210);
   digitalWrite(in1, HIGH);
   digitalWrite(in2, LOW);  }
   else
   {
   analogWrite(enA,140);
   digitalWrite(in1, HIGH);
   digitalWrite(in2, LOW); }

Serial.print("Moisture value of Soil: ");
 Serial.println(moisture);

 if(moisture < WET)
 {
   Serial.println("Plant is too WET!!");
   lcd.setCursor(0,0);
   lcd.print("  Plant is too");
   lcd.setCursor(4,1);
   lcd.print("   WET ");
   digitalWrite(LED_WET, HIGH);
   digitalWrite(LED_DRY, LOW);
   digitalWrite(LED_PRE, LOW);
   delay(1000);
   lcd.clear();}

 else if(moisture > DRY)
 {
   Serial.println("Plant is too DRY!!");
   lcd.setCursor(0,0);
   lcd.print("  Plant is too");
   lcd.setCursor(4,1);
   lcd.print("   DRY ");
   digitalWrite(LED_WET, LOW);
```

```
  digitalWrite(LED_DRY, HIGH);
  digitalWrite(LED_PRE, LOW);
  delay(1000);
  lcd.clear();
 }
 else
 {
  Serial.println("Soil is PERFECT to plant!!");
  lcd.setCursor(0,0);
  lcd.print("  Soil is ");
  lcd.setCursor(3,1);
  lcd.print("  PREFECT !!");
  digitalWrite(LED_WET, LOW);
  digitalWrite(LED_DRY, LOW);
  digitalWrite(LED_PRE, HIGH);
  delay(1000);
  lcd.clear(); }

 int LDRStatus = analogRead(LDR);
 int LDRStatus2 = analogRead(LDR2);
 int LDRStatus3 = analogRead(LDR3);
 int LDRStatus4 = analogRead(LDR4);
 int LDRStatus5 = analogRead(LDR5);
 int LDRStatus6 = analogRead(LDR6);

 if(LDRStatus > 300 || LDRStatus2 > 300 || LDRStatus3 > 300 || LDRStatus4 > 300 ||
LDRStatus5 > 300 || LDRStatus6 > 300)
 {
  Serial.println("INTRUSION HAPPEN");
   if(LDRStatus > 300)
  {
   digitalWrite(LED_RED, HIGH);
   tone(BUZZER, 100);
   tone(BUZZER2, 100);
   lcd.setCursor(2,0);  lcd.print("BIG INTRUDER");
   lcd.setCursor(2,1);  lcd.print("IN MAIN GATE");
   servo1.write(180);
   delay(1000);
   lcd.clear(); }

   else if(LDRStatus > 300 && LDRStatus2 > 300)
   {
   digitalWrite(LED_RED, HIGH);
   tone(BUZZER, 100);
   tone(BUZZER2, 100);
   lcd.setCursor(2,0); lcd.print("BIG INTRUDER");
   lcd.setCursor(2,1);  lcd.print("IN MAIN GATE");
   servo1.write(180);
   delay(1000);
   lcd.clear(); }
```

```
 else if(LDRStatus3> 300)
 {
  digitalWrite(LED_RED, HIGH);
  tone(BUZZER, 100);
  tone(BUZZER2, 100);
  lcd.setCursor(2,0);  lcd.print("BIG INTRUDER");
  lcd.setCursor(2,1);  lcd.print("IN LEFT GATE");
  servo2.write(180);
  delay(1000);
  lcd.clear();      }
  else if(LDRStatus3> 300 && LDRStatus4 > 300)
  {
  digitalWrite(LED_RED, HIGH);
  tone(BUZZER, 100);
  tone(BUZZER2, 100);
  lcd.setCursor(2,0); lcd.print("BIG INTRUDER");
  lcd.setCursor(2,1);  lcd.print("IN LEFT GATE");
  servo2.write(180);
  delay(1000);
  lcd.clear() }
  else if(LDRStatus2 > 300)
  {
  digitalWrite(LED_YEL, HIGH);
  tone(BUZZER, 100);
  tone(BUZZER2, 100);
  lcd.setCursor(2,0); lcd.print(" INTRUDER");
  lcd.setCursor(2,1);  lcd.print("IN MAIN GATE");
  servo1.write(180);
  delay(1000);
  lcd.clear();}
  else if(LDRStatus4 > 300)
  {
  digitalWrite(LED_YEL, HIGH);
  tone(BUZZER, 100);
  tone(BUZZER2, 100);
  lcd.setCursor(2,0);lcd.print(" INTRUDER");
  lcd.setCursor(2,1); lcd.print("IN LEFT GATE");
  servo.write(180);
  delay(1000);
  lcd.clear();}
  else if(LDRStatus5> 300 && LDRStatus6 > 300)
  {
  digitalWrite(LED_RED, HIGH);
  tone(BUZZER, 100);
  tone(BUZZER2, 100);
  lcd.setCursour(2,0); lcd.print("BIG INTRUDER");
  lcd.setCursor(2,1); lcd.print("IN RIGHT GATE");
  servo3.write(180);
  delay(1000);
  lcd.clear();}
```

