Faculty of Electronics & Computer Technology and Engineering

DEVELOPMENT OF A SMART FERTILIZATION SYSTEM USING MYSQL DATABASE FOR MODERN FARMS

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

2024

DEVELOPMENT OF A SMART FERTILIZATION SYSTEM USING MYSQL DATABASE FOR MODERN FARMS

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours

Faculty of Electronics & Computer Technology and Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2024

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development Of A Smart Fertilization System Using MySQL Database For Modern Farms

Sesi Pengajian : 2023/2024

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DEDICATION

I would like to say thank you a lot of my parents Johari Bin Yusof and Nor Haini Binti Yahaya who gave me so many support words of encouragement as I completed my final year project. They support me to succeeded my final year project. They also prepared a comfortable place for me to find ideas and inspiration to complete my assignments. A part from that, let's not forget my colleagues Muhammad Amirul Amin Bin Arsah, Alif Helmi Bin Rohadi, Amir Wafiq Aizat Bin Kamaruddin and Haiqal Bin Idris who gave a lot of opinions and ideas for me to improve my work to be better. Apart from that, to my supervisor Ts. Ahmad Fairuz Bin Muhammad Amin for his insightful comments and suggestion which gave me a lot of help in the process of the project development. His suggestion had me a lot of completing this project without any delay. I very appreciate his helpness and teaching to succeeded my final year project.

ABSTRACT

This study introduces a smart fertilization system designed to revolutionize traditional farming practices by addressing the limitations of standardized fertilization methods. Leveraging modern technology and a MySQL database, the system aims to enhance precision farming, improve resource efficiency, and foster sustainable agricultural practices. By integrating a network of sensors to monitor real-time data on temperature, humidity and water levels, the system establishes a foundation for informed decision-making. These data points are processed and stored in a MySQL database, enabling comprehensive historical tracking and analysis. An intelligent backend application interprets the data, guiding precise fertilizer applications tailored to the specific needs of crops and the evolving conditions of the farm. Accessible through a user-friendly web dashboard or mobile application, the interface empowers farmers with real-time monitoring and visualization of historical data, facilitating data-driven decisions for long-term crop management. Automation features alleviate manual labor, ensuring prompt and accurate fertilization adjustments. The holistic approach of this smart fertilization system aspires to optimize yields, conserve resources, and promote environmentally conscious farming practices.

ABSTRAK

Kajian ini memperkenalkan sistem penaburan pintar yang direka untuk mengubah amalan pertanian tradisional dengan mengatasi kekurangan kaedah penaburan piawai. Dengan menggunakan teknologi moden dan pangkalan data MySQL, sistem ini bertujuan untuk meningkatkan pertanian presisi, meningkatkan kecekapan sumber, dan memupuk amalan pertanian lestari. Dengan mengintegrasikan rangkaian sensor untuk memantau data secara langsung mengenai suhu, kelembapan, dan paras air, sistem ini membina asas untuk membuat keputusan yang berinformasi. Data-data ini diproses dan disimpan dalam pangkalan data MySQL, membolehkan penjejakan sejarah yang komprehensif dan analisis. Aplikasi backend yang pintar menafsirkan data tersebut, membimbing aplikasi baja yang tepat disesuaikan dengan keperluan spesifik tanaman dan keadaan pertanian yang berkembang. Mudah diakses melalui papan pemuka web yang mesra pengguna atau aplikasi mudah alih, antara muka ini memberi kuasa kepada petani untuk memantau secara langsung dan memvisualisasikan data sejarah, memudahkan keputusan berasaskan data untuk pengurusan tanaman jangka panjang. Ciri-ciri pengautomatan mengurangkan kerja manual, memastikan penyesuaian penaburan yang tepat dan tepat pada masanya. Pendekatan holistik sistem penaburan pintar ini bercita-cita untuk mengoptimumkan hasil tanaman, melestarikan sumber, dan menggalakkan amalan pertanian yang cekap.

ACKNOWLEDGEMENTS

First First and foremost, I wish to express my profound gratitude to my supervisor, Mr. Ts. Ahmad Fairuz Bin Muhammad Amin, for their invaluable guidance, words of wisdom, and unwavering patience throughout the course of this project.

I am sincerely indebted to Universiti Teknikal Malaysia Melaka (UTeM) and Tabung Amanah Pendidikan Negeri Melaka for their generous financial, which has played a pivotal role in enabling the successful completion of this project. I extend my sincere appreciation to Muhammad Amirul Amin Bin Arsah , my fellow colleague, for graciously sharing his thoughts and ideas, contributing significantly to the development of this research endeavor.

My heartfelt gratitude goes to my parents, and family members for their unending love and prayers during the entirety of my academic journey. Special acknowledgment is also extended to my parents Johari Bin Yusof and Nor Haini Binti Yahaya, whose motivation and understanding have been instrumental in overcoming challenges.

Finally, I am grateful to other individuals who, although not specifically mentioned, have been cooperative and helpful throughout this academic pursuit. Your collective support has been instrumental in the successful completion of this project.

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CHAPTER 1

INTRODUCTION

1.1 Background

Development of a smart fertilization system using a MySQL database for modern farms is rooted in the challenges faced by traditional farming practices. Traditional agricultural methods often rely on standardized fertilization techniques that may not align with the specific and dynamic needs of crops and soil conditions. The result can in inefficient resource usage, increased operational costs, and environmental concerns such as nutrient runoff and pollution. The choice of a MySQL database is motivated by its reliability, scalability, and efficiency in handling relational data. By utilizing MySQL, the smart fertilization system aims to establish a structured and organized repository for storing historical data, enabling farmers to track trends, analyze patterns, and make data-driven decisions for long-term crop management.

1.2 Problem Statement

Nowdays, our country Malaysia has been badly affected by climate change due to heavy deforestation. So many campaigns arose planting more trees. Farmers are also unable to go down to their fields to see the condition of their farms. There are also those who suffer from dehydration because they often go down to their farms in hot weather. Because of that, I created a system to check watering plants and saved the data in a MYSQL Database to reduce the gardening efforts. This system will designed and installed so that the plants would always be irrigated. As a result, monitoring temperature, humidity and water levels is crucial in contemporary agriculture and horticulture. It also has the potential to be a fascinating component of a smart farming system that makes use of Internet of Things (IoT) technology. This leads to inefficiencies in resource utilization, increased operational costs, and environmental concerns. The absence of a systematic data storage and analysis system further compounds these challenges, hindering farmers from tracking and utilizing historical fertilization data for informed decision-making. To address these issues, the development of a smart fertilization system using a MySQL database for modern farms is proposed. This system aims to leverage modern technology, incorporating a network of sensors to monitor real-time data on soil conditions, and a MySQL database to efficiently store and analyze this information. The primary objective is to optimize and automate the fertilization process, enhancing precision farming, improving resource efficiency, and promoting sustainable agricultural practices.

1.5 Scope of Project

The scope of this project are as follows:

i) Hardware which includes Rapsberry pi to collect the data sensors.

ii) Mosquitto Broker which communicate with ESP 32 and data sensors

iii) MySQL, which is used to store and insert data from Rapsberry into a database.

iv) Web-Based .PHP is used to create user interfaces that show MySQL data. Therefore, the user may conveniently monitor the plant via the website..

1.4 Project Objective

The aim of developing a smart fertilization system using a MySQL database for modern farms is to revolutionize traditional farming practices by introducing a technologically advanced and data-driven approach to fertilization. The objective of this project are listed below:

i) Data-driven Decision Making

Collect and store sensor data related to water level, humidity, and temperature. Farmers may make well-informed judgements on fertilization schedules, changes, and long-term improvements in fertilization techniques by examining historical data.

ii) User-Friendly Interface

Develop a user-friendly interface, accessible through a web-based, to allow farmers to monitor by system easily. The interface should provide real-time insights

iii) **Real Time Monitoring System**

The smart fertilization system aims store real-time data in a MySQL database for historical tracking and analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, The project "Development of A Smart Fertilisation System Using MySQL Database For Modern Farms" is covered in its entirety in this chapter. Numerous investigations were conducted in order to move forward with this project and make sure the system meets the requirements and is well-developed. The prior system or current systems were the subject of the investigation. The purpose of the literature review is to gather knowledge about projects that will enhance future developments and help achieve the project's data.

2.2 IOT Based Fertilizer System for Smart Agriculture

NextPCB in 2018 were developed IOT Based Fertilizer System For Smart Agriculture. The IoT-based fertilizer system for smart agriculture [1] is a valuable tool for farmers who are looking to improve their crop yields and reduce their environmental impact. The system is simple to use and adaptable to the unique requirements of various crops and growth environments. The device tracks the amount of nutrients and moisture in the soil using sensors. Data is sent to a central server by the sensors, which are buried in the ground. Fertilizer dispensing is managed by the server through analysis of the data. The technology is adaptable to the unique requirements of various crops and growth environments. The sensors provide their data to a central server, which analyses and uses it to regulate the fertilizer's distribution. The data flow in the IoT-based fertilizer system is meant to be efficient and precise. The sensors are positioned in the field to gather information on the nutrients and moisture content of the soil. The best amount of fertilizer to apply is determined by analysing the data that is transmitted via a wireless network to a central computer. The land is subsequently treated with fertilizer as needed. The technology is adaptable to the unique requirements of various crops and growth environments. Because of this, it is a flexible tool that may be applied in a range of contexts to enhance agricultural yields and quality. For instance, the system might be used to safeguard crops from pests and illnesses or to provide them the ideal quantity of nutrients and water. This method has a number of benefits, including the ability for users to monitor the water and fertilizer cycle via a database. Water managers may make plans for water conservation and make sure that water is used effectively with the help of this information. In addition, by automatically distributing fertilizer as needed, the system may support the maintenance of soil and tree fertility. Both the quality of the soil and the quantity of fertilizer wasted may be enhanced by it.

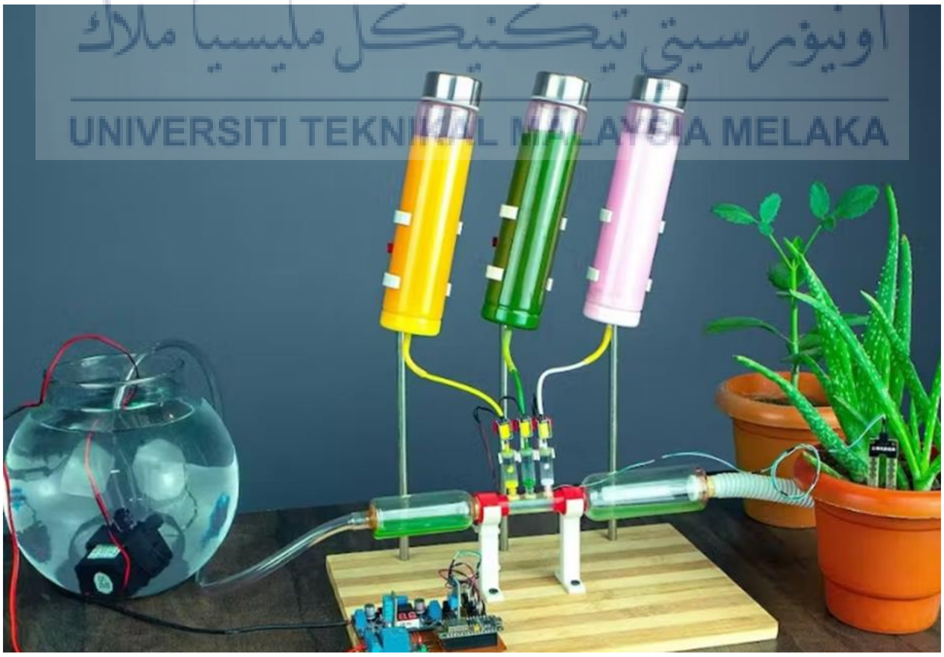


Figure 2-1 Fertilizer System (NextPCB 2018)

2.3 IoT Based Smart Fertilizer Management System

The goal of Jagadesh's (2021) [2] smart fertilizer management system is to provide farmers with an atomized smart fertilizer management system that will help them save time, money, and energy while also reducing resource waste. The distribution of fertilizer, soil moisture, and nutrient levels are all managed by an Internet of Things (IoT)-based smart fertilizer management system in agriculture. The water moisture sensor uses a controller and a GSM module to transmit SMS notifications to the farmer's mobile device. The controller may receive orders from the farmer via the GSM module. Another source of information is Internet of Things (IoT)-based smart farming systems, which provide farmers remote control over the amount and volume of fertilizer injected. These systems employ sensors to collect information on soil moisture, fertilization, and weather.

2.4 IoT Enabled Smart Fertilization and Irrigation Aid for Agricultural Purposes

The IEEE research by Jieying Sun and Amir M. Abdulghani [3] centers around a farming preparation and water system help that is empowered by the Web of Things. Determining the soil's moisture content and NPK value for irrigation and fertilisation is the project's main goal. The Grove Moisture Sensor, a particular LED, and a photodiode are linked to the Arduino circuitry in this project. We'll use an algorithm and an Internet of Things programme to separate the data into different levels and transmit measurements to the gateway at the proper rate. The system gadgets, however, rely on dependable and steady internet access to send data because many communities lack strong internet connections, especially in the rural areas where most farms are situated. Using the Web of Things to integrate a clever water system and treatment for horticulture has several advantages. IoT devices provide sensors that help collect a wealth of important data for ranchers. It facilitates the gathering of information on the temperature, humidity, quality of the soil, and other factors that may affect crop development. Furthermore, farmers may now remotely manage increasingly automated operations for irrigation, fertilisation, and pest management. With the help of IoT-enabled agricultural solutions, farmers can carefully monitor the environment and their goods in real time and gather vital information on animals, crops, weather, and other elements.

