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# DEVELOPMENT OF SMART SYSTEM FOR AGRICULTURE

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Thesis submitted in fulfillment of the requirements
for the award of the degree of
BACHELOR OF ENGINEERING TECHNOLOGY (ELECTRICAL) WITH HONORS

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## ABSTRAK

Pertanian adalah amalan memupuk tumbuhan dan ternakan. Untuk membuat pertanian yang mampan, sistem ini dicadangkan. Dalam sistem ini Wi-Fi, HC12 (RF) dan Modul RTC DS3231 digunakan untuk mengawal dan memantau sistem pengairan. Sistem ini menyediakan mudah digunakan untuk menghidupkan dan mematikan injap solenoid. Terdapat dua jenis injap solenoid ON / OFF, pertama adalah Hidupkan dan dimatikan secara tetap maka ia mempunyai pemasa hidup / mati untuk 5, 7 dan 10 minit. Pengairan Auto juga telah diintegrasikan ke sistem; Sistem akan menghidupkan injap pada pukul 8 pagi dan 5 petang selama 10 minit setiap hari. Terdapat 4 sensor kelembapan tanah yang digunakan dalam prototaip ini. Semua sensor boleh dipantau melalui papan pemuka IOT. Data dari sensor akan dihantar ke mikrokontroler maka data akan dipindahkan ke papan pemuka IOT dan kad SD untuk penjejakan data luar talian. Papan pemuka IOT juga boleh menganalisis dan melihat data yang dikumpulkan dalam bentuk graf, untuk pemahaman yang lebih baik. Data ini boleh meningkatkan pengeluaran.

## ABSTRACT

Agriculture is the practice of cultivating plants and livestock. To make the sustainable agriculture, this system is proposed. In this system Wi-Fi, HC12 (RF) and RTC Module DS3231 is used to control and monitor the irrigation system. This system provide easy to use for turn on and turn off solenoid valve. There are two types of on/off solenoid valve, first is regular turn on and off then it has timer on/off for 5, 7 and 10 minutes. Auto irrigation also has been integrated to the system; system will turn on valve at 8am and 5pm for 10 minutes every day. There are 4 soil moisture sensor are used in this prototype. All the sensor can be monitor through the IOT Dashboard. The data from the sensor will be sending to the microcontroller then the data will be transfer to the IOT Dashboard and SD Card for offline data tracking. The IOT Dashboard can also analyze and view the collected data in the form of graphs, for better understanding. These data can improve the production.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background Study

The Internet of Things (IoT) is gaining traction in almost every sector, including banking, industry, consumer electronics, automotive, and many others. In today's world, everything is linked to everything else in some way. From our offices, we can monitor the lights and appliances in our homes. Activities in industries and other fields are monitored and observed from distance. Controlling street lights from distance, using a smart food order system, and so on are no longer ideas. Gone are the days when monitoring and control required the presence of an individual on the scene.

Technology has advanced to the point that you can do almost everything from the comfort of your own home or office cubicle. The Internet of Things (IoT) plays a significant role in this. The Internet of Things (IoT) links various objects such as sensors, actuators, electronics, and network connectivity to enable them to exchange data and stay connected (ShilpaDevalal&A.Karthikeyan, 2018). In agriculture, an example of loT technology implementation is a greenhouse production environment controlling and monitoring device. In the agriculture manufacturing system, critical temperature, humidity, and soil signals are collected in real time and transmitted through wireless networks via an M2M (machine to machine) support platform. The art and science of cultivating soil, growing crops, and raising livestock is known as agriculture. It necessitates the processing and distribution of human-grade plant and animal products. Agriculture produces the bulk of the world's food and textiles. Agricultural products include cotton, wool, and leather. (JI- chun Zhao & Jun-feng Zhang & Jian-Xin Guo, 2010).

