Faculty of Electronics and Computer Technology and Engineering

DEVELOPMENT OF IOT-BASED FISH MONITORING SYSTEM FOR AQUACULTURE

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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DEVELOPMENT OF IOT-BASED FISH MONITORING SYSTEM FOR AQUACULTURE

NUR IZZATUL SYAZWANI BINTI MOHD RADZI

A project report submitted
in partial fulfillment of the requirements for the degree of
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FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

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DEDICATION

This project is dedicated to the unwavering support and love of my parents, whose sacrifices and encouragement have been my foundation throughout this academic journey. Your financial support has allowed me to pursue my dreams, and for that, I am immensely grateful.

I extend my heartfelt appreciation to my dedicated supervisor, Ts. Niza Binti Mohd Idris. Your guidance, patience, and continuous support from the inception to the completion of this project have been instrumental in its success. Your mentorship has been a guiding light, and I am truly thankful for the knowledge and skills gained under your tutelage.

To my friends, thank you for being the pillars of strength and for the camaraderie that made the challenges more manageable. Your moral support has been a source of inspiration, making this semester at Universiti Teknikal Malaysia Melaka memorable.

This achievement is not just mine but a collective effort, and I am grateful for the invaluable contributions of everyone who played a role in this endeavor.

ABSTRACT

Development of an IoT-based fish monitoring system for aquaculture is a project that focuses on leveraging IoT technology to monitor water quality, feeding patterns and scale of fish as many fisheries face various challenges including sub-optimal water quality and inefficient feeding patterns. In addition, they also monitor and control the aquarium manually. This system aims to design a fish monitoring system to ensure water quality and feeding patterns in real time can be optimized such as the use of resources such as water, food and energy. Based on the findings, a prototype IoT-based fish monitoring system will be developed using a combination of sensors such as temperature, turbidity and water level, a microcontroller (Arduino) and wireless communication. Therefore, quantitative data on system performance in terms of early detection of fish abnormalities, better water quality management and feeding patterns can be optimized.

ABSTRAK

Pembangunan sistem pemantauan ikan untuk akuakultur berasaskan IoT ialah projek yang memfokuskan pada memanfaatkan teknologi IoT untuk memantau kualiti air, corak pemakanan dan skala ikan memandangkan banyak perikanan menghadapi pelbagai cabaran termasuk kualiti air yang tidak optimum dan corak pemakanan yang tidak cekap. Selain itu, mereka juga memantau dan mengawal akuarium secara manual. Sistem ini bertujuan untuk mereka bentuk sistem pemantauan ikan bagi memastikan kualiti air dan corak pemakanan dalam masa nyata dapat dioptimumkan seperti penggunaan sumber seperti air, makanan dan tenaga. Berdasarkan penemuan, prototaip sistem pemantauan ikan berasaskan IoT akan dibangunkan menggunakan gabungan sensor seperti suhu, kekeruhan dan paras air, mikropengawal (Arduino) dan komunikasi tanpa wayar. Oleh itu, data kuantitatif mengenai prestasi sistem dari segi pengesanan awal keabnormalan ikan, pengurusan kualiti air yang lebih baik dan corak pemakanan dapat dioptimumkan.

ACKNOWLEDGEMENTS

In completing this final year project, I wish to extend my deepest gratitude to several individuals who have played important roles in its realizations. Firstly, I am indebted to my parents for their unwavering support, both emotionally and financially. Their sacrifices and encouragement have been the bedrock of my academic journey, and this achievement is a testament to their unwavering belief in my abilities.

A special acknowledgement goes to my supervisor, Ts. Niza Binti Mohd Idris, whose guidance, expertise and patience have been instrumental throughout the entire project. Her mentorship provided me with invaluable insights and a framework for success. I am very grateful for the opportunities to learn and grow under her supervision.

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CHAPTER 1

INTRODUCTION

1.1 Background

According to [1] , Malaysia possesses numerous natural resources that play a crucial role in supplying protein for freshwater aquaculture. The demand for this resource is high due to lifestyle changes and population growth, making the aquaculture industry diverse in terms of systems, cultures, and species. However, managing a fish farm can pose various challenges, some of which may be directly or indirectly linked to technical inefficiencies. Factors such as experience, frequent interaction with more experienced workers, farm status, and an unregulated feeding system can contribute to technical inefficiencies at the farm level, stemming from the adoption of water management technology and procedures[2].

To understand how aquaculture impacts the ecosystem, Kasim Mousa Al-Aubidy [3] has undertaken the design and implementation of an Internet of Things (IoT)-based system for real-time monitoring, control, and management of fish farming. The traditional manual control of water quality is addressed by introducing a system where each fishpond is treated as a node in a wireless sensor network. Each node comprises an embedded microcontroller connected to sensors, actuators, and a wireless communication module. The system aims to improve fish growth and increase productivity by utilizing information gathered from various variables. Practical results from the implementation demonstrate the accuracy of the measurement system, comparing favorably with results obtained from commercial devices used on the farm.

1.2 Problem Statement

The problem at hand revolves around inefficiency and lack of proper monitoring in fish farming operations. Firstly, the inefficient use of resources such as water, feed, and energy pose several challenges. This includes unnecessary waste, elevated costs, and negative environmental consequences.

Secondly, the inadequate monitoring of fish feeding patterns and consumption rates can lead to problems like overfeeding or underfeeding. Without accurate data on feeding habits, it becomes challenging to provide the right amount of food to the fish. Overfeeding not only leads to wastage but also affects water quality and the overall health of the fish. On the other hand, underfeeding can impede their growth and compromise their well-being.

Lastly, the reliance on manual monitoring and control of fish farming operations is another challenge. Manual methods are prone to human errors and limitations, making it difficult to maintain consistent and optimal conditions for the fish. Automated systems and advanced technologies can play a crucial role in streamlining operations, improving efficiency, and reducing the potential for errors.

To overcome these issues, it is important to develop and implement efficient resource management strategies to minimize waste and environmental impacts. Additionally, investing in advanced monitoring systems that can accurately track fish feeding patterns and consumption rates is essential. Transitioning from manual monitoring to automated systems can significantly improve overall operational efficiency and ensure the well-being of the fish in fish farming operations.

1.3 Project Objective

The main aim of this project is to propose a fish monitoring system that can monitor and control the condition of aquarium automatically by using smartphones. Specifically, the objectives are as follows:

1. To develop an IoT system for fish farming that enables real-time monitoring and control of water quality in aquarium through the integration of sensors.
2. To develop a user-friendly mobile application that serves as the primary interface for farmers to monitor the system.
3. To produce monitoring and controlling system for the water temperature in the aquarium using fan.

1.4 Scope of Project

The scope of this project are as follows:

a) Monitoring parameters in the aquarium, including water temperature, water level, and water clarity.

a)

b) Integrating the system with the Android Studio to send alerts to fish farmers regarding the water temperature, turbidity and depth of the water.

c) Collecting sensor data and controlling the system through the ESP8266 microcontroller.

d) Allowing fish farmers to remotely monitor and control the aquarium through the fish monitoring application on their smartphones.

e) Offering a user-friendly dashboard in the mobile application to view sensor data, set alerts, and receive real-time notifications.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Fish monitoring systems play an important role in aquaculture operations, ensuring the well-being and productivity of fish by measuring the parameters condition of water quality and feeding scheduling. Over the years, advances in technology have led to the development of innovative monitoring systems tailored specifically for fish farming. This literature review aims to explore the existing body of research on fish monitoring systems in aquaculture, analyzing the various methodologies, sensor technologies, and data analysis techniques employed in these systems. By examining the literature, we seek to understand the effectiveness of different monitoring approaches and their overall impact on the sustainability of aquaculture operations. The insights gained from this review will help researchers and fish farmers make informed decisions regarding the implementation of fish monitoring systems, ultimately contributing to the improvement of fish welfare and the overall success of aquaculture practices.

