# DEVELOPMENT OF IOT BASED DIGITAL TIMER CONTROLLER FOR MUSHROOM HOUSE WATERING SYSTEM



ADLI HAKEEM BIN DJALILUDIN
B071710501

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2020

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# DEVELOPMENT OF IOT BASED DIGITAL TIMER CONTROLLER FOR MUSHROOM HOUSE WATERING SYSTEM

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours.

by


**ADLI HAKEEM BIN DJALILUDIN**

**B071710501**

**960730-59-5121**

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING

TECHNOLOGY



2020

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA**

Tajuk: Development of IoT Based Digital Timer Controller for Mushroom House Watering System

Sesi Pengajian: 2020

Saya **Adli Hakeem bin Djaliludin** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

| | | |
|---|---|---|
| ☐ | SULIT* | Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972. |
| ☐ | TERHAD* | Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan. |
| ☒ | TIDAK TERHAD | |

Yang benar,

..........................................................

Adli Hakeem bin Djaliludin

Alamat Tetap:

62, Lorong Desa Flora 1/7

Taman Desa Flora Senawang

70450 Seremban

Negeri Sembilan

Tarikh: 13 / 02 / 21

Disahkan oleh penyelia:

..........................................................

IR TS MOHD SYAHRIN AMRI BIN MOHD NOH

Cop Rasmi Penyelia

Ir. Ts. Mohd Syahrin Amri B Mohd Noh
Penyelaras Program BEEE
Jabatan Teknologi Kejuruteraan Elektronik dan Komputer
Fakulti Teknologi Kejuruteraan Elektronik & Komputer
Universiti Teknikal Malaysia Melaka

Tarikh:



*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

**DECLARATION**

I hereby, declared this report entitled Development of IoT Based Digital Timer Controller for Mushroom House Watering System is the results of my own research except as cited in references.

Signature: ……………………………………

Author : Adli Hakeem bin Djaliludin

Date: 13 / 02 / 21

# APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours. The member of the supervisory is as follow:

Signature: ......................................................

Supervisor: IR TS MOHD SYAHRIN AMRI BIN MOHD NOH

# ABSTRAK

Projek yang dicadangkan bertujuan untuk menghasilkan sistem pemantauan automatik pam air bersama dengan suhu dan kelembapan pada peranti luaran seperti telefon pintar atau komputer dengan menggunakan platform IoT. Masalah baru-baru ini dalam industri berkaitan ladang cendawan adalah sistem pemantauan terhad dan pengubahsuai masa untuk hidupkan dan matikan pam air secara manual. Oleh itu, projek ini akan membantu menyelesaikan masalah yang dihadapi dalam bidang berkaitan ini. Ringkasan aliran projek ini terdiri daripada penetapan pemasa pam air untuk mengawal dan memantau kelembapan dan suhu di platform IoT. Sistem ini terdiri dari sensor yang dapat mengesan suhu dan kelembapan yang akan bertindak sebagai parameter bagi pam air untuk melakukan tugas yang diberikan. Data yang dikumpulkan dari sensor dan pam air akan dihantar ke NodeMCU Wifi Modul ESP 8266 (ESP-12E). Kemudian, modul Wi-Fi akan menghantar data pelayan awan di platform IoT yang merupakan Blynk untuk melakukan sistem pemantauan pada peranti luaran seperti telefon pintar. Jadi, dalam platform Blynk melalui telefon pintar, akan ada visual data suhu dan kelembapan dengan keadaan pam air. Pengujian akan dilakukan dalam urutan berulang sehingga pengaturan pemasa terbaik untuk pam hidup atau mati dapat dilaksanakan untuk menjaga suhu dan kelembapan pada tahap optimum iaitu bawah $30^0$C dan 60% ke atas.

# ABSTRACT

The proposed project intended in producing automated monitoring system of water pump along with the temperature and humidity in external devices such as smartphones by using IoT platform. The recent problem in related industry of mushroom fields is the limited monitoring system and manual setting of timer devices for watering pump to turn on or off. So, this project will help in resolving the problem encountered in this related field. The summarize flow of this project comprised of the setting of timer of water pump to control and monitor the humidity and temperature in IoT platform. The system consisted of sensors that can detect temperature and humidity which will act as the parameters for the water pump to do the task given. The data that collected from the sensors and water pump will be sent to NodeMCU Wi-Fi Module ESP 8266(ESP-12E). Then, the Wi-Fi module will send the data the cloud server in IoT application which is Blynk to do the monitoring system on external devices such as smartphones. So, in Blynk application through smartphones, there will be visuals of data of temperature and humidity with the condition of the water pump. The testing would be done in repeating sequence so that the best setting of timer for the pump to on or off can be implemented to keep the temperature and humidity at the optimum level which are below $30^0$C and above 60% respectively.

## DEDICATION

I would like to dedicate this project this to my beloved parents in encouraging me on finishing this project. Not to forget, to my friends and course mates in giving supports and positive feedbacks throughout the semester on completing this project.

## ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to all those that help me in completing this report especially to my supervisor, Ir Ts Mohd Syahrin Amri bin Mohd Noh in giving me encouragement and providing suggestions about the whole process of completing the project. Nevertheless, I want to express my gratitude to my friends and course mates in helping me by giving positive feedbacks and opinions on the project. Moreover, I want to express my utmost gratitude to Encik Syukor, the man in charge for Sinar Syukrawi Enterprise that expertise in mushroom industry cultivation for giving recommendation and feedbacks for the project. Along the journey in completing the project, I get a lot of inspirations and morals from everyone that involved in this project which will help me in improving the quality of this project.

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF APPENDICES

# LIST OF SYMBOLS

| | | |
|---|---|---|
| **$^{0}$C** | - | Temperature |
| **%** | - | Humidity |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **IoT** | Internet of Things |
| **WMSN** | Wireless Mesh Sensor Network |
| **RFID** | Radio Frequency Identification |
| **RTC** | Real Time Clock |
| **ADC** | Analog Digital Converter |
| **LCD** | Liquid Crystal Display |
| **FSM** | Finite State Machine |
| **MCU** | Microcontroller Unit |
| **FPGA** | Field Programmable Array |
| **LED** | Light Emitting Diode |
| **SDA** | Serial Data |
| **SCL** | Serial Clock |
| **LAN** | Local Area Network |
| **RH** | Relative Humidity |

# CHAPTER 1

# INTRODUCTION

This chapter gives overview and detailed explanations about the project background, the problem statements, the objectives, and the scope of the project. Finally, the thesis organization of this project were also included in this chapter.

## 1.1 Background

### 1.1.1 Development of Mushroom in Agriculture

In terms of agriculture product, mushroom proved to be one of reliable source income for small scale farmers. In Malaysia, mushroom industry is still not well known compared to other agriculture product. Mushroom cannot grow easily without suitable environmental condition. As stated, mushroom need optimum humidity and temperature to maximise its productivity as excess moisture can cause contamination (Marzuki and Ying, 2017). In conclusion, environmental system that consisted of humidity, temperature, light intensity, and carbon dioxide concentration need to be monitored and controlled wisely to overcome the problem that may occur in stated above.



### 1.1.2 Use of Digital Timer Controller in Industries

Digital timer can be categorised or used in many events or applications. Timer can be classified as a device used to determine the time sequence prior to the user demands. It can be used for repetitive action after a period is initiated. In terms of agricultural perspectives, timer would be used on continuous control of watering device to ensure the maximised product output. But sometimes, farmers or users tend to forget to optimize watering schedule daily which can lead to inefficient growth of plant products (Primisima, Sudiro and Wardijono, 2016). The timer would be used in these circumstances to increase rate production. Nevertheless, the use of manual timer sometimes does not synchronize or in accordance to the condition of plant or mushroom. So, the timer would be added with IOT or monitoring system as a common approach in controlling the efficiency of controlling water usage while able to produce remote monitoring system. To be more detailed, the timer that used to control watering device in mushroom house can be more efficient if added with IOT application to maximise efficiency while reducing power consumption.

### 1.1.3 Internet of Things (IOT)

IOT or known as Internet of Things proved to be able to build amazing industrial systems and applications. Nowadays, a broad range of industries that uses IOT applications have been developed and deployed. Besides that, IOT consisted of combination of sensor, network connectivity, internet and computer technology to obtain efficient and smart processing (Chieochan, Saokaew and Boonchieng, 2017). Furthermore, IOT is very important within agriculture industries for monitoring system. In agriculture world, IOT tend to help farmers on latest and new methods to improve the productivity of yields. For example, WMSN and RFID are applied as IOT application to do real-time monitoring and control system by producing automated irrigation system. This method would substantially manage in reducing human effort and gives advantages to the agricultural industries. This system proven to be most useful as great irrigation strategies to maximised crop yields as it can communicate with hardware and software automatically to send and collect data. To be more simple but precise, farmers can monitor their farm in any places by using devices such as smartphones and computers which defines the IOT system if the systems in the farms are connected by wireless network (Zulkifli and Noor, 2017).

## 1.2 Problem Statement

There is no denying that mushroom farming had huge prospects and able to generate income or profits to the user or farmers. However, there will always be problems when it comes to the process of producing mushroom. The first problem comes from the surroundings of temperature and humidity in mushroom house. To produce the continuous growth of mushroom, the humidity and the temperature are the important factors that need to be handle correctly which the optimum value determined in providing better growth of mushroom. Based on experience, when the mushroom farming house need more monitoring from human or in other words need to be manually monitoring, there will come problems. The afterward problem comes when the house need human assistance at the most to trigger the water pump according to the estimated weather on the same day. So, the farmer required more time for themselves to be in the mushroom house to continue the process. To solve this problem, the presence and use of microcontroller and RTC (Real Time Clock) module helps in setting the timer for the pump so that the pump can turn on and off automatically based on the choice of the user and the estimated weather. However, the user needs more time and a lot of presence in the mushroom house because they need to monitor temperature and humidity with the condition of the pump locally. The user cannot monitor from other locations or far distance.

So, to solve the problem, the timer will be used to turn on and off the pump and will be applied with IOT to reduce human effort and able to monitor from long distance or different places. This will be aligned with the purpose to control the temperature and humidity at optimum level. The monitoring system can be done and observed on external devices such as smartphones through IoT platforms which subsequently reaching the objective for this project.

## 1.3 Project Objectives

The sole purpose of our project is to develop digital timer controller with IOT application aligned to solve the problems stated. There are few main objectives to be achieved:

- To develop IOT monitoring digital timer controller using IoT application
- To monitor and control the temperature below 30°C and humidity above 60% in mushroom house.

## 1.4 Project Scope



This project will be focusing on developing IOT into digital timer controller that will be used to control the conditions of water pump in the mushroom house. In other words, the user can monitor the condition of the water pump from far distance through the smartphones whether the pump is on and off based on the timer that had been set. In this project, NodeMCU ESP 8266 will be used as the microcontroller with built-in Wi-Fi module to give access to Wi-Fi network to meet the requirement of IOT solution in this project which is monitoring of condition of water pump with timer through devices such as smartphones. The IOT platform will be accessed through Blynk on smartphone devices which will help in keeping track of water pumps from far distance thus meet the requirement of objectives.

## 1.5 Thesis Organization

The report is comprised into five main chapters. Chapter 1 will give brief introduction on this project while in chapter 2 will provides the previous research that related to the project. In chapter 3, the methods and the components involved in this project will be illustrated and explained precisely. Chapter 4 will discuss the result from the completed system by doing testing and analysing. Chapter 5 will conclude the whole project result and testing and at the same time give the recommendation or the idea on improvement of the project in the future.

# CHAPTER 2

# LITERATURE REVIEW

This chapter concentrates on the monitoring and control system concept and principle involved in the project. The review and study of previous research that are related to this project should help provide better understanding of this project development from time to time. Somehow, while in progress of completing the project, ideas from information in this chapter will help in contributing to complete the project.

## 2.1 Sensors in Irrigation and Agriculture System

### 2.1.1 Temperature and Humidity Sensor

Most of fields that involved irrigation and agriculture system used temperature and humidity sensor to maximize plant growth. Kaewwiset stated the use of fuzzy logic algorithm to control and monitor the temperature and humidity surroundings the mushroom house automatically (Kaewwiset and Yodkhad, 2017). The procedure of the system initially to obtain data from temperature and humidity sensor. Then, the information is sent to the microcontroller to allow fuzzy logic algorithm to analyze and control them. Then, the mist sprayer and heater will do their job according to the signal received by the microcontroller. The sensor used in this research is DHT11 that are installed in the mushroom house for data input.



Chieochan mentioned the use of DHT22 is very important in mushroom field Lingzhi. The most significant natural viewpoint that should have been monitored in the mushroom field was the humidity (Chieochan, Saokaew and Boonchieng, 2017).

Naturally triggering the water sprinkler and the mist was needed. The time for watering process was subject to the moistness of the mushroom field. The appropriate moistness required by the mushroom field is between 90-95%. Additionally, the framework ought to be financially savvy and requires straightforward support. Mugginess information was transmitted to distributed computing by NETPIE and is appeared on PCs and cell phones. The watering condition was seen on PCs and cell phones. The research was finished throughout the winter season. The normal day of temperature is around 20 to 25 degree Celsius. The value is viewed as appropriate for the development of the mushroom field. So, the improvement of the IoT framework is not intended to monitor and record the temperature. Nonetheless, a DHT22 was a sensor that measured temperature and humidity simultaneously. In this exploration, just moistness of the mushroom field should have been estimated. Useful condition of the water sprinkler and mist siphons were expected to give warnings. The normal stickiness ought to be 90-95%. The mushroom field was likewise planned to utilize nearby materials.

Subedi implemented different approach on the use of temperature sensor. The thermocouple is a temperature sensor that accumulates the data from a source and modifies the data into reasonable sort for an onlooker. The LM35 is a normally utilized temperature sensor that estimates data of temperature in degree Celsius. It can gauge temperature even more accurately contrasted and a thermistor. It has low self-warming and does not cause more than 0.1°C temperature rise. It can gauge temperature from -55°C to +150°C. LM35 can be worked from a 5V flexibly (Subedi *et al.*, 2020).

From the perspective of Rohadi in the automation system, sensors take data from the sensors. The temperature in the work field is measured by the sensors. As the process is run, the framework obtained information from the temperature sensor, air dampness, speed of wind, and light power (Rohadi *et al.*, 2018). At that point, the information is joined with information from the Open Weather Map API. Besides, the system will check if the encompassing temperature is between $21^0$C to $30^0$C. On the off chance that it achieved the temperature benchmarks, the system will check again if the climate is bright or shady. On the off chance that the climate is radiant or shady, at that point watering is done two times every day each morning and evening to keep away from unreasonable dissipation and progressively ideal plant development. On the off chance that the climate is blustery, there is no compelling reason to water. If the temperature exceeds 30°C, the water will act to decrease the temperature in the field.

Singh used different approach in utilising temperature sensor to be used in the system. DS18b20 which is the temperature sensor that used to record the amount of water used in the field and checking the crops sensitivity to the temperature (Singh and Saikia, 2017). The DS18B20 is useful because of its direct-to-computerized sensor of temperature. The DS18B20 controls up in a low force inert state. To start a temperature estimation and A-to-D transformation, the master must issue a Convert T command. The result about warm information is put away in the 2-byte temperature register in the scratchpad memory and the DS18B20 comes back to its inactive state.

In terms of different implement, the framework is intended for flexible uses, for example, moistness and temperature on nurseries control, incubator hatcheries and climate observing stations. Commonly, environmental temperature is evolving slowly, and a rapid control not required by the agriculture. Subsequently, the control mode in hysteresis can be utilized. The regulation of high and low setpoints are directed at the temperature and humidity. Contrasting with a framework that utilizes a solitary setpoint, the hysteresis control strategy can forestall presenting on and off states all the time. In the control of temperature in hysteresis, it very well may be warm or cool as the control of temperature is 30-35 degrees in terms of two setpoints. In terms of control in humidity hysteresis, the dampness was controlled on different setpoints, for example 80 to 90 percent. The humidifier or depleting fans can be an actuator in the increment and diminishing mugginess separately (Wiangtong and Sirisuk, 2018).

### 2.1.2 Other Sensors

The soil moisture sensor and ADC Module formed the input block. The sensor of soil moisture produces a voltage in which the ADC module transforms the data into pieces of computerized signal. Scope confidence is the product of transformation result as demonstrated by humid conditions. The switch is selected in accordance with the utilization of this gadget in correlation with kind of plant. The transformation results conveyed characterization. This order depends, for example, on the perfect state of the plant, high water need, medium water need and low water need. Information got from tests led at three different plants. The Stew plants, Cactus plant, and Adenium plant are plants used in this trial. Each of the three of these plants utilize same soil development media and volume. Information assortment was completed 6 hours subsequent to dry conditions and water volume are similarly averaged for watering (Primisima, Sudiro and Wardijono, 2016).