Due to climate change the rainy and dry season it makes extremely difficult to store and utilize water resources effectively. In agriculture sector smart irrigation is demand because of the irrigation water distribution mostly run manually which it hard to calculate accurate losses. (Licensee MDPI, 2017). This problem will lead to the crop losses and poor product in agriculture. Smart irrigation system in agriculture can give ability to monitor the irrigation to the crops and automated irrigation systems that keep provide crops water also utilize water resources effectively. This smart irrigation system is designed with a few major elements. First is sensor that communicates with system collect soil moisture of crops. Next is data transfer to the IOT dashboard and SD card, both of these method will go through microcontroller then it will go the IOT database wirelessly and will be stored in the SD card. Lastly is IOT dashboard ( CayenneMyDevices), this IOT dashboard is a web base application that give user ability to control and monitor anywhere that have internet connection. All the reading of sensor can be access and download by user. If there is no internet connection that connects to the microcontroller the data can be access through SD card. IOT dashboard can be custom the template to make user easy to use and friendly use. A prototype smart irrigation system have been developed to collect data required using IOT dashboard and analyze the data

## 1.2 Problem Statement

Risk in the agricultural sector is caused by a variety of factors, including natural, biological, climatic, and input and production prices, all of which have negative consequences (Agwe, Fissha, Nair, & Larson, 2009; AIT/UNEP, 2011; Jain & M, 2006). Climate change is one of the most significant threats to agricultural extension programs, affecting farms and farmers in a variety of ways. Climate change effects, according to Mulder (2017), should not be overlooked in the pursuit of sustainable growth. Extension service providers, on the other hand, are not yet professionally trained and prepared to assist farmers in managing agricultural risks through immediate and low-cost solutions (Ali, Man, Abd Latif, Muharam, &Zobidah Omar, 2018). Rising temperatures, irregular weather patterns, increased intensity of droughts, floods, and cyclones have all been evidence of climatic change, resulting in massive losses in agricultural production and livestock populations (Jain & M, 2006). These events will have a low quality of crop production as a sequence. Agriculture is the world's greatest consumer of freshwater, and irrigation practices can be environmentally, economically, and socially unsustainable, squandering water, energy, and money, drying up rivers and lakes, lowering crop yields, damaging fish and animals, and polluting water (Aberra, 2004). More food, profits, livelihoods, and ecological advantages must be produced at lower social and environmental costs to minimize the amount of water consumed. Water management should therefore balance the need for water for agriculture and the need for a sustainable environment (Bin Abdullah, 2006). Consequently, irrigation must be closely linked with water-use efficiency to boost productivity and improve food quality, especially in those areas where problems of water shortages or collection and delivery are widespread (García- Tejero, Durán-Zuazo, Muriel-Fernández, & Rodríguez-Pleguezuelo, 2011).

## 1.3 Research Objective

This project has objectives as follows:

1. To test the proposed methods in real environment.
2. Develop irrigation system using solar energy
3. To integrate smart irrigation system using Wi-Fi and RF communication system
4. To design and develop the GUI for data visualization.

## 1.4 Research Scope

LPWAN system for agriculture will be test at the pre-nursery at FTKEE. The test site will have the width of 0.7 hectares. Besides that, this LPWAN system for agriculture will also be test on 99,000 seed that have been planted on the site. There are also water tank with 2.4m of length and 7.8m of width will be connect to the agriculture machine. Frequency band will be use for LPWAN in range of 920-925 MHz. The distance of the office that will be use monitor all the sensors is about around 2KM so we will use gateway that can reach up to 2KM. For the local network to control the solenoid valve, we will install router. This router will connect to the microcontroller to able to control the solenoid valve. This router also needs to reach up to 300m range.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Discuss the wireless sensor networks have recently been used in a variety of applications, including agriculture data collection, industrial control, logistics management, and meteorological monitoring. In agriculture, the deployment of IoT devices, wireless sensors, and sensor networks can be extremely beneficial in terms of monitoring the environment and growing crops but having a network to support those devices is needed to make the most of those tools (Yoo et al., 2007).Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you. Wi-Fi is one of the wireless sensors that had been widely used in the industrial sectors. Wi-Fi was defined as the wireless technology used to connect electrical devices such as computers and televisions to the internet (Al-Alawi & Ismail, 2006). This chapter discussed more on Wi-Fi technology and its advantages, smart irrigation system in agriculture, and benefits of smart irrigation system.