2.2 Previous of Related Project

2.2.1 Internet of Things (IoT)

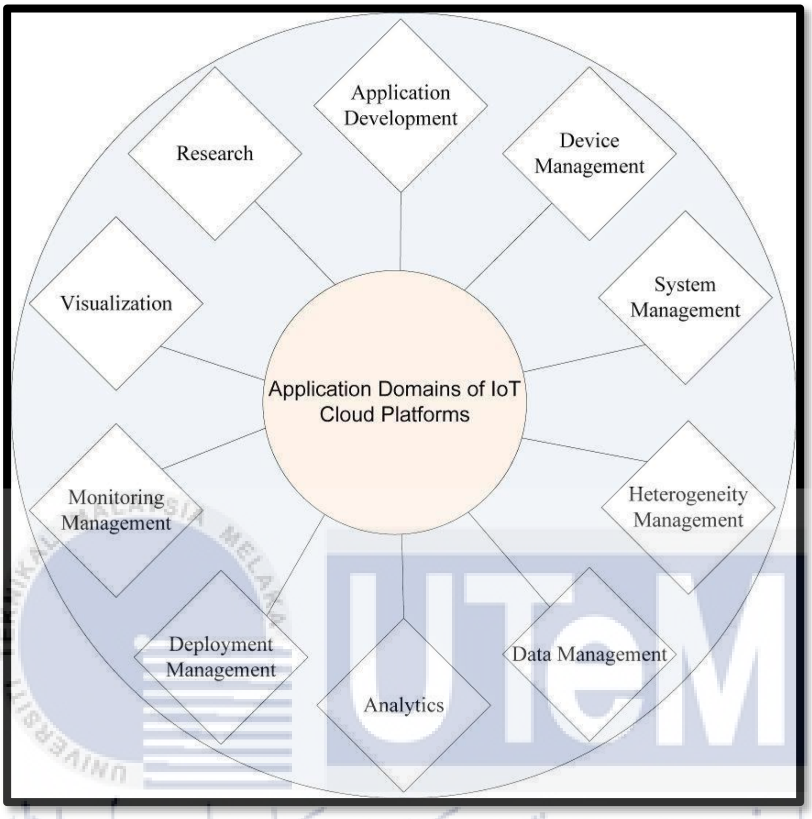


Figure 2.1 Application domains of IoT cloud platforms [4]

According to [4], the Internet of Things (IoT) is a platform that makes everyday objects smarter, everyday computation more intelligent, and everyday communication more educational. The Internet of Things is still in its early stages, but it has already made remarkable progress as a global media solution for the linked world. Based on Figure 2.1, there are different IoT cloud service providers that are being popularly used in the current market such as hospital management, smart city, road condition monitoring, aquaculture etc. The author stated that an IoT for aquaculture provides real-time information system called "*E-Nose*" to pursue the information of water quality via smartphone. Based on data gathered, the system forecasts change in the trend of water quality.

2.2.2 Aquarium Monitoring System via IoT

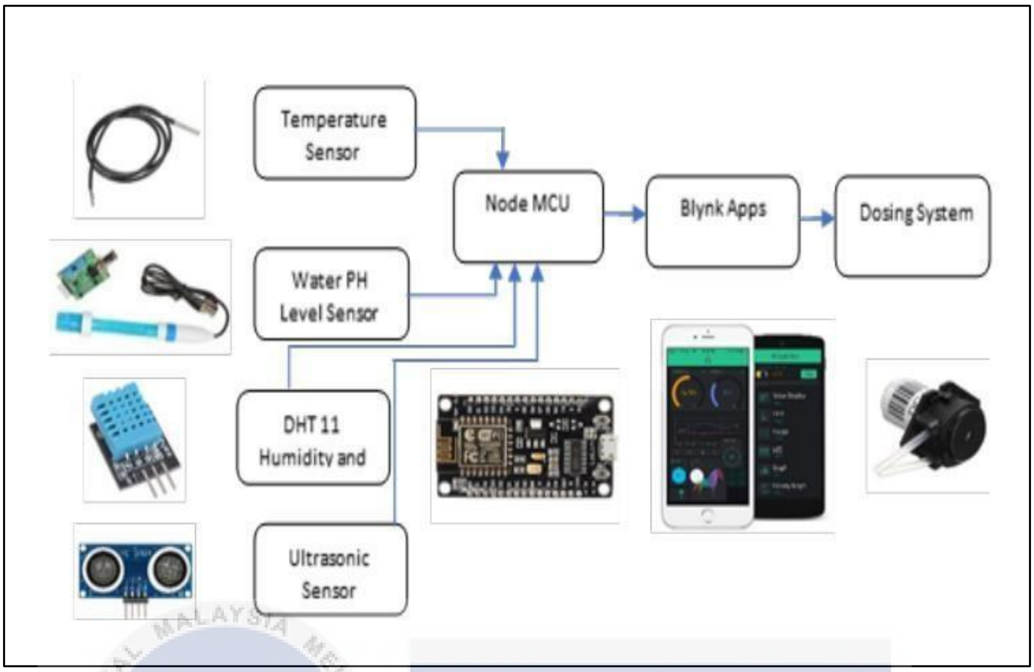


Figure 2.2 Aquarium Monitoring System block diagram [5].

By referring to [5], the author aims to provide an efficient monitoring system for aquarium enthusiasts, featuring a dosing system for nutrient supplements. The initiative addresses the common issue of neglect and overspending, ensuring that aquatic life receives sufficient nutrients. Based on Figure 2.2, the system continuously monitors water parameters, alerting users to potential issues and promoting the systematic care of aquariums. By utilizing sensors, an ESP8266 NodeMCU microcontroller, and Blynk's mobile app, the project enables real-time monitoring and eliminates the need for manual checks, enhancing the overall well-being of aquatic life.

2.2.3 Android-Based Monitoring System of Aquaculture Farming with Sensor Technology and Automatic Fish Feeder

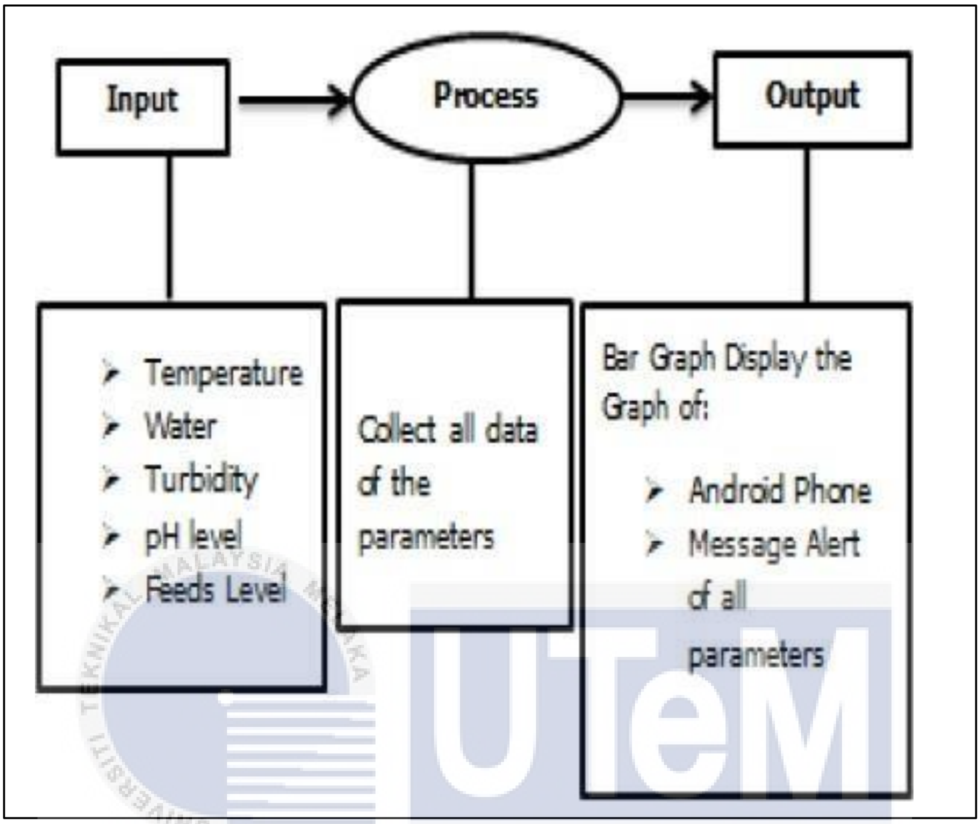


Figure 2.3 Operational Framework [2]

Based on Figure 2.3, the project titled "Android-Based Monitoring System for Aquaponics Farming with Sensor Technology and Automated Fish Feeder," focuses on monitoring water temperature, turbidity, and pH in an aquaponics system. The data collected from three sensors are stored in a database via the Ethernet shield. The process involves real-time monitoring of aquaponics system sensors, with results automatically displayed in an Android application. Recommendations include implementing notifications for irregularities or critical levels in temperature, turbidity, and pH, incorporating a wireless connection, strategically placing sensors in critical areas, determining sensor coverage, and ensuring real-time graphs display units for clarity to farmers/users [2].

2.2.4 Sample Project of Monitoring of Aquarium Water Temperature for Decorated Fish using IoT

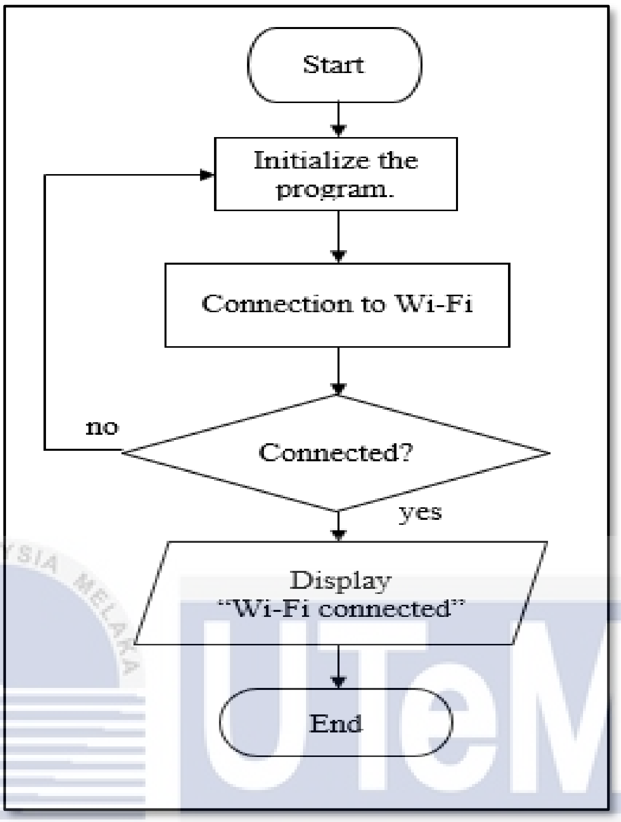


Figure 2.4 Program Flowchart for connection using Wi-Fi [6].