Subedi stated that the sensor of soil moisture is utilized to quantify the water volume substance on dirt. The VH400 sensor tests decisively in measuring the content of soil water. So, the sensor permits minimal effort observing with high goals. The force utilization of this sensor is under 7mA. The working temperature goes between - 40° C to 85° C (Subedi *et al.*, 2020). The light intensity sensor is a detached component which changes over this light vitality as noticeable or in the infra-red pieces of the range into an output of electrical sign. So, the sensor changes the opposition when light falls on it. The working extent can be discovered it for the most part works in the scope of - 20 to 75 degrees centigrade. The photoelectric or photograph sensor is consisted of light sensors due to the proselyte light vitality into power.

Kamelia stated the usage of YL69 sensor in quantify the level of soil humidity and show the outcomes on the website and LCD locally (Kamelia *et al.*, 2018). The estimated measurement value work as the marker to mechanize for plant watering in the water system framework. The automated framework uses the sensor YL69 innovation as information contribution to screen the humidity of the soil. The ESP8266 is used to send data to cloud server to implement Wi-Fi connection. The information from humidity is send to the web server through Wi-Fi server. It means that the estimation of soil mugginess could be shown at internet browser which can be access in the web associated PC. The yield of the pin is different rely upon the obstruction of the condition of the soil. In this way, the yield from the pin is utilized as the contribution for the microcontroller. The component of soil moisture sensor is by passed the electric flow through the dirt. On the off chance that the level of dirt condition is high, the low value is shown on the obstruction of the ground, therefore the level of yield voltage is high. The circuit of the sensor is tried by contrasting the incentive with the calibrator Dampness Meter ETP306.

According to Singh, the soil moisture sensor used capacity to measure the comprehensive medium's dielectric permittivity. Dielectric permittivity is an integral part of the water content in soil (Singh and Saikia, 2017). The sensor allows a voltage relative to the dielectric permittivity, and thus the dirt's water content. The sensor midpoints the water content throughout the entire sensor length. On the approach of Bounnady, the sensor of soil moisture is utilized in measuring dampness in the soil (Bounnady *et al.*, 2019). The component works on electrical lead along the obstruction (soil dampness went about as opposition), also, it changes to the dampness content in the dirt. The dirt dampness is a factor deciding plant development. The water stream sensor, this component comprised of a water rotor and a sensor. As the water streams, the rotor is rolled, and the sensor acted to yield the beat signal relating to the water speed streams. We utilized it for assessed water utilization on the homestead.

In other notes, the parameter in choosing the time for water to flow is controlled from the measure of dampness right now present at one point in the dirt. The robotic program measured the value by continually roam at the field and check the dampness content in the dirt for the assigned districts. The robot is additionally fitted with the important sensors for transmitting the information to the raspberry pi. The state of the robot is like a creepy crawly. This permits it to roam freely on the dirt without the leg stalling out in the dirt. The microcontroller obtained the value, and the water is supplied to the territory that have low moisture. LoRa (Long Range correspondence) Transmitter is utilized to send constant data to the raspberry pi. The degree of system availability extends over a range of 5km which would basically cover the whole field. In the event of an enormous field we can utilize various robots to examine the field and check for the dampness content in the territory (Sri Heera *et al.*, 2019).

## 2.2 Monitoring and Control System

### 2.2.1 Locally

Primisima stated that one of the fundamental focal points of executing a connection of FSM and VHDL is that user able to straightforward get the code of VHDL from a graph chart on ASM. The document of VHDL will incorporate three primary areas. The segments are present, next and yield state. FSM that comprised of two parts which are Moore Machine. In the hypothesis of calculation, the system is a limited state transducer where the yields are dictated solely by the current state. Secondly, is Mealy Machine. In the calculation of hypothesis, a Mealy machine is a limited state transducer that produces a yield dependent on its current state and information. This implies the state graph will incorporate both information and each edge progress for yield signal (Primisima, Sudiro and Wardijono, 2016).

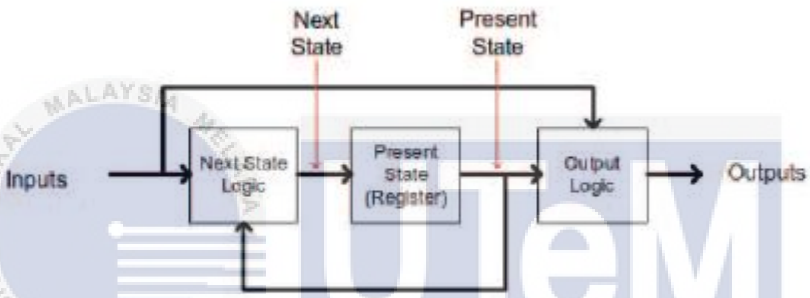


**Figure 2-1:Block Diagram of State Machine**



The procedure is comprised of FPGA along with the switch. On the gadget there are three changes utilized to choose the mode of watering. Switch number 1 is watering mode for plants with a high-water need, switch number 2 is watering mode for plants with a medium water need, and switch number 3 is watering mode for plants with a low water need. A construction of FPGA based segment will be utilize programs or on the other hand rationale entryway circuit schematic for handling advanced information obtained through sensor utilizing VHDL. The yield square comprised of LED and water siphon. LED and water siphon are the last agent of the gadget. Once the dirt is in dry state, water siphon is started or initiated which dormant occur when the dirt is wet. The humid and dry state rely on the turn environment of the switch. While LED distinctly conveyed more than one turn as a pointer when watering mode is enabled. Equipment testing is led by utilized logic analyser. A logic analyser is a research centre measuring device intended in show and assesses computerized signals. The gadget works in a way such as the oscilloscope shows and encourages the investigation of simple signs. The testing instruments involving oscilloscope and logic analyser are not the same. As the two instruments have a fundamentally the same as structure of show, for example showing waveforms, they were used on a very basic level distinctive operational idea. The process starts with deciding the area of I/O pins of FPGA utilizing Xilinx's I/O Pin Planning (PlanAhead) element (Primisima, Sudiro and Wardijono, 2016).

Kaewwiset implement the approach of Fuzzy Logic which defined as a mainstream apparatus in examining category of information for settling on choice help. Fuzzy logic can investigate vulnerability information and able to adapt. Fuzzy logic works from the reason which is copy man reasoning strategy and consisted of highlights that unique in relation to Boolean logic. So, the Fuzzy able to discover the appropriate response multiple answers. As precisely, fuzzification is the procedure to change over information to fluffy info dataset. The base of knowledge is a section to gather information comprises of two sections. Firstly, the Rule base is a piece of characterize control process. The Rule base characterize by master individual configuration in type of Linguistic guideline. The next section is a database consisted of a piece of storing information and overseeing information for Fuzzy logic. Besides that, Inference Engine is dissecting and recognize the realities and rules for making condition or motivation to unravelling issue. Furthermore, Inference Engine is a procedure to decipher in looking through suitable solutions. Defuzzification is a section to change over fluffy info dataset to yield information that are in suitable scope of answer. The last procedure of this part is allowing the estimation for investigation with new circumstance or new input information (Kaewwiset and Yodkhad, 2017).

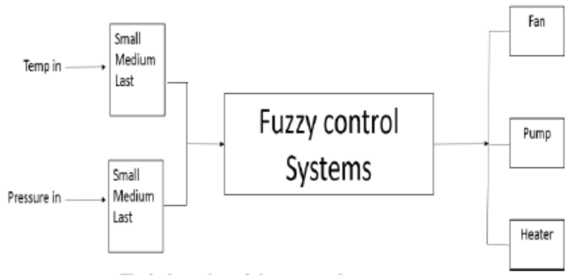


**Figure 2-2: Overview of Fuzzy Logic System**

| (Input) | | Output | | |
|---|---|---|---|---|
| $T_{in}$ | $H_{in}$ | *F* | *M* | *L* |
| Low | Low | off | Medium | High |
| Low | Meduim | off | Low | High |
| Low | High | off | off | medium |
| Meduim | Low | off | off | High |
| Meduim | Meduim | off | off | off |
| Meduim | High | Low | off | Low |
| High | Low | High | Low | off |
| High | Meduim | High | off | off |
| High | High | High | off | off |

**Table 2-1: Rule Base in Fuzzy Logic Process**



The approach of MATLAB is used as one of the system in monitoring the temperature and humidity sensor (Subedi *et al.*, 2020). The data from the sensors were recorded in MATLAB through LM35 and DHT11 in different time instances which would then send to the cloud server. Wiangtong also stated the use of MATLAB is possible in presenting the results of the system which stored in cloud server (Wiangtong and Sirisuk, 2018).

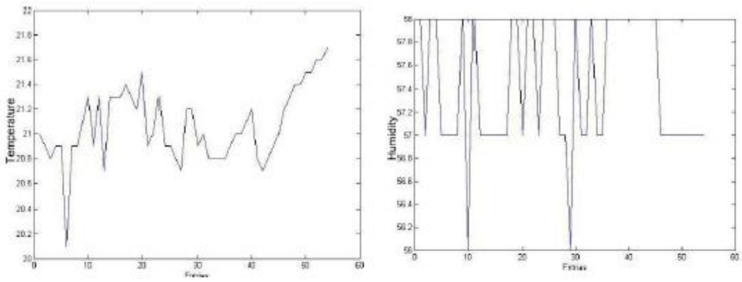


**Figure 2-3: Data in MATLAB**

According to Chieochan, CCTV was constructed on top surrounding to do the monitoring of the watering system status and to ensure that the pumps were working. The use of LCD also involved in order to show the status or measurement of humidity data that installed with the circuit box (Chieochan, Saokaew and Boonchieng, 2017). Based on Kamelia, the use of LCD is involved in showing results and measurements of soil humidity level along with the process of automation system for watering plant. The LCD that connected with 12C-module and ESP8266 module, so it only comprised with SDA and SCL. The display of soil humidity data on LCD proven to have the same value in the visually data on website (Kamelia *et al.*, 2018).



### 2.2.2 Remotely (IoT)

Chieochan mentioned the use of IOT in monitoring humidity in the mushroom field. The work involves the utilization of controlled sprinkler and fog pumps automatically through IOT application (Chieochan, Saokaew and Boonchieng, 2017). The results indicated that the model of smart farming can be improved by using the sensor that applied with IoT. The equipment applied in this system consisted of Node MCU, moistness sensor, real time clock, NETPIE and others. The research stated that the data able to be monitored on PCs and smartphones. So, the humidity sensor is controlled by IoT to monitor the humidity data. IoT also controlling the condition of the water sprinkler and mist consequently. The Wi-Fi module was utilized as equipment with the IoT to associate with the mentioned university passage point to allow internet connection. Then NETPIE was utilized to transmit humidity data to the internet and subsequently send data to the computers and smartphones using NETPIE Freeboard. LINE application was applied to detect the functionality of water sprinkler and mist.

Subedi used IoT to create a system to monitor and control the environmental conditions in a mushroom field. This allows farmer to observe important parameters such as temperature, humidity, moisture and the light intensity through the devices (Subedi *et al.*, 2020). The sensor that detects the parameters is transmitted to the remote monitoring system through NodeMCU. So, the coding that were programmed in Arduino software programming is applied to the microcontroller that used Arduino advancement. The outcome shows useful checking of natural conditions getting to the web from anyplace. It limits human endeavors and computerizes creation, which could be advantageous to Nepalese ranchers. The interfacing of the IoT framework was applied IoT platform which is Blynk that show data from sensors through low powered NodeMCU.

Kamelia stated that the automation framework uses the YL-69 sensor innovation as information contribution to detect the soil moisture. The ESP8266 Wi-Fi module function as information handling and server. The dampness information is sent through the Wi-Fi system and transmitted to the server. After that, the estimation of soil dampness could be shown at internet browser which is accessible on the web associated PC (Kamelia *et al.*, 2018). The structuring of programming is begun with composing the calculation programming to allow the microcontroller to be controlled as the principal unit of the mechanization framework. The final procedure is structuring the web server with the interface, so it tends to be gotten to by the PC. The last testing has finished with different dampness conditions. The framework triggered the water siphon if the dampness underneath 15 percent and naturally shut down the system when moistness arrives at 45%. The dirt dampness observing has been effectively shown in the site utilizing web organize. The react time for show the incentive in the site relies upon the web association speed of the PC that is utilized to get to the worth.

From the automated framework, the sensors obtained information from the parameters involved. The sensor of temperature and humidity will gauge the data of temperature, as the light power sensor act to quantify the force of daylight in the field. At that point, as the sensors obtained the estimation information, the information will be gone into the database stored in the raspberry pi. The sensor observing information stored in the raspberry pi will be contrasted and information from the Open Weather Map API (Rohadi *et al.*, 2018). The information is contrasted with the mean to check whether the information from the sensors is precise or not while deciding the climate in the zone (on the land). The advantages stated in this system is that the use of Raspberry to slide putting away DB into MySQL legitimately from Python. This means to facilitate the developer keep up all information from the sensors. Then the system utilizes the web-based monitoring system. Along these lines, the users don't have to go to the field to observe the value of the sensor and land condition continuously. Besides that, the system comprised of a climate monitoring framework for markers of watering plants. So, in this condition if rain is anticipated, watering is not essential. After that, the including of sensors like temperature, dampness, wind speed, and light power with the help of a module which is Automatic Weather System able to provide the system that help to forestall plant watering if rain is occur.

As to provide communication with users in a website, it require server to transmit and get information from microcontroller to the users and the other way around (Singh and Saikia, 2017). To accomplish an ideal yield, a right calculation is required. The calculation comprised of the accompanying advances which are the first stage is to power ON the framework which incorporates the microcontroller, sensors, and different peripherals. The next stage required the triggering of the framework, that comprises of sensors, Wi-Fi module and UI. In stage three, read the framework design document which implies to peruse the guidelines from the arrangement record and the framework activity as indicated by the arrangement record. As for stage four, read information from the sensors and dissect information to check regardless of whether it is required to caution the client or keep checking. The next stage required the send of information to the user upon demand utilizing ESP8266 what is more, waiting for the result from the user. Last stage, if result is true at that point, it measured the condition of water system siphons and water sprinkler, flip the status, and spare the current status in framework arrangement document. The users able to transmit various orders to pick whether water sprinkler and water system siphons. The possibility and structure Arduino in the system is based on shrewd water system by utilizing ESP 8266 Wi-Fi module that was applied utilizing a model created in a research centre. So, user utilize each gadget except for the water system siphon and water sprinkler. The principal part in the model close to Arduino is the ESP 8266 Wi-Fi module that permit user to transmit and get information from the web. ESP 8266 fundamentally chips away on AT orders. For trial reason, ESP8266 is used in a LAN status. Nevertheless, for the real use of ESP8266, it can be reconnected to a switch that permit user in getting to the information through anyplace on the planet in the web.

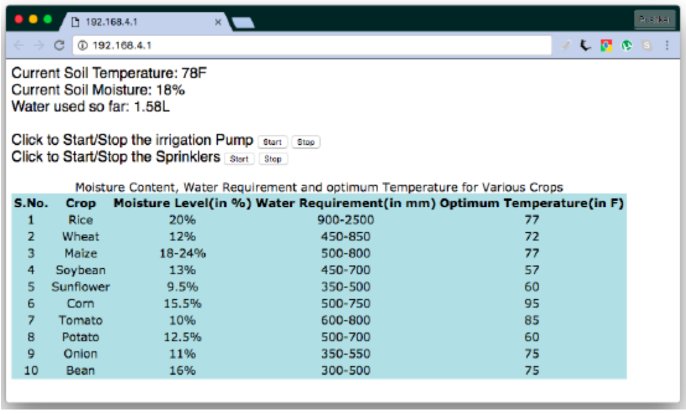


**Figure 2-4: Webpage with sensor data**

To add more research, Bounnady implemented the use of NodeMCU ESP8266. This microcontroller is utilized as a fundamental preparing device within the proposed system. The sensors that applied with the microcontroller and it fills in as a server locally to get the data retrieved from the sensor, likewise it can speak with the cloud server for constant database memory. The framework can transmit information to the cloud and get information from a cloud that helps the client to screen and control the ranch. Then, the Android application for UI is developed and connected with the system. So, the user able to observe information from the sensor, for example, soil moisture, temperature, humidity, water volume and furthermore they can modify a few parameters for the system, for example, the limit in watering the soil moisture. So, the system used for productive crop observing for the agricultural fields. The framework observing of soil moisture, temperature and water control has been proposed by utilizing Node MCU ESP 8266, sensors and cloud server. The designed framework was successful with development rate, profitability and water sparing, additionally the user can observe and modify some an incentive in the monitoring system through the application (Bounnady *et al.*, 2019).

As stated from Wiangtong, hysteresis is an input devices that changes suddenly in different states, in which regularly in controlling a plant that acknowledges binary input and generates conditions of yields in two way (Wiangtong and Sirisuk, 2018). For instance, a sprinkler siphon is either totally on or totally off attempting to keep within humidity between 80%-90%. In this system, Arduino Mega2560 is utilized as an equipment stage for fast creating with numerous equipment shields and libraries bolstered. It can deal with SHT21 that have humidity precision, in estimating humidity and temperature. The cloud server obtain data by utilizing ESP 8266. The coding program in C is created dependent on genuine prerequisites from farmers. Aside from temperature and humidity control, a plant may require a light during the night or on the other hand wind current from ventilation fans to prevent CO2. The control of hybrid techniques shown in the work are actualized in types of control such as temperature and humidity control.

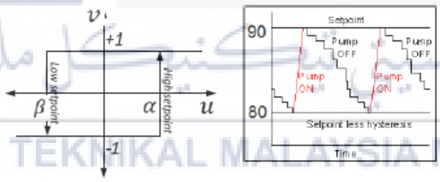


Fig. 2. Hysteresis control

$$v = +1 \text{ if } u > \alpha \text{ (the high setpoint)}$$
$$v = -1 \text{ if } u < \beta \text{ (the low set point)}$$
$$v \text{ remains unchanged if } \beta < u < \alpha$$

**Figure 2-5: Hysteresis control**



While the IoT equipment is ready for action, there are various information estimation of production of sensors. The data tends to be put away locally or sent to a cloud framework through the web. Information can be put away, handled, and investigated in the cloud server. IoT cloud frameworks which are Xively and ThingSpeak are utilized in this work. The IoT application that incorporates with MATLAB programming permitting clients in breaking down with the visualization of transferred information. Typically cloud frameworks give Application Programming Interface or API that used to keep and recover information by utilizing the protocol of HTTP. Users can screen information continuously or show verifiable information records by means of computers or cell phones. The monitoring burdens able to be constrained by customers through the support of cloud service. Be that as it may, there must be some criticism data to ensure that a monitored load can be turned ON or OFF. As the order is conveyed through different courses in the web and missing which can cause flaw in operations. The feature need to be planned wisely and coordinated in future (Wiangtong and Sirisuk, 2018).

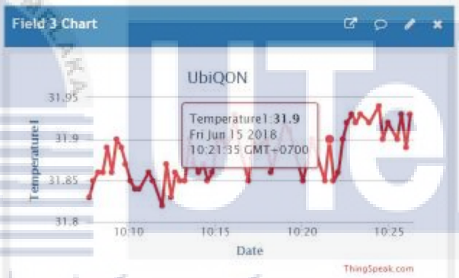


**Figure 2-6: Sensor data in ThingSpeak**



According to Sri Heera, the principle point in the framework proposed is to lessen the measure of overabundance water in a piece of the field gets because of manually water system (Sri Heera *et al.*, 2019). The framework utilizes pipelines that are associated with the field by means of a raspberry pi focus which consequently triggered the supplement of water to the land. The parameter for choosing in permitting water is dictated by the measure of moisture as of now present in the dirt at a moment. The data is observed by a robotic program which continually roam on the land to check the dampness value in the dirt on assigned districts. The robotic program is likewise fitted with the fundamental sensors to transmit the information to the raspberry pi. The state of the robotic program is like a creepy crawly. This permits in moving freely along the dirt without the legs stalling out through the dirt. The worth is transferred to raspberry pi and the region obtained water if the dampness is low. LoRa (Long Range correspondence) Transmitter is utilized in transmitting ongoing data to the raspberry pi. The degree in system availability extends on a range of 5 kilometres that basically covering the whole field. On the event of an enormous field, user can utilize numerous robotic programs to filter the field and checking the dampness data along the zone. Raspberry pi is associated with the yields of the rain gauge framework, to obtain continuous information on the level of the rains. In case of substantial rain, the water system does not have to be accomplished in a while, that determined dependent on levels of the rain.

On the off chance that there happens water stagnation because of rain, it is estimated using sensor with overabundance water is depleted to the groundwater using regular conduit system. The ESP32 is the cerebrum in the framework. It is utilized for the control of servo engine for the exact development and sensor NAVIC is utilized to obtain the area subtleties precisely, LoRa is a sending and accepting module which has a scope of 5km Automated Irrigation and Smart Farming. So, the utilization of robotics and AI can expand the yield of harvests, alongside decrease the work and ideal use of water (Sri Heera *et al.*, 2019). This will help in building the benefit of the rancher, thus allow them to go to different works without trading off the work in the field. The rancher likewise went to the emergency in the field as the rancher will be notified of the water system exercises progressively. Utilizing the robot creates massive benefits for the rancher. The presence of a critical increment to obtains and a decline in the sum spent. By and large, everyone that doing the task in the field is paid Rs.400 every day for the water system exercises. Likewise, water system is done on exchange days. Hence, the farmer would need to pay the laborers estimated on Rs.12000 each cycle per individual. The expense turned to be high as the quantity of individuals included increments. In this manner, by utilizing the robot the farmer can eliminate these costs and get great benefit by contributing less.

Amri mentioned the purposes in optimizing the temperature and humidity at below $30^0$C and above 60% respectively (Amri *et al.*, 2019). As stated in the research, the time period that is crucial during a day is 12pm to 5 pm which is in Melaka (Amri *et al.*, 2019). To support the previous statement, the daily monitoring of the system by utilizing data logger were implemented to measure temperature and humidity. The data logger was only used in hot weather condition. The record from the data logger proven that the crucial condition of temperature and humidity are within the range of 12.00pm to 5.00pm. It is because the temperature started to reach the highest point which is around $30^{o}$C to $37^{o}$C at 12.00pm to 4.00pm and will start to drop around $26^{o}$C after 5.00pm. As for humidity, it started to reach the lowest point which is around 63% to 54% at 12.00pm to 2.00pm and will start to rise again after 5.00pm (Amri *et al.*, 2019). So, the procedures and analyzation of the system is determined to maximize the output growth of mushroom. To support and validate the purpose of the paper, the expertise of mushroom from Malaysia and Indonesia stated that the optimum environment for the mushroom to harvest is within temperature that are lower than $30^0$C and range of 60% to 80% in humidity (Fuady *et al.*, 2017)(Adhitya *et al.*, 2017).

## 2.3 Comparison of related works

| Author | Microcontroller | Monitoring & Control System | Input | Output | Description |
|---|---|---|---|---|---|
| (Primisima, Sudiro and Wardijono, 2016) | -FPGA | -Logic analyzer<br>-FSM | -Soil moisture<br>-ADC | -Water pump<br>-LED | -Does not use timer concept.<br>-The condition of soil moisture sensor determined output process |
| (Kaewwiset and Yodkhad, 2017) | -Arduino Mega Uno R3 | -Fuzzy logic | -DHT 11 | -Fan<br>-Spray mist<br>-Lamp | -Does not use timer concept.<br>-Parameter of DHT 11 determined the output process. |
| (Chieochan, Saokaew and Boonchieng, 2017) | -ESP8266 NodeMCU | -NETPIE on computers<br>-LINE on smartphones<br>-LCD display<br>-CCTV | -DHT22<br>-RTC | -Sprinkler pump<br>-Fog pump<br>-LCD | -Use timer concept.<br>-Use LINE application to give messages to users on conditions of input and output parameters on smartphones.<br>-NETPIE show the conditions of input and output parameters on computers. |
| (Subedi *et al.*, 2020) | -Arduino ATmega328 | -MATLAB<br>-IoT (Blynk app) on smartphone<br>-Thing Speak | -LM35<br>-DHT-11<br>-Soil moisture<br>-LDR | Measurement on IoT app<br>-Temperature<br>-Humidity<br>-Soil moisture | -Does not use timer concept.<br>-The process only involved monitoring of input parameters.<br>- Used IoT app which is Blynk app to monitor the parameters. |
| (Kamelia *et al.*, 2018) | -ESP 8266 | -IoT<br>-LCD display | -YL-69 | -LCD<br>-Water pump | -Does not use timer concept.<br>-The parameters from YL-69 that used for measuring soil humidity determined whether water pump is on or off. |
| (Rohadi *et al.*, 2018) | -Raspberry Pi | -IoT<br>-Automated weathering system | -DHT11<br>-Wind speed sensor<br>-Light intensity sensor | -Water Pump | -Use timer concept.<br>-Used data from input parameters to be compared with weathering system through internet.<br>-Prevent watering if rain is predicted to provide optimal plant growth. |
| (Singh and Saikia, 2017) | -Arduino UNO<br>-ESP 8266 | -IoT<br>(Android App) | -Water flow sensor<br>-Soil moisture sensor<br>-DS18B20 | -Irrigation pump<br>-Sprinklers | -Does not use timer concept.<br>-Used data from sensors that send to ESP 8266 to check feedback and toggle the state of outputs. |

| | | | | | |
|---|---|---|---|---|---|
| (Bounnady *et al.*, 2019) | -ESP 8266 NodeMCU | -IoT (Android App) | -Soil moisture sensor<br>-DHT22<br>-Water flow sensor | -Solenoid valve | -Compare three method which is the proposed, traditional and using timer to control soil moisture.<br>-The proposed method is better in controlling water flow to system |
| (Wiangtong and Sirisuk, 2018) | -Arduino Mega2560<br>-ESP 8266 | -IoT (Xively, Thingspeak, UbiQON)<br>-MATLAB | -Two SHT 21 | - Sprinklers<br>-Exhaust fans | -Use hysteresis control which is sprinkler is completely turned on or off. |
| (Sri Heera *et al.*, 2019) | -ESP 32<br>-Raspberry Pi<br>-LoRa | -Robotics<br>-Computers<br>-Smartphones | -NAVIC<br>-Soil moisture<br>-Rainwater sensor | -Servo motor<br>-Water pump | -Reduce the excess water flow by auto turn on and off water supply.<br>-Use robot that moves around the field to check parameters.<br>-LoRa send data to Raspberry Pi. |
| (Amri *et al.*, 2019) | -Arduino UNO | -Bluetooth<br>-Smartphones | -Water sensor<br>-Humidity sensor | -Exhaust fans<br>-Humidifiers<br>-Submersible pump | -Control and monitor temperature at below $30^{oC}$ and humidity at above 60% in mushroom house.<br>-Using Bluetooth to monitor the parameter on smartphones. |

**Table 2-2: Comparison of related works**

## 2.4 Conclusion

In conclusion for this chapter, the previous research that related to the proposed project briefly explains the input and output used in irrigation system or mushroom field. This chapter also provides related and proven information for the flow on how the system works, whether in locally or remotely. Locally means that the users often need to check to the field from time to time to monitor output while for remotely, the system used IoT method. IoT helps user in monitoring the system from other places on external devices such as smartphones or computers. To summarize this chapter, the proposed project will be an improvement from the previous project research which can set the timer for the pump to on and off while monitoring temperature and humidity data and at the same time.

# CHAPTER 3

# METHODOLOGY

This chapter gave detailed overview on the system of digital timer controller for watering pump by using IOT application. This system development and process were shown in step by step from the initial procedure until the last step with the materials, components and devices involved. The specifications and estimated cost of these components required to produce the system were explained in detail in this chapter. The design for this system were consisted of the construction of the circuit and the layout for the IOT application by using selected software application to control the system. This system is comprised and divided into four main phases.

## 3.1 Project Specification

| | |
|---|---|
| **Project Title** | - Development of IoT Based Digital Timer Controller for Mushroom House Watering System |
| **Operation Mode** | - Manual or Auto through IoT platform |
| **Power Supply** | -240V AC<br>- 5V DC |
| **Control and Monitor Device** | -Smartphone |
| **IoT Application** | -Blynk |
| **Process Parameter** | -Temperature<br>-Humidity |

| | |
|---|---|
| **Main Components** | -NodeMCU ESP 8266 (ESP-12E)<br>-Submersible Water Pump<br>-DHT11 Temperature & Humidity Sensor<br>-Ultrasonic Sensor<br>-5V Relay Module |

**Table 3-1: Project Specification**

## 3.2 Project Phase

In this step, the system is divided into four main phases. Each phase is explained and presented precisely and visually to allow easier and better understanding regarding the flow of the project from start until end process.



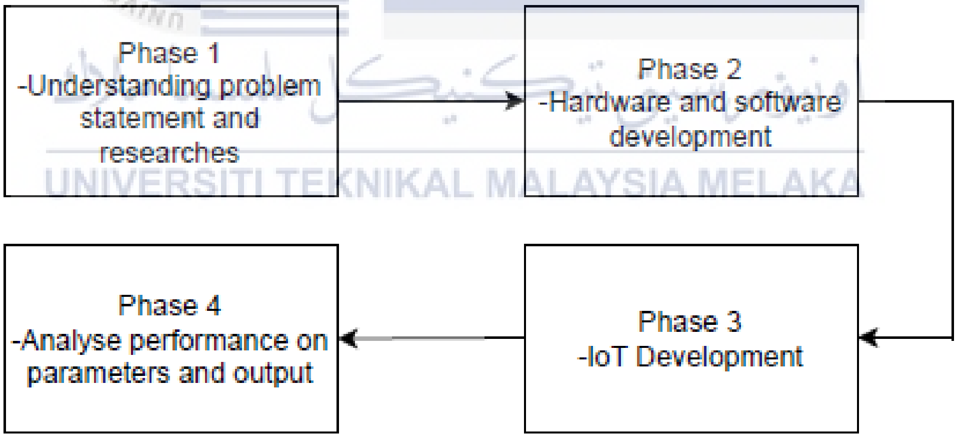


**Figure 3-1: Overall Project Phase**

In phase 1, the initial step that need to be taken is to find and understand the main problem of a study before working in developing a solution which is a must do and comes later, the objectives of this project. As per stated from the objectives, the most important things need to be done to validate and sensing our project into reality, various research on previous related works that relate to the project need to be done specifically and carefully. The more research, the better because it helps in determining and making decisions in choosing and using hardware and software that to be used for this project.

Next, phase 2 considered as the most important part before decided to integrate with IOT platform. Every step in this phase need to be taken in matter very seriously whether in costing, hardware, and software development and IoT platform. In hardware and software development, the hardware components and software application that were chosen is explained precisely and how the connections are constructed to transmit and receive signals. As in IoT development, the process system required IOT to allow monitoring of parameters and output on external devices such as smartphones and computers. By the involvement of IoT platforms, the realization of Industry 4.0 is achieved which reduce human involvement in the system process. The project costing is important aspect in this project as it helps in assuring the success of this project and how it can be implemented in the market with suitable prices aligned with the improvement of its efficiency.



As for phase 3, the design of the circuit and how each component connected with each other in terms of transmitting and receiving communication were elaborated precisely. This phase is very important in terms of giving success simulation to the hardware and software involved for this project before decided to test and analyse the system.

In phase 4, testing and troubleshooting when the system process works is very important in determining the performance of the system. In other words, the observation and analyzation on the system helps in improving the system of this project so that the objectives of this project can be done in maximized efforts. The idea and outcome of the improvement of the project depends on the method used to collect data that are obtained during the repeated testing of the system.

## 3.3 Hardware Development

### 3.3.1 NodeMCU LUA V2 ESP-12E

**Figure 3-2: ESP-12E Hardware**



| SPECIFICATION | |
|---|---|
| **Power** | Micro-USB |
| **Operating voltage** | 3.3V<br>Vin as external power supply |
| **Input voltage (recommended)** | 7-12V |
| **Digital I/O Pins** | 16 |
| **Analog input pins** | 1 |
| **Flash memory** | 4 MB |
| **SRAM** | 64 KB |
| **Clock speed** | 80 MHz |

**Table 3-2: ESP-12E Specification**

NodeMCU ESP-12E is used as a microcontroller for this system. With additional features of Wi-Fi module built in from the device, it can be applied as a device that helps in interface Wi-Fi functionalities to become IoT program. To allow this microcontroller to send data to the output devices, software programming which is Arduino IDE is used and need to be compiled with this microcontroller so that NodeMCU can fully function and communicate with the system. The NodeMCU is a bit different compare with other Arduino microcontrollers such as Uno, Nano, Due and Mega because it has ESP 8266 chip that can provide Wi-Fi transmission which makes it more easier and reliable to use. In this project, NodeMCU do the task as both microcontroller and Wi-Fi module that connected to input and output devices which are DHT 11, submersible water pump and ultrasonic sensor which is HC-SR04.

### 3.3.2 HC-SR04 Ultrasonic Sensor

**Figure 3-3: HC-SR04 Hardware**

HC-SR04 is an ultrasonic sensor that can be used as detector in distance of an object in front of the sensor with correct measurements. Generally, this sensor can help in detecting the presence of an object. It detects by using ultrasonic sound waves in measuring the distance of an object. The features or specifications of this sensor includes the detection range of around 2 to 400 cm which includes around 15 degree of view in distance field. The sensor can be operated only on 5V to make it fully function. The assembly has a 4-pin header on it and the GND pin is connected to the floor of the device. As for its operating voltage, the 5V is connected to the Vcc pin. To start the measurement cycle, the Trigger pin is an input pin which send 10 microsecond pulse to be applied. The Echo pin is an output pin that is kept HIGH for the duration from when a 40KHz pulse is sent out by the module until it receives the echo back. In this project, the sensor will be used to measure the distance of base of water in which the submersible pump is used to the top of sensor. In other words, the sensor will be installed on top facing downward. So, the sensor will be used a safety feature in this project. To say, the sensor will help to cut off the pump supply when the water level reach low level which subsequently can damage the pump if the pump is still on although the water run out.

### 3.3.3 DHT 11



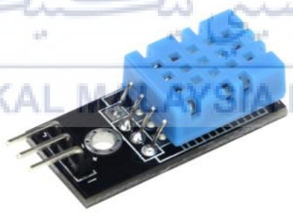

**Figure 3-4: DHT11 Hardware**

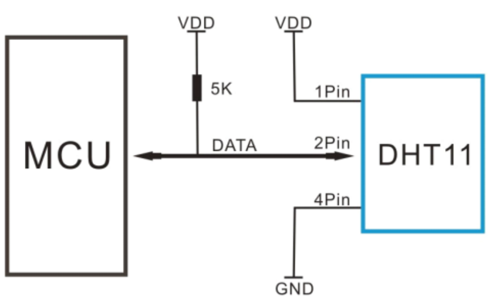


**Figure 3-5: DHT11 Diagram Pin**

| SPECIFICATION | |
|---|---|
| **Suitable Voltage** | 3.5V - 5V |
| **Suitable Current** | 0.3 mA |
| **Range of temperature** | $0^{\circ}C$ – $50^{\circ}C$ |
| **Humidity range** | 20% to 90% |

**Table 3-3: DHT11 Specification**

DHT 11 is a sensor that are very precise in calibrating temperature and humidity. Its tiny size and small power usage make it the best choice in measuring parameters. The sensor can be connected to the microcontroller to fully maximize its function according to the coding installed in the microcontroller such as Arduino. As for configuration and compilation of IOT to DHT11, it depends first on the pins of DHT11 whether in 3 or 4 pins. In this project, sensor DHT 11 is connected to the pin of Arduino UNO to send the data of parameters measured. So, ESP 8266 send the data received from Arduino to the MIT App Inventor so that the user can monitor the temperature and humidity remotely from smartphones or computers.



### 3.3.4 Submersible Water Pump


**Figure 3-6: Water Pump Hardware**

| SPECIFICATION | |
|---|---|
| **Item code** | WP083 |
| **Power consumption** | 80W |
| **Max flow output** | 9000l/h |
| **Max head** | 5.3m |
| **Electrical** | 240-260V / 50Hz |

**Table 3-4: Water Pump Specification**

Submersible water pump proved to be a very useful component or device especially in irrigation system. The pump is unique because it is installed underwater which means that the pump is waterproof. The pump also tends to be more energy efficient as the task that it required to do is only to push up the water rather than suck the water into it. So, in this case, this pump is a very suitable devices to be used in mushroom house. In this project, the pump is connected to Arduino UNO through relay module 5V to send the signal as the pump is in AC mode. Then the ESP 8266 will send the data from Arduino to MIT App Inventor so that the user can control the condition of the pump remotely from the smartphones or computers.



### 3.3.5 Relay Module

**Figure 3-7: Relay 5V Hardware**

| SPECIFICATION | |
|---|---|
| **Control signal** | Digital output |
| **Compatibility** | Microcontroller |
| **Maximum switching voltage** | 250V AC/ 30V DC |
| **Maximum switching current** | 10A |
| **Size** | 43mm x17mm x 17mm |

**Table 3-5: Relay Module Specification**

This relay module is configured as a single channel relay module. It is a very reliable and easy-to-use board that function in controlling high voltage and current from AC devices such as pump and lamps. The most important part in this device is its compatibility with the microcontroller. As for this system, the relay is connected to AC submersible water pump which then it will convert the signal to DC and transmit the signal to Arduino microcontroller.



## 3.4 Software Development



### 3.4.1 Arduino IDE

**Figure 3-8: Arduino IDE Logo**

Arduino IDE which stands for Integrated Development Environment is a software programming that can be used with any types of microcontroller Arduino such as UNO, NANO and DUE to communicate. The process is where the required code that was programmed is uploaded into Arduino microcontrollers. The special trait of this software developer is that the coding compilation is easy to use which even users with little knowledge on this area of learning able to adapt easily and gain learning process faster. In this project, Arduino IDE is used as programming software to allow Arduino UNO to communicate with the system.

## 3.5 Internet of Things (IoT) Development

### 3.5.1 Blynk

**Figure 3-9: Blynk Logo**



Blynk is a web application where it helps users in building mobile apps in creation to the Internet of Things (IOT). This application allowed users in creating application software on operating systems such as Android and iOS. The interesting part of this software is that it provided the basic coding of most widget so that the user has the capability and knowledge in proceed with the coding for their project. The server obtain data from NodeMCU and convert it into visual layout system from external devices which are smartphones. In this project, Blynk is used to allow the user to monitor the parameters which are temperature and humidity data from the smartphones. Besides that, the user able to monitor and change the condition of the pump from the smartphones. The user also can change the setting for temperature and humidity. In this progress, the objectives able to be completed as IOT project.

## 3.6 Project Costing

| No. | Items Description | Quantity | Price/Unit (RM) | Total Price (RM) |
|---|---|---|---|---|
| 1. | NodeMCU ESP-12E | 1 | RM19.50 | RM19.50 |
| 2. | Ultrasonic Sensor HC-SR04 | 1 | RM5.40 | RM5.40 |
| 3. | DHT11 Temperature & Humidity Sensor | 1 | RM4.90 | RM4.90 |
| 4. | Submersible Water Pump | 1 | RM66.00 | RM66.00 |
| 5. | 5V Relay Module | 1 | RM4.20 | RM4.20 |
| 6. | Blynk Energy | 1 | RM30.00 | RM30.00 |
| | | | **Total Amount** | **RM 130.00** |

**Table 3-6: Project Costing**



## 3.7 Project Process Flow

In addition of explanation to the flow process, the IoT platform will do the task as soon the data from the NodeMCU ESP-12E is sent to Blynk application. Input which are temperature and humidity with the output which is water pump are monitored on the screen of devices such as smartphones through Blynk. So, the program will ask user if they want to turn on pump in automatic or manual mode based on the monitored input and output. So, if the temperature and humidity already reached desired level before doing the process, manual mode allow the users to forced turn ON or OFF the system. As to when the measured sensors still not reach desired level, the automatic mode allow the water pump to turn ON and OFF the pump within specific time which helps to decrease the workload of the users. The users do not need to go check time to time if the measured parameters already reached desired level before the timer for automatic pump to end. So, the water pump will automatically turn off if the temperature and humidity reach objective. For the safety features, ultrasonic sensor HC-SR04 will help in cut off the water pump supply if the water in the container reach low level or nearly empty.

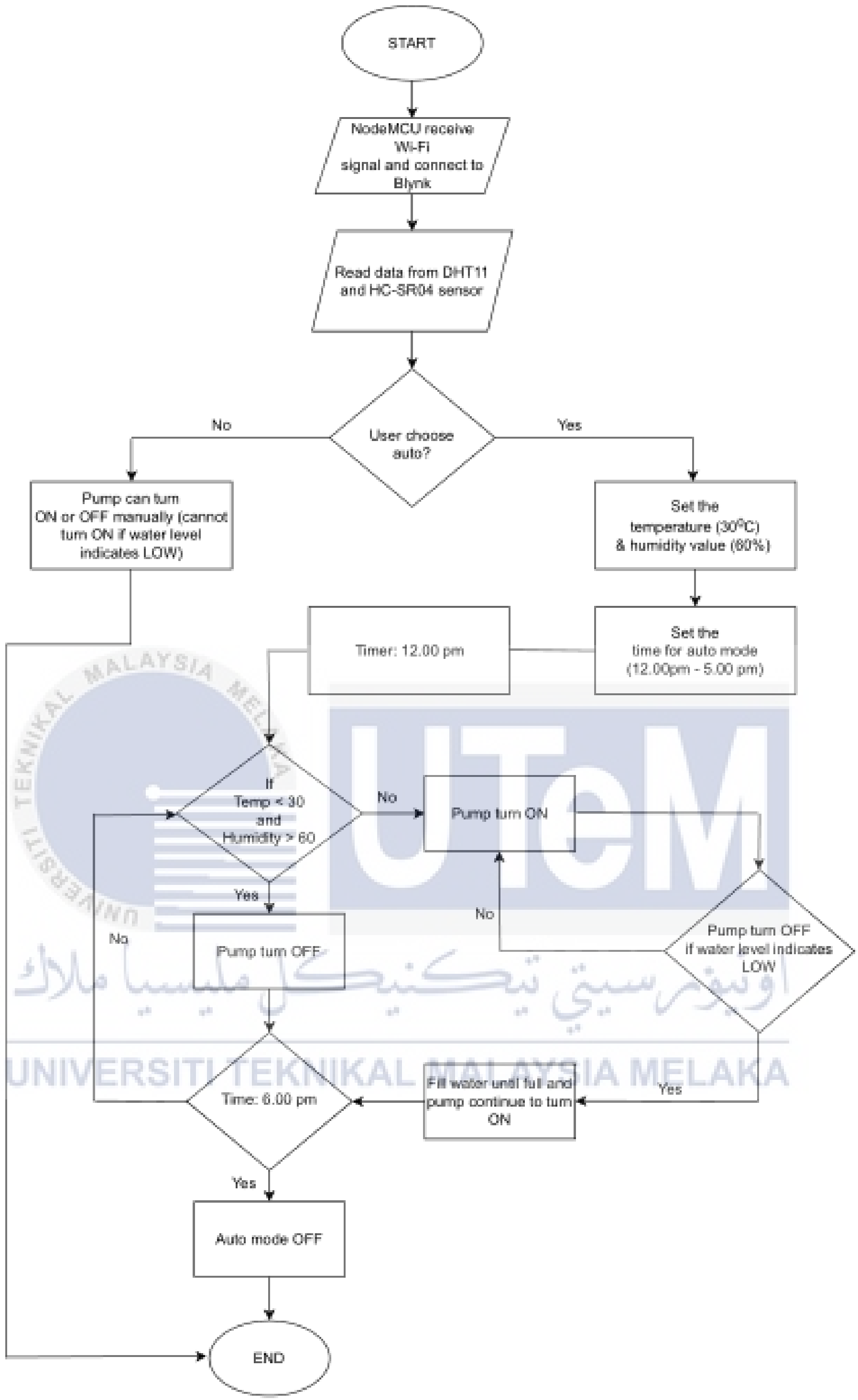


**Figure 3-10: Flowchart of System Process**

## 3.8 Project Block Diagram

From this block diagram, the system consisted of input, the controller and output. The input which is sensors DHT11 for measuring temperature and humidity transmitting the data to the NodeMCU ESP-12E. The measured data then transmitted to the IOT server which is Blynk that were installed and constructed in smartphone. The condition or parameter measured by the input earlier determined the condition of the output which is water pump to turn and off within set timer with the help of microcontroller that integrated with Wi-Fi module and IOT cloud server. The project also included with water level sensor as a safety feature for water pump.

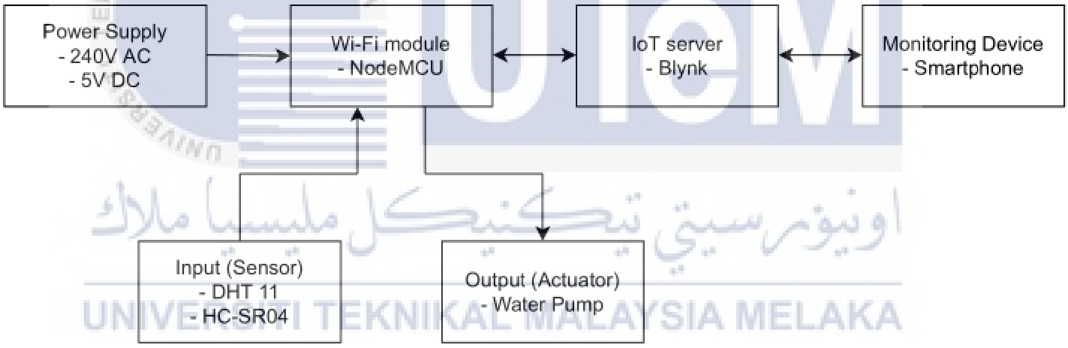


**Figure 3-11: Block diagram of System**

## 3.9 Circuit Design

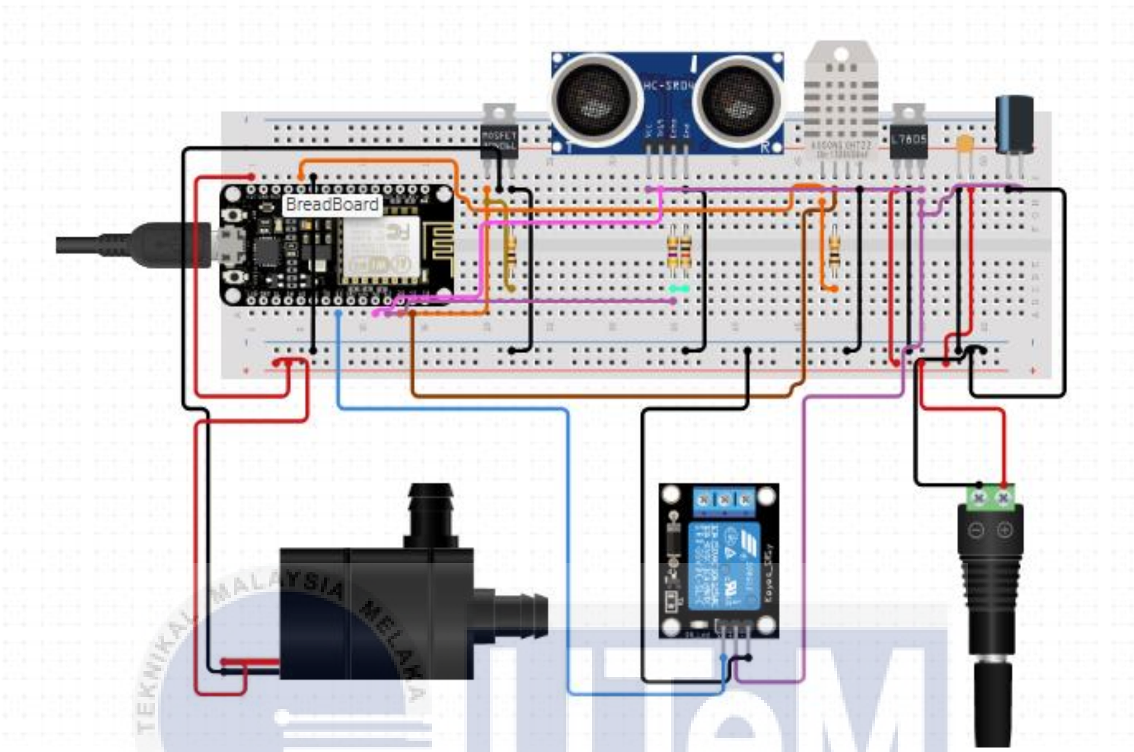


Figure 3-12: Circuit Design

## 3.10 Conclusion



To conclude this chapter, the process flow of this system can be seen clearly with the development of hardware and software to be used in creating this project. The phases of project able to help provide more understanding of the overview of the flow process of the system before deciding to proceed with the circuit installation and software programming. For construction and installation of circuit and its software programming, simulation circuit should help providing the confirmation on how the configuration of the devices communicating on each other. Additionally, the IOT that required in this project should give more understanding and easiness to the users in handling the process flow of the system efficiently.

# CHAPTER 4

# RESULT AND DISCUSSION

This chapter explains on the outcomes in reaching the objectives of the project based on the prototype of circuit that had been constructed aligned with the construction of base for the project to be initialized. The results are shown based on the graph that were observed and analyzed thoroughly aligned in reaching the objectives of the project according to the parameters involved.

## 4.1 Results and Discussion

### 4.1.1 Project Prototype and Application

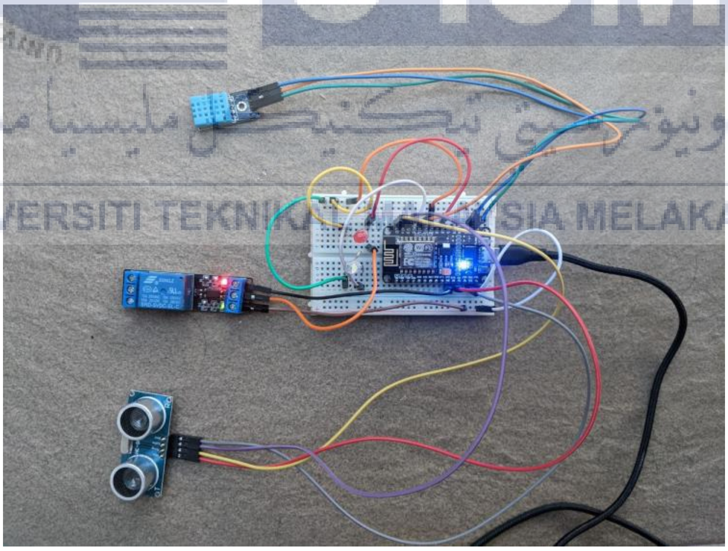

**Figure 4-1: Circuit on Breadboard**

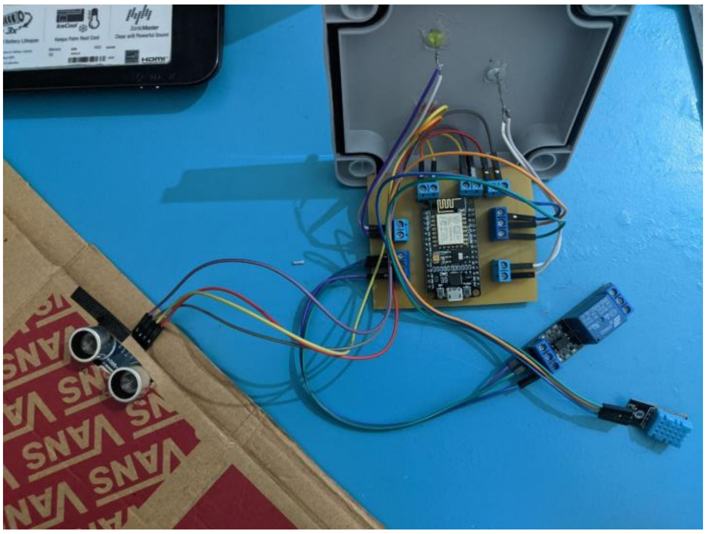

**Figure 4-2: Circuit on PCB Board**



**Figure 4-3: Prototype**

**Figure 4-4: Mini Mushroom House**

The figures above give detailed overview on the construction and testing of the circuit. The circuit design was first constructed on a breadboard to test their functionality before proceeding to the next step which is PCB circuit design. In testing process, these two sensors which are DHT 11 and HC-SR04 were checked and monitored on both Blynk application. The relay for the water pump were also observed on its supply from AC and its signal to DC supply to be configured in NodeMCU. Afterwards, the circuit were implemented in PCB board by etching process. The components involved were soldered based on their connections to the PCB board and testing process were done again so that there was no error during analyzing process. The complete circuit on PCB were placed in PVC casing with additional LED as the indicator for condition of the pump, the status of manual and automatic mode and the status of the timer.


**Figure 4-5: Project Layout from Blynk**



From the figure above, the completed layout from Blynk application determined the whole process of this project which including the input and output of these process. This type of innovation allows the user the easiness in controlling and monitoring the process around the mushroom house by the presence of IoT on a smartphone. Each widget in this application have their own characteristics and functions in relation to the coding that were constructed for this project. The controlling process of manual and automatic mode, the timer mode and the pump status were assigned in button widget. The value for temperature and humidity were monitored in gauge widget while the water level is monitored in virtual led indicator widget based on three level which are high, medium, and low. Moreover, the setting for temperature and humidity can be varied by the user from this application using level widget. There was addition of notification widget from the Blynk application which helps in notify the status of pump and the manual and automatic mode. The start and stop process for timer also were indicated in notification widget. The important part in this layout from the application were the use of timer widget which allow user to set the time for the process to start and stop automatically.

### 4.1.2 Control System Operations

| | Water Pump | Timer |
|---|---|---|
| Temperature > $30^{o}$C | ON | |
| Humidity < 60 | ON | |
| Temperature < $30^{o}$C & Humidity > 60 | OFF | Set from 12.00 am to 5.00 pm |
| Water level high | ON | |
| Water level medium | ON | |
| Water level low | OFF | |

**Table 4-1: System Operation**

### 4.1.3 Temperature and Humidity Monitoring Without Factors

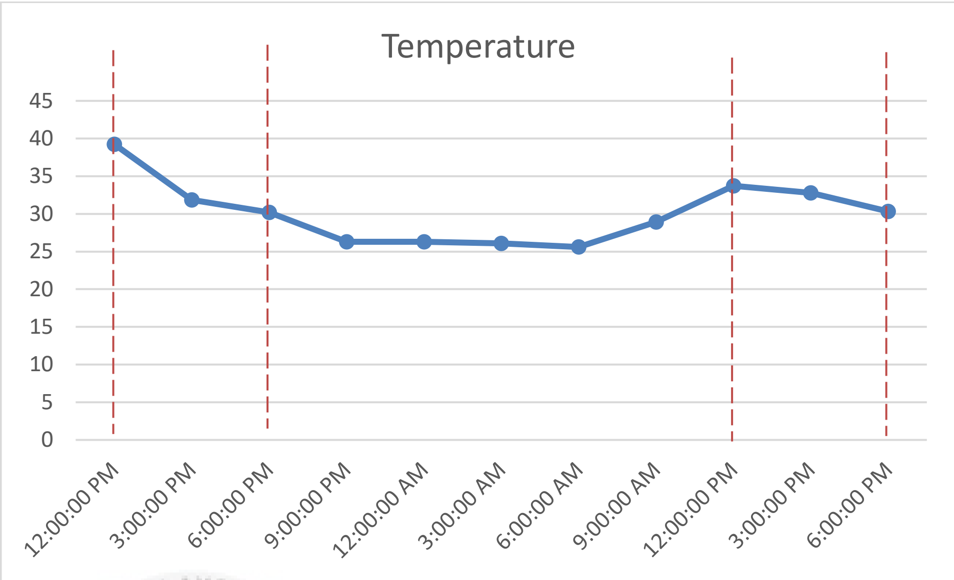


**Figure 4-6: Temperature Monitoring**

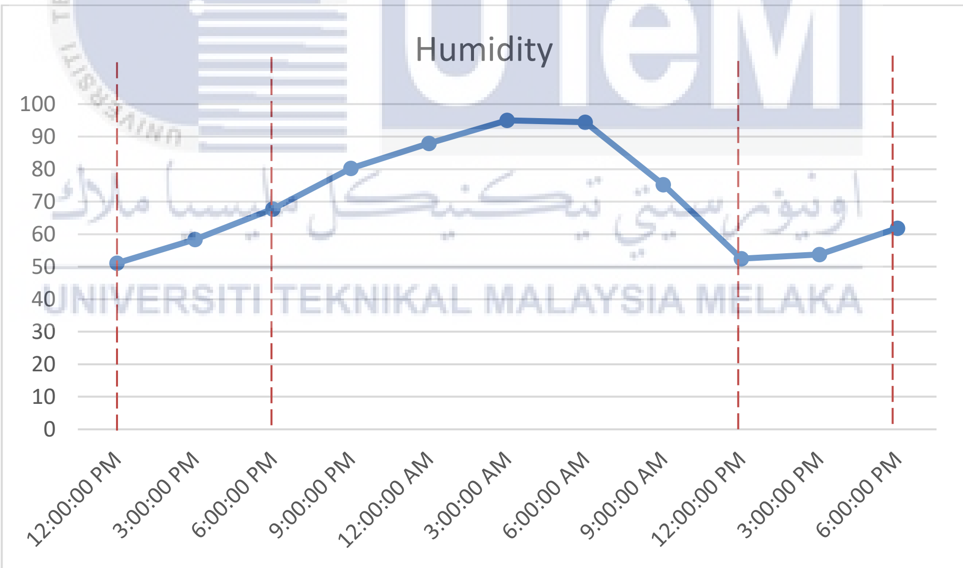




**Figure 4-7: Humidity Monitoring**

The figure above shows the analysis and observation of temperature and humidity in the mushroom house. The analysis was evaluated in graph context. Specifically, the widget of Superchart from Blynk application helps in visualize live and historical data for temperature and humidity in the mushroom house. Essentially, the data analysis of temperature and humidity from the Blynk were converted to Excel file to be visualized in this report. The figure above shows the data of temperature and humidity that were monitored for two days. In important context, these two whole days of data were taken without the use of factors likewise water pump, the number of splitters from the misting spray and the size of the cooling pad. The data were taken in three hours gap for each point of data. The data from temperature monitoring shows the highest point of temperature which is at 39.23$^0$C on 12.00 pm. The temperature starts dropping to 31.84$^0$C on 3.00 pm and continue to drop slightly until 6.00 pm on the value of 30.21$^0$C. After 6.00 pm, the temperature continues to drop until lowest point value of temperature which is 25.6$^0$C on 6.00 am in the morning. Then from 6.00 am to 9.00 am shows significant rise to the value of 28.92$^0$C. After that, the temperature rises to 33.73$^0$C on 12.00 pm and subsequently dropped again to 30.31$^0$C on 6.00 pm.

The data from humidity monitoring shows the lowest point of humidity which is at 51.08 % on 12.00 pm. The humidity start rising to 58.43% on 3.00 pm and continue rising to 67.76% on 6.00 pm. After 6.00 pm, the humidity continues to rise until the highest point of humidity which is 94.46% on 6.00 am in the morning. Then, from 6.00 am to 9.00 am, the humidity value starts dropping to 75.45%. After that, the humidity value drops to 52.49% on 12.00 pm and subsequently rise again to 61.86% on 6.00 pm.

Therefore, from the overall analysis and result on the data of temperature and humidity, the value of temperature was inversely proportional to the value of humidity. In general, the higher the temperature, the lower the humidity. Furthermore, the critical value of temperature and humidity where the mushroom would be in worst growth performance were identified on between 12.00 pm until 6.00 pm. This analysis were strongly supported and proven from the research that were done by (Amri *et al.*, 2019).

### 4.1.4 Condition of Factors in Design of Experiment (DOE)

| Parameter \ Condition | 0 | 1 |
|---|---|---|
| Water Pump | 1800 L/h | 3000 L/h |
| Number of Dripper | 3 | 6 |
| Size of Cooling Pad | 1/2 ft x 1/2 ft | 1 ft x 1 ft |

**Table 4-2: Condition of Factors**

The figure above shows the condition of factors to be analyzed in the design of experiment. The factors included the flow rate of the water pump, the number of drippers from the water misting spray and the size of the cooling pad. From the water pump factors, it was analyzed based on the maximum flow rate of the water to the pump, so there were two water pump that have different maximum flow rate. From the perspective of the number of drippers in water misting spray, there were two different ways of construction of the number of drippers. The three drippers were constructed to the top center of the mushroom house while the six drippers to both top sides of the mushroom house. In terms the cooling pad, there were the two different size of the cooling pad that were constructed under the misting spray.

### 4.1.5 Design of Experiment (DOE)

| | Water Pump | Number of Dripper | Size of Cooling Pad |
|---|---|---|---|
| Run 1 | 0 | 0 | 0 |
| Run 2 | 0 | 0 | 1 |
| Run 3 | 0 | 1 | 0 |
| Run 4 | 0 | 1 | 1 |
| Run 5 | 1 | 0 | 0 |
| Run 6 | 1 | 0 | 1 |
| Run 7 | 1 | 1 | 0 |
| Run 8 | 1 | 1 | 1 |

**Table 4-3: Design of Experiment (DOE)**



In the design of experiment, the analysis was conducted in eight runs. Each run has different condition aligned to the condition of the factors involved in the analysis system. This analysis were done within the setting timer from 12.00 pm to 5.00 pm in determining the best run in reaching the optimum value for temperature and humidity for the mushroom house which is below $30^0$C and above 60% respectively (Amri *et al.*, 2019).

#### 4.1.5.1 Run 1

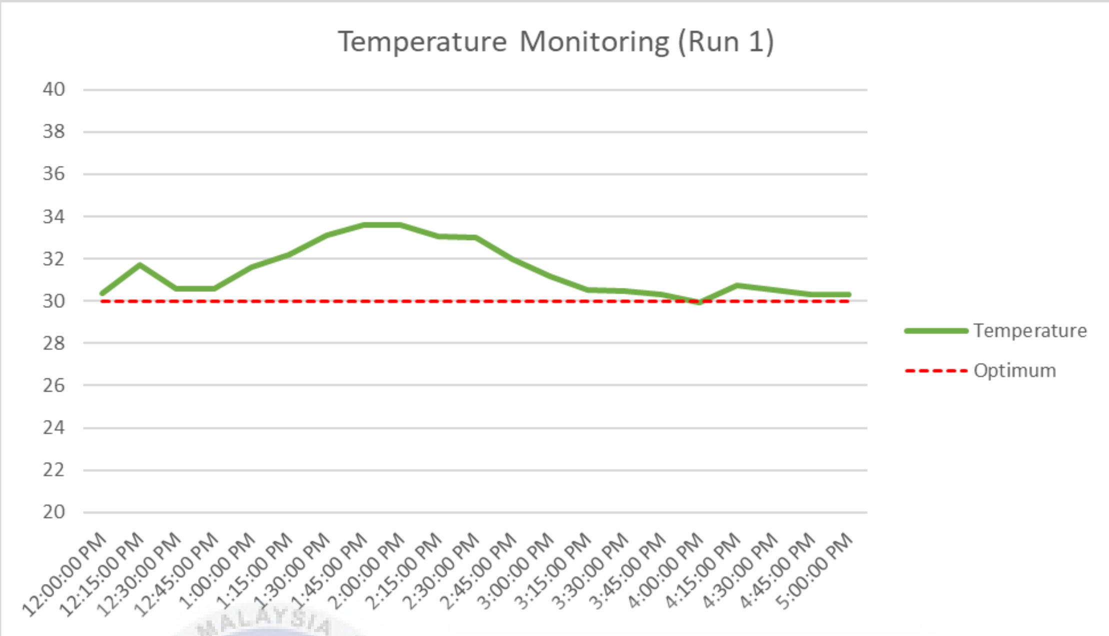


**Figure 4-8: Run 1 (Temperature)**

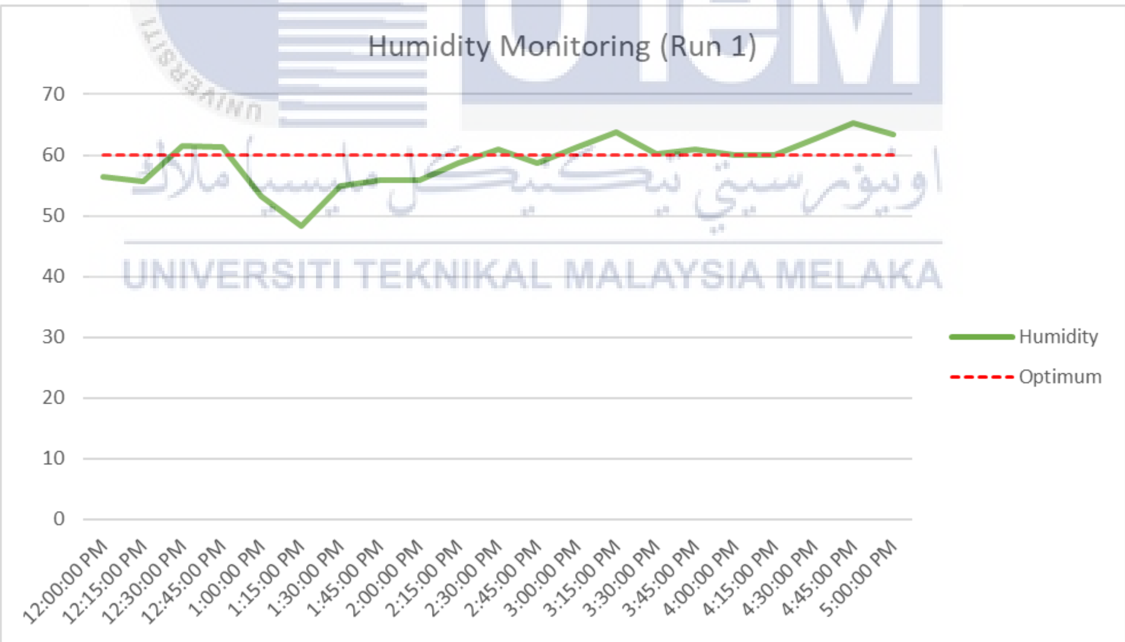




**Figure 4-9: Run 1 (Humidity)**

#### 4.1.5.2 Run 2

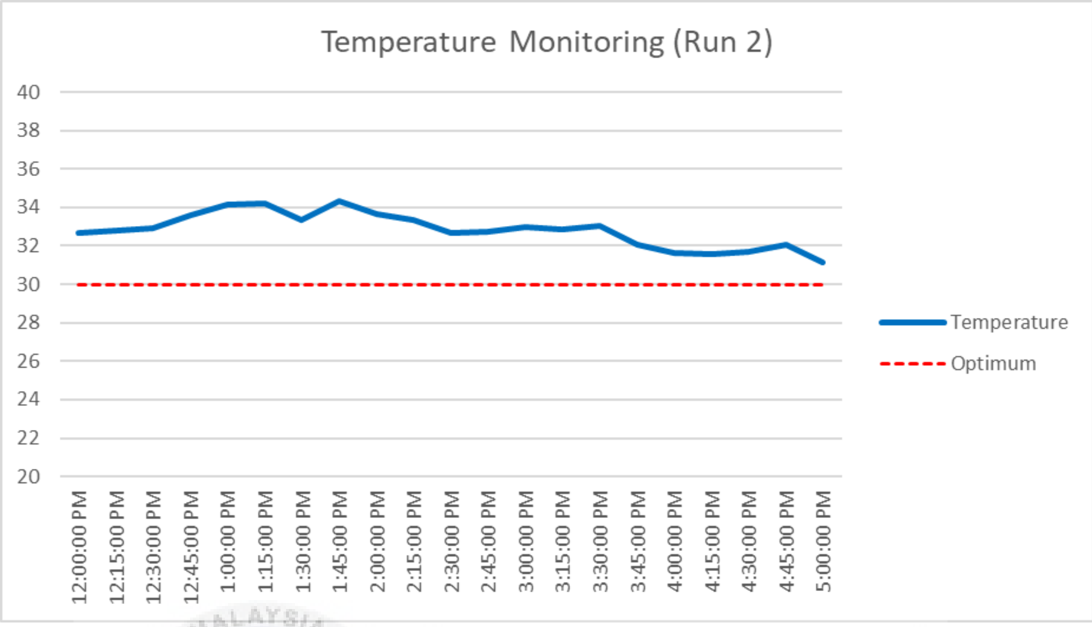


**Figure 4-10: Run 2 (Temperature)**

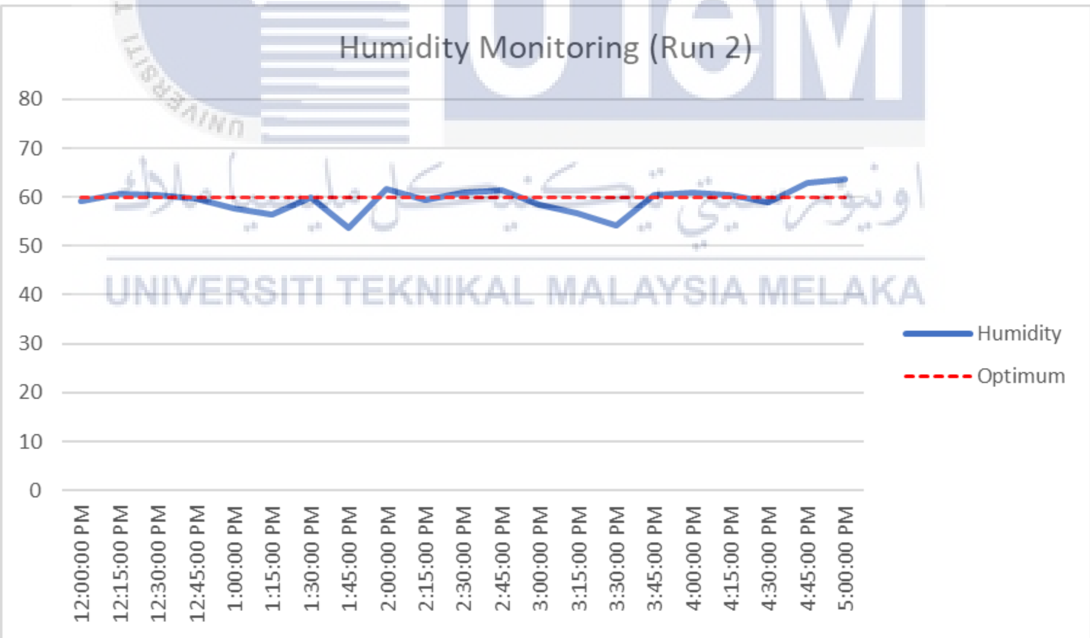


**Figure 4-11: Run 2 (Humidity)**

### 4.1.5.3 Run 3

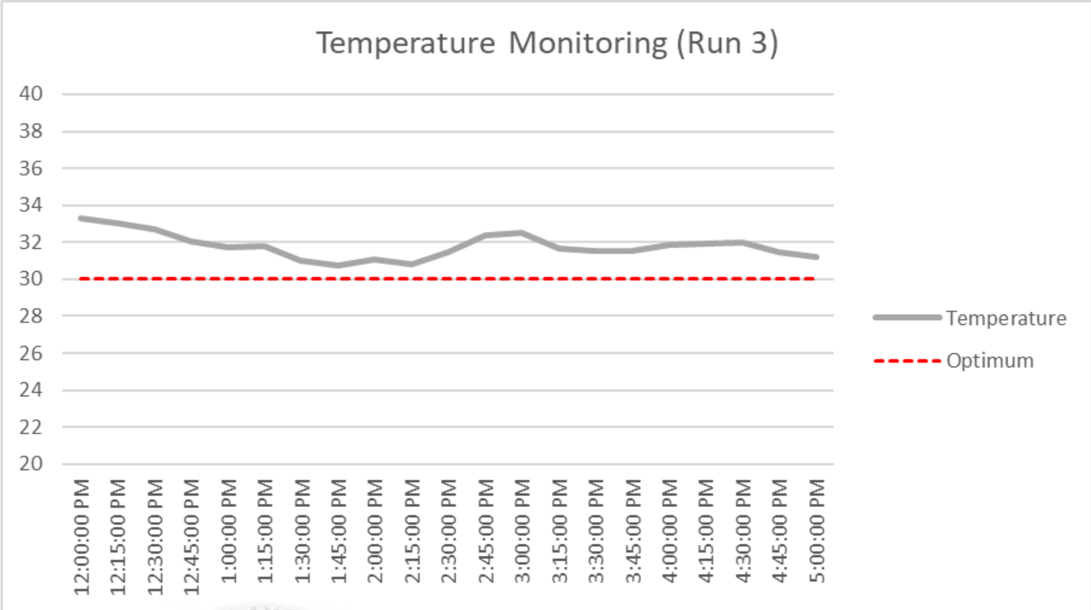


**Figure 4-12: Run 3 (Temperature)**

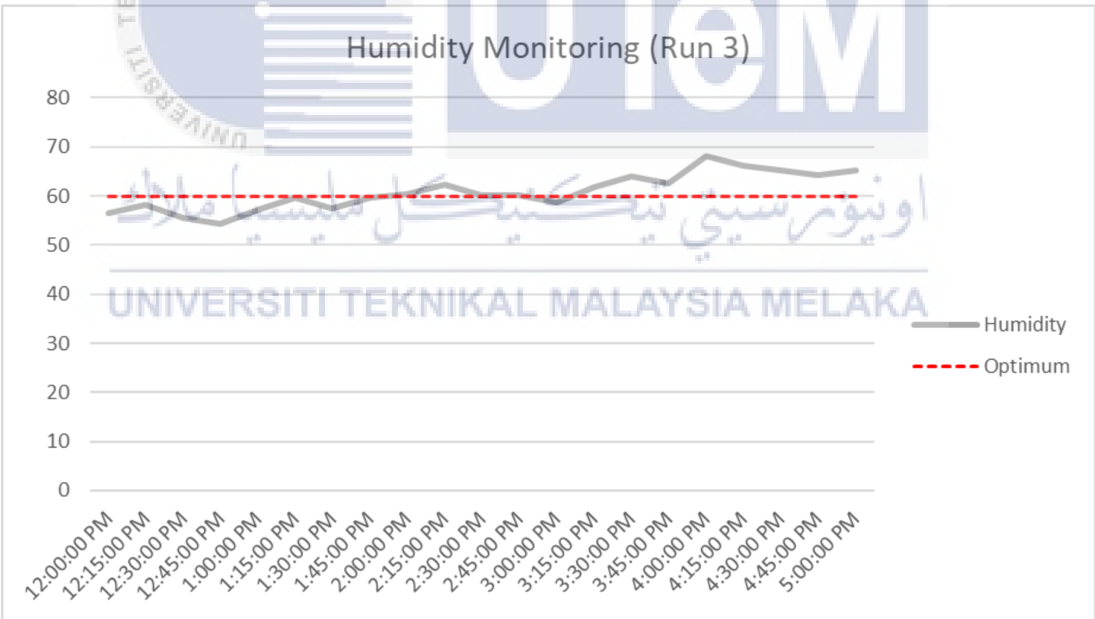




**Figure 4-13: Run 3 (Humidity)**

#### 4.1.5.4 Run 4

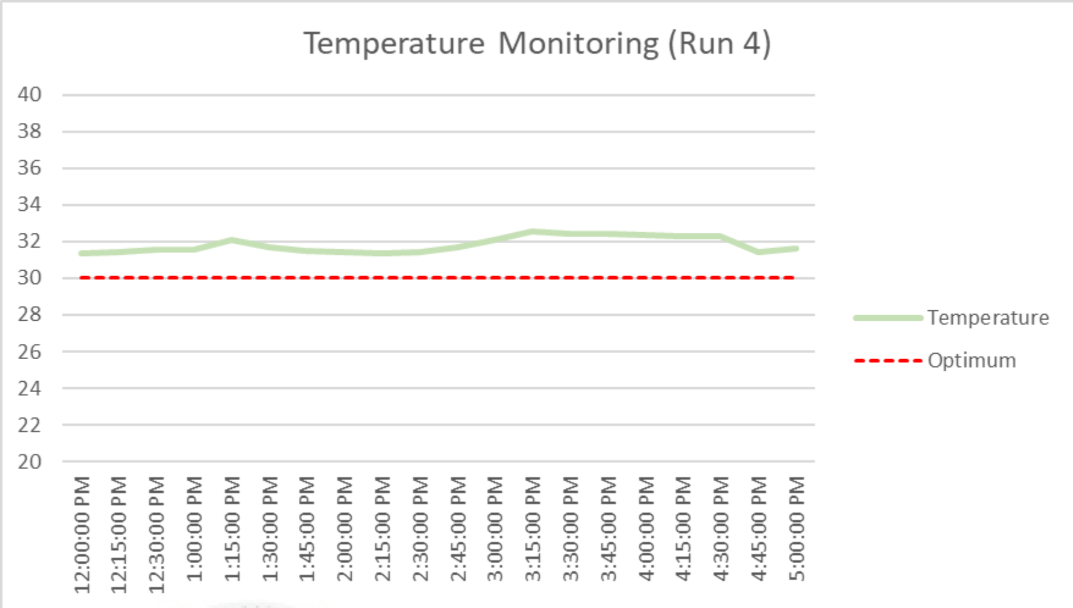


**Figure 4-14: Run 4 (Temperature)**

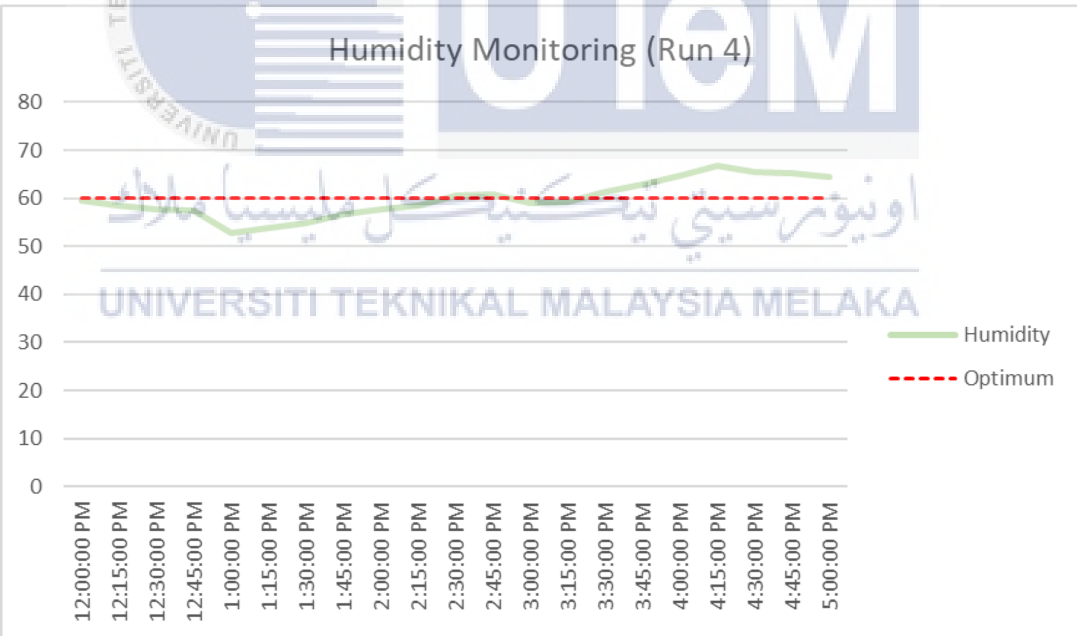




**Figure 4-15: Run 4 (Humidity)**

#### 4.1.5.5 Run 5

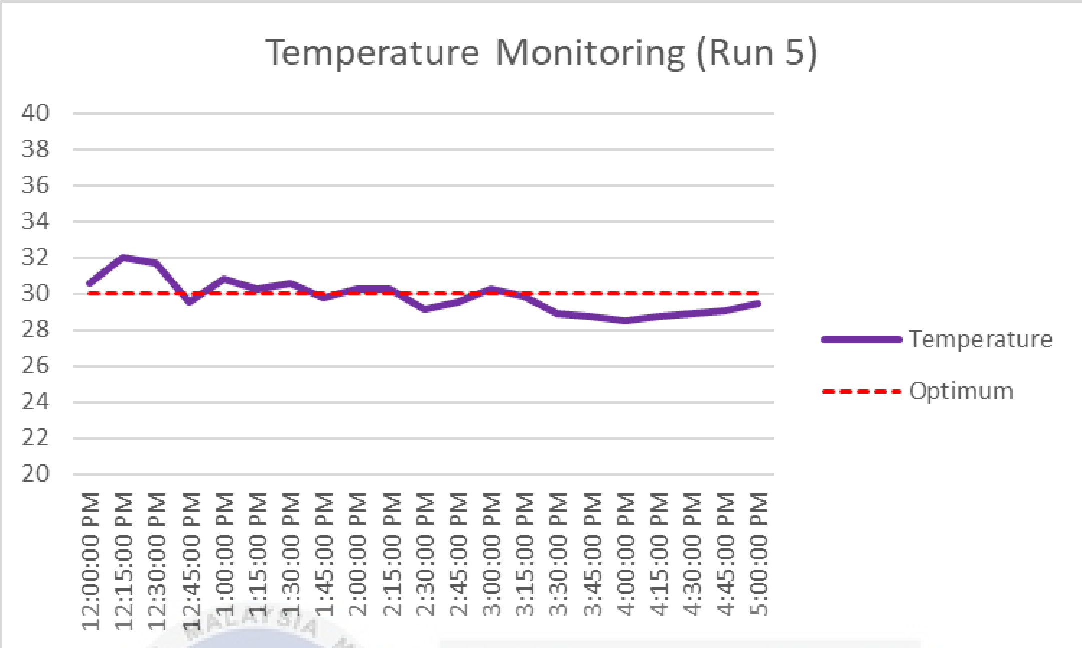


**Figure 4-16: Run 5 (Temperature)**

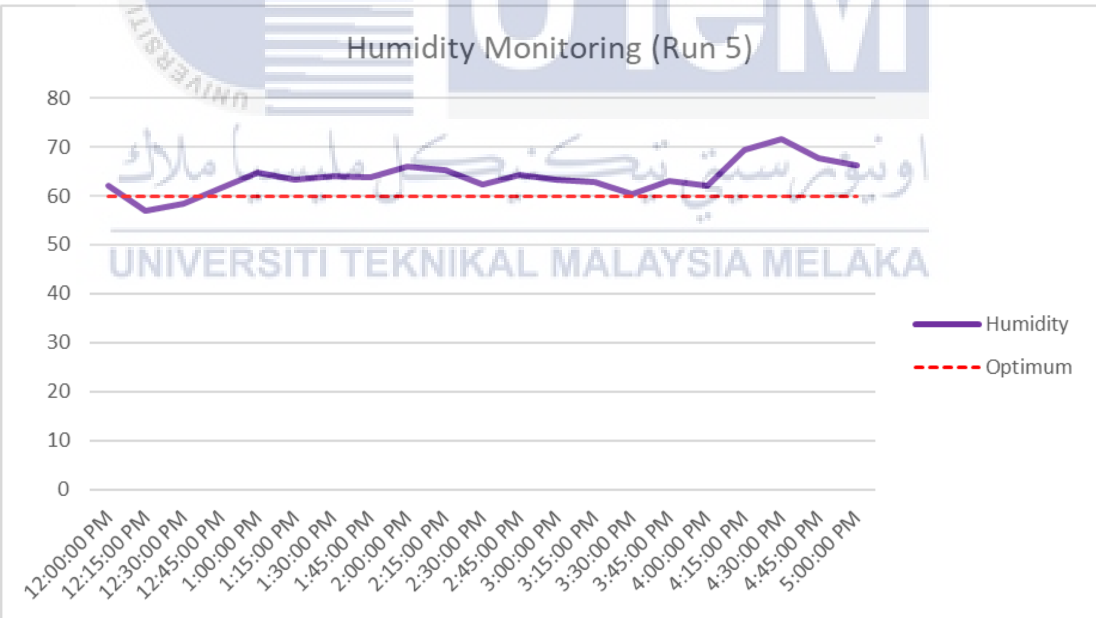




**Figure 4-17: Run 5 (Humidity)**

### 4.1.5.6 Run 6

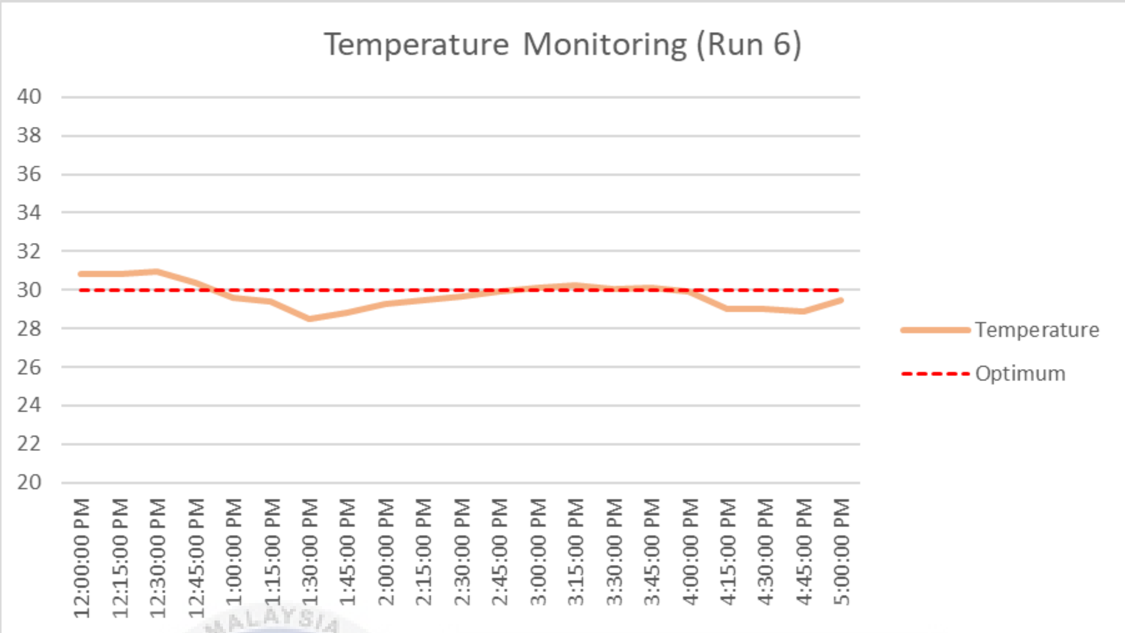


**Figure 4-18: Run 6 (Temperature)**

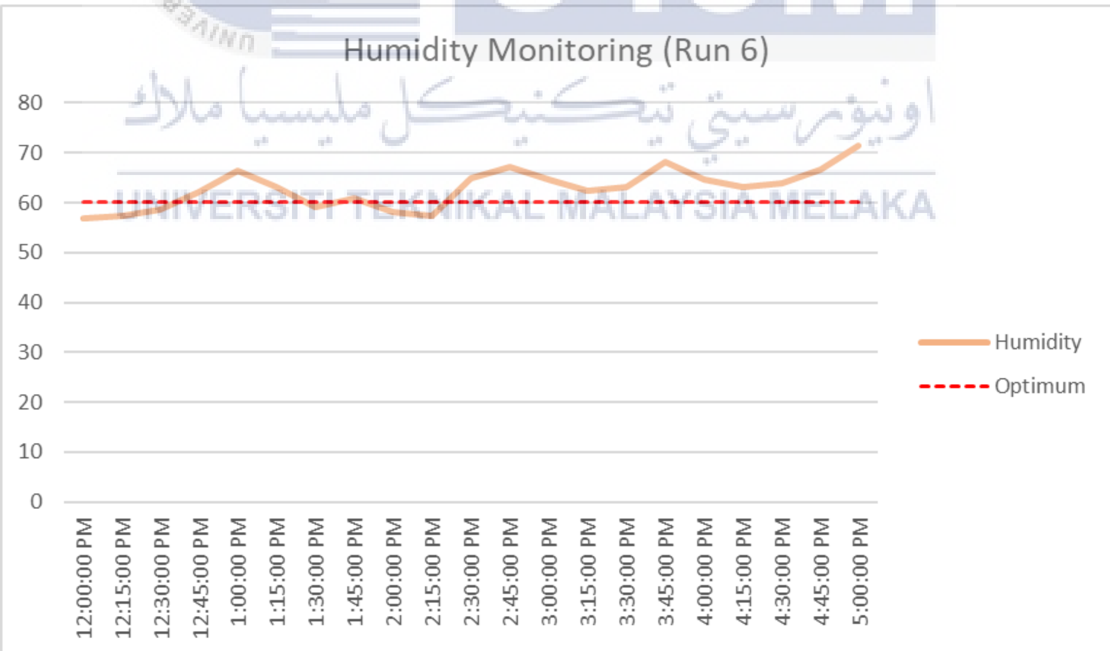


**Figure 4-19: Run 6 (Humidity)**

### 4.1.5.7 Run 7

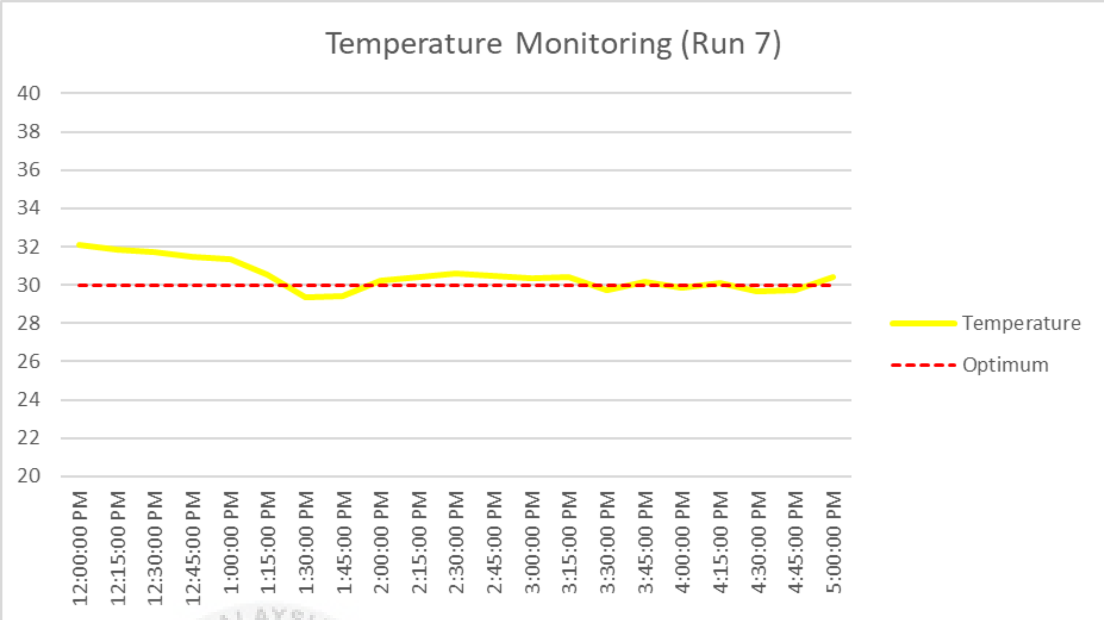


**Figure 4-20: Run 7 (Temperature)**

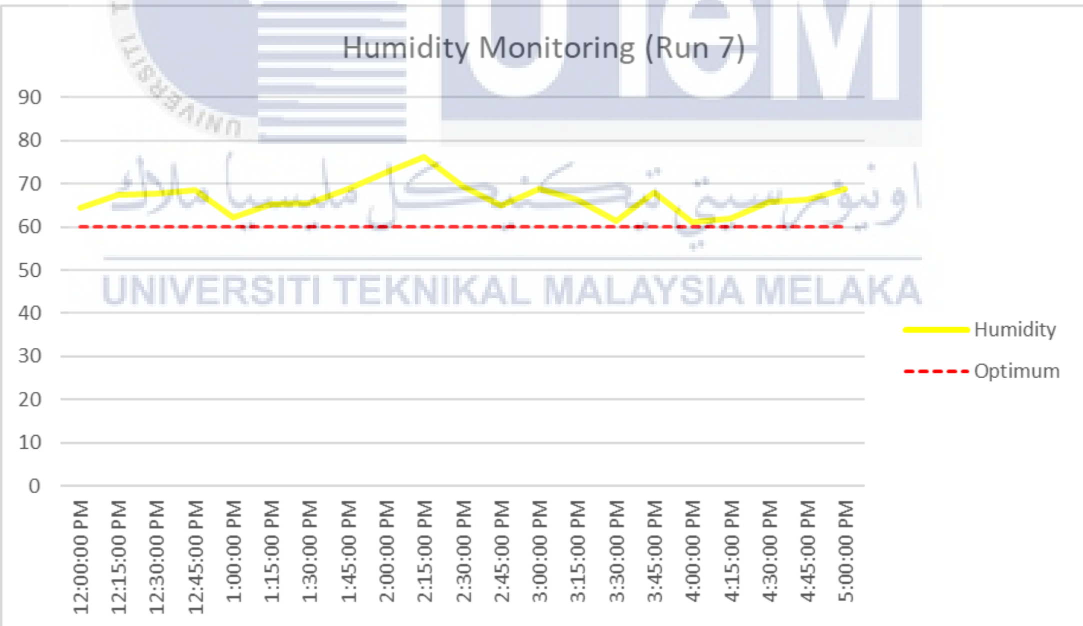




**Figure 4-21: Run 7 (Humidity)**

#### 4.1.5.8 Run 8

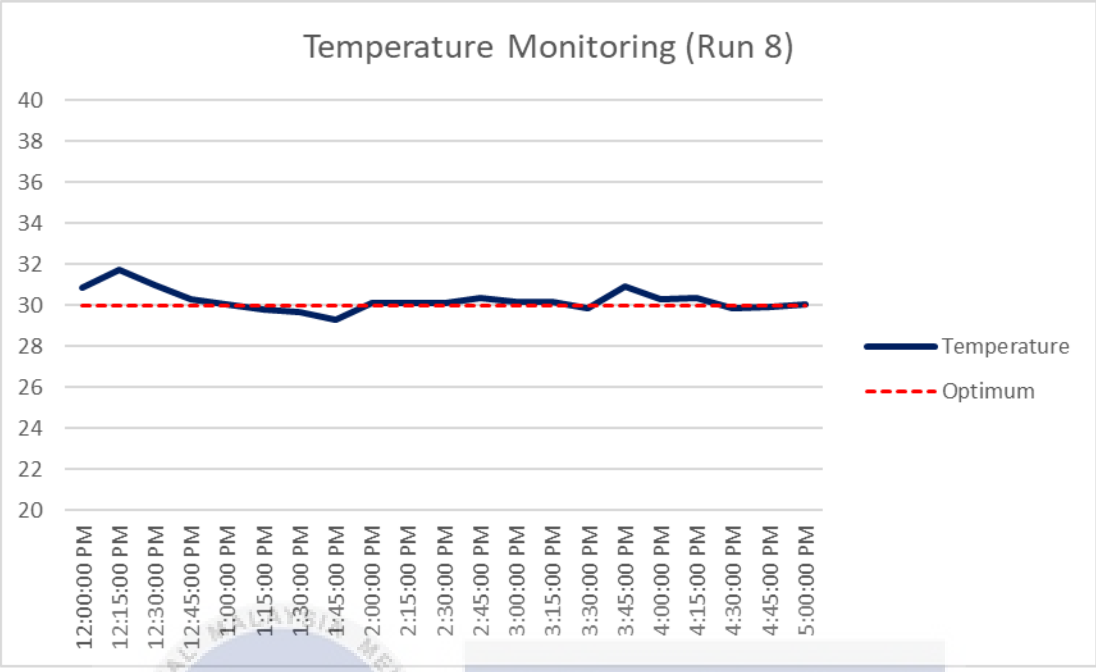


**Figure 4-22: Run 8 (Temperature)**



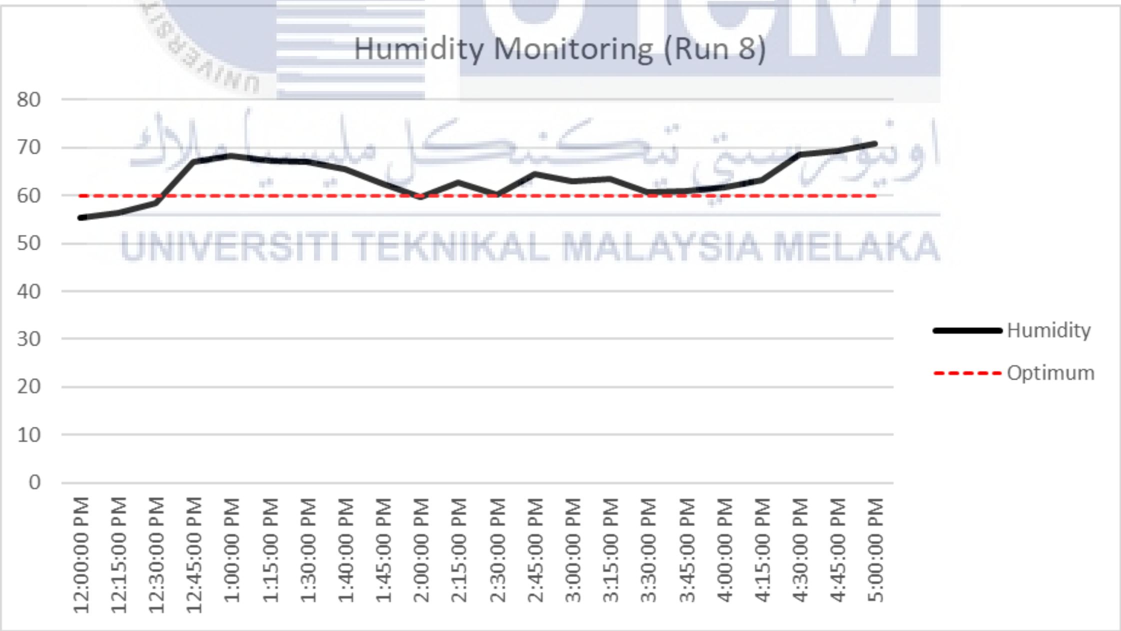


**Figure 4-23: Run 8 (Humidity)**

### 4.1.6 Evaluation and T-Test on Temperature and Humidity Performance

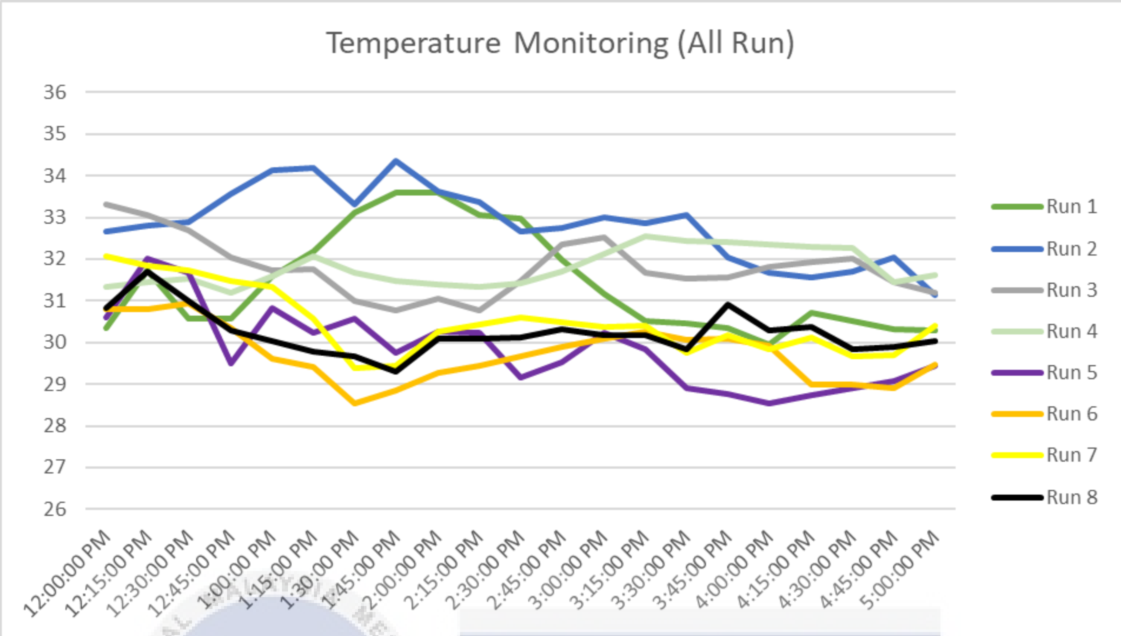


**Figure 4-24: Evaluation on Temperature Performance**

| | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | Run 7 | Run 8 |
|---|---|---|---|---|---|---|---|---|
| Min ($^0$C) | 30.29 | 31.13 | 30.77 | 31.33 | 28.54 | 28.52 | 29.38 | 29.31 |
| Average ($^0$C) | 31.41 | 32.83 | 31.79 | 31.80 | 29.84 | 29.73 | 30.48 | 30.22 |
| Max ($^0$C) | 33.60 | 34.35 | 33.30 | 32.56 | 32.01 | 30.93 | 32.06 | 31.70 |

**Table 4-4: Average Temperature for Each Run**

| | Run 1 | Run 6 |
|---|---|---|
| Min ($^0$C) | 30.29 | 28.52 |
| Average ($^0$C) | 31.41 | 29.73 |
| Max ($^0$C) | 33.6 | 30.93 |
| T-Test | 5.31215E-06 | |

**Table 4-5: T-Test Analysis on Temperature Performance**

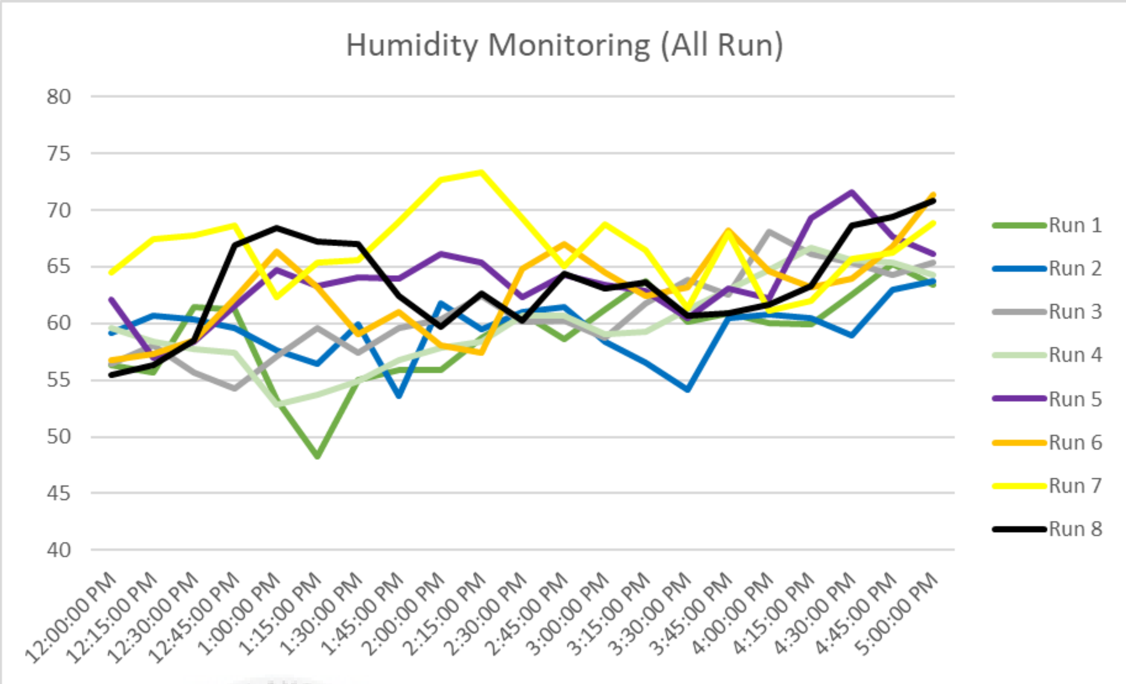


**Figure 4-25: Evaluation on Humidity Performance**

| | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | Run 7 | Run 8 |
|---|---|---|---|---|---|---|---|---|
| Min (%) | 48.27 | 53.6 | 54.27 | 52.84 | 56.92 | 56.77 | 61.34 | 55.47 |
| Average (%) | 58.98 | 59.40 | 60.82 | 59.90 | 63.79 | 62.86 | 66.63 | 63.40 |
| Max (%) | 65.29 | 63.73 | 66.11 | 66.67 | 71.56 | 71.31 | 73.31 | 70.83 |



**Table 4-6: Average Humidity for Each Run**

| | Run 1 | Run 6 |
|---|---|---|
| Min (%) | 48.27 | 56.77 |
| Average (%) | 58.98 | 62.86 |
| Max (%) | 65.29 | 71.31 |
| T-Test | 3.07682E-02 | |

**Table 4-7: T-Test Analysis on Humidity Performance**

From the analysis result and observation of each run from the Design of Experiment (DOE), run 1 until run 4 were observed as not able to maximise the system in reaching optimum level for temperature and humidity in terms of average performance whereas run 5 until run 8 were able to reach optimum level for temperature and humidity within the setting time. In terms of T-Test analysis, 95% of confidence level were used to determine the p-value. So, if p-value is lower than or equal to 0.05, there is a significant difference. From the observation and calculation of T-Test of run 1 and run 6, there were significant difference in terms of temperature and humidity performance for run 1 and run 6 because the p-value for temperature and humidity performance for both runs were lower than 0.05. In terms of temperature, the maximum temperature of $33.6^0$C were managed to drop to a minimum temperature of $28.52^0$C whereas in terms of humidity, the minimum humidity of 48.27% were managed to rise to a maximum humidity of 71.31%. So, from the condition of factors in Design of Experiment (DOE), the flow rate of pump proven to be the major factor in decreasing temperature and increasing humidity to reach the optimum level for both parameters which means that the bigger flow rate of submersible water pump was much better in helping to reach the optimum level for temperature and humidity which is below $30^0$C and above 60% respectively. The size of cooling pad and the number of drippers only brought minor differences to the performance of temperature and humidity. This can be proven as the drippers from the misting spray depends on the supply of water from the submersible water pump. So, from the observation of view, the lower flow rate of water pump cannot supply enough water to the drippers in misting spray to be splashed as evaporation water to the area of cooling pad which proven the worst performance of run 1 until run 4 which use the lower rate of water pump which is 1800L/h. In terms of the size of cooling pad, as stated before, it depends on the flow rate of water pump to bring major factor in reaching optimum level for temperature and humidity due to the presence of the cooling pad similar to the research from (Amri *et al.*, 2019) and the use of misting spray system.

### 4.1.7 Limitations

The research had several limitations. The results and analysis were taken and observed in most of the month of December. Most of the time during the month were in bad weather and rain which would subsequently disrupt the operation in the process of reaching the optimum level for temperature and humidity by the factors used. This can be proven due to the low temperature and high humidity that already caused by the presence of rain which shows that there would be no significant use of these factors. So, the operation for the analysis of the project need to be stop or cancel on the rainy day. Moreover, due to the presence of Covid-19, the restriction movement gave disadvantages of a frequent visit to actual mushroom house whether in the university or outside in terms of studying the growth of mushroom and the utilisation of the components involved in reaching the optimum level for temperature and humidity. The use of small storage tank for water limit the easiness and comfortability for user in handling the water pump. In terms of the growth of mushroom, the utilisation of cooling pad proven to reduce temperature and increase humidity but need to change the pad often to prevent the growth of fungal on mushroom. Furthermore, the cost for the bigger flowrate or wattage of the water pump to allow the misting spray to produce evaporated water limit the better functionality in providing better growth for mushroom.

## 4.2 Conclusion

To conclude this chapter, the result and observation were analysed in different runs within three factors in relation to reach the optimum level for temperature and humidity. The overview of this chapter provide understanding in terms of the control system operations involved due to the requirement in the Design of Experiment (DOE).

# CHAPTER 5

# CONCLUSION AND RECOMMENDATION

In this chapter, the overall project that were explained and observed through chapter 1 until 4 were concluded. The recommendation for this project would be explained related to the industry for future reference or to be applied in the next project.

## 5.1 Conclusion

From what can be concluded, the objectives for this project were achieved based on the result that were analysed and discussed. The first objective for this project that were achieved which is the IoT monitoring digital timer controller using IoT application. In details, the system for the project that involved digital timer monitoring included with the monitoring of temperature and humidity were able to be utilised and implemented in IoT application which is Blynk. Moreover, the safety features included in the project which is utilisation of ultrasonic sensor to protect water pump from damage caused from short of water also can function successfully and can be monitored from smartphone through Blynk. The manual and automatic mode for this project were able to be utilised according to the user demands. In the most important part, the availability setting of timers from Blynk application to allow the automatic mode to function within specific time were utilised successfully. Hence, for the second objectives, the monitoring and controlling of the temperature and humidity to the optimum level which are below $30^0$C and above 60% respectively able to be achieved by the observation from the results through Design of Experiment (DOE). It is proved by utilise the combination of three factors that included the water pump, the misting spray and the cooling pad, the significant decrease of temperature and increase of humidity able to be achieved to the optimum level for mushroom growth or cultivation.

## 5.2 Future Research and Recommendation

After various research and experiment conducted in reaching the objectives of the project, the evaluation of this project was conducted with one of the industry enterprises that expertise in mushroom cultivation, which is Sinar Syukrawi Enterprise. The man in charge, Encik Syukor that were very expertise in mushroom related industry evaluated and gives some recommendation on the improvement or for future research of this project. One of the future ideas or innovation that can be implemented is the utilisation and construction of the misting spray system in correct position. Due to the already constructed black net around the wall of mushroom house, the dripper from the misting spray can be allocated around the wall of mushroom house so that it can be splashed to reduce the temperature and humidity. The power in wattage and the flowrate of submersible water pump must be bigger so that the misting spray can produce evaporated water which can be proven from the analysis that were conducted in this project. In terms of water usage from the tank, the valve is recommended to fully innovate the system of water in the tank which means that if low water level is reached, the valve will open and helps to allow water to automatically fill the tank until reach high level and then close the valve to stop the water from flowing to the storage. From the observation conducted at Sinar Syukrawi Enterprise, a big size of container was used as the storage for water to be supplied to the mushroom house. One of the additions is the utilisation of aluminium foil bubble wrap. The bubble wrap can be installed on top of the roof of the mushroom house which will help in reducing the temperature, thus increasing the humidity.

## 5.3 Project Commercialization Potential

From the completion of the project and evaluation from mushroom industry, the system of this project can benefit the mushroom industry due to the innovation of IoT application which can help the user remotely control the system for the mushroom house by smartphone. The project has the potential to be commercialized as in generally, with the available setting of the timer from IoT application it can give awareness to the user about the condition of the mushroom house from a far distance.

## REFERENCES

1) Adhitya, R. Y. *et al.* (2017) 'Comparison methods of Fuzzy Logic Control and Feed Forward Neural Network in automatic operating temperature and humidity control system (Oyster Mushroom Farm House) using microcontroller', in *2016 International Symposium on Electronics and Smart Devices, ISESD 2016*. doi: 10.1109/ISESD.2016.7886713.

2) Amri, M. S. *et al.* (2019) 'An effective automated control system for low temperature and high humidity mushroom house', *ARPN Journal of Engineering and Applied Sciences*.

3) Bounnady, K. *et al.* (2019) 'Smart crop cultivation monitoring system by using IoT', in *Proceeding - 5th International Conference on Engineering, Applied Sciences and Technology, ICEAST 2019*. doi: 10.1109/ICEAST.2019.8802584.

4) Chieochan, O., Saokaew, A. and Boonchieng, E. (2017) 'IOT for smart farm: A case study of the Lingzhi mushroom farm at Maejo University', in *Proceedings of the 2017 14th International Joint Conference on Computer Science and Software Engineering, JCSSE 2017*. Institute of Electrical and Electronics Engineers Inc. doi: 10.1109/JCSSE.2017.8025904.

5) Fuady, G. M. *et al.* (2017) 'Extreme learning machine and back propagation neural network comparison for temperature and humidity control of oyster mushroom based on microcontroller', in *2017 International Symposium on Electronics and Smart Devices, ISESD 2017*. doi: 10.1109/ISESD.2017.8253303.

6) Kaewwiset, T. and Yodkhad, P. (2017) 'Automatic temperature and humidity control system by using Fuzzy Logic algorithm for mushroom nursery', in *2nd Joint*

*International Conference on Digital Arts, Media and Technology 2017: Digital Economy for Sustainable Growth, ICDAMT 2017*. Institute of Electrical and Electronics Engineers Inc., pp. 396–399. doi: 10.1109/ICDAMT.2017.7905000.

7) Kamelia, L. *et al.* (2018) 'Implementation of Automation System for Humidity Monitoring and Irrigation System', in *IOP Conference Series: Materials Science and Engineering*. doi: 10.1088/1757-899X/288/1/012092.

8) Marzuki, A. and Ying, S. Y. (2017) 'Environmental Monitoring and Controlling System for Mushroom Farm with Online Interface', *International Journal of Computer Science and Information Technology*. doi: 10.5121/ijcsit.2017.9402.

9) Primisima, I., Sudiro, S. A. and Wardijono, B. A. (2016) 'Automatic plant watering controller component using FPGA device', in *ICACSIS 2015 - 2015 International Conference on Advanced Computer Science and Information Systems, Proceedings*. Institute of Electrical and Electronics Engineers Inc., pp. 43–49. doi: 10.1109/ICACSIS.2015.7415167.

10) Rohadi, E. *et al.* (2018) 'Raspberry Pi-Based Farming Automation and Monitoring System using Automatic Weather System (AWS) (Case Study: Chili Plants)', *International Journal of Engineering & Technology*, 7(4.44), p. 172. doi: 10.14419/ijet.v7i4.44.26977.

11) Singh, P. and Saikia, S. (2017) 'Arduino-based smart irrigation using water flow sensor, soil moisture sensor, temperature sensor and ESP8266 WiFi module', in *IEEE Region 10 Humanitarian Technology Conference 2016, R10-HTC 2016 - Proceedings*. doi: 10.1109/R10-HTC.2016.7906792.

12) Sri Heera, S. *et al.* (2019) 'Automated irrigation and smart farming', *International Journal of Engineering and Advanced Technology*. doi:

10.35940/ijeat.F1258.0986S319.

13) Subedi, A. *et al.* (2020) 'IoT Based Monitoring System for White Button Mushroom Farming', in. MDPI AG, p. 6545. doi: 10.3390/ecsa-6-06545.

14) Wiangtong, T. and Sirisuk, P. (2018) 'IoT-based Versatile Platform for Precision Farming', in *ISCIT 2018 - 18th International Symposium on Communication and Information Technology*. doi: 10.1109/ISCIT.2018.8587989.

15) Zulkifli, C. Z. and Noor, N. N. (2017) 'Wireless sensor network and internet of things (IoT) solution in agriculture', *Pertanika Journal of Science and Technology*.

# APPENDIX

## Appendix 1 Gantt Chart for PSM 1

| Project Activity | WEEK | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Discussion with supervisor | PSM 1 BRIEFING | ■ | ■ | ■ | ■ | ■ | | | | | | ■ | ■ | ■ | |
| Project background | | | ■ | ■ | | | | | | | | | | | |
| Literature reviews | | | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | | | | |
| Methodology | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| Progression Report | | | | | | ■ | | | | | | ■ | | | |
| Submission report and Turnitin | | | | | | | | | | | | | | ■ | |
| Project presentation | | | | | | | | | | | | | | | ■ |

**Appendix 2 Gantt Chart for PSM 2**

| Project Activity | WEEK | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Discussion with supervisor | PSM 2 BRIEFING | ■ | ■ | | ■ | ■ | | | | | | ■ | ■ | | |
| Project components purchase | | | ■ | ■ | | | | | | | | | | | |
| Testing circuit | | | | | | ■ | ■ | | | | | | | | |
| Pcb circuit construct | | | | | | | | ■ | | | | | | | |
| Analysis | | | | | | | | | ■ | ■ | ■ | | | | |
| Progress and draft submission report | | | | | | ■ | | | | | | ■ | ■ | | |
| Video presentation | | | | | | | | | | | | | ■ | | |
| Live Q&A from panel | | | | | | | | | | | | | | ■ | |

## Appendix 3 Site Visit to Sinar Syukrawi Enterprise