## 2.2 Development of Smart Agriculture System

The Smart Agriculture system was referred to as an Internet of Things-based technology that could automate the irrigation process by evaluating soil moisture and weather conditions. Smart irrigation technologies helped in saving water outdoors (Elijah, Rahman, Orikumhi, Leow, & Hindia, 2018). In agriculture, the IoT was used to provide farmers with decision-making tools and automation technologies that seamlessly combine products, knowledge, and services for increased production, quality, and profit. In comparison to standard automatic system timers, which irrigated on a userdetermined set schedule, smart irrigation controllers and sensors have been created to reduce outdoor water use by irrigating based on plant water needs (Zhao, Zhang, Feng, & Guo, 2010). There are several important technical elements to consider while deploying an IoT device. The range of communication distance, data throughput, battery life, mobility, latency, security and resilience, and cost of gateway modems should all be examined when considering wireless connectivity (García, Parra, Jimenez, Lloret, & Lorenz, 2020; Zhao et al., 2010)

## 2.3 Benefits of Smart Agriculture System

Agriculture can be benefits in so many different aspects. One of that is enables farmers to increase yields by using the least amount of resources possible, such as water, agricultural inputs, and seeds. Drones and robotics are used in smart agriculture to assist in a variety of ways. This facilitates data collection and aids in wireless tracking and control. Approaching smart irrigation systems has become a top priority to provide farmers with a smart tool that will assist them in producing high-quality crops. In the agriculture sector, smart irrigation has several advantages. The first benefit of a smart irrigation system in agriculture would be monitoring. Data includes the amount of rainfall, leaf wetness, temperature, humidity, soil moisture, salinity, climate, pest movement, and human activities to help understand the patterns and processes of the crops. The acquisition of such a complete record allows for optimal decision-making to improve the quality of agricultural output, reduce risk, and generate more revenue (Nawandar & Satpute, 2019). Furthermore, precise and timely weather forecasting data, such as climate changes and rainfall, may boost productivity. Such information can assist farmers in the planning stage and save labor costs (Chen, Xu, Liu, Hu, & Wang, 2014). When compared to employees physically evaluating the field using trucks or walking, the usage of IoT in agriculture will help save time and money when inspecting massive areas. The ability to use IoT to determine when and where pesticides or insecticides should be applied will save costs and waste (Asplund & Nadjm-Tehrani, 2016)

## 2.4 Challenges in Smart Agriculture

Farmers must understand and learn how to use technology in order to use smart farming equipment. Adopting smart agriculture farming on a wide scale across countries is a major challenge. The internet must be available at all times in order for smart agriculture to work. Many developed countries' rural areas do not meet these criteria. In addition, the internet connection is slower.

## 2.5 Wireless Sensor Network in Agriculture

Wireless Sensor Network (WSN) is defined by (Matin, 2012) as a self-configured and infrastructure-less wireless network that has been used in monitoring physical or environmental conditions, such as temperature, sound, vibration, pressure, motion, or pollutants. WSN is also being used to cooperatively pass their data through the network to the main location or sink where the data can be commemorated and evaluated. Wireless Sensor Networks are made up of sensors that are dispersed around an area to track and control it based on physical phenomena. Those small devices are called sensors (Vieira, Coelho, Da Silva, & Da Mata, 2003; Xijun, Limei, & Lizhong, 2009). Such operations can be carried out automatically using computing resources and suitable technology. We can make proper decisions for each zone in the farm using WSN in Precision agriculture. Unlike traditional networks, which assume that the user is a human agent, WSNs are focused on the physical world, particularly the data (Karl & Willig, 2005). For modern precision agriculture tracking, wireless sensor network technologies are increasingly being used. The benefits of a wireless sensor network in agriculture include high accuracy, increased production efficiency while lowering costs, low power consumption, and distributed data collection (Sahota, Kumar, Kamal, & Huang, 2010). Agriculture faces numerous challenges, and humanity's survival is dependent on agriculture and water, so precision agriculture monitoring is essential, and the demand for environmental monitoring and remote control in agriculture is rapidly increasing. There have been few studies on how WSN can be used in agriculture. Miranda used a closed-loop irrigation method with distributed soil water measurements to calculate irrigation amounts (Kim, Evans, & Iversen, 2008). For soil moisture data from data loggers to a central computer logging location, Shock used radio transmission (De Lima, E Silva, & Neto, 2010). Wall and King looked at prototypes for plugand-play smart soil moisture sensors and sprinkler valve controllers, as well as distributed sensor network architectures for site-specific irrigation automation (Xijun et al., 2009). Hyun-Joong Kang simulates the output of a sensor node in a greenhouse environment with low power activity, as well as the impact of crop growth when an inter-node contact point is blocked (Vieira et al., 2003).