```
   else if(LDRStatus5> 300)
   {
     digitalWrite(LED_RED, HIGH);
     tone(BUZZER, 100);
     tone(BUZZER2, 100);
     lcd.setCursour(2,0); lcd.print("BIG INTRUDER");
     lcd.setCursor(2,1); lcd.print("IN RIGHT GATE");
    servo3.write(180);
     delay(1000);
     lcd.clear();}
      else if(LDRStatus6 > 300)
     {
     digitalWrite(LED_YEL, HIGH);
     tone(BUZZER, 100);
     tone(BUZZER2, 100);
     lcd.setCursor(2,0); lcd.print(" INTRUDER");
     lcd.setCursor(2,1);  lcd.print("IN RIGHT GATE");
     servo3.write(180);
     delay(1000);
     lcd.clear();      }}
   else
   {
     digitalWrite(LED_RED, LOW);
     digitalWrite(LED_YEL, LOW);
     lcd.clear();
     lcd.setCursor(2,0); lcd.print("  GREENHOUSE");
     lcd.setCursor(2,1);  lcd.print("   IS SAFE !");
     noTone(BUZZER);
     noTone(BUZZER2);
     delay(1000);
     lcd.clear();
     servo1.write(90);servo2.write(90); servo3.write(90);
}
cdata = String(t) +"," +String(h) +"," +String(moisture)+"," +String(LDRStatus) +","
+String(LDRStatus2)+","+String(LDRStatus3) +"," +String(LDRStatus4)
+","+String(LDRStatus5) +"," +String(LDRStatus6)+"," +String(light);
  Serial.println(cdata);
  ArduinoMega.println(cdata); delay(100);}

int readMoisture()
{
 digitalWrite(POWER, HIGH);
 delay(200
 int val = analogRead(moisturePin);
 digitalWrite(POWER, LOW);
 return val;
  }
```

Appendix 2 NodeMCU coding

```
#include <SimpleTimer.h>
#include <SoftwareSerial.h>
#include <ESP8266WiFi.h>
#define BLYNK_PRINT Serial
#include <BlynkSimpleEsp8266.h>

char auth[]= "qs7peI6dK888POFAHzf8MtSWrzMlcIJG";
char ssid[]= "vivo 1609";
char pass[] ="kaihern1912";
String apiKey= "9IX21ANQ0BT4NP8I";
const char* server = "api.thingspeak.com";
WiFiClient client;
SoftwareSerial NodeMCU(D5, D6);
SimpleTimer timer;
char rdata;
String dataIn;
String dt[20];
int i=0;
int a; //main gate
int b; //left gate
int c; //right gate

void myTimerEvent()
{
  Blynk.virtualWrite(V0, dt[0].toInt()); //temp
  Blynk.virtualWrite(V1, dt[1].toInt()); //humidity
  Blynk.virtualWrite(V2, dt[2].toInt()); //moisture
  Blynk.virtualWrite(V3, dt[3].toInt()); //LDR1
  Blynk.virtualWrite(V4, dt[4].toInt()); //LDR2
  Blynk.virtualWrite(V3, dt[5].toInt()); //LDR3
  Blynk.virtualWrite(V4, dt[6].toInt()); //LDR4
  Blynk.virtualWrite(V3, dt[7].toInt()); //LDR5
  Blynk.virtualWrite(V4, dt[8].toInt()); //LDR6
  Blynk.virtualWrite(V5, dt[9].toInt()); //LDR_Light }

void setup()
{
  Serial.begin(9600);
  NodeMCU.begin(9600);
  Blynk.begin(auth, ssid, pass);
  timer.setInterval(1000L, myTimerEvent);
  WiFi.begin(ssid, pass);
  while (WiFi.status() != WL_CONNECTED)
    {     delay(500);
          Serial.print("."); }
```