2.5 Conceptual Framework of Smart Fertilization Management of Oil Palm Tree Based on IoT [5]

The research by N A N Mohd Adib and S Daliman [4] proposes a conceptual framework of smart fertilization management for oil palm trees based on IoT and deep learning. The goal of implementing an IoT is to identify environmental elements that impact young oil palm tree development and nutritional deficits in oil palm plants under three different treatment scenarios. The use of Internet of Things (IoT) sensors and devices that connect to the database through many connection options, information transmission from sensors to an Arduino device serving as the sensor node, and data processing by a Raspberry Pi serving as a gateway are some of the benefits of the suggested system. IoT sensors, data collecting systems, deep learning algorithms, and decision-making processes are just a few of the components that must be integrated in order to execute the conceptual framework that integrates IoT with deep learning for smart fertilization management. This may be a challenging procedure. According to the study, the suggested framework may improve the effectiveness of oil palm plants' intelligent fertilization management. The way the Internet of Things (IoT) sensor and device system operates is that sensors gather data and send it to a device that serves as the sensor node, such an Arduino. After that, the data is sent via I2C or serial transmission to a gateway—like a Raspberry Pi—that handles data processing. After processing, the data is delivered via a variety of communication methods to a database.

2.6 A Smart Decision System for Digital Farming

The research paper titled "A Smart Decision System for Digital Farming" by Carlos Cambra Baseca and Sandra Sendra [5] discusses how the integrated into interactive innovation models for fertilization, IoT-based application development platforms can run farm management tools that can monitor events in real time. This article presents a remote-operated multimedia platform and an open data network for smart farming with shared restriction levels for information sharing. For every separate rule set in the system, including weather, fertilisation, pest control, agronomy parameter, and irrigation system operation, there are associated parameter rules. Only in the simple demo mode does each category have its own set of rules. In order to determine how much water is required, the website also provides average daily temperature data (in degrees Celsius) and wind speed data (in metres per second) for a period of ten months.

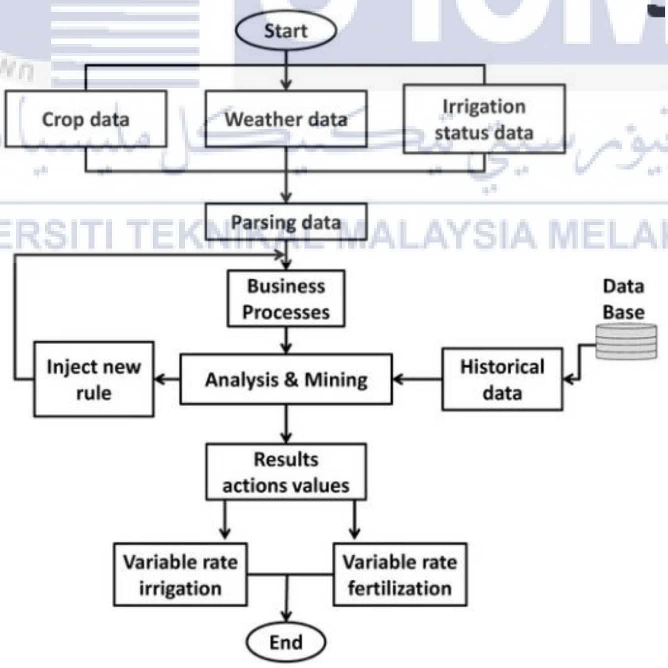


Figure 2-2 Flow Diagram [5]

2.7 Solar Ferigation: A Sustainable and Smart IoT-Based Irrigation and Fertilization System for Efficient Water and Nutrient Management

The research titled "Solar Fertigation: A Sustainable and Smart IoT-Based Irrigation and Fertilization System for Efficient Water and Nutrient Management" by Uzair Ahmad and Artuno Aalvino [6] focuses on developing a sustainable and intelligent system for irrigation and fertilization in agriculture. The goal of the project is to combine intelligent systems that can schedule fertilisation and watering according to the unique requirements of plants with agronomic models. By automatically watering the soil, this technology also seeks to monitor and maintain the appropriate moisture level. The report highlights the clever design of monitoring tools as one of its benefits. Here, the effective functioning of an adaptive decision support system depends on the precise integration of soil, weather, and plant sensors. One significant drawback of solar fertigation systems is the requirement to store extra solar energy for use just at night for irrigation. This suggests that there may be difficulties in effectively using solar energy for irrigation when it is not in the daytime. In general, the study investigates the possibility of combining solar energy with Internet of Things (IoT)-based technologies, such sensors and intelligent decision support systems, to build an effective and sustainable irrigation and fertilisation system for farming.

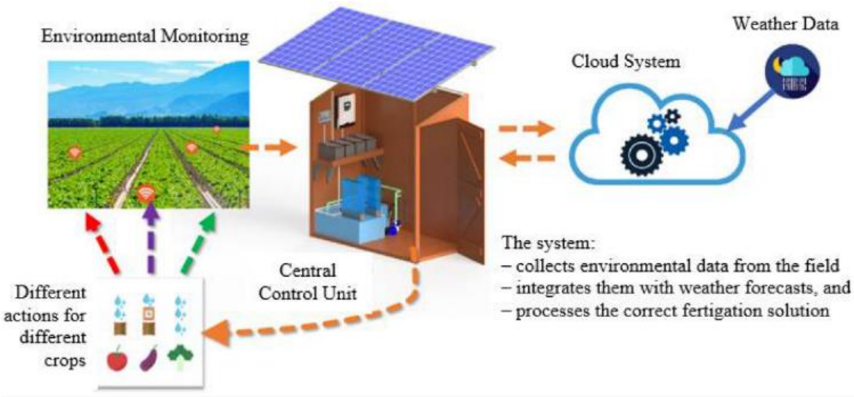


Figure 2-3 Flow diagram of the system [6]

2.8 Solar Fertigation: Smart Fertilizer Software, Sup Plant Lunch App for Improving Water and Fertilization Efficiency

SupPlant [7] has launched an app called GroPlant, which is a smart fertilizer software designed to improve water and fertilization efficiency for farmers of all capabilities. The software gives farmers advice based on inputs from remote sensing and aggregate data. Features like field design for crop selection, field area, planting date, irrigation techniques, and auto geolocation are all included in GroPlant. Additionally, it gives farmers real-time weather notifications and guides them in implementing the best irrigation plan in the event of severe weather. The storage and specifications of a device, however, are crucial. If a farmer uses an outdated gadget—for example, one with a little storage capacity or an antiquated operating system—they will not be able to utilise the programme. One of the software's benefits is its capacity to offer farmers advice based on aggregate data and inputs from remote sensing. Among the features provided by the GroPlant programme are the ability to create fields for crop selection, set field area, planting date, irrigation techniques, and automated geolocation. Additionally, it offers in-the-moment weather notifications, enabling farmers to respond to harsh weather circumstances with the proper irrigation plan. Overall, the study shows how solar fertilisation, while taking weather into account, may help farmers improve their water and fertilisation efficiency. It also highlights the device compatibility constraints, which can prevent certain farmers from making good use of the programme.

Figure 2-4 Interface of GroPlant Apps [7]

2.9 Internet of Things (IoT) and Agricultural Unmanned Aerial Vehicles (UAVs) in Smart Farming

The research paper titled "Internet of Things (IoT) and Agricultural Unmanned Aerial Vehicles (UAVs) in Smart Farming" by Achilles D. Boursianis and Maria S. Papadopoulou [8] examines the IoT and unmanned aerial vehicle (UAV) technologies in smart farming. The research aims to optimise several agricultural factors, reduce costs, and increase crop yields. The article highlights the advantages of utilising IoT and UAV technology in agriculture, characterising them as two significant advancements that enable the transition from traditional agricultural practices to precision farming. Several agricultural characteristics may be monitored and controlled thanks to the integration of IoT, which boosts farming output and efficiency. Unmanned aerial vehicles, or drones, provide the ability to collect data and conduct aerial surveillance, enabling farmers to assess their crops and make informed decisions. The study does, however, also highlight a potential disadvantage of integrating these technology into farming practices. The complexity of the architecture may provide a challenge for ranchers who are unfamiliar with IoT and UAV advancements. Because of this complexity, farmers may need to learn new skills and expertise in order to manage and run the integrated system successfully, which might prevent adoption. The study paper concludes by examining the potential applications of IoT and unmanned aerial vehicles (UAVs) in smart farming, emphasising the benefits of enhanced monitoring and data-driven decision making. It also recognises the complexity of the system, which may cause issues for farmers who are not familiar with these technology.

2.10 Wireless Mid-Infrared Spectroscopy Sensor Network for Automatic Carbon Dioxide Fertilization in a Greenhouse Environment [10]

The research paper titled "Wireless Mid-Infrared Spectroscopy Sensor Network for Automatic Carbon Dioxide Fertilization in a Greenhouse Environment" by Jianing Wang and Xintao Niu [9] focuses on preventing agriculture's potential product losses from unpredictable harmful factors. One benefit of the suggested wireless sensor network is the use of intelligent transmission power management based on the Received Signal Strength Indication (RSSI). This technique guarantees very steady communication while saving electricity. But the report also points out several shortcomings. One restriction is the challenge of reestablishing a wireless network connection once it has been lost. Furthermore, farmers can have trouble identifying and fixing problems connected to connections.

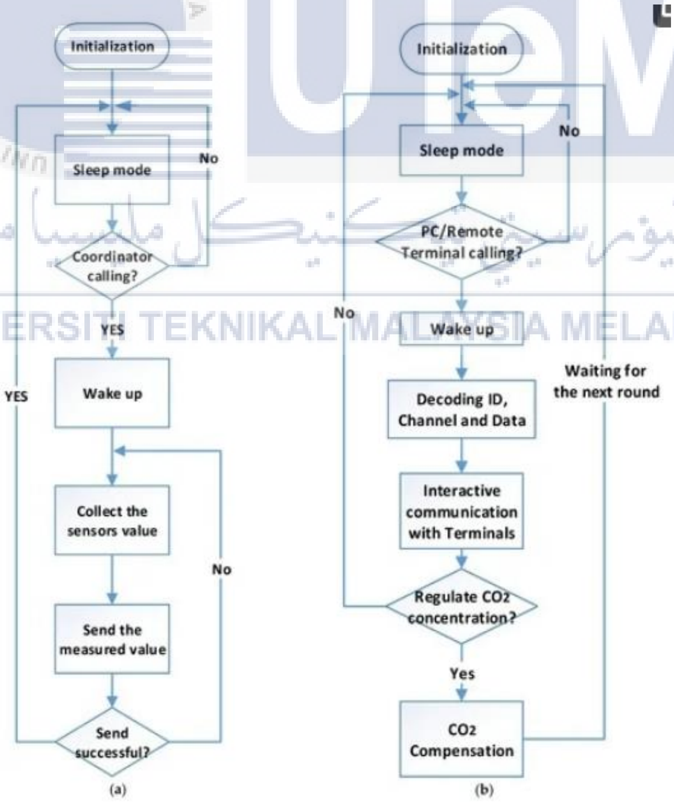


Figure 2-5 Functional block diagram [9]

2.11 Recent advancements and challenges of Internet of Things in Smart Agriculture

The research titled "Recent advancements and challenges of Internet of Things in smart agriculture" by Bam Bahadur Sinha and R. Dhanalakshmi [10] explores the advantages, drawbacks, and potential uses of the Internet of Things (IoT) in smart agriculture. The objective of the project is to enable the autonomous administration and monitoring of agricultural areas with little human intervention through the development of many IoT-based frameworks. The authors list some benefits of IoT application in smart agriculture. First, farmers may now connect remotely to their farms at any time and from practically anywhere thanks to IoT-enabled devices. They are able to monitor and manage several elements of their farms, such as crop health, soil moisture, temperature, and humidity, by utilising networked sensors and gadgets. The authors do, however, also point out several limitations and challenges associated with the Internet of Things in smart agriculture. One challenge is the potential for agricultural data to be lost due to equipment malfunctions, network node failures, data processing mistakes, or pest and disease infestation. These problems might jeopardise the dependability and accuracy of data-driven agricultural decision making. The article covers the benefits and latest developments of IoT integration for smart agriculture, along with the challenges and constraints that need to be addressed for effective implementation.

2.12 A Mobile Application for Smart Fertilization Based on Linked Data

Stefan Burgstaller and Wolfgang Angermair's research for the IEEE journal "A Mobile Application for Smart Fertilisation Based on Linked Data" [11] focuses on the creation of a mobile application called LEOpatra that makes use of linked data to enable smart fertilisation in agricultural areas. Applying fertiliser to a field at different rates is the aim of LEOpatra, which uses information gathered from satellite pictures and other geospatial data. In order to provide more accurate and effective fertiliser application, the application is made to designate limited zones where little or no fertiliser is permitted. The study emphasises a number of benefits of LEOpatra use. First of all, it provides better accuracy in some places, especially those with rivers and shallow water. Moreover, the data that the programme uses is publicly accessible and freely available, offering farmers an affordable option. Nevertheless, the report also notes a number of drawbacks and difficulties related to LEOpatra's deployment. These consist of data aggregation delays, possible fading and interference problems, and wireless communication security challenges. Dependence on wireless networks might lead to a decline in the dependability and performance of the network. Furthermore, there may be trade-offs and restrictions associated with network feature optimisation. To summarise, the development of LEOpatra, a mobile application for connected data-based smart fertilisation, is the main emphasis of the IEEE study. While it has benefits like increased accuracy and free information availability, its deployment will not be successful unless problems with data latency, wireless connection, and network constraints are resolved.

2.13 The Multi-Objecctive Optimization Alghorithm Based on Sperm Fertilzation Produce (MOSFP) Method for Solving Wireless Sensor Networks Optimization Problems in Smart Grid Applications

The research paper titled "The Multi-Objective Optimization Algorithm Based on Sperm Fertilization Procedure (MOSFP)" by Hisham A. Shehadeh and Mohd Yamani Idna Idris [12] focuses on addressing the challenges faced by wireless sensor networks (WSN) and the need for optimization methods to enhance their quality of service (QoS). One of the system's benefits is that it incorporates the suggested algorithms. New methods and experiments aimed at optimizing network properties of wireless sensor networks (WSN) are presented in the research. The QoS of WSNs utilized in several applications, such as smart grids and healthcare, is intended to be enhanced by these techniques. Beside that, The optimisation approaches mentioned in the research attempt to boost the QoS of WSNs. These techniques can be used to get around problems with data aggregation delays, fading and interference, and wireless communication security. However, there are a number of drawbacks to this method. First, fading, interference, and data aggregation latency are issues that WSNs deal with in wireless communication. These elements may have a detrimental effect on the network's dependability and performance. Second, reduced network performance and reliability may result from constraints and trade-offs in feature optimization. This emphasises the necessity of efficient optimization strategies to lessen these problems. The study report offers an overview of suggested algorithms and research projects that optimize network characteristics and raise the quality of service (QoS) of wireless sensor networks used in smart grid applications and other fields. It also recognizes the difficulties and constraints involved in making these networks more efficient.

2.14 Estimating Crop National Status Using Smart Apps to Support Nitrogen Fertilization

The research titled "Estimating Crop Nutritional Status Using Smart Apps to Support Nitrogen Fertilization: A Case Study on Paddy Rice" by Livia Paleari and Ermes Movedi [13] discusses the development and testing of a diagnostic system that utilizes intelligent apps to derive a nitrogen nutritional index for supporting nitrogen fertilization in paddy rice. This system's benefits include the ability to measure real plant nitrogen content (PNC) and Ncrit (critical nitrogen concentration) non-destructively using low-cost, extremely portable instruments like cellphones. The technology helps farmers to efficiently control nitrogen in rice crops by giving them access to real-time information. This might result in better fertilizer use and less harm to the environment. There are a few drawbacks, though, to take into account. In order to evaluate the nitrogen status of plants, the system uses non-destructive techniques and cellphones, which may need that farmers purchase or get the required equipment. Furthermore, farmers might need to have some technical know-how and training in order to use and understand the data that the applications give. To promote nitrogen fertilization, the research summarises a diagnostic system that uses smart applications to determine crop nutritional status in paddy rice, especially nitrogen levels. Although the system has advantages like affordability and real-time data, farmers' access to cellphones and their capacity to comprehend and use the supplied information efficiently may be prerequisites for the system's successful deployment.

2.15 Wireless Sensor Network System Design Using Rapsberry Pi and Arduino for Environmental Monitoring System

The research paper titled "Wireless Sensor Network System Design using Raspberry Pi and Arduino for Environmental Monitoring Applications" by Sheikh Ferdoush and Xinrong Li [14] focuses on developing a wireless sensor network system using open-source hardware, specifically Arduino and Raspberry Pi, and the ZigBee module, XBee S2B. One of the system's benefits is its affordability, which enables a larger user base to utilise it. The framework's frugal size enables straightforward transmitting under many circumstances. The system is also quite flexible, enabling customers to add or remove sensors and other parts to customise it to their specifications. One possible downside, though, might be that users who are unfamiliar with information technology (IT) would find it difficult to understand the system.

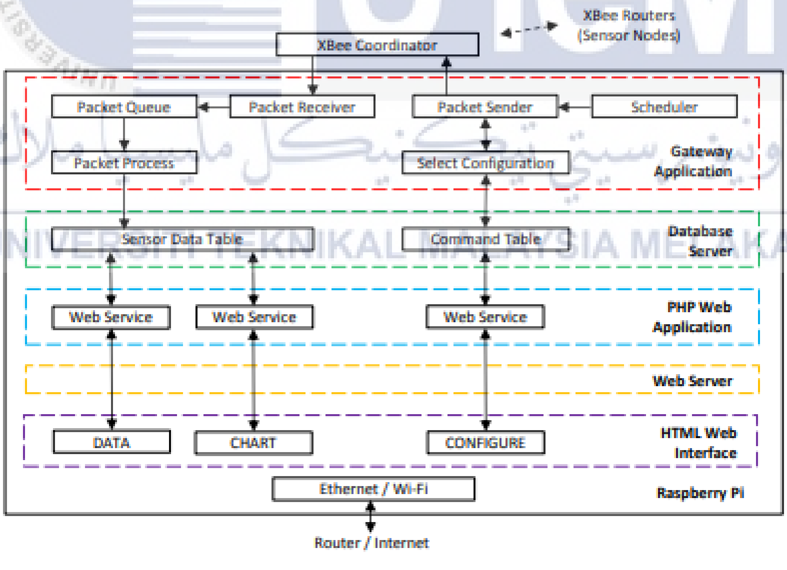


Figure 2-6 Functional block diagram [14]

2.16 Smart Monitoring Temperature and Humidity of the Room Server Using Raspberry Pi and Whatsapp Notifications

The research paper titled "Smart Monitoring Temperature and Humidity of the Room Server Using Raspberry Pi and Whatsapp Notifications" by Dwi Ely Kurniawan [15] focuses on the creation of a system for real-time server room temperature and humidity monitoring. The system's task is to maintain a specified level of humidity and temperature and to notify the server room administrator via WhatsApp if certain parameters are exceeded. The advantages of the system are as follows. It is designed to be inexpensive, so more people can afford it. Second, the system's compact size makes it simple to operate in a range of contexts. Finally, the system's high degree of adaptability enables users to modify sensors and other components to suit their unique needs. However, the system has a few shortcomings. First of all, WhatsApp requires a steady internet connection in order to deliver alerts; as a result, an inconsistent or unreliable connection might impair the system's performance. Secondly, the system requires the usage of several devices, which might increase the system's complexity and need more maintenance. The study report concludes by proposing a small, affordable solution that uses a Raspberry Pi and WhatsApp to monitor the temperature and humidity levels in the server rooms. It offers benefits like being inexpensive and customisable, but it also requires several devices and a dependable internet connection, which might lead to issues.

2.17 Smart Farming is Key to Developing Sustainable Agriculture

The research article titled "Smart farming is key to developing sustainable agriculture" by Achim Walter and Robert Finger [16] discusses the potential benefits and challenges of implementing information and communication technology (ICT) in agriculture, specifically through smart farming techniques. The writers stress the benefits of smart farming, such as its ability to lessen farming's environmental impact. This is made possible by methods like precision agriculture, which enables the minimal and targeted use of inputs like pesticides and fertilizers. Smart farming also has the ability to improve product quality via the optimization of management procedures. ICT usage in agriculture does, however, come with certain drawbacks. The authors note that it presents moral and legal issues with regard to responsibility, property rights, and data ownership. These difficulties include figuring out who is entitled to and how to use the data gathered by smart agricultural systems. Accountability concerns must also be addressed when mistakes or poor management have the potential to have negative effects on the environment and the economy. The study article's overall message highlights the significance of smart farming for the advancement of sustainable agriculture, while also recognising the necessity of addressing the ethical, legal, and accountability issues related to ICT usage in farming.

2.18 Smart Fertilizer Management: The Progress of Imaging Technologies and Possible

The research paper titled "Smart fertilizer management: the progress of imaging technologies and possible implementation of plant biomarkers in agriculture" by Raj Kishan Agrahari and Yuriko Kobayashi [17] discusses the application of imaging technologies, sensor technologies, and biomarkers in smart fertilizer management and precision agriculture The authors stress the benefits of combining robots, IoT (Internet of Things), and phenotyping—the study of plant traits—for effective fertiliser management. Fertiliser application may now be managed automatically, quickly, and in real time thanks to this connection. Farmers may monitor plant growth, nutrient levels, and other pertinent parameters to optimise fertiliser consumption by employing image and sensor technology. The authors also go into the possible application of biomarkers in agriculture. Indicators known as biomarkers can be used to track how early in a plant's life cycle it responds to nutrients. This makes it possible to identify nutritional deficits early and take appropriate action. Farmers can prevent any nutrient-related problems and make modifications to fertilizer application by employing real-time biomarker monitoring. The study does, however, also note several drawbacks with cutting-edge sensor and image technology. For example, the acquisition and upkeep of technology such as portable sensors and hyperspectral imaging might be costly. Their adoption may be restricted by this expense, especially by small-scale farmers who might have limited resources. In conclusion, the study article emphasises the possible advantages of combining biomarkers, sensor technologies, and imaging technologies for intelligent fertiliser management in agriculture. Although real-time monitoring and early nutrient deficiency identification are two benefits of these improvements, small-scale farmers may find it difficult to widely embrace these new technology due to their high costs.

2.19 The Antelope Interface to PHP and Applications: Web-based Real-time Monitoring

The research paper titled "The Antelope Interface to PHP and Applications: Web-based Real-time Monitoring" by K.G. Lindquist and R.L. Newman [18] explains how the Antelope PHP interface could be used for environmental real-time monitoring and data analysis on the web. The authors want to raise readers' awareness of the features available in the Antelope PHP interface and inspire further web-based solutions to be developed in this area. The study highlights the Antelope PHP interface for several reasons. Firstly, it leverages PHP 5's capabilities for object-oriented programming, which enables appropriate handling of object ring buffer (ORB) packets and facilitates simpler packet inspection. This feature improves the usefulness and flexibility of the interface. The Antelope PHP interface also uses cascading style sheets (CSS) to keep layout and content apart. This division allows for a clean and succinct source code for the program Furthermore, it enables total customisation of the application with just CSS knowledge needed, negating the requirement for previous PHP or HTML understanding. This improves the versatility of the interface and streamlines the development process. However, the study also looks at a drawback of the Pronghorn PHP interface. Because HTTP interactions are stateless, database operations must be resumed each time an Antelope-PHP page is called. This limitation puts a strain on the system and might affect its performance. The study's findings generally demonstrate the value of the Antelope PHP interface for environmental web-based real-time data analysis and monitoring. It highlights some of its advantages, like CSS content-layout separation and support for object-oriented programming. However, it also acknowledges the limitations of the stateless concept of HTTP correspondences and the requirement to resume data set operations upon page conjuring.

2.20 PHP-based Undergraduate Data Reporting and teaching quality evaluation information system

The research by Xin Zhang and Zhengang Wei [19] focuses on the development and implementation of a PHP-based undergraduate data reporting and teaching quality evaluation information system. The system's objective is to offer a reporting and assessment platform for undergraduate data and instructional quality. The system's ability to provide a uniform data storage architecture and guarantee consistency and uniformity throughout the data is one of its benefits. To further improve the accuracy of the data, it additionally uses appropriate default values to fill in any missing information. Nonetheless, the study points out a few drawbacks. First of all, data governance is a difficult, continuous process that needs constant attention. It's possible that the system doesn't fully cover every facet of data governance. Second, the system's data cleaning procedure lacks precise and workable standards and techniques, which might have an effect on the quality and accuracy of the data. Overall, the study emphasises the creation and application of a PHP-based system for teaching quality evaluation and undergraduate data reporting, highlighting its benefits for managing default values and data storage while recognising the difficulties with data governance and data cleansing..

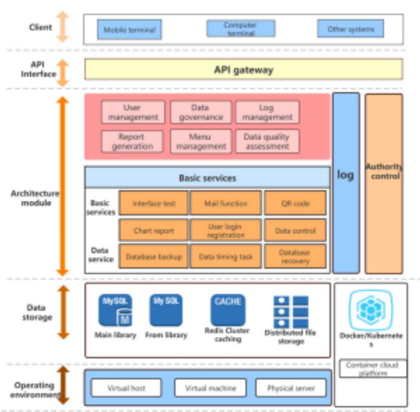


Figure 2-7 Overall System Architecture [19]

2.21 A Framework for Web-Based Student Record Management System Using PHP

The research paper titled "A Framework for Web Based Student Record Management System using PHP" by Er. Saurabh Walia and Er. Satinderjit Kaur Gill [20] presents the development of a web-based student record management system using PHP and MySQL. The goal of the study is to provide an overview of the development process used to create the system, which includes using PHP, MySQL, XAMPP server, and SQL. The study outlines a number of the suggested system's benefits. It first makes automated and efficient administration of student records possible by doing away with the necessity for human record-keeping. To further enhance its capabilities, the system allows for connectivity with other services via HTTP, POP3, and IMAP protocols. In order to monitor user access and guarantee compliance with data access policies, the system also includes a sophisticated logging mechanism. One drawback is that the research notes that creating the system calls for a high-spec gadget.

Table 2-1 Comparison between Related Research Journal

NO	TITLE	AUTHOR	PURPOSE	ADVANTAGES	DISADAVNTAGES
1.	IOT Based Fertilizer System for Smart Agriculture	NextPCB	The project aims to keep an eye on the nitrogen (N), phosphorus (P), and potassium (K) (NPK) values of indoor plants as well as the temperature and humidity of the soil.	- To maintain soil and tree fertility. - Users can observe the water and fertilizer cycle through the database only. - You can control your device staying anywhere in the world through the Blynk apk in your phone.	- IoT devices require a continuous power supply to operate effectively. - If there is no electricity source in the area, then the system cannot be run.
2.	IoT Based Smart Fertilizer Management System	Jagadesh	To deliver an atomized smart fertiliser management system to farming in order to reduce resource waste and to save farmers' important time, money, and energy.	- The water moisturiser sensor uses the controller to send an SMS notification to the farmer's mobile device via the GSM module. - The farmer will provide alpha numerical values as input commands to the controller via the GSM module. These numbers will be used to determine how long the valves will be opened for.	- Setting up and maintaining an IoT-based fertilizer system requires technical expertise. - Farmers who are not familiar with IoT technology may face challenges in installation, configuration, and troubleshooting.
3.	IoT Enabled Smart Fertilization and Irrigation Aid for Agricultural Purposes	- Jieying Sun - Amir M. Abdulghani - Muhammad A. Imran - Qammer H. Abbasi	It detects the moisture and NPK value inside the soil, which stands for irrigation and fertilization.	- The project connect Grove Moisture Sensor, specific LED & photodiode with Arduino hardware - It will develop Internet of Thing program to transmit measurements to gateway at proper rate, and algorithm will use to classify data into different level.	- The systems devices rely on stable and reliable internet connectivity to transmit data. - Several of the village does not have internet connection stability. Because the because most farms are in the interior areas.

4.	Conceptual framework of smart fertilization management for oil palm tree based on IOT and deep learning	- N A N Mohd Adib - S Daliman	- Research the implementation of IoT application to detect the environmental factors that affecting the growth of young oil palm trees and nutrient deficiencies of palm oil trees under three treatments.	- The system of an IoT comprising the sensors and devices that connect to the database via several types of connectivity. - The information will be delivered by the sensors to Arduino device that acts as the sensor node. - The Arduino device sends the information through serial communication or I2C communication to Raspberry Pi that acts as gateway. - The Raspberry Pi performs the amount of processing data .	- Implementing a conceptual framework that combines IoT and deep learning for smart fertilization management can be complex. - It requires integrating various components, such as IoT sensors, data collection systems, deep learning algorithms, and decision-making processes.
5.	A Smart Decision System for Digital Farming	- Carlos Cambra Baseca - Sandra Sendra - Jaime Lloret - Jesus Tomas	- Farm management systems that are capable of monitoring events in real time can be operated by application development platforms based on the Internet of Things (IoT). - A smart farming is available on the multimedia platform, and it can be managed remotely. - To establish a farmer-specific open data network with standardized restriction levels for information flow.	- The functionality of the irrigation system, fertilization, pest control, agronomy parameters, and the weather; In the basic demo mode, there is only one rule for each type. that include the parameters of each rule set's rules. - Display the average daily temperature (in °C) and daily wind speed (in m/s), as measured over a 10-month period. These numbers are used to determine how much irrigation is required.	- Farmers who are as old as the elderly cannot understand and use this system properly because with this system it is difficult for them to understand how the system works. - There are too many processes that need to be carried out

6.	Solar Fertigation: A Sustainable and Smart IoT-Based Irrigation and Fertilization System for Efficient Water and Nutrient Management	- Uzair Ahmad - Artuno Aalvino - Stefano Marino	The agronomic models that should be incorporated into the intelligent system that automatically monitors and maintains the desired soil moisture content and plans fertilization and irrigation according to plant needs	- An adaptive decision support system's successful operation necessitates, however, a well-thought-out design of monitoring tools that includes the precise integration of soil, weather, and plant sensors.	- Solar fertigation systems need to store excess solar energy for irrigation during non-daylight hours only.
7.	Smart Fertilizer Software, SupPlant Launch App for Improving Water and Fertilization Efficiency	- SupPlant	Farmers of all capabilities access to data and satellite driven information designed to improve water and fertilization efficiency, while taking into consideration weather events.	- Use remote sensing data and collective data to make suggestions for farmers. - GroPlant's features include crop selection field creation, field area, planting date, irrigation methods, and automatic geo-location. - GroPlant will likewise give continuous weather conditions caution and lead the ranchers	- The storage and requirements of a device also play an important role, if the device used by the farmer is out of date such as a small storage, an old operating system, the farmer cannot use the application.
8.	Internet of Things (IoT) and Agricultural Unmanned Aerial Vehicles (UAVs) in Smart Farming	- Achilles D. Boursianis - Maria S. Papadopoulou - Panagiotis Diamantoulakis	In smart farming, a wide range of agricultural data, such as environmental factors, growth state, soil status, irrigation water, applications of pesticides and fertilizers, weed control, and production conditions in greenhouses, can be monitored to improve process inputs, reduce costs, and increase crop yields.	- The Internet of Things (IoT) and unmanned aerial vehicles (UAVs) are two popular agricultural technologies that transform conventional farming practices into a new era of precision agriculture.	The system will be complicated to the farmers.

9.	Wireless Mid-Infrared Spectroscopy Sensor Network for Automatic Carbon Dioxide Fertilization in a Greenhouse Environment	- JianingWang - Xintao Niu - Lingjiao Zheng - Chuantao Zheng	In today's agriculture, it is of utmost importance to reduce potential product losses caused by unpredictable harmful factors.	- The wireless sensor network utilized intelligent transmission power management to achieve high communication stability and low power consumption, as indicated by the Received Signal Strength Indication (RSSI).	- Hard to connect with wireless when connection lost. - The farmer hard to fix any problem about connections
10.	Recent advancements and challenges of Internet of Things in smart agriculture	- Bam Bahadur Sinha - R. Dhanalakshmi	To autonomously manage and track agricultural fields with the least amount of human involvement, numerous IoT-based frameworks have been developed.	- Utilizing IoT-enabled technologies, farmers are able to connect to their farms at any time and from almost any location. - In addition to reducing pesticide and fertilizer use, precision farming employing IoT-based technologies also saves water and energy, making farming more environmentally friendly.	- Agricultural data may be lost due to equipment failure or network node breakdown, post-processing errors, or pest/disease infestation. - The introduction of physical objects into the internet creates a number of problems in terms of the adaptability of existing internet protocols and applications to these objects
11.	A Mobile Application for Smart Fertilization	- Stefan Burgstaller - Wolfgang Angermair	Fertilizer application in a field at a variable rate using data from satellite images and other geospatial sources. LEOpatra is able to locate restricted zones in	- More precise in some areas, particularly in rivers and shallow water. - Open and free access to information	- Identification of the extension of water bodies fail in accuracy. - Cost of high resolution EO data makes it not practicable

	Based on Linked Data		which fertilizers are either prohibited or restricted in quantity.		to use this data source for the desired low-cost mobile application.
12	The Multi-Objective Optimization Algorithm Based on Sperm Fertilization Procedure (MOSFP) Method for Solving Wireless Sensor Networks Optimization Problems in Smart Grid Applications	- Hisham A. Shehadeh - Mohd Yamani Idna Idris	The purpose of this document is to discuss the challenges faced by wireless sensor networks (WSN) and the need for optimization methods to improve their quality of service (QoS)	- It does provide information on proposed algorithms and studies that aim to optimize network features - improve the quality of service (QoS) of wireless sensor networks (WSN) used in various applications such as smart grids and healthcare.	- Delay of data aggregation, interference and fading, and security issues in wireless communication. - Decreased network performance and reliability - Limitations and trade-offs in optimizing network features.
13.	Estimating Crop Nutritional Status Using Smart Apps to Support Nitrogen Fertilization. A Case Study on	- Livia Paleari - Ermes Movedi - Fosco M. Vesely	To discuss the development and testing of a diagnostic system for supporting nitrogen fertilization in paddy rice using smart apps to derive a nitrogen nutritional index (NNI).	- The system uses inexpensive and highly portable tools like smartphones for non-destructive estimates of Ncrit and actual PNC - The system provides real-time information for nitrogen management in rice crops, which could help farmers improve their use of fertilizers and reduce environmental damage	- The system relies on the use of smartphones and non-destructive methods for assessing plant nitrogen status - The system may require some level of technical expertise and training for farmers to effectively use

	Paddy Rice				and interpret the data provided by the apps.
14.	Wireless Sensor Network System Design using Raspberry Pi and Arduino for Environmental Monitoring Applications	- Sheikh Ferdoush - Xinrong Li	To talk about a system for a wireless sensor network that was made with open-source hardware platforms Raspberry Pi and Arduino and the XBee S2B ZigBee module.	- The system is designed to be affordable, allowing a wider range of customers to utilize it. - The system's small size makes it easy to use in a variety of settings. - The framework is not difficult to alter, permitting clients to add or change sensors and different parts on a case by case basis.	- It is not easy to understand for users who are new to the IT field
15	Smart Monitoring Temperature and Humidity of the Room Server Using Raspberry Pi and Whatsapp Notifications	- Dwi Ely Kurniawan	To describe a system that monitors the temperature and humidity of a server room with the help of IoT technology, the wireless sensor Wemos DHT Shield, and the Raspberry Pi.	- It provides real-time monitoring of a server room's temperature and humidity, which is essential for maintaining the room's normal temperature and humidity. - If the temperature or humidity exceeds predetermined standards, the system can notify the administrator of the server room through WhatsApp.	- The system relies on the availability of a stable internet connection to send notifications to the server room admin via WhatsApp. - the system requires the use of multiple devices, which may increase the complexity of the system and require additional maintenance.
16.	Smart farming is key to developing sustainable agriculture	- Achim Walter - Robert Finger	- To talk about the potential advantages and drawbacks of using information and communication technology (ICT) in agriculture, especially when smart farming methods are used.	- By minimizing or applying inputs, such as fertilizers and pesticides, to specific sites in precision agriculture systems, smart farming can reduce farming's ecological footprint. - Product quality can also be improved by optimizing management.	- The use of ICT in agriculture raises legal and ethical challenges related to data ownership, property rights, and accountability for mismanagement.

17.	Smart fertilizer management: the progress of imaging technologies and possible implementation of plant biomarkers in agriculture	- Raj Kishan Agrahari - Yuriko Kobayashi - Takashi Sonam Tashi Tanaka	- To talk about how smart fertilizer management and precision agriculture can make use of a variety of imaging and sensor technologies and biomarkers.	- The application of fertilizer can be managed automatically, quickly, and in real time by combining phenotyping with IoT and robotics. - In order to detect nutrient deficiencies early, biomarkers can be used to monitor plant responses to nutrients in real time at the beginning of plant development.	- Some of the advanced imaging and sensor technologies, such as hyperspectral imaging and portable sensors, can be expensive to acquire and maintain, which may limit their adoption by small-scale farmers.
18.	The Antelope Interface to PHP and Applications: Web-based Real-time Monitoring	- K.G. Lindquist - R.L. Newman - F.L. Vernon	- To encourage the development of web-based tools for environmental monitoring and data analysis and to inform readers about the Antelope PHP interface's capabilities and potential applications.	- Support for object-oriented programming in PHP 5, which makes it possible to properly handle object ring buffer (ORB) packets and explore their contents. - Cascading style sheets (CSS) allow for the separation of content and layout, resulting in concise and uncluttered application source code and complete application customization without the need for prior knowledge of PHP or HTML.	- Stateless nature of HTTP communications and the need to start database operations afresh with each invocation of an Antelope-PHP web page.
19	PHP-based undergraduate data reporting and teaching quality evaluation information system	- Xin Zhang - Zhengang Wei - Tongjun Han	- To talk about how a PHP-based undergraduate data reporting and teaching quality evaluation information system came to be.	- In order to guarantee the standard and consistency of the entire data, the system establishes a standard data storage model and uses reasonable default values to complete missing data.	- Data governance is a long-term and complex task, and that the system's data cleaning process lacks accurate and feasible standards and strategies.

20.	A Framework for Web Based Student Record Management System using PHP	- Er. Saurabh Walia - Er. Satinderjit Kaur Gill	- To talk about how PHP and MySQL were used to create a web-based system for managing student records. - Details on the method used to build the system, including how PHP, MySQL, and SQL were used.	- There won't be any need to keep records by hand. - Support for using protocols like IMAP, POP3, and HTTP to communicate with other services. - Complex logging system to keep track of all user access and make sure that data access rules are changed.	- The device must have high specifications to develop the system.

2.22 Summary of Related Project Research

Generally speaking, it seems that most prior research projects using Python or PhpMyAdmin have employed the same hardware and software. Also, this project utilises a Raspberry Pi 4 Model B to gather data from the fertilization process, whereas the prior journal utilised a different version of the Raspberry Pi. Basically, the idea of this project is to show the rancher that they can use any kind of device, such a tablet or smartphone, to access the framework. Thanks to the supplied data, the user may additionally observe their plant. Users are unable to monitor their plants at all times due to the system's inability to be accessed via an unstable internet connection. The system for this project will be the Raspberry Pi 4 Model B, which takes some electricity to run in place of the microcontroller-based system. The middle and tiny dimensions of the credit card-sized Raspberry Pi device. The methodology will encompass all developments.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The methodology is the overarching research plan that specifies the methodologies to be employed together with how the study will be carried out. These procedures, which are outlined in the methodology, specify the ways in which data is to be collected or, in some situations, how a certain outcome is to be computed. Although much attention is devoted to the nature and types of processes to be followed in a certain operation or to attain a target, the methodology does not prescribe precise procedures. Such processes, when suitable for a methodological study, provide a constructive generic framework that may be divided into smaller processes, joined, or have their order altered. Parallel to a technique, a paradigm is a constructive framework. The development of paradigms in theoretical work satisfies most, if not all, of the requirements for methodology. Similar to a paradigm, an algorithm is a kind of constructive framework; that is, instead of being a physical array, the building is a logical array of connected pieces.

3.2 Project Workflow

Creating an orderly an efficient workflow chart is critical for identifying and ensuring the success of project. A well-organized and planned strategy is crucial for a successful venture. When you have finished your planning, the following step is to undertake research. A project must implemented to make things simpler. Therefore, the project's design is produced, and the project execution because of extensive investigation.

3.2.1 Block Diagram

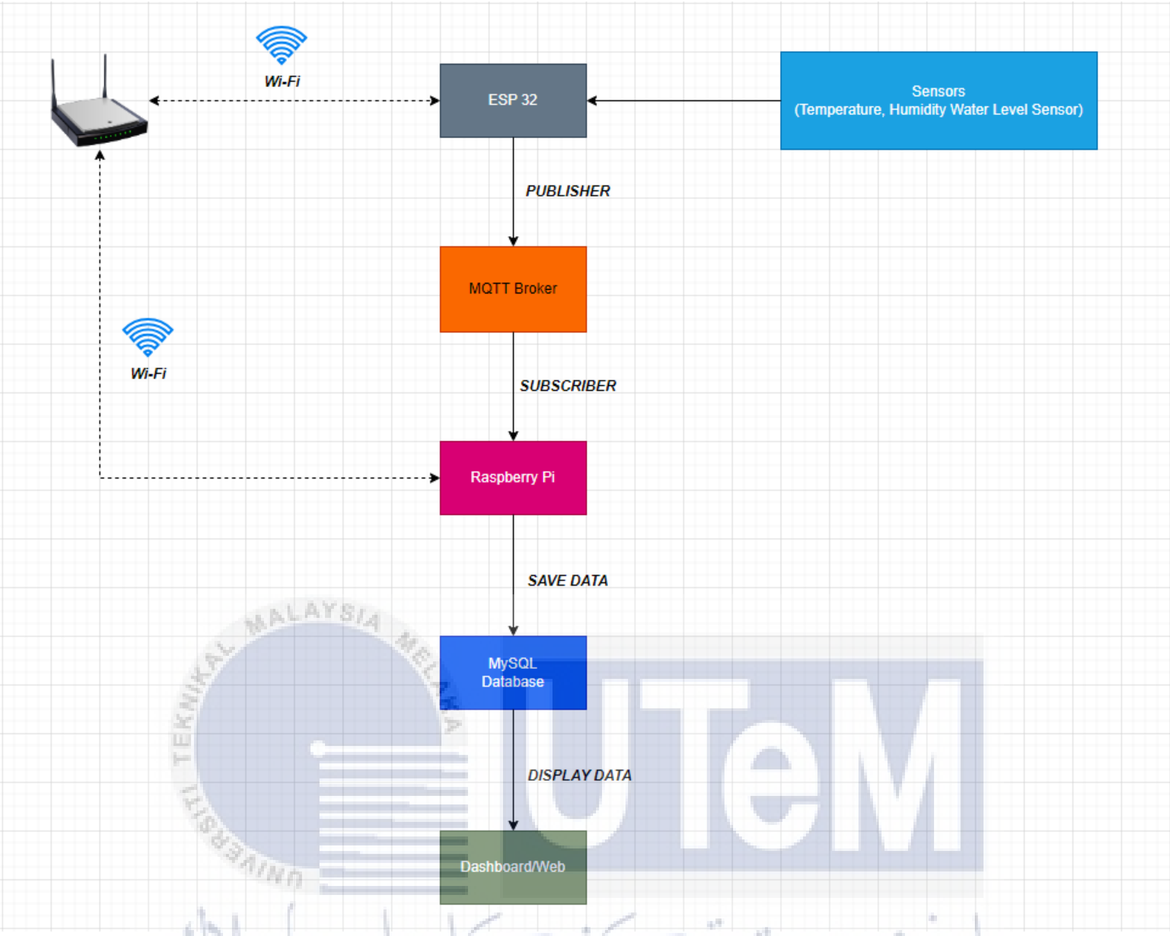


Figure 3-1 Block Diagram

As shows in Figure 3-1, the system begins when sensors Temperature, Humidity and Water Level Sensor connected with ESP 32. ESP 32 with configure as MQTT Client. Then, ESP 32 will connected with MQTT Broker. ESP 32 will send the data sensors to MQTT broker. Raspberry Pi being as subscriber to receive data from ESP 32 throught MQTT Broker. Raspberry Pi will insert the data into MySQL Database. After the data insert into database, it will display at the Dashboard. The user can see the data by website and system will developed.

3.2.2 Flowchart For Project Development

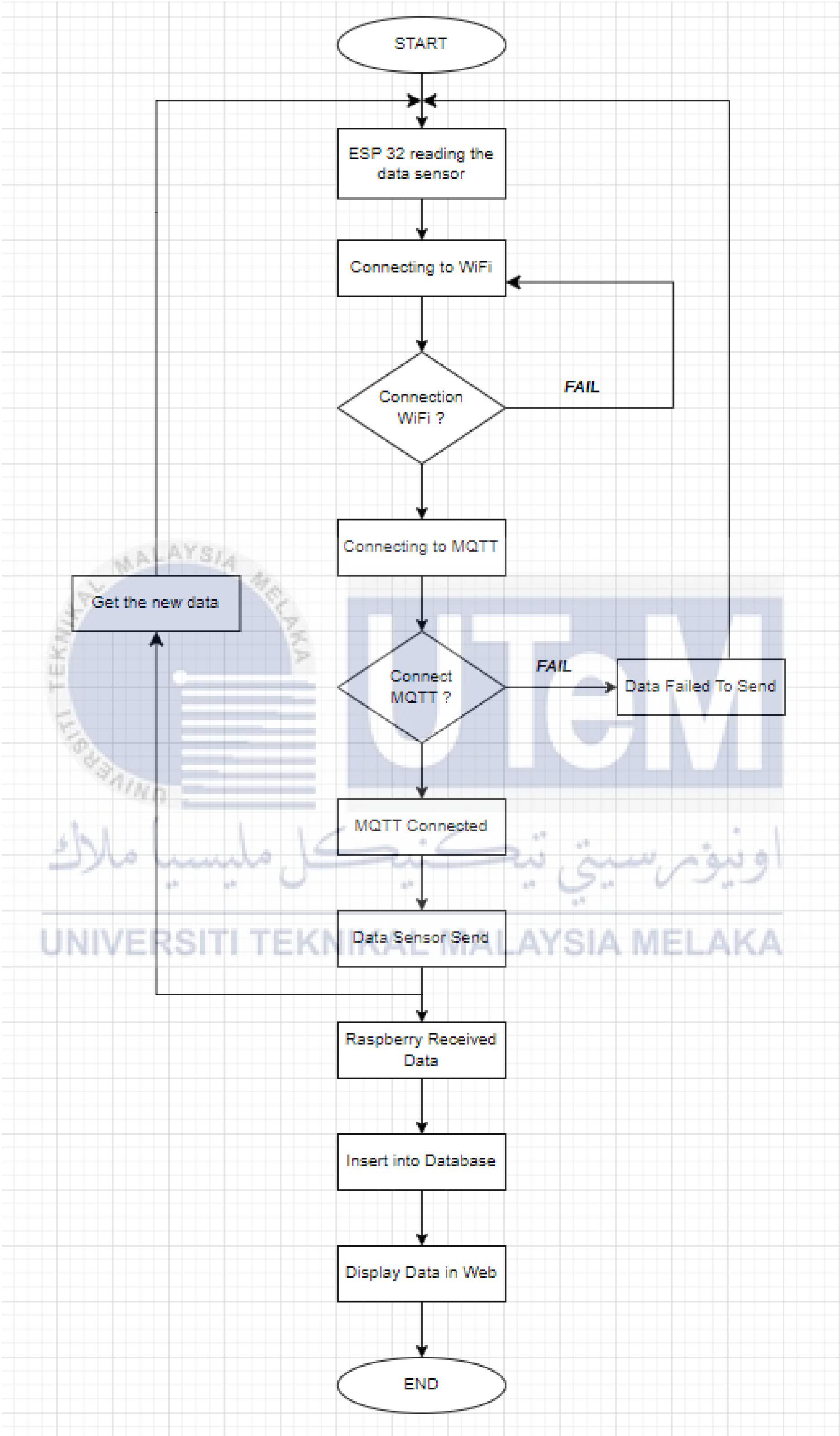


Figure 3-2 Flow Chart of the Project Development

3.2.3 Setup Microcontroller ESP 32 to Raspberry Pi Communication

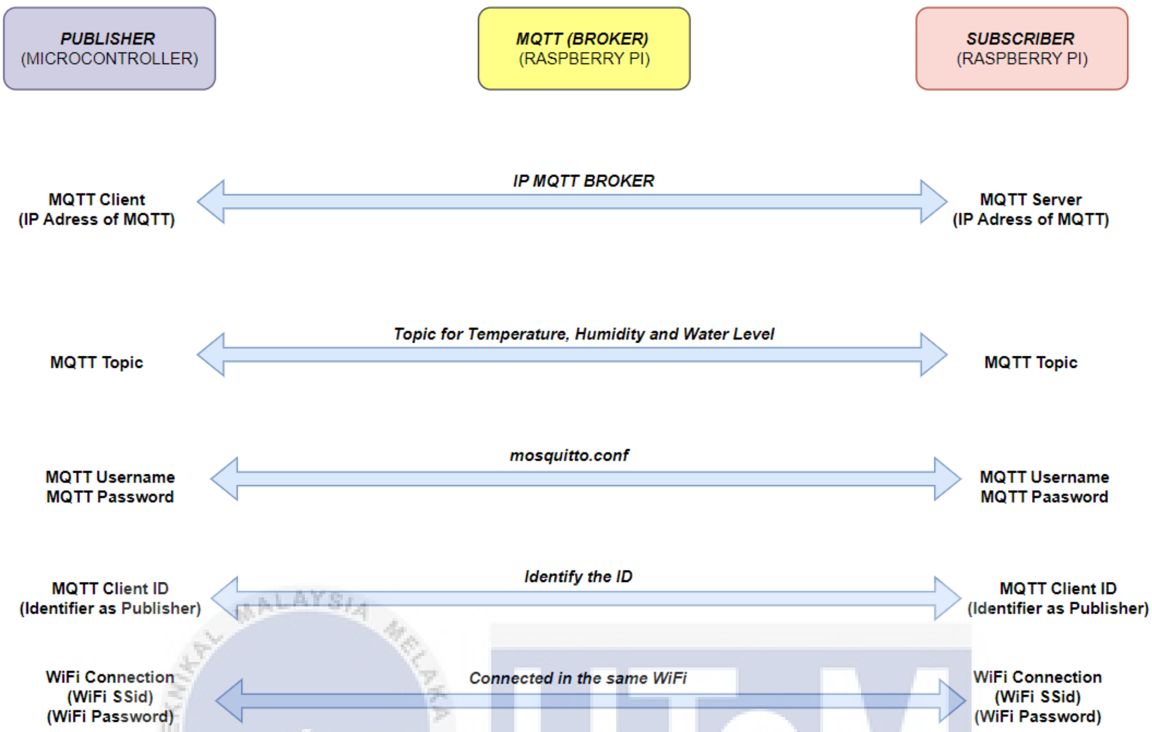
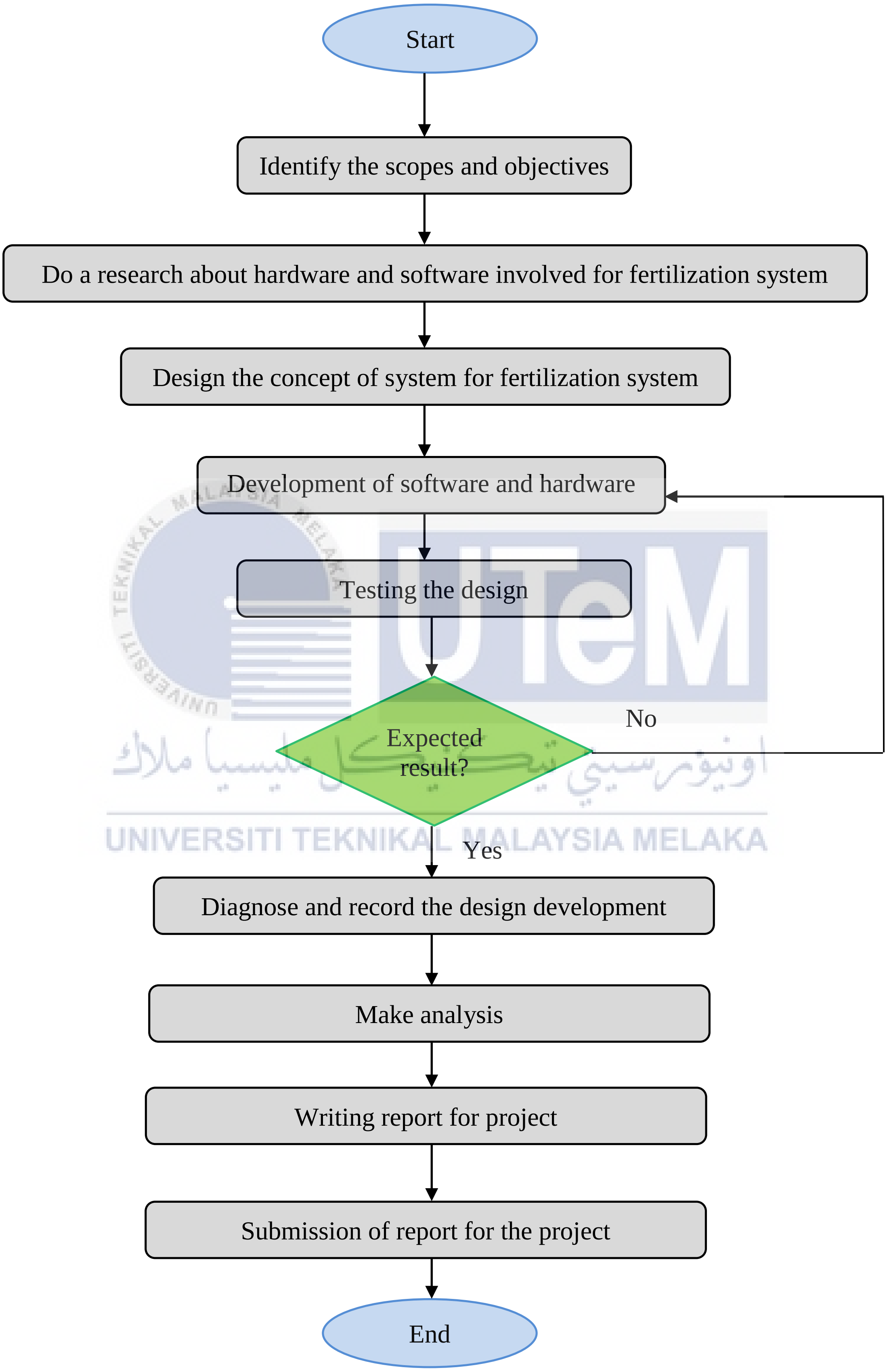


Figure 3-3 Communication Between ESP 32 with Raspberry Pi

Figure 3-3 shows the communication between of ESP 32 with Raspberry Pi. First we need define the variables that are related publisher, broker and subscriber. ESP 32 as the publisher while the MQTT Broker as the middle of communication to communicate with ESP 32 and Raspberry Pi. The MQTT Broker IP adress must same as the Raspberry Pi network address. We must identify first in the Raspberry Pi using Command Tool (hostname –I). The topic we are set to publish topic for tempertature, humidity and Water level to send the data to subscriber which is Raspberry Pi. MQTT username and password we create in Raspberry Pi using mosquitto.conf. Id of MQTT mut have too. MQTT Client and MQTT server must connected in the same wifi network.

3.2.4 Flowchart For PSM



3.2.5 Gantt Chart

Table 3-1 Gantt Chart For PSM (1)

ACTIVITY	WEEK													
FYP (1)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Determination of tittle														
Meeting and Discuss with Supervisor														
Registration of tittle														
Online meeting with JK PSM														
Project Planning with Supervisor														
Discuss the flow of the project														
Discuss the component will be applied														
Discuss the expected output														
Writing Report														
Abstract														
Chapter 1: Introduction														
Background														
Problem Statement														
Project Objective														
Scope of Project														
Visit the plantation site and observe the structure with Supervisor														
Chapter 2: Literature Review														
Do research about the project														
Comparison of Previous Chapter														
Submit Draft of Literature Review														
Chapter 3: Methodology														
Block Diagram														
Flow chart of the project														
Research about software and hardware														
Chapter 4: Results and Discussion														
Preliminary Results														
Chapter 5: Conclusion														
Future Works Recommendation														
Submit Report														
Check Plagiarism at Turnitin														
Presentation PSM														

Table 3-2 Gantt Chart for PSM (2)

ACTIVITY	WEEK													
FYP (2)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Meeting and Discuss with Supervisor														
Meeting and Discuss with Supervisor														
Project Planning with Supervisor														
Discuss the flow of the project in site														
Discuss the component will be applied														
Discuss the expected output														
WINDOWS														
Developed the database MySQL														
Test the database														
Develop the user interface system														
Developed the php coding														
Connect the database with php coding														
Show the progress to supervisor														
Test the system														
Redevelop the system (repair)														
Transfer the php file from windows to raspberry Pi														
RASPBERRY PI														
Data transfer using WinSCP														
Install MQTT Broker														
Install MQTT Client														
Develop Coding Python for MQTT														
Transfer Database														
Testing the fully system														
Implement the system in Raspberry Pi														
Connect MQTT with ESP 32														
Writing Report PSM														

The Gantt chart for the PSM2 project is displayed in the table above. I developed a system that ran on the Windows operating system from the first to the tenth week. On the eleventh week, once everything was prepared and tested without any issues, I moved the file system (PhP) to the Raspberry Pi platform. In the eleventh week, I set up MQTT and worked on the Raspberry Pi database.

3.2.6 Entity Relationship Diagram

An Entity-Relationship Diagram (ERD) is a visual representation of the relationships among entities in a database system. It illustrates how different entities interact with one another and the nature of those interactions. In the diagram, entities are represented as boxes, and relationships between them are depicted by connecting lines. Each entity has attributes, which are characteristics or properties associated with it. Primary keys uniquely identify each record in an entity, while foreign keys establish relationships between entities. ERDs serve as a crucial tool in database design, aiding in the conceptualization and communication of the database structure, ensuring a clear understanding of data organization and relationships within a system.

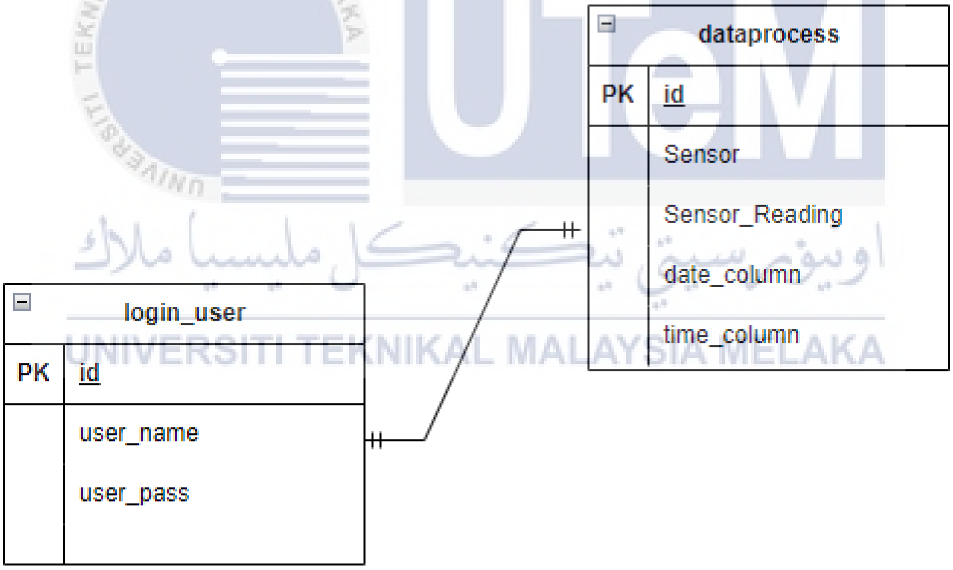


Figure 3-4 Entity Relationship Diagram (ERD)

3.3 Hardware Implementation

3.3.1 Raspberry Pi

The Raspberry Pi line of small single-board computers was developed in the United Kingdom by working together with Broadcom and the Raspberry Pi Foundation. These computers are made to be affordable, about the size of a credit card, and can be used by professionals as well as hobbyists. The Raspberry Pi boards are frequently utilized in a variety of projects and applications, including media centers, retro gaming consoles, home automation, and robotics. Over the years, the Raspberry Pi Foundation has released a number of models, each with unique capabilities and specifications. The Raspberry Pi 4 Model B, Raspberry Pi 3 Model B+, Raspberry Pi 2 Model B, and Raspberry Pi Zero are a few of the most well-liked variants. The Raspberry Pi boards typically include a system-on-a-chip (SoC) with a CPU, GPU, RAM, and other operating system-related components.

Figure 3-5 Raspberry Pi 4 Model B

Table 3-3 Comparison of model Raspberry Pi [21]

Model	Raspberry Pi 4 Model B	Raspberry Pi 3 Model B+	Raspberry Pi 2 Model B	Raspberry Pi Zero
Processor	Broadcom BCM2711	Broadcom BCM2837B0	Broadcom BCM2836	Broadcom BCM2835
Processor Speed	Quad-core Cortex-A72	Quad-core Cortex-A53	Quad-core Cortex-A7	Single-core ARM11
CPU Clock Speed	1.5GHz	1.4GHz	900MHz	1GHz
RAM	2GB, 4GB, or 8GB LPDDR4	1GB LPDDR2	1GB LPDDR2	512MB LPDDR2
GPU	VideoCore VI	VideoCore IV	VideoCore IV	VideoCore IV
USB Ports	2x USB 3.0, 2x USB 2.0	4x USB 2.0	4x USB 2.0	1x Micro USB (for power and data)
Ethernet Port	Yes	Yes	Yes	Yes
Storage	MicroSD card slot	MicroSD card slot	MicroSD card slot	MicroSD card slot

GPIO Pins	40-pin GPIO header	40-pin GPIO header	40-pin GPIO header	40-pin unpopulated GPIO header
Power Requirements	5V, 3A	5V, 2.5A	5V, 1.8A	5V, 1A

3.4 Software Implementation

3.4.1 Xampp

A complete web server solution for local development is provided by Xampp, a free and open-source software package. It includes the web server software Apache, the database management system MySQL, the web development scripting language PHP, and the general-purpose programming language Perl. You can develop and test websites or web applications offline before deploying them to a live server by setting up a local web server on your computer with XAMPP. Because it is so easy to set up a local development environment, developers use it a lot.

Figure 3-6 Xampp Server

3.4.2 Apache Web Server

The Apache Software Foundation is responsible for the development and upkeep of the open-source web server software known as the Apache HTTP Server, or Apache for short. It has been a dominant player in the web hosting industry for a number of years and is one of the most widely used web server software in the world. The delivery of web content over the internet is handled by Apache Server. It works by returning the requested content to clients, such as web browsers, after accepting requests. This content can incorporate site pages, pictures, recordings, documents, and different assets.

Figure 3-7 Apache Web Server

3.4.3 MySQL Database

Open-source relational database management system (RDBMS) MySQL is widely utilized for structured data management and organization. It is renowned for its dependability, scalability, and performance, making it one of the most widely used databases worldwide. The client-server architecture of MySQL enables a client application to communicate with the MySQL server to carry out a variety of database operations, including data storage, retrieval, updating, and deletion. It can be used for everything from small personal projects to large-scale business systems.

Figure 3-8 MySQL Database Logo

Table 3-4 : Comparison Between MySQL and Oracle Database [22]

Specifications	MySQL	Oracle
Licensing	Open-source (GPL) or commercial	Commercial
Performance	Good for small to medium-sized applications	Scalable and high-performance for large-scale applications
Target Market	Web applications, startups, small businesses	Enterprise-level applications, large corporations
Data integrity	Basic enforcement mechanisms	Advanced security and integrity features
Data types	Standard data types	Support for complex data types

3.4.4 PhPMyAdmin

PhpMyAdmin is a well-known web application for managing MySQL or MariaDB databases. It has a graphical user interface that makes it easy for people to work with the database without having to use tools for the command line. PhpMyAdmin gives users the ability to create, edit, and delete databases, tables, and fields, among other things. It also lets users run SQL queries, manage user accounts and permissions, import and export data, and carry out other database administration tasks. PhpMyAdmin is easy to use for managing databases because it is written in PHP and can be accessed through a web browser.

Figure 3-9 PhpMyAdmin

3.4.5 Sublime Text 3

A text editor for coding and programming, Sublime Text 3 is versatile and effective. It improves productivity and makes code editing more efficient by providing a command palette, syntax highlighting, multiple selections, split editing, and extensive language support. The accessibility of Bundle Control empowers simple establishment and the executives of modules, while the supervisor's adaptability permits clients to tailor its appearance and conduct. Sublime Text 3 has gained popularity among developers as a fast and dependable option for both large and small coding projects due to its lightweight and cross-platform capabilities.

Table 3-5 Advantages and Disadvantages of Sublime Text 3

Advantages	Disadvantages
The color themes that come with it are very pleasant and clear, which made it easier to code for a long time without straining your eyes.	While typing the code, the code's suggestion has some issues.
Sublime Text is a fantastic tool for writing code and markup text.	Due to the absence of integrated collaboration tools, Sublime Text 3 is unsuitable for real-time coding sessions.
Decent IDE and truly lovely to utilize programming.	Users are unable to directly contribute to its development or independently resolve issues as a result of this.

Figure 3-10 Sublime Text 3 Logo

3.4.6 Thonny

Thonny is a popular Python integrated development environment (IDE) that is beginner-friendly and easy to use. It is designed to be suitable for education and learning Python programming. Thonny can be installed and used on Raspberry Pi to develop Python applications. serves as an integrated development environment (IDE) on Raspberry Pi, offering a user-friendly platform for Python programming. Its primary functions include providing a code editor for writing Python scripts, an interactive shell for immediate code execution, and tools for debugging and managing Python packages. Thonny is designed to be beginner-friendly, making it suitable for learners and educators working with Raspberry Pi to explore and develop Python programming skills.

Figure 3-11 Thonny

3.4.7 Wi-Fi

WiFi, which stands for "Wireless Fidelity," is a technology that makes it possible for devices to wirelessly connect to the internet and communicate with one another. It is a well-liked approach to local area networking (LAN) that eliminates the requirement for actual wired connections. Data is transmitted between computers, smartphones, tablets, and other electronic devices via Wi-Fi using radio waves. These devices can connect to Wi-Fi networks because they have Wi-Fi capabilities built into their hardware. A wireless router or access point serves as the network's central hub in a typical Wi-Fi setup. A wireless signal that devices can detect and connect to is broadcast by the router, which is connected to an internet source like a modem. A device can access the internet and communicate with other devices that are connected to the same Wi-Fi network. Wi-Fi networks use a variety of standards, such as 802.11n, 802.11ac, or the most recent 802.11ax (Wi-Fi 6), and they operate on various frequencies, typically 2.4 GHz or 5 GHz. Data transfer rates, network security, and other features are all specified in the standards. With the availability of public Wi-Fi hotspots, Wi-Fi has become ubiquitous in homes, offices, public spaces, and even on the go.

Figure 3-12 WiFi icon

3.4.8 Mosquitto (MQTT Broker)

An MQTT broker serves as a central communication hub in the MQTT protocol, facilitating the exchange of messages between devices in a publish/subscribe model. Devices, acting as publishers, send messages to specific topics, while subscribers express interest in receiving messages on those topics. The broker, such as Mosquitto or HiveMQ, manages the routing and delivery of messages based on topics, ensuring that subscribers receive relevant information from publishers. With support for different Quality of Service levels and security features, MQTT brokers play a crucial role in enabling efficient, lightweight, and reliable communication in various applications, including IoT and home automation, where bandwidth and latency considerations are paramount.

Figure 3-13 Mosquitto (MQTT)

3.5 Summary

This chapter outlines a number of crucial steps. First, the components of the hardware are chosen and set up. The Raspberry Pi 4 Model B is one of these, and it is used to collect data for fertilization. In this project, software databases and web servers like PhpMyAdmin and MySQL will be used to store the fertilization system's data collection. The sublime text3 is used to create a user interface for their plant observation. We design a user interface that is straightforward and simple to use for everyone in order to guarantee that the user comprehends the system. The database and table will grow properly and become easy to observe and comprehend. The MQTT (Message Queuing Telemetry Transport) protocol functions as a lightweight and efficient messaging protocol designed for reliable communication in constrained or unreliable networks. It operates on a publish/subscribe model, where devices can publish messages to specific topics, and other devices can subscribe to receive messages on those topics. We declare the topic of the data at ESP 32 and Raspberry Pi by using python coding langguage.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the preliminary results of the “Development of A Smart Fertilization System Using MySQL Database For Modern Farms” the progress that was made in the implementation of a smart fertilization. The goal of this study is to optimise the good condition of plant by fusing IoT technology with Rapsberry Pi 4 Model B. The technology seeks to give data to customers to observe their plantation. The preliminary results will show the user interface for modern farmes to see their data-process plantation. The system's performance, energy efficiency and satisfaction with it are currently the subject of additional investigation and assessment with the aim of advancing the creation of smart fertilization applications and advancing sustainable living.

4.2 Project Hardware Sensor

Figure 4.1 and Figure 4.2 below shows the Sensor DHT 11 and Water Level Sensor showing where the two sensors are placed. DHT 11 is placed in the middle of the level of crops and the Water Level sensor is placed at the lowest level of crops beacause we want to measure the avaibality of water for plant.

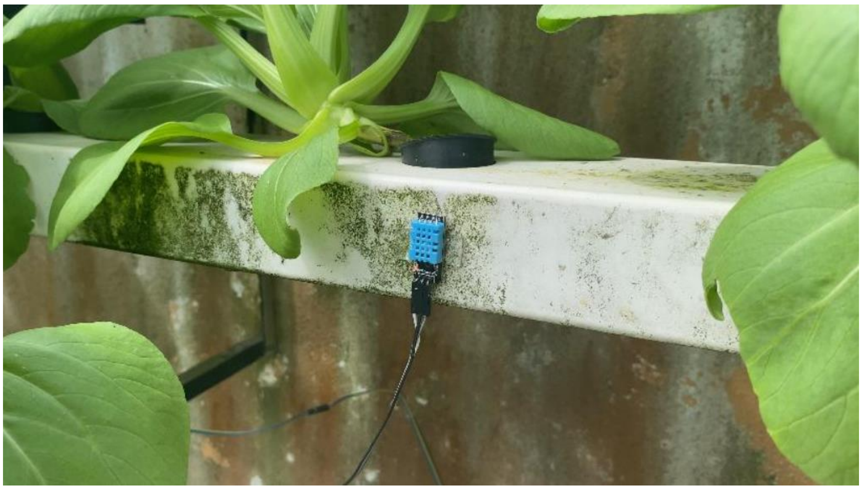


Figure 4-1 DHT 11 Sensor

Figure 4-2 Water Level Sensor

4.3 Project Demonstration

Figure 4.3 shows illustrates the block diagram of the internet connection between ESP 32 and the internet access point, which is the WiFi router. The data will show at the monitor which is the WiFi Client.

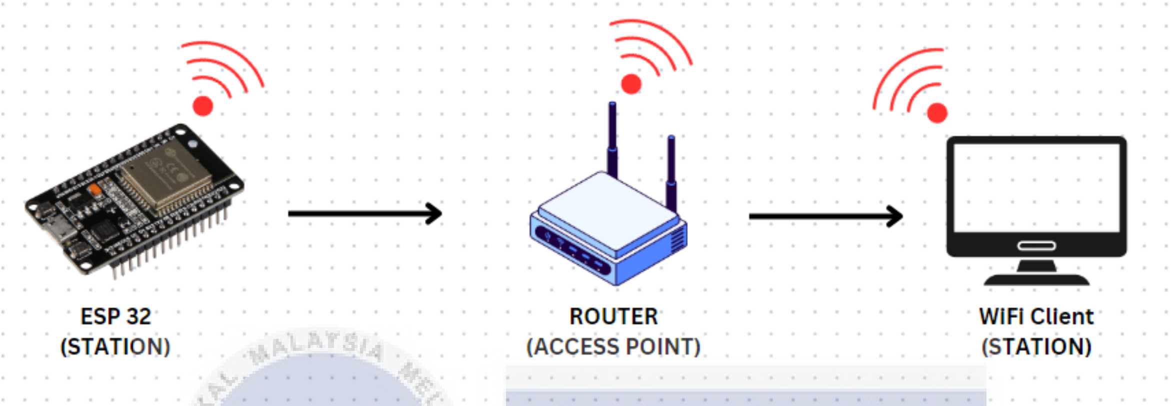


Figure 4-3 Block Diagram Of Internet Connection to ESP 32

```
Humidity: 72.00 %
Temperature: 30.50 *C
Water Level: 0
Connecting to nasanetwork@Mesh
..WiFi connected
IP address: 192.168.68.64
```

Figure 4-4 Serial Monitor WiFi Connected

Figure 4-4 shows the ESP 32 is already connected to the nasanetwork@Mesh internet connection, so it can request the information from the internet using ESP 32 board such as DH11 sensor and Water Level Sensor and publish data to Raspberry Pi using the MQTT protocol.

4.3.1 Data from ESP 32 with DHT 11 Sensor and Water Level Sensor (using MQTT Protocol

The Figure 4-5 shows the connection between ESP 32 (Publisher) and Raspberry Pi (subscriber) successfully connected using MQTT Client ID. All the data that will be given to the Raspberry Pi when the ESP 32 receives from the DH11 sensor and Water Level Sensor. All data from the ESP 32 was sent using IP address from the broker to be identfied. Arduino IDE must declared the topic of the sensor to publish the data in raspberry. MQTT username and MQTT pasword also must have to send data in the true platform.

Figure 4-5 Setup WiFi and MQTT in Arduino IDE

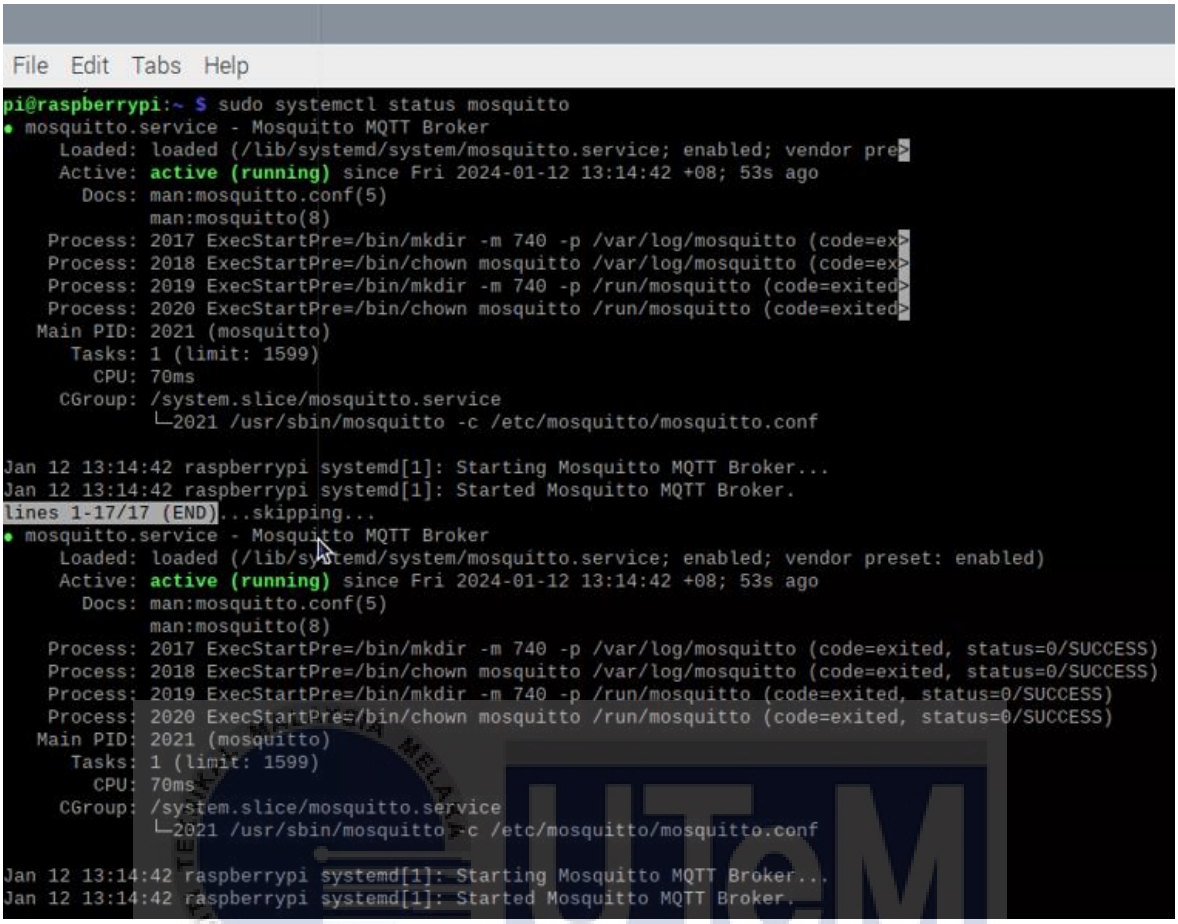


Figure 4-6 Status MQTT Active (Running)

Figure 4-6 shows the status of MQTT broker is running and active. Subscribing to a topic and observing received messages can indicate if the broker is actively processing data. Reviewing the broker's logs for error messages provides insights into potential issues. Some MQTT brokers offer administrative interfaces or command-line tools to check overall status and connected clients. While there isn't a standardized "status" command in MQTT, a combination of these approaches helps monitor and ensure the proper functioning of the broker.

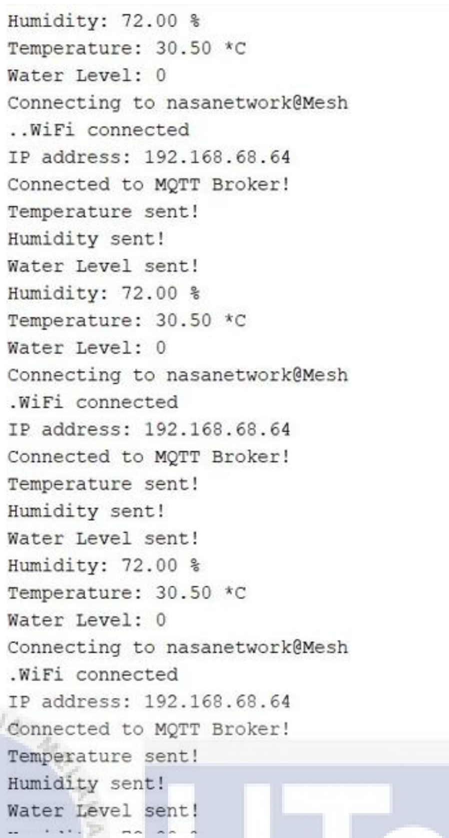


Figure 4-7 WiFi and MQTT Broker Connected

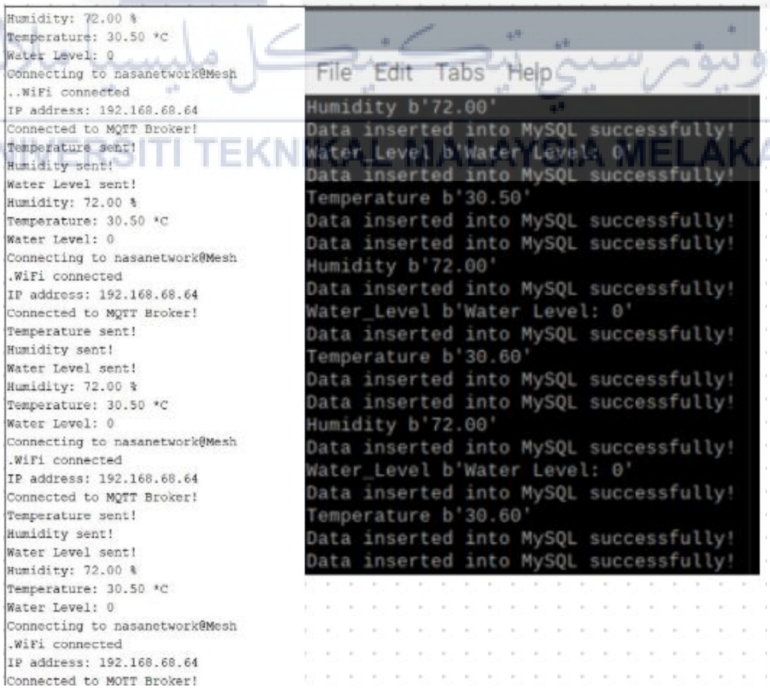


Figure 4-8 Output From ESP 32 to Raspberry Pi using MQTT Protocol

4.3.2 Data from ESP 32 with DHT 11 Sensor and Water Level Sensor Publish in MySQL Database

To publish data from an ESP32 equipped with a DHT11 sensor and a water level sensor to a MySQL database, a systematic process is followed. First, a MySQL database is established with a corresponding table to store sensor readings. The necessary libraries for ESP32 development and MySQL connectivity are installed. The ESP32 code, written in the Arduino IDE, involves initializing sensors, connecting to Wi-Fi, reading sensor data, establishing a connection to the MySQL database, and inserting the collected data into the designated table. The code is uploaded to the ESP32 through the Arduino IDE, and the Serial Monitor is used for debugging. Customization includes adjusting sensor pins and implementing security measures for MySQL credentials. Troubleshooting involves monitoring the Serial Monitor for errors and verifying hardware connections. This comprehensive approach ensures a successful integration of sensor data with a MySQL database for effective monitoring.

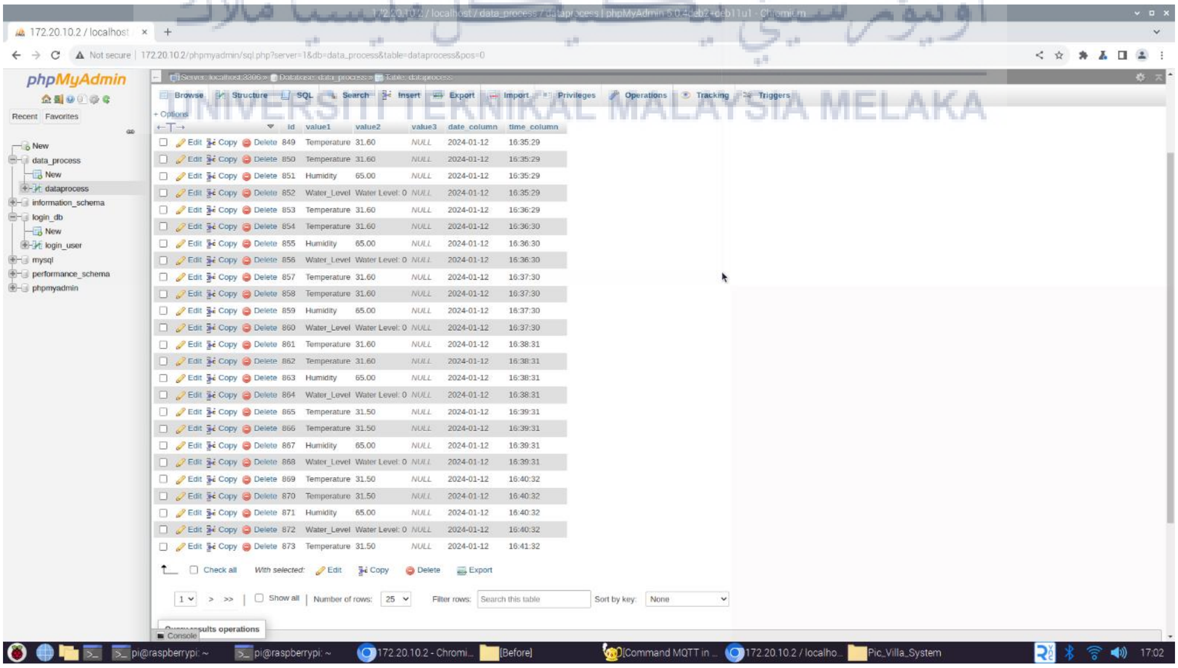


Figure 4-9 Data From the Sensor Data

4.3.3 System and User Interface for Display Data Sensor via Website

Creating a system and user interface for displaying sensor data via a website involves setting up a web server, developing a backend to fetch data from a MySQL database, and creating APIs to expose this data. On the frontend side, HTML, CSS, and PHP are used to design an interactive interface, often employing frameworks like React or Angular. Real-time updates can be implemented using technologies like WebSockets. Visualization of sensor data is achieved through charting libraries, aiding users in interpreting trends. Optional features such as user authentication and responsive design contribute to a secure and user-friendly experience. Testing ensures functionality, responsiveness, and security before deploying the website on a chosen hosting platform. Continuous monitoring and maintenance are crucial for a successful and reliable system.

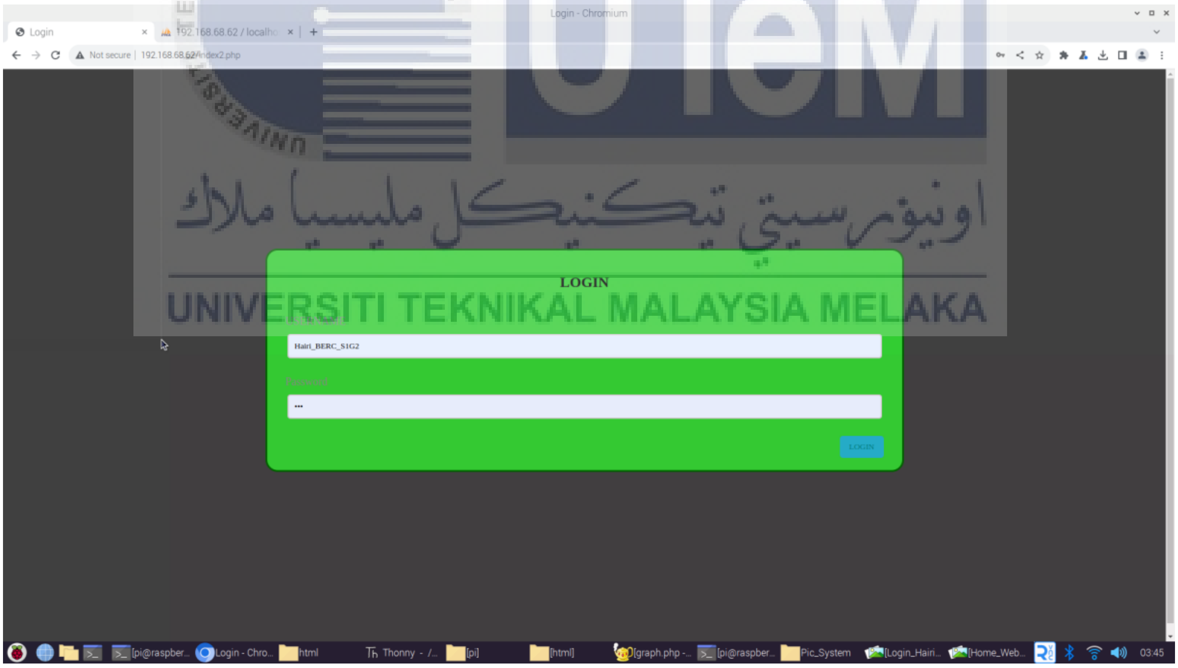


Figure 4-10 Login For User

Figure 4-11 Main Interface After Login

ID	Date	Time	Sensor	Sensor Reading
740	2024-01-12	03:26:00	Water_Level	Water Level: 0
739	2024-01-12	03:26:00	Humidity	71.00
738	2024-01-12	03:25:59	Temperature	30.60
737	2024-01-12	03:25:59	Temperature	30.60
736	2024-01-12	03:23:52	Water_Level	Water Level: 1
735	2024-01-12	03:23:52	Humidity	72.00
734	2024-01-12	03:23:52	Temperature	30.60
733	2024-01-12	03:23:52	Temperature	30.60
732	2024-01-12	03:21:47	Water_Level	Water Level: 0
731	2024-01-12	03:21:47	Humidity	72.00
730	2024-01-12	03:21:47	Temperature	30.50
729	2024-01-12	03:21:47	Temperature	30.50
728	2024-01-12	03:20:45	Water_Level	Water Level: 0
727	2024-01-12	03:20:45	Humidity	72.00
726	2024-01-12	03:20:45	Temperature	30.50
725	2024-01-12	03:20:45	Temperature	30.50
724	2024-01-12	03:19:44	Water_Level	Water Level: 0
723	2024-01-12	03:19:44	Humidity	72.00
722	2024-01-12	03:19:44	Temperature	30.40
721	2024-01-12	03:19:44	Temperature	30.40
720	2024-01-12	03:18:42	Water_Level	Water Level: 0
719	2024-01-12	03:18:42	Humidity	72.00
718	2024-01-12	03:18:42	Temperature	30.40

Figure 4-12 Display Data Sensors

4.4 Analysis Project

4.4.1 Datasize in the MySQL Database

Figure 4-13 show the datasize of Database for table dataprocess. Datasize typically refers to the amount of storage space used by the data in a database. The size of a database is influenced by various factors, including the number of tables, the number of rows in each table, and the data types and sizes of the columns. Thus, 32.0 KiB (kibibytes) is the entire data size that we employ for this system. This shows that MySQL database is 32 kilobytes in total size. A kibibyte is equivalent to 1024 bytes and is a binary unit used in digital information storage.

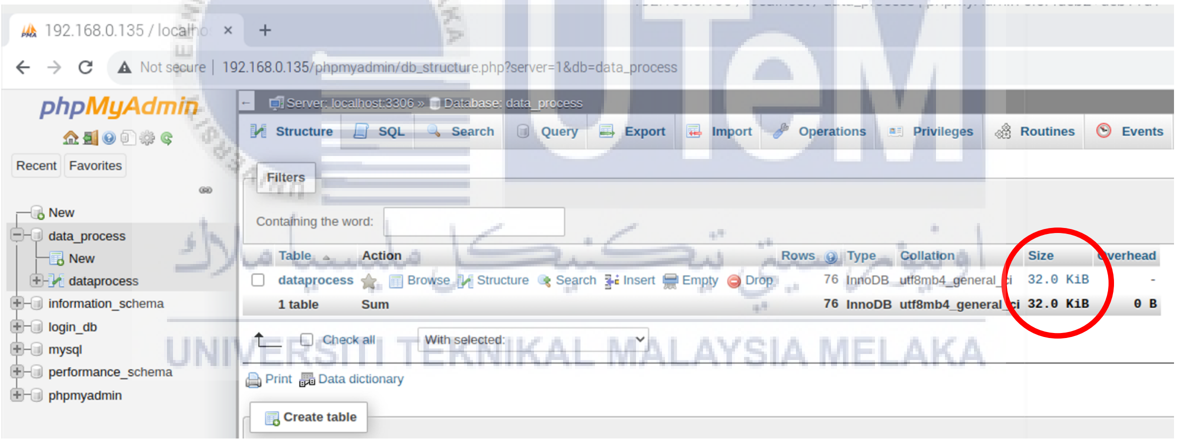


Figure 4-13 Data Size Of Database

4.4.2 Data Sensor Analysis By Time

Table 4.1 shows the data taken by MQTT which is taken by mqtt in real time and published into the MySQL database. The data taken is the DHT11 sensor which is the Temperature sensor and the Water Level Sensor. Analysis is also taken to see the accuracy of the real time system.

Table 4-1 Data Sensor Taken By Time

TIME	TEMPERATURE	HUMIDITY
4.35 p.m	31.6	65
4.36 p.m	31.6	65
4.37 p.m	31.6	65
4.38 p.m	31.6	65
4.39 p.m	31.5	65
4.40 p.m	31.5	65
4.48 p.m	31.5	65
4.49 p.m	31.4	65
4.50 p.m	31.4	65
4.51 p.m	31.3	65
4.52 p.m	31.3	65

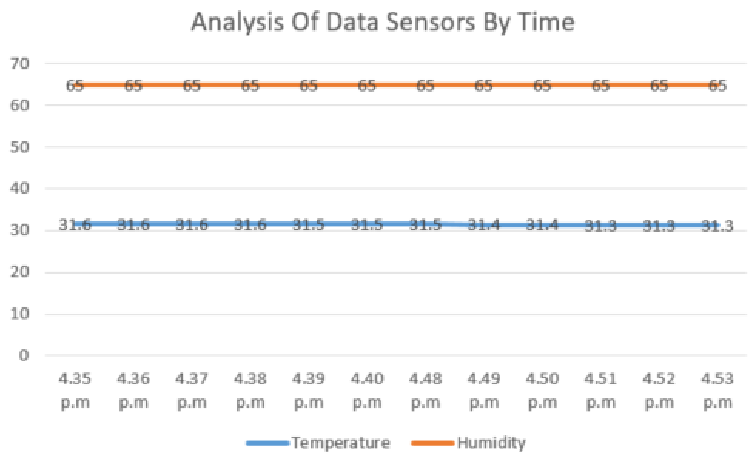


Figure 4-14 Graph of Data Analysis

Figure 4-13 show the graph of the Temperature and Humidity based on Time. As we can see at 4.38 p.m the temperature 31.6 celcius because the weather sunny and hot. But, at 4.52 p.m the temperature drop to 3.13 celcius because the weather cloudy and not as hot like 4.38 p.m.

4.5 Discussion

Overall testing consists of testing two components, namely hardware and software. The first part is the sensor, which works as the first input to the microcontroller. The second part is the receiver, which is linked to the microcontroller to process received data. The receive data will subsequently be saved in the MySQL database. Finally, the condition of hydroponic plant system will be automatically shown via the Website. A user friendly system also succes without any error for the last testing. A user-friendly interface in the context of a website displaying sensor data refers to a design that prioritizes simplicity, intuitiveness, and efficiency, enhancing the overall user experience. This involves presenting information in a clear and organized manner, using easily navigable menus and controls.

However, there are various issues that must be addressed while carrying out this project. Among the concerns are:

1. Network connection
2. The problem of data transmission from ESP 32 to Raspberry Pi using MQTT Protocol because communication between publisher and subscriber is not connected.

There may be a solution to every dificulty. Perhaps the following step might be considered to solve the issue:

1. The network must be stable and free of any interruptions.
2. MQTT needs the correct configuration for the connection to succeed. This includes setup for IP address (MQTT server) and Topic for data.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, the marriage of technology and agriculture has given rise to the transformative field of Smart Fertilization Systems. By seamlessly integrating advanced technologies such as sensors, data analytics, and automated actuators, these systems represent a pivotal shift towards precision agriculture. The aim is clear: to optimize crop yield, conserve resources, and foster sustainable farming practices. At the core of this innovation is the strategic integration of a robust database system, exemplified by MySQL. The relational database not only serves as a repository for a wealth of data but acts as the backbone for intelligent decision-making within the Smart Fertilization System. From real-time insights derived from soil and weather sensors to the historical context encapsulated in past fertilizer applications, MySQL facilitates comprehensive agricultural management. This exploration into the intricacies of the Smart Fertilization System and its symbiotic relationship with MySQL highlights the empowerment of farmers and agricultural practitioners. Real-time data, historical analyses, and a user-friendly interface converge to provide a platform for informed decision-making. As we navigate the path towards enhanced crop productivity and sustainable agriculture, the Smart Fertilization System stands as a beacon of innovation, ushering in a new era where technology cultivates a greener and more efficient future for global agriculture.

5.2 Future Works

Future work for the smart fertilization system involves exploring the integration of machine learning algorithms for adaptive decision-making, diversifying the sensor network to include additional environmental parameters, and leveraging Internet of Things (IoT) devices with edge computing for enhanced connectivity and faster response times. Advanced data analytics techniques, such as predictive analytics and anomaly detection, can be incorporated to anticipate trends and optimize fertilization strategies proactively. Consideration of cloud-based solutions, collaboration with agricultural experts for field trials, and implementing energy-efficient measures are essential for scalability, user accessibility, and sustainability. Iterative design based on user feedback, integration with precision agriculture technologies, and expansion to different crops and regions will contribute to the continuous improvement and applicability of the system in diverse agricultural contexts.

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DEVELOPMENT OF A SMART FERTILIZATION SYSTEM USING MYSQL DATABASE FOR MODERN FARMS

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