According to [6] , fish growth is highly dependent on a variety of factors, including fish type, genetics, diet, density of fish seed distribution, and factors range. Fish can grow slowly due to environmental factors such as the water temperature for long growth, appetite feeding, and fish weight at 25°C to 27°C. Based on Figure 2.4, initialising the programme and the library used is the first step that is completed. The following step is to establish a connection to a Wi-Fi network that has already been configured with its SSID name and password; if it is successful, Wi-Fi will then move on to the following step. Following that, the temperature sensor DS18B20 will be read. If the temperature is less than 25° C, the peltier will turn on; if it is greater than 27°C, the peltier will turn off.

2.2.5 Smart Aquarium design using raspberry Pi and android based

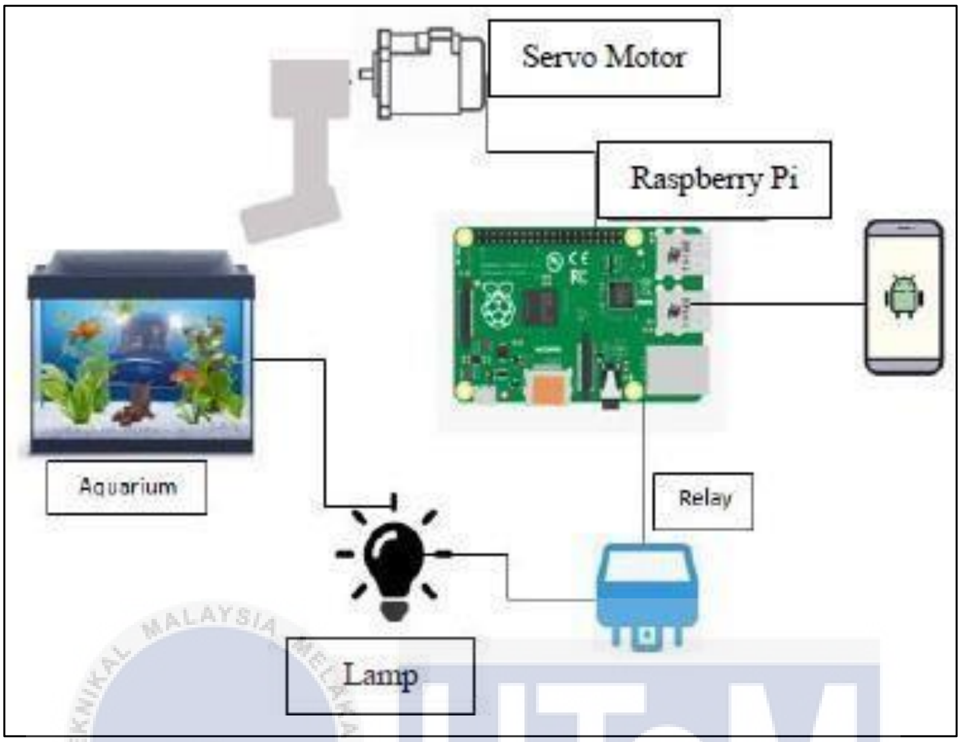


Figure 2.5 Block diagram applied using Raspberry Pi [7].

Based on [7], the project utilizes system process flow, as depicted in Figure 2.5, to illustrate the components involved. The system includes a servo motor, Raspberry Pi, relay, decorative lights, and Android interface. The Android app allows users to schedule fish feeding in the aquarium. At the designated time, the Raspberry Pi signals the servo motor to open the food valve, releasing the fish food. Additionally, the system can control the on/off status of decorative lights, programmed to activate at 6 pm and deactivate at 6 am, with the Raspberry Pi connected to a decorative light relay. The research design serves as a roadmap, facilitating the implementation of the study's objectives in a structured and organized manner.

2.2.6 Sample Project of IoT based Aquaculture system with Cloud Analytics

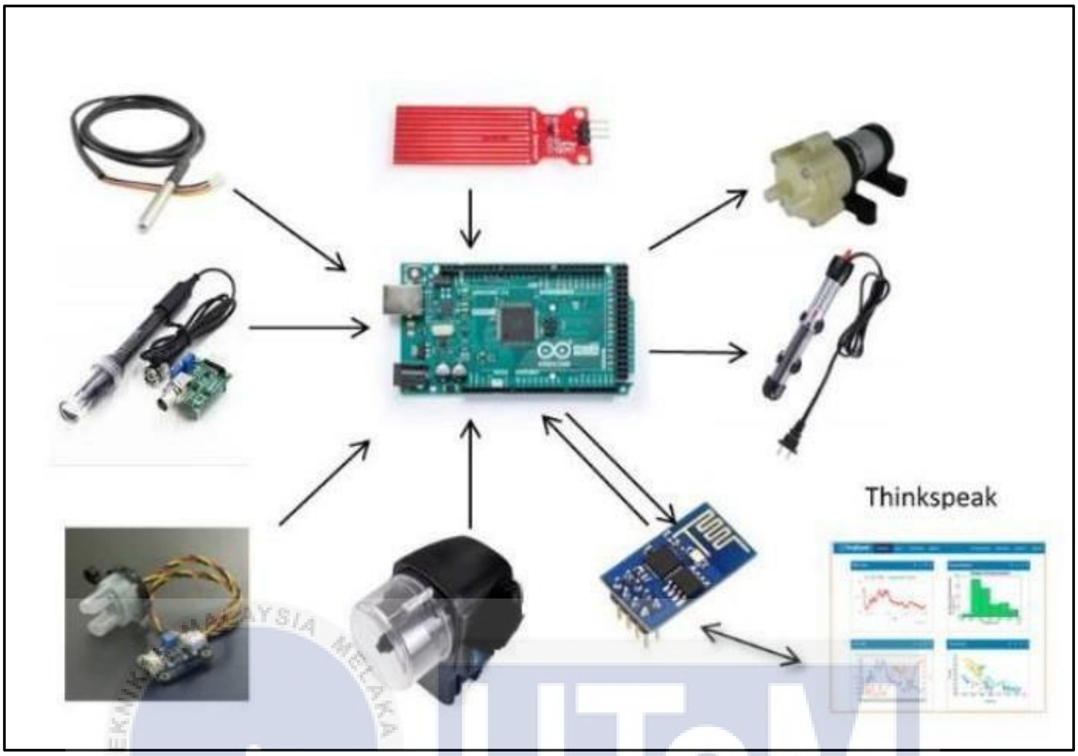


Figure 2.6 Block Diagram of smart aquaculture system [8]

The propose solutions assessed based on the it's applicability, suistainibility for remote locations and form facrot of the finasl product. It is linked to the temperature sensor, turbidity sensor, and ultrasonic sensor such as Figure 2.6. The temperature sensor is a waterproof one-wire temperature sensor that senses temperature with minimum hardware and wiring. This sensor sends accurate temperature measurements straight to the NodeMCU via a digital interface, eliminating the need for an analogue to digital conversion or other hardware[8]. An analogue pH meter is utilised here, with a power indicator LED, a bayonet neill-concelman (BNC) connector, and a pH sensor interface. The pH sensor must be linked to a BNC connector in order to be used. When utilised in a new setting, calibration should be done. A water safety sensor was utilised to detect water quality by measuring turbidity. It detects floating particles in water using light by measuring light transmittance and scattering rate. The turbidity of fluids increases as TSS increases.

2.2.7 Sample of Project Design of an IoT Water Quality Monitoring System for Tropical Fish Aquaculture

According to [9], who proposed a technique to monitor water quality parameters such as turbidity, pH and temperature using an IoT system. The parameters will be measured using electrical sensors and a microcontroller before the values are sent to the user via SMS. This system may inform users of the current turbidity, pH, and temperature of the pond water, allowing them to determine when maintenance should be performed.

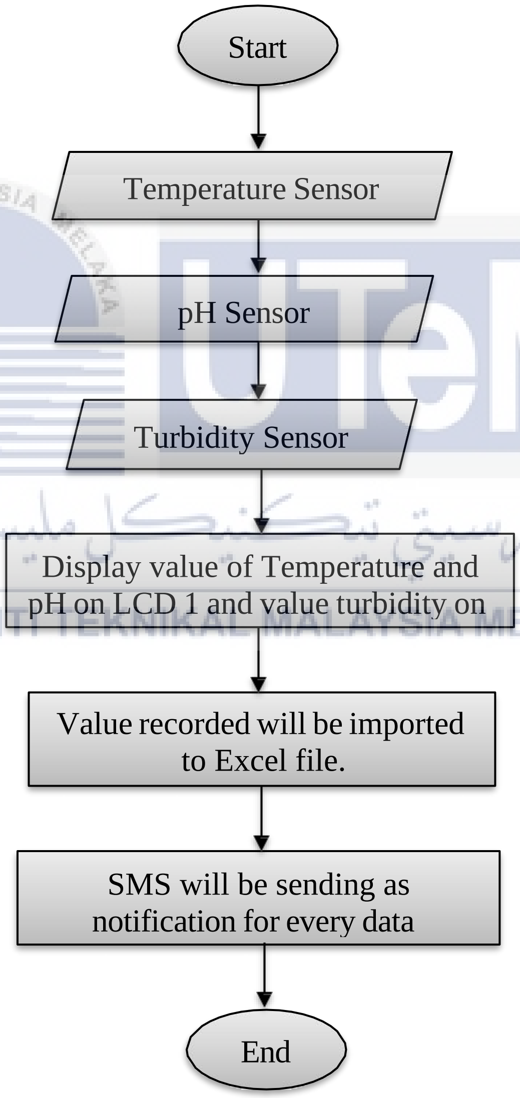


Figure 2.7 Flowchart of water quality [9]

The flowchart in Figure 2.7 demonstrates the project's flow. When the project begins, it will monitor all of the water quality indicators related with the sensors utilised, including the water temperature, pH, and turbidity sensor. Two LCDs were connected to the microcontroller for validation purposes in order to display the values of the measured parameters. As a result, an SMS will be sent as a notification for each interval of data collection. Furthermore, the parameters that were read were saved in an Excel file for user monitoring.

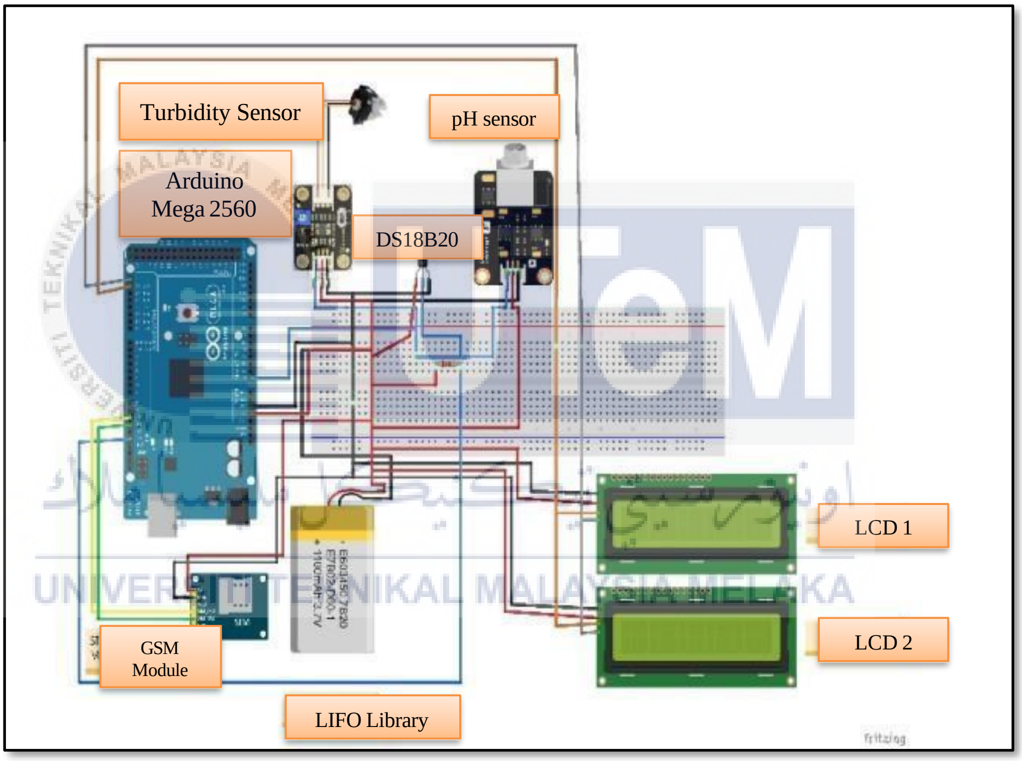


Figure 2.8 Circuit diagram for IoT water quality and monitoring system [9]

Figure 2.8 represents the project's proposed system circuit diagram. All sensors were attached to Arduino board pin A0. Pin TXD on the SIM900 GSM Module was linked to pin D10 on the Arduino Mega board, while pin RXD on the SIM900 GSM Module was connected to pin D11 on the Arduino Mega board. LCD 1 and LCD 2's SDA pins were connected to pin SDA.

2.2.8 Sample of Project Wireless Tank Control and Monitoring using IoT

According to [10], liquid level monitoring and control systems are crucial components in numerous fields and applications. The goals of the mentioned IoT system are to regulate and keep track of the liquid level in a distributed tank system. The liquid tank system is shown in Figure 2.9 with the aim of maintaining a particular liquid level in the process tank. A level sensor is used to periodically read the liquid level and transmit the readings to a controller for liquid level monitoring. Therefore, in order to maintain the required liquid level and prevent overflow, the controller will activate the pump. The controller generates the appropriate signal to turn on the pump by using the received liquid level and comparing it to the desired level.

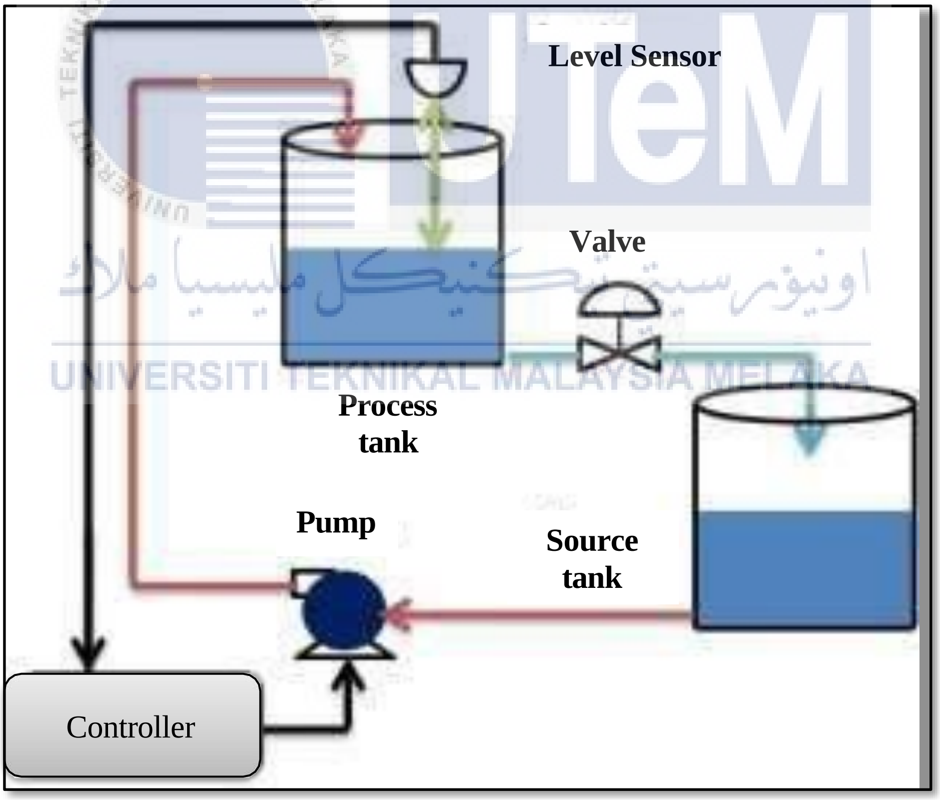


Figure 2.9 Liquid level process [10]

The proposed implementation included a PC for data storage and analysis, an ESP8266 Wi-Fi module for internet access, an ultrasonic sensor, a 12V DC pump, a DC pump control module, and an Arduino board for controller implementation. An ultrasonic signal is sent from the trig pin of the Arduino to the Ultra Sonic HC-SR04 sensor.The signal is reflected as it strikes the liquid's surface and is then picked up at the echo pin. The reflected signal's round trip time is timed, and the result is utilised to determine the liquid level.

2.2.9 Sample project of IoT-based Guppy Fish Farming Monitoring and Controlling System

Figure 2.7 Web application user interface

By referring to [1], whose author conducted the investigation, guppy fish farming is still being overseen by hand. As a result, they create a system with a sensor and monitoring module. Only pH and salinity values are monitored and controlled via function monitoring, an IoT web-based system. In addition, farmers employ servo motors to alter pH via websites, allowing them to determine whether the water dissolved inside aquariums is risky for guppy fish or not. The authors also display the system's general block diagram, which is divided into two sections: the controlled module and the monitoring module[20] . For monitoring module, it handles monitoring in manually using web application that use Raspberry-Pi as a processor to sends data to database cloud storage. All data of pH and salinity will be display inside the web application. Furthermore, web application also can control the opening of the pH neutralizing valve through virtual button as Figure 2.11 above.

2.2.10 Sample project of Development of IoT Based Fish Monitoring System for Aquaculture

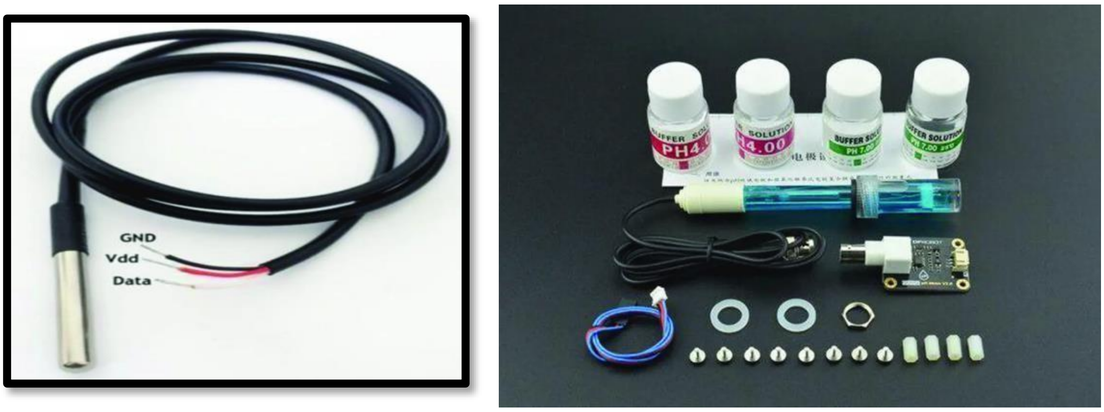


Figure 2.8 Sensors used for the system

According to [12], the authors propose a system using IoT based for aquaculture where is to improve and monitor the quality of water in fishing industry. There are several important parameters that must be considered like temperature available, dissolved ammonia level, pH level, oxygen quality supply, and pH level. By making this system, fisheries know how to maintain equilibrium level by providing the equipment to monitor all the parameters that have been mentioned. The authors also said that by using this system, iOS based mobile apps can be integrated in future. As we can see in Figure 2.12, there are types of sensors used such as pH sensor, DS18B20 temperature sensor, and dissolved test kit. The system also uses microcontrollers such as ESP-12E module that have internal 32-bit controller to perform multiple communications. Other than that, they also use 12V battery, LM2596 buck converter, 10K resistor, switch, and wires. For user-interfaces, the system uses MIT and Google firebase where is very user-friendly, that have simple interface an back-end connection.

2.2.11 Sample Project of IoT-based Smart Monitoring and Management System for Fish Farming

Based on journals from [3], the authors write about the journals stated that water quality and fish feeding still controlled manually in fish industry. So the authors has implementation and design IoT-based system for real-time monitoring, control and management of fish farming. The system design to measure different types of variables and use the information to control fish growth.

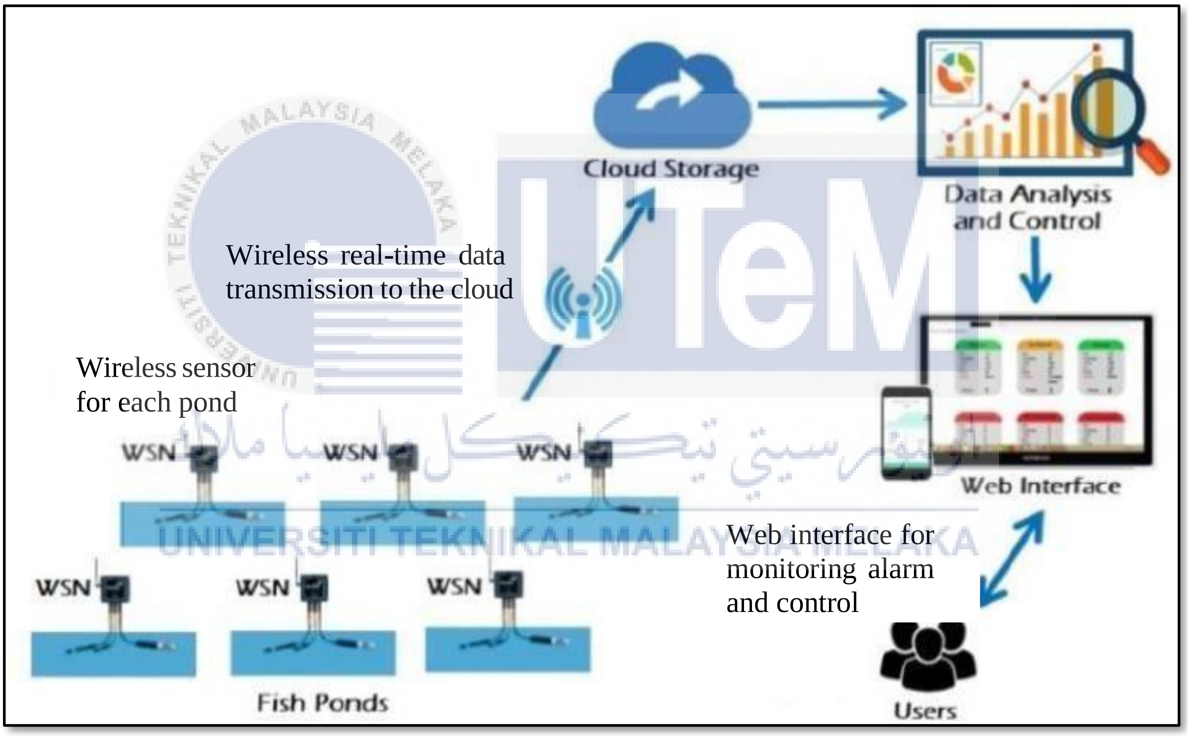


Figure 2.9 General layout of the proposed monitoring and control system

From Figure 2.13, we can see that each fish pond is anode in a wireless network by using embedded microcontroller to connect each sensors to the wireless module. To display the data, web interface are used to receive all the data from sensors in real-time. The fish farmers will receive alert notifications thriugh web portal or smartphone to generate control signals to avoid any disaster from occur.

There are a fuzzzy controllers such as fuzzifier, fuzzy interface engine, fuzzy rule-base and a defuzzier as shown below in Figure 2.14. To proposed this system, two fuzzy are required to control water quality in each pond and to control the environment. As we can see in figure 2.20, it contains three modules inside the implementation fuzzy controller which is fuzzification module, a reasoning module and defuzzication module. To control the environment for pond, there are five inputs variables consists of pH, Turbidity, DO, TDS and WC then it also have three outputs such as water inlet control, drainage and oxygen supply control while for environment controller it have three inputs where is air temperature, air quality and lighting that will generate for actuators such as cooling, fans, exhaust and lighting.

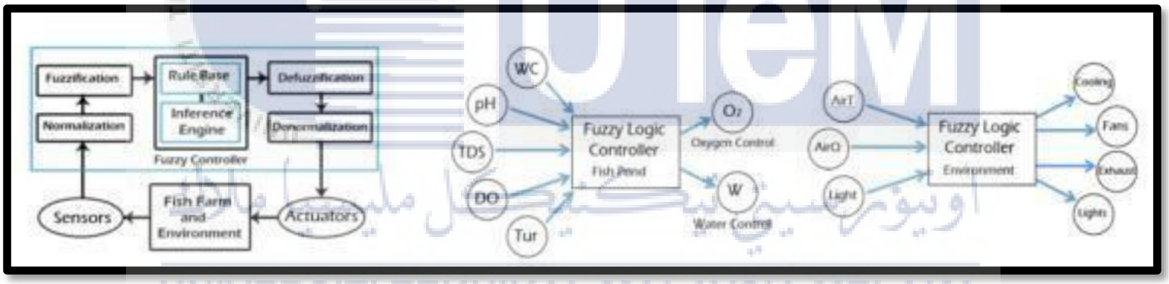


Figure 2.10 Fuzzy Logic Controllers [3]

2.2.12 Sample Project of Automatic System to Fish Feeder and Water Turbidity Detector using Arduino Mega

According to [13], the hardware for autonomous fish feeding and water turbidity sensing was designed and manufactured using the Arduino Mega 2560 and RTC. The system can control a microcontroller's actions as a timer for fish feeding. The solution enables real-time monitoring of their program, identifying issues like time arrival, and permitting quick adjustments along the road. The system that was designed also has a flowchart of its own, which is depicted in Figure 2.18 and includes an algorithm, computer, system, and process.

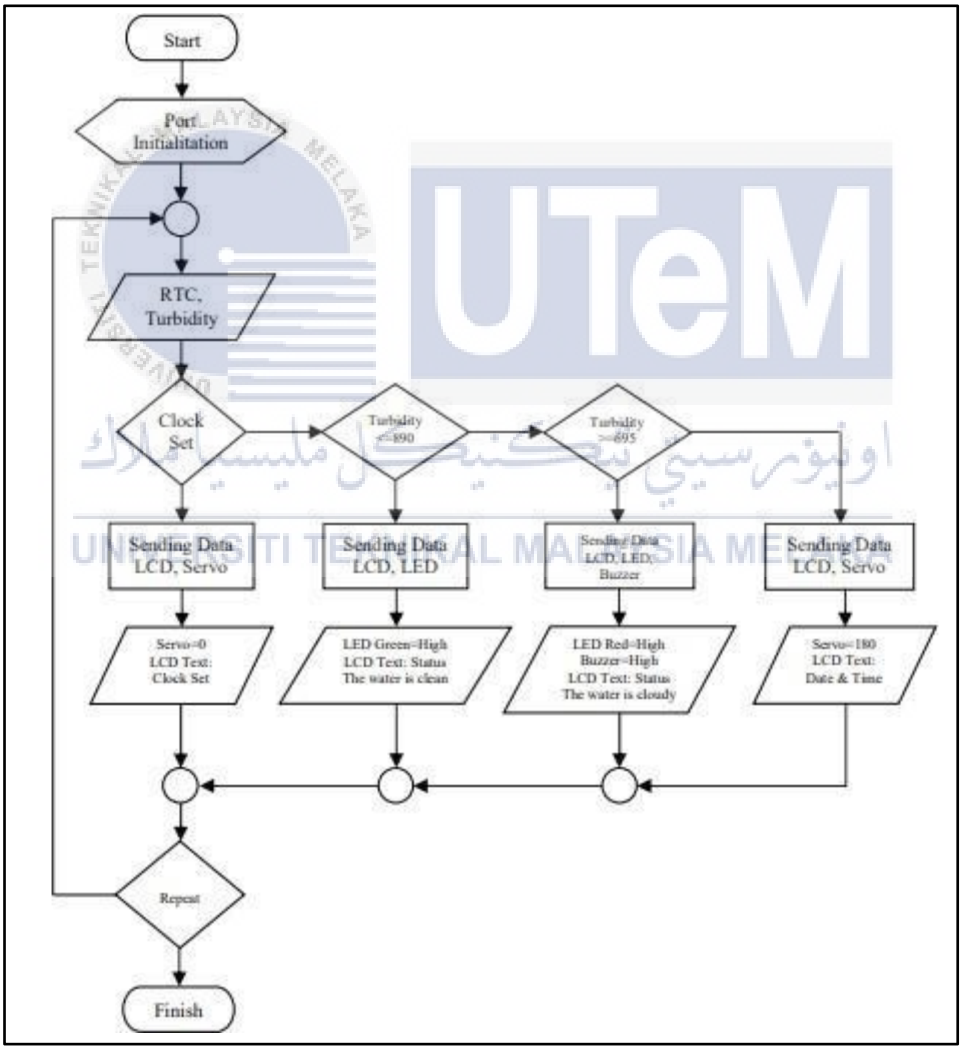
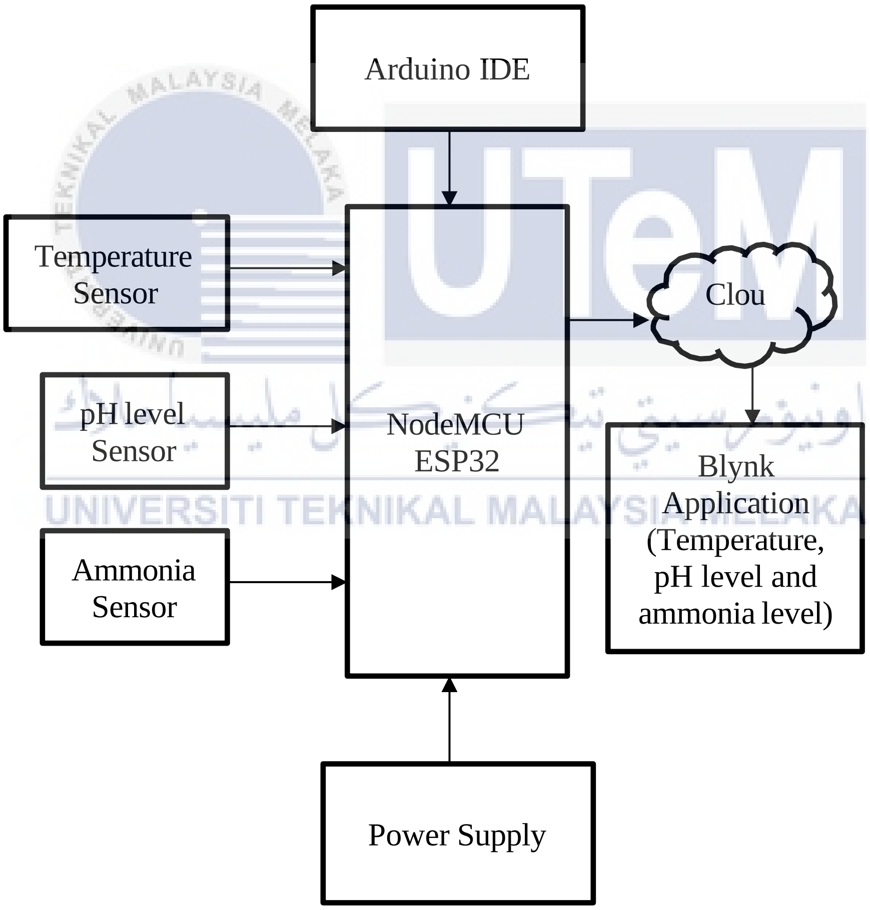


Figure 2.11 Flowchart diagram [13]

2.2.13 Analysis and Development of IoT-based Aqua Fish Monitoring System

According [14], applying the technology of IoT can help to monitor water quality, temperature, pH level and ammonia toxicity in real-time. In this project, the authors implemented a method to a system to monitor all the requirements of fish behavior. An Internet of Things (IoT) based project that has been using NodeMCU ESP32 controller to process the data collected from all sensors and viewed via mobile devices using the Blynk application. This combination of IoT and ESP32 based on Figure 2.16 in this sector can help to improve water quality, which supports aquatic life production and health.



2.2.14 Planning and Implementation of the Feed System IoT-Based Automatic Fish

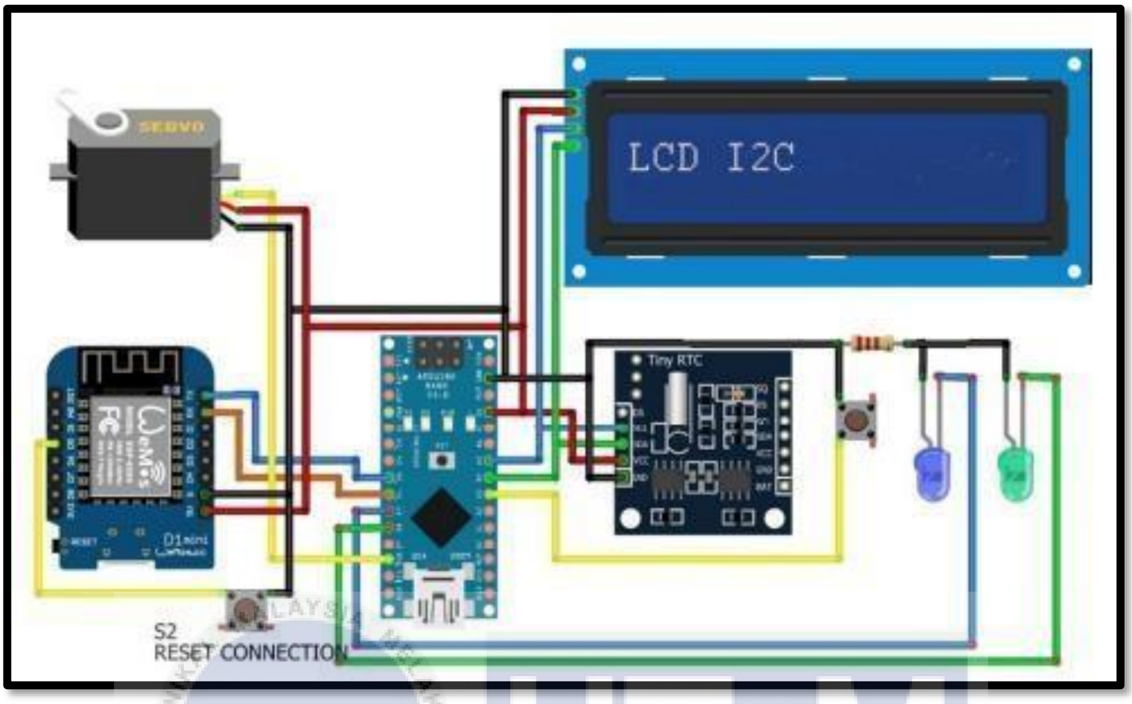


Figure 2.12 Wiring scheme for connecting components of the hardware [15]

The timing of feeding is crucial in fish farming because fish need to eat on a regular schedule and in sufficient amounts. Fernanda R, Wellem T, who develop a system that automatically feeds fish according to their nutritional needs on a predetermined schedule[15]. An Arduino Nano serves as the primary controller for the system's hardware. Additionally, a servo motor is used to open the fish feeder's barrier gap, and an ESP8266 WiFi module is used to connect the hardware to the Internet. The hardware configuration for the automatic fish feeder system is illustrated in Figure 2.17. The system comprises several key components to facilitate its functionality. Firstly, an Arduino Nano Board serves as the central processing unit, responsible for running the software and controlling various hardware elements. Additionally, an ESP8266 module is integrated to provide WiFi connectivity, enabling internet access for the Arduino Nano board. Real-time clocks (RTCs) are employed to generate time-related data, including hours, minutes, and seconds, which can be stored in databases for scheduling purposes.

2.2.15 Aquarium Fish Smart Farming on Internet of Things (IoT) and Mobile Application Technology

Figure 2.13 Aquarium device

Based on Figure 2.16, it shows the aquarium device which is consist of water pump, relay and Arduino Uno R3. By referring to [16], this project introduces a mobile application system leveraging IoT and Android technology for the effective care and management of fish raised in mini-aquarium fish farming. The development involves the use of Android Studio, Java, C, Arduino IDE, SQL, and Firebase. Hardware components, including Node ESP8266 MCU V.2 boards, Wemos-D1 boards, and ultrasonic modules, are utilized to create a comprehensive control system. The system is tested in a real home mini-aquarium, with performance data collected and evaluated through Black Box testing involving both users and experts. The system demonstrates its potential as a valuable information tool for users, offering assistance in fish care, and serves as a prototype for application in other smart farming contexts.

2.2.16 An integrated system of mobile application and IoT solution for pond monitoring

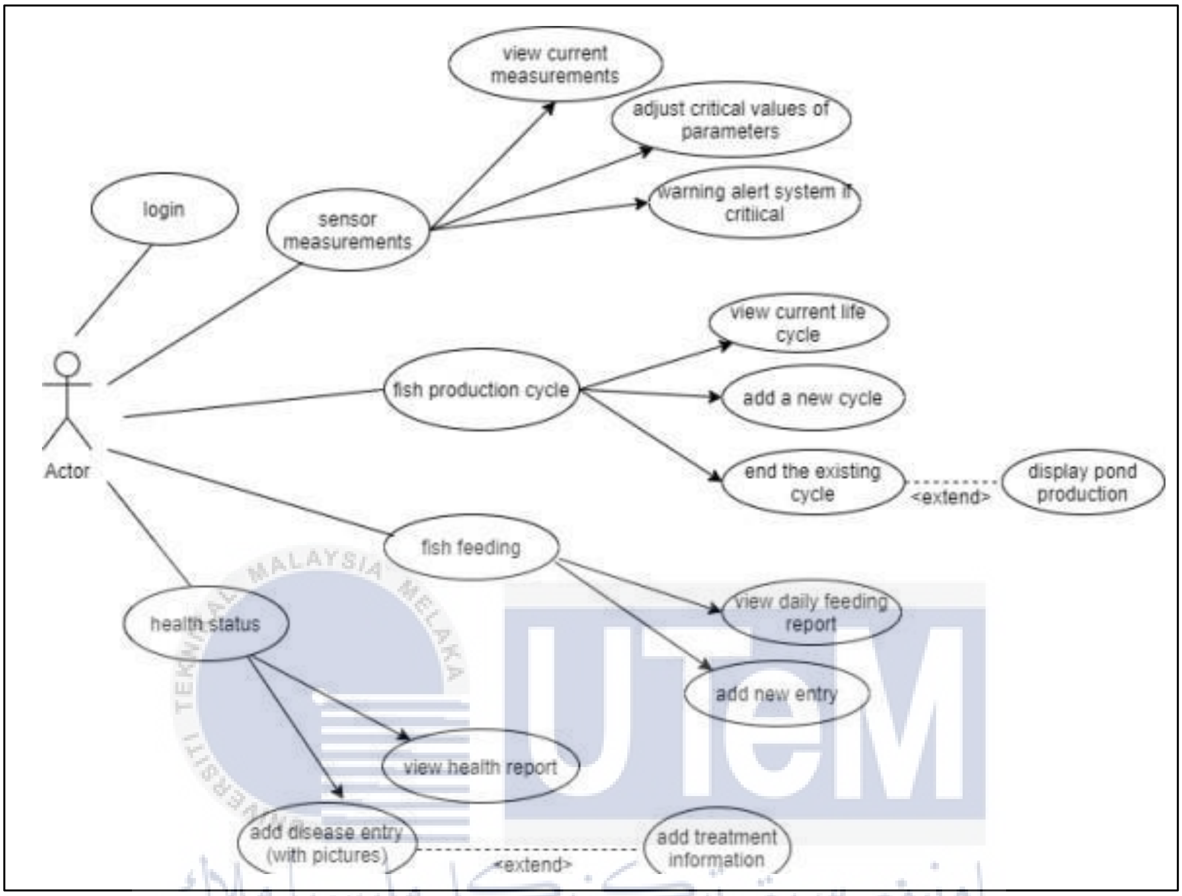


Figure 2.14 Use diagram case pond management implemented in Nusapond app

By referring to [17], the authors creates an Android-based platform named Nusapond has been developed to facilitate comprehensive control and monitoring of the smart pond IoT. The application focuses on four main monitoring tasks for each pond: real-time sensor measurements, ongoing fish production cycles, daily feeding records, and fish health monitoring. The use case diagram illustrates in Figure 2.17 shows the entire monitoring scheme managed through Nusapond. Upon successful login, users access the main dashboard displaying real-time water parameter measurements for all ponds at a specific site. The dashboard categorizes ponds into normal and problematic based on health status, with automatic alerts notifying users of abnormal conditions.

2.2.17 Cost Effective IoT based Automated Fish Farming System with Flood Prediction

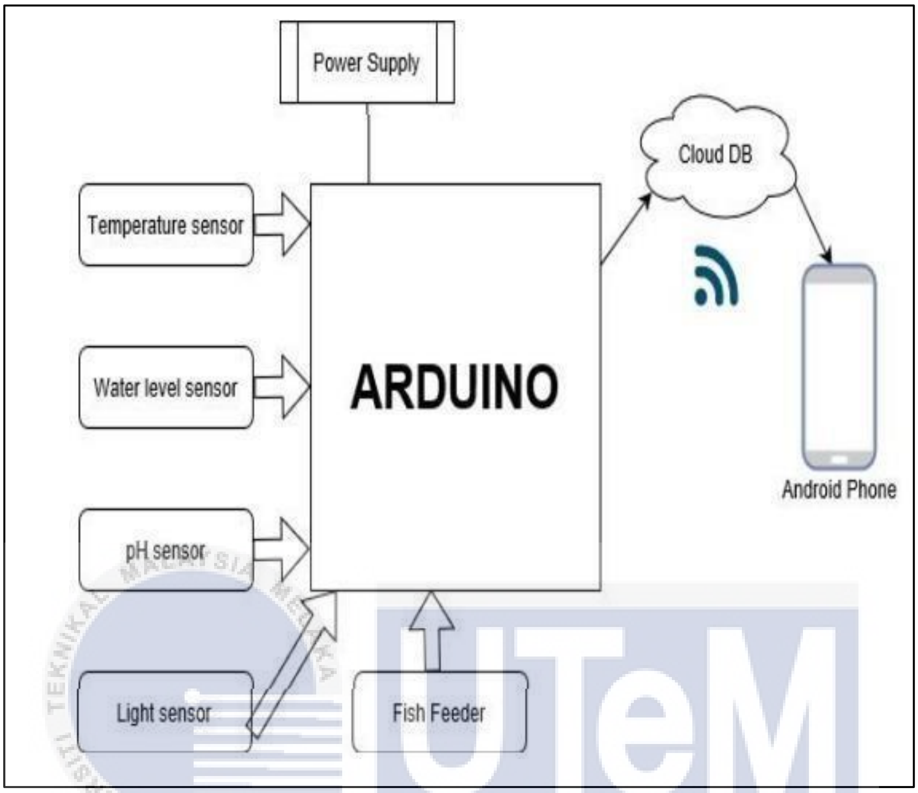


Figure 2.15 General Scheme of the system[18].

Based on [18], the system architecture for the automated fish farming project involves various interconnected components and subsystems to create a cohesive system. Figure 2.18 shows the sensors, including temperature, pH, water level, and light sensors, are integrated with an Arduino board for data collection and communication. An Android application is developed for remote access to sensor information, enabling users to take necessary actions. Flood prediction is a crucial feature, utilizing an ultrasonic sensor to measure water levels; if the threshold (set at 25cm) is not met, an alert is sent to the user's Android application. The Arduino board is consistently powered. Additionally, a fish feeder is connected for further processing. The collected sensor data is transmitted to a cloud database using a Wi-Fi module (esp8266), with Firebase utilized in this context.

2.2.18 Internet of Things (IoT) Based Aquaculture Monitoring System

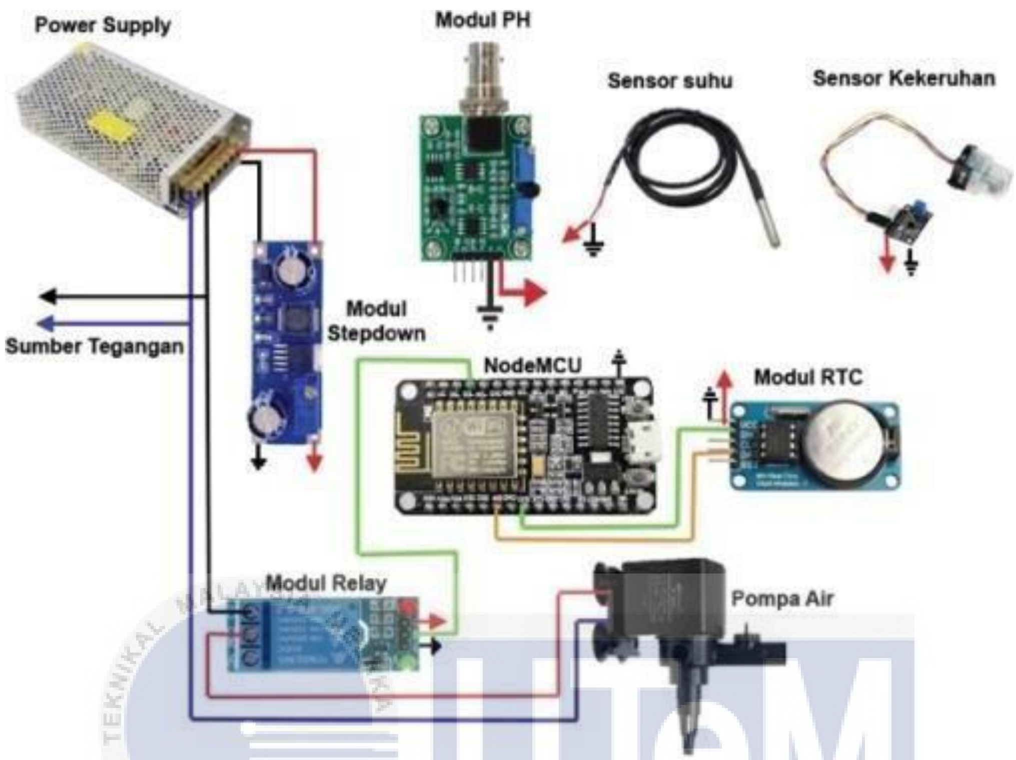


Figure 2.16 System Component Design

By referring to[19], the authors design a system, as depicted in the Figure 2.19, encompasses multiple components, including a microcontroller, sensors, and pumps, all integrated into a unified block. This study focuses on the monitoring of 20 tilapia fish with a medium length and an initial weight of 5cm/7g. The water quality, serving as the fish environment, is monitored through various sensors. The pH levels are tracked using a pH sensor, temperature is measured with a temperature sensor, and water turbidity is assessed using a turbidity sensor. The data processed by these sensors is transmitted to a server and stored in a database, enabling remote monitoring over the Internet and Android networks. This comprehensive approach ensures real-time assessment of key environmental factors for the well-being of the tilapia fish, facilitating effective fish farming management.

2.2.19 Development of monitoring System Based on Internet of Things (IoT) for freshwater Prawn farming

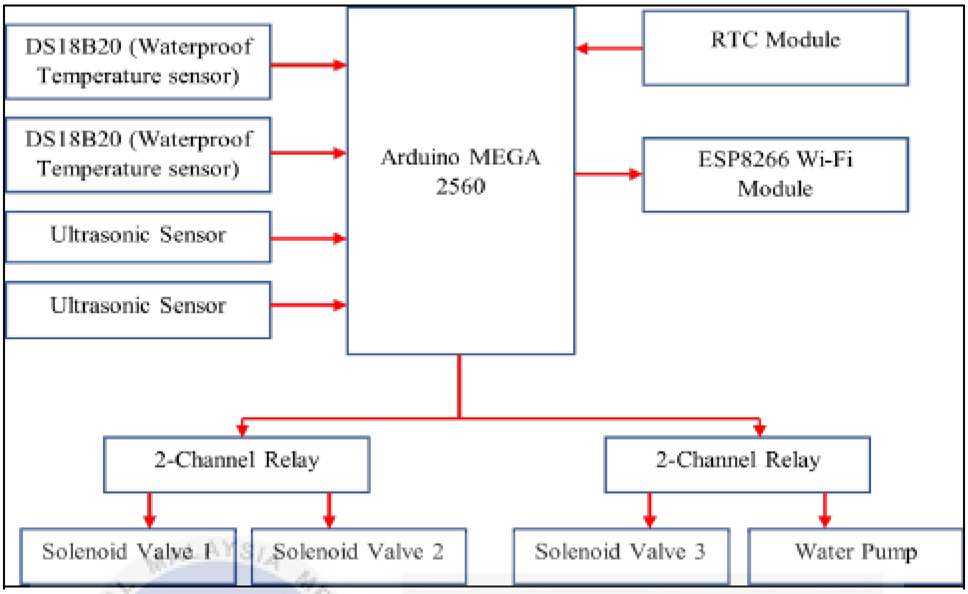


Figure 2.17 Block diagram design of the autonomous and monitoring system [20]

In the illustrated block diagram in Figure 2.20, the monitoring and autonomous system components are connected to the Arduino Mega 2560, serving as the main microcontroller unit (MCU). The system is divided into two main sections: the monitoring process and the water-changing process (autonomous system). The Arduino Mega 2560 is powered by a 9V power supply, while a solenoid valve, a crucial component in the water-changing process, is powered by a separate 5V external power supply. This arrangement ensures the isolation of circuits, particularly the relays, and enhances the overall safety and reliability of the system. The block diagram depicts the clear interconnections between the MCU and various system components, emphasizing the role of the Arduino Mega 2560 in coordinating and controlling both monitoring and autonomous functionalities[20].

2.3 Comparison of previous related projects

Table 1 Comparison of Previous related Projects

No.	Reference	Components	Purpose	Advantages	Disadvantages
1.	[1]	Automation Module: -Salinity sensor -Buzzer -Arduino -pH sensor -Servo motor Monitoring module: -Raspberry pi -Laptop -Web server	-To display the value of salinity and pH on the web application continuously and the value state on the LCD.	-The system can maintain the water quality in guppy fishponds. -Can ensure the pH level not too high or too low so that the guppy fish can survive.	-The valve opening system in pH-neutralizing fluids can function properly but still has a delay in response.
2.	[12]	-User Interfaces -sensors: pH level, water temperature, measurement of dissolved oxygen level, and ammonia level using testing kits. -Node Mcu	-Aims to enhance fish production and maintain aquaculture's aquatic environment. -Fisheries will know the level of oxygen or ammonia or pH and temperature and provide the equipment to maintain an equilibrium level.	-Can monitor aquaculture's basic needs and help provide things needed for fisheries. -Consist of various sensors that will detect the pH level, water temperature, and measurement of dissolved oxygen and ammonia level for proper fish farming in the right water.	-Too much info on this main page.
3.	[3]	-Wireless communication module -Sensors: Analog pH sensor, Tur sensor, water temp sensor, DO sensor,	-To design and realize real-time monitoring and control of fish farms to provide a safe environment at the lowest possible cost.	-real-time monitoring and control of the aquaculture environment through a mobile phone	-Too many sensors used -using a real-time monitoring system

		TDS sensor, pressure sensor, float level sensor, air quality sensor -ESP8266 microcontroller		or the internet. -providing the farmer with automatic warning signals to avoid any risks.	
4.	[13]	-Arduino Mega 2560 -LCD -Buzzer -Turbidity sensor -Servo motor -LED -RTC DS3231	-The system works automatically, which functions to feed the fish and detect the water turbidity using the on/off button and turbidity sensor.	-Faster because users do not need to remove, distribute and store feeding again. More precisely because measuring sensors is more accurate than human measurement.	-Only focus on feeding fish and turbidity only. -Do not used IoT platform.
5.	[19]	-NodeMcu (ESP8266) ADC converter -Dissolved oxygen and temp sensor -pH sensor -Turbidity sensor -TDS sensor -DC converter -power supply	-To develop high-performance and low-cost sensors. -To accommodate the required environment for snakehead fish to grow well.	-Affordable and easy-to-deploy technology. -Smart and friendly environmental system for aquaculture. -Users can easily spot any abnormal conditions of the pond and can immediately take action to solve the problem.	-Focus on one type of fish only.

2.4 Summary

As a conclusion, after a thorough reading and observation done on the previous related projects, it is understandable that the traditional microcontroller brings several disadvantages compared to the Arduino and Raspberry Pi as they are the improvement from the old technology. The automatic fish feeder system features a hardware setup with key components. The ESP8266 module provides internet connectivity, while real-time clocks generate time data for scheduling. A user-friendly LCD display showcases scheduled times, and a servo motor regulates the fish feed compartment door. LEDs indicate system status, with blue LEDs showing internet connection and green LEDs signaling device activity. The research of fish monitoring system based project assist in achieving the objectives of the development of fish monitoring system. As a result, the use of wireless networks in these prior connected projects highlights the pros and cons of each method of communication.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter presents the method used to develop the project and to achieve the objectives. This chapter is divided into three sections: the study design, the elaboration of the process flow, the hardware and software specification. To ensure that the project flows effectively, detailed research on the used hardware was conducted to have a clear vision and better knowledge of how to handle it and the best model to use for this project. This chapter is also important in gaining an overall understanding of the project flowchart that was created. The process flow is detailed, and the hardware specifications will be detailed after that. Finally, a diagram of the connection of the project is shown and discussed briefly in this chapter.

3.2 Methodology

An IoT-based fish monitoring system is created by gathering requirements, choosing appropriate sensors, integrating a microcontroller and a Wi-Fi module, designing the circuit, acquiring and transmitting data, setting up a cloud platform, creating a mobile application, testing and validating the system, and deploying it. With real-time data and remote control capabilities for effective aquaculture management, this methodical approach guarantees the system's functionality and dependability in monitoring fish and their environment.

3.3 Elaboration of Process Flow

3.3.1 Block Diagram