## 2.6 Solenoid Valve Technologies

A solenoid is an electrical device that works on the principle of an electromagnet (i.e., a magnetic field is formed when an electric current is conducted through a wire or a coil). They are widely utilized as inexpensive and reliable switching components. An electromechanical device, a solenoid is used in a variety of industrial applications, including fluid power hydraulic systems, cylinder control, process control systems, and manufacturing departments. A solenoid's basic construction is depicted in Figure 2.1. The solenoid body is constructed out of a tightly wound coil made of copper or any other conducting alloy and insulated with mica. The plunger, which is formed of ferromagnetic material, is the free-moving portion of the solenoid. When electricity is fed through the coil, a magnetic field is created, and the right hand clasp rule can be used to determine the direction of the field. This magnetic field exerts a force on the ferromagnetic plunger, which pulls or pushes it in one direction or the other.

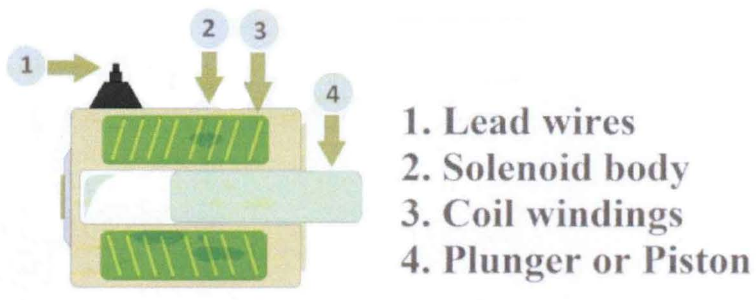


Figure 2.1 Architecture of a push type solenoid

## CHAPTER 3

## METHODOLOGY

### 3.1 Introduction

This section explained the methodology that have been used to conduct the research and findings the most suitable method to achieve the objective of the research.

### 3.2 Microcontroller Unit

The Arduino Uno board is used in this project. It is built around an Atmel AVR microcontroller. The ease of programming is high since arduino has standard connections. It can be directly connected to the CPU. There are 14 digital I/O pins, 6 analogue inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button on this board. It has a 5V working voltage. The arduino captures and processes data from the sensors.

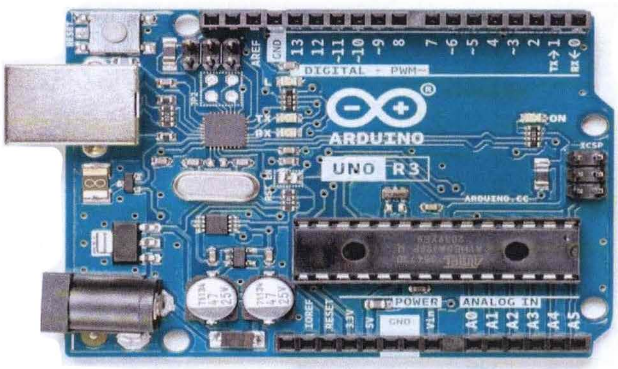


Figure 3.1 Arduino Uno

## 3.3 Flowchart System

Figure below shows that system flow. First the arduino gateway connected to the internet. The system will be On by the time has been set which is 8am and 5pm. The data will be stored in 2 ways which SD Card and IoT dashboard.

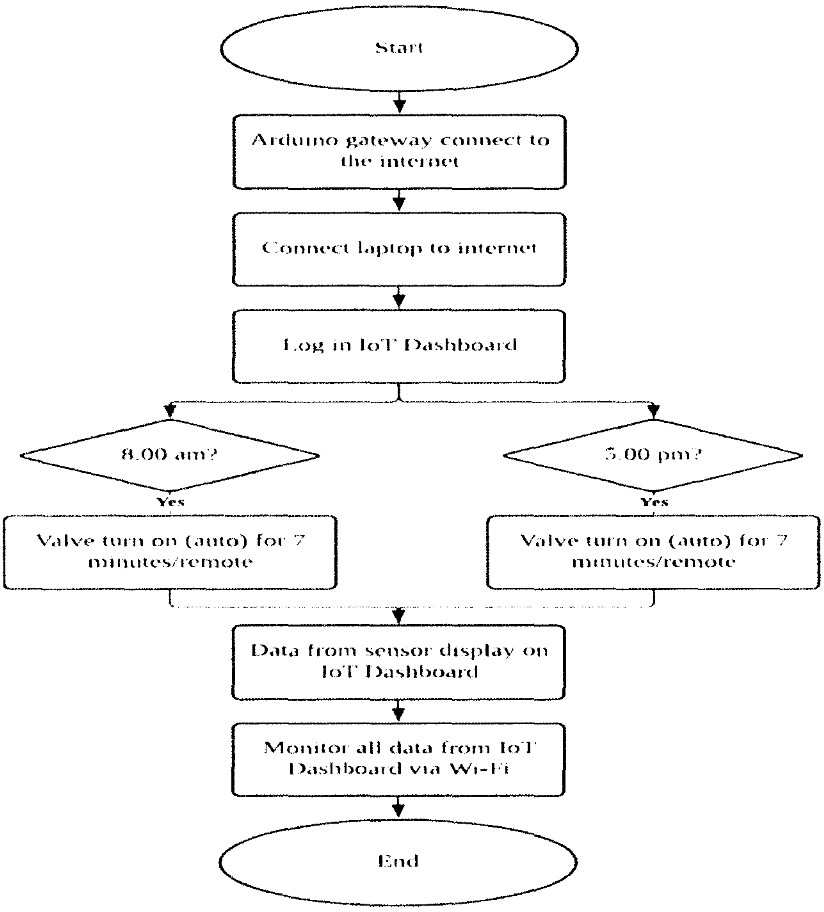


Figure 3.2 Project flow

## 3.4 Smart Agriculture

The figure 3.1 and Figure 3.2 below shows the connection of soil moisture sensors, piping system, trays and the valve at pre-nursery. There have 4 soil moisture sensors that plug into the trays in Figure. In Figure shows that how the piping system fixed above the trays to flow the water to the baby plants.

Figure 3.3 Soil Moisture connection

Figure 3.4 Piping System & Valve

## 3.5 Proposed Circuit Diagram

### 3.5.1 Relay Controller

The connection between the Arduino Uno, 5V Relay, and irrigation solenoid valve is shown in Figure 1.4. The Arduino Uno will upload the code to the relay, which will switch on and off the solenoid valve. Figure 1.5 shows the constructed circuit.

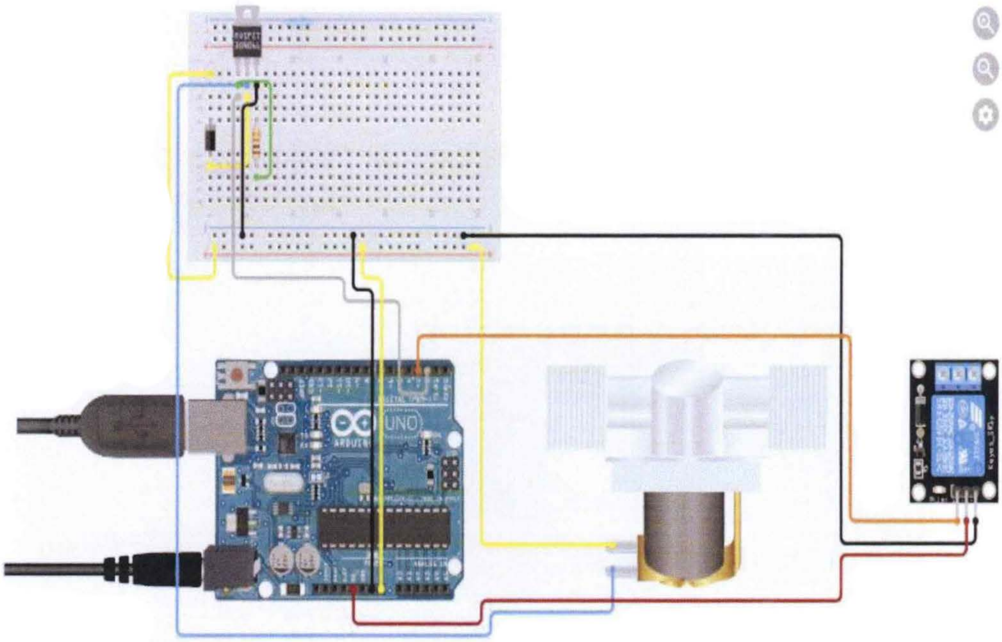


Figure 3.5 Relay Controller

### 3.5.2 Local Controller of Valve (Receiver Circuit)

Figure 3.6 shows the receiver circuit that have been tested on the pre-nursery. The circuit below consists of relays, Arduino Uno, HC12 (RF) and RTC Module DS3231. This is a receiver circuit that to control the valve. The connection of the valves is directly connected to the 3 relays. From the relays it connected to the Arduino Uno. The connection from arduino Uno to relay as GND to GND, VCC to 5v, IN1, IN2 IN3 connect to digital PWM 4, 5, 6. Arduino Uno is power up by direct power from solar. HC12 is for transfer the data.

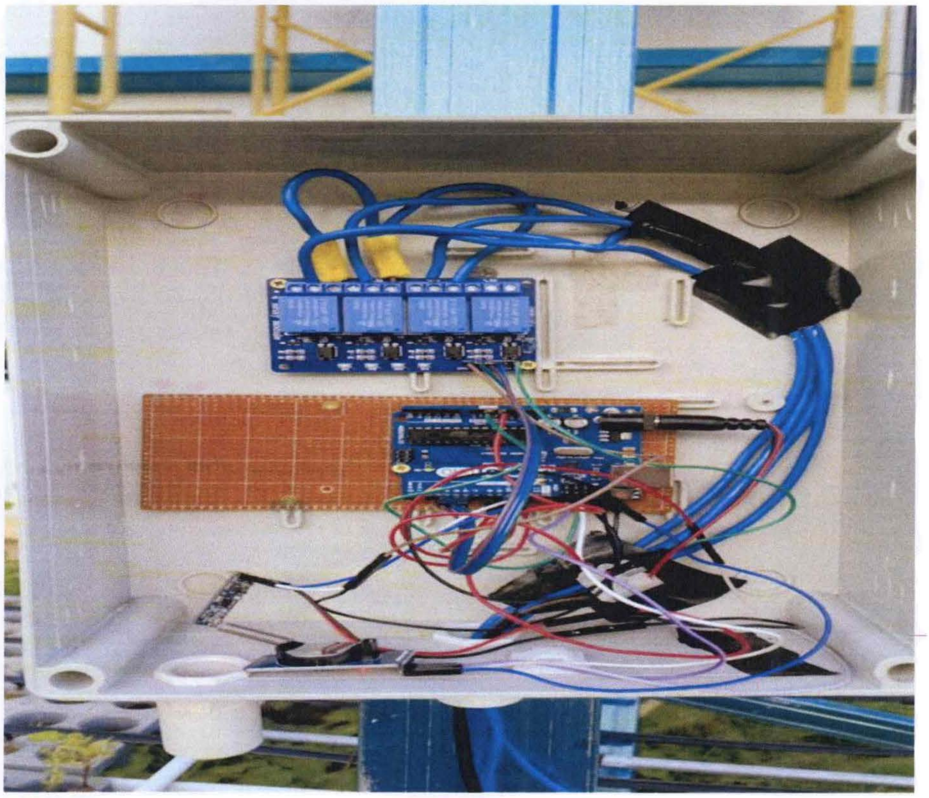

Figure 3.6 Fabricated Receiver Circuit

### 3.5.3 Local Controller of Soil Moisture

Figure 3.7 shows the soil moisture circuit that have been tested on the pre-nursery. The circuit below consists of Arduino uno Wi-Fi and SD Card. All the soil moisture sensors are connected Arduino uno Wi-Fi. The system connected with Wi-Fi directly. There have two methods to stored the data from the sensors. One is online which live data from the IoT dashboard. Another one is offline, by placing a SD Card directly to the arduino. It helps to store the data if occurred any lost connection.

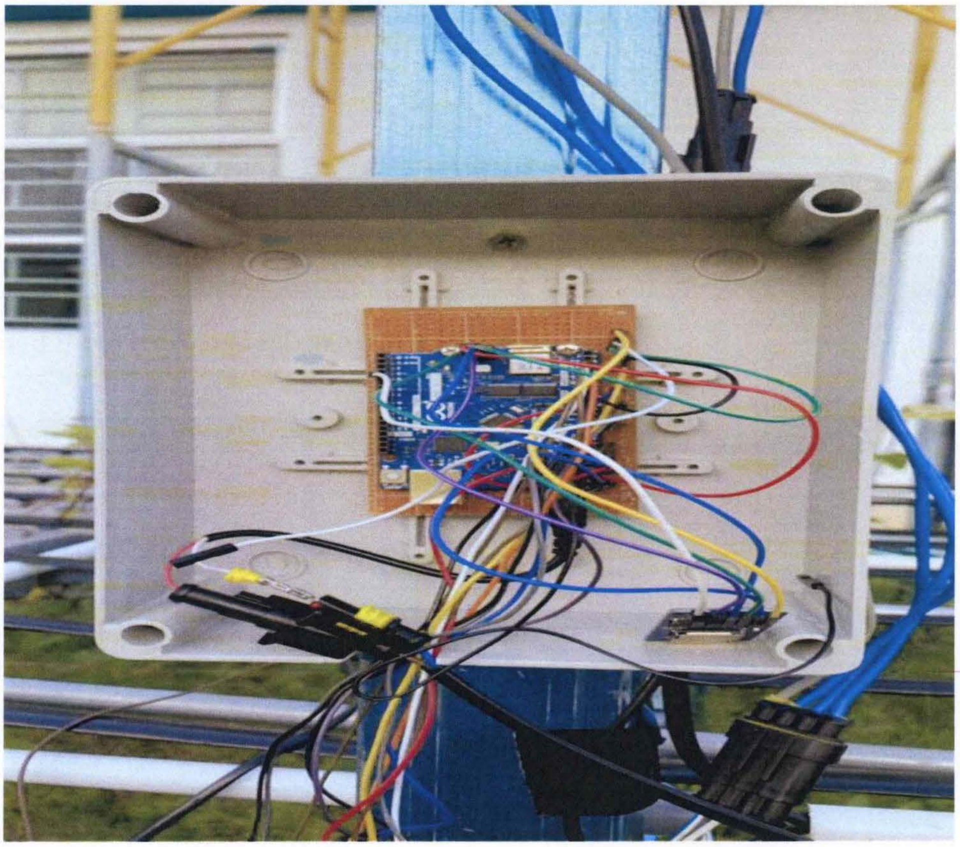

Figure 3.7 Fabricated Soil Moisture Circuit

## CHAPTER 4

## RESULTS AND DISCUSSION

### 4.1 Introduction

All of these sensors are commonly used in smart farming all of the study's findings are presented in this chapter. There include tables of findings, an interface, and figures. There is also a detailed description of the interface and figures.

### 4.2 Sensor Monitoring

The figure below shows that the combination reading of the four soil moisture on the left side. The readings are 39.00, 42.00 20.00 and 24.00. On the right side shows the combination of soil moisture 1 & soil moisture 2 and soil moisture 3 &soil moisture 4 in graph pattern.


Figure 4.1 Sensor monitoring

## 4.3 Data Logging (Online)

Figure 4.2 shows the how the data stored in Cayenne database from all the 4 sensors.


Figure 4.2 Data(Online)

## 4.4 Data Logging (Offline)

Figure 4.3 shows that all the data from sensor will be stored in SD Card in notepad file. It prevents that the data can be stored in offline mode.

```
READING.TXT - Notepad
File Edit Format View Help

2022-1-22 17:15:3
Soil Moisture 1 : 43
Soil Moisture 2 : 64
Soil Moisture 3 : 8
Soil Moisture 4 : 45
2022-1-22 17:15:6
Soil Moisture 1 : 32
Soil Moisture 2 : 61
Soil Moisture 3 : 8
Soil Moisture 4 : 45
2022-1-22 17:15:9
Soil Moisture 1 : 32
Soil Moisture 2 : 61
Soil Moisture 3 : 8
Soil Moisture 4 : 45
2022-1-22 17:15:12
Soil Moisture 1 : 33
Soil Moisture 2 : 61
Soil Moisture 3 : 8
Soil Moisture 4 : 45
```

Figure 4.3 Data (Offline)

# CHAPTER 5

# CONCLUSION

## 5.1 Introduction

This chapter summarised the research's most important findings. The research's findings provided an overview of this case study. The limitations or problems identified during the research process were also reported, along with recommendations for future research.

## 5.2 Conclusion

The IoT-based Smart Irrigation monitoring system could assist users in reducing burden and providing accurate analysis readings. Furthermore, by utilising the Cayenne dashboard, the system can provide users with immediate access. The system is capable of tracking the sensors and detecting critical changes in input. The system's convenience is expected to boost productivity while decreasing water consumption. Confidently state that this smart irrigation system will improve the farming experience for all users. The four main objectives that must be met in order for this project to be completed. Although the system is in good working order, it could be improved in the future. Only one type of sensor was used for this project. However, for the upcoming project, additional sensors such as a rain sensor, pH sensor, and humidity and temperature sensor could be added. The established smart irrigation system is practical and cost-effective in terms of maximising water resources for agricultural productivity.

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# APPENDICES

Appendix A:

Arduino Uno Datasheet