```
    Serial.println("");
    Serial.println("WiFi connected"); }
void loop()
{ while(NodeMCU.available() > 0 )
  { rdata = NodeMCU.read();
   dataIn += rdata;
   if(rdata =='\n')
   { int j = 0;
    dt[j]="";

    for(i=0; i<dataIn.length();i++)
    { if((dataIn[i]==','))
       { j++;
        dt[j]=""; }
      else {
        dt[j]=dt[j]+dataIn[i];}}

if(dt[3].toInt()>300 || dt[4].toInt()>300 ||dt[5].toInt()>300 || dt[6].toInt()>300
||dt[7].toInt()>300 || dt[8].toInt()>300)
   {
    if(dt[3].toInt()>300 && dt[4].toInt()>300)
    {  Blynk.notify("1st Level Intrusion at MAIN ENTRANCE!");
      Serial.println("1st Level intrusion at main entrances");
      a = 1; }
    else if(dt[3].toInt()>300)
    { Blynk.notify("1st Level Intrusion at MAIN ENTRANCE!");
      Serial.println("1st Level intrusion at main entrances");
      a = 1; }
    else if(dt[4].toInt()>300)
    { Blynk.notify("2nd Level Intrusion at MAIN ENTRANCE!");
      Serial.println("2nd Level intrusion at main entrances");
      a = 1; }
    else if(dt[5].toInt()>300 && dt[6].toInt()>300)
    {Blynk.notify("1st Level Intrusion at LEFT FENCE!");
      Serial.println("1st Level intrusion at Left fence");
      b = 1;}
    else if(dt[5].toInt()>300)
    { Blynk.notify("1st Level Intrusion at LEFT FENCE!");
      Serial.println("1st Level intrusion at Left Fence");
       b = 1;  }
    else if(dt[6].toInt()>300)
    { Blynk.notify("2nd Level Intrusion at LEFT FENCE!");
      Serial.println("2nd Level intrusion at Left Fence");
       b = 1; }
     else if(dt[7].toInt()>300 && dt[8].toInt()>300)
    { Blynk.notify("1st Level Intrusion at RIGHT FENCE!");
      Serial.println("1st Level intrusion at RIGHT fence");
      c = 1; }
    else if(dt[7].toInt()>300)
    {Blynk.notify("1st Level Intrusion at RIGHT FENCE!");
```

```
      Serial.println("1st Level intrusion at RIGHT Fence");
      c = 1;}
    else if(dt[8].toInt()>300)
    { Blynk.notify("2nd Level Intrusion at RIGHT FENCE!");
      Serial.println("2nd Level intrusion at RIGHT Fence");
      c = 1; }  }
  else
  {  a = 0; b = 0;  c = 0; }
 Serial.print("Temp : "); Serial.print(dt[0].toInt());  Serial.print("\n");
 Serial.print("Humid : "); Serial.print(dt[1].toInt()); Serial.print("\n");
 Serial.print("Moisture Level: ");  Serial.print(dt[2].toInt()); Serial.print("\n");
 Blynk.run(); timer.run(); }}

 if (client.connect(server,80))
 {
  String postStr = apiKey;
  postStr +="&field1=";  postStr += String(dt[0].toInt());
  postStr +="&field2=";  postStr += String(dt[1].toInt());
  postStr +="&field3=";  postStr+= String(dt[2].toInt());
  postStr +="&field7=";  postStr += String(dt[9].toInt());
  postStr +="&field4=";  postStr += String(a);
  postStr +="&field5=";  postStr += String(b);
  postStr +="&field6=";  postStr+= String(c);
  postStr += "\r\n\r\n";

  client.print("POST /update HTTP/1.1\n");
  client.print("Host: api.thingspeak.com\n");
  client.print("Connection: close\n");
  client.print("X-THINGSPEAKAPIKEY: "+apiKey+"\n");
  client.print("Content-Type: application/x-www-form-urlencoded\n");
  client.print("Content-Length: ");
  client.print(postStr.length());
  client.print("\n\n");
  client.print(postStr);
  Serial.println(postStr);

 }
 client.stop();
delay(1000);
}
```

Appendix 3 Gantt chart for PSM 1

Project progress	Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Decision on the title project and confirmation with supervisor	■	■												
Registration for the Topic project.	■	■												
Briefing about the Bachelor Degree Project Launched.			■											
Gathering all the genuine about background of project.			■	■										
Constructing the Chapter 1: Introduction			■	■	■									
Constructing the Chapter 2: Literature Review				■	■	■								
Updated the week 6 progress towards Supervisor.				■	■	■								
Preparation for Chapter 3: Methodology						■	■	■	■	■				
Testing hardware						■	■	■	■	■				
Report Draft Submission.											■	■		
Preparation for the Presentation.												■	■	
Video Presentation Submission												■	■	
PSM Presentation Evaluation with Full Report Submission.													■	■

Appendix 4 Gantt chart for PSM 2

Project progress	Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Designing the coding for the project	■	■	■											
Testing the implementation of hardware	■	■	■											
Analyse the result obtained				■	■									
Result and discussion					■	■	■							
Conclusion								■						
Report									■	■				
Report and Turnitin											■	■		
Presentation slide and poster												■	■	
Presentation for BDP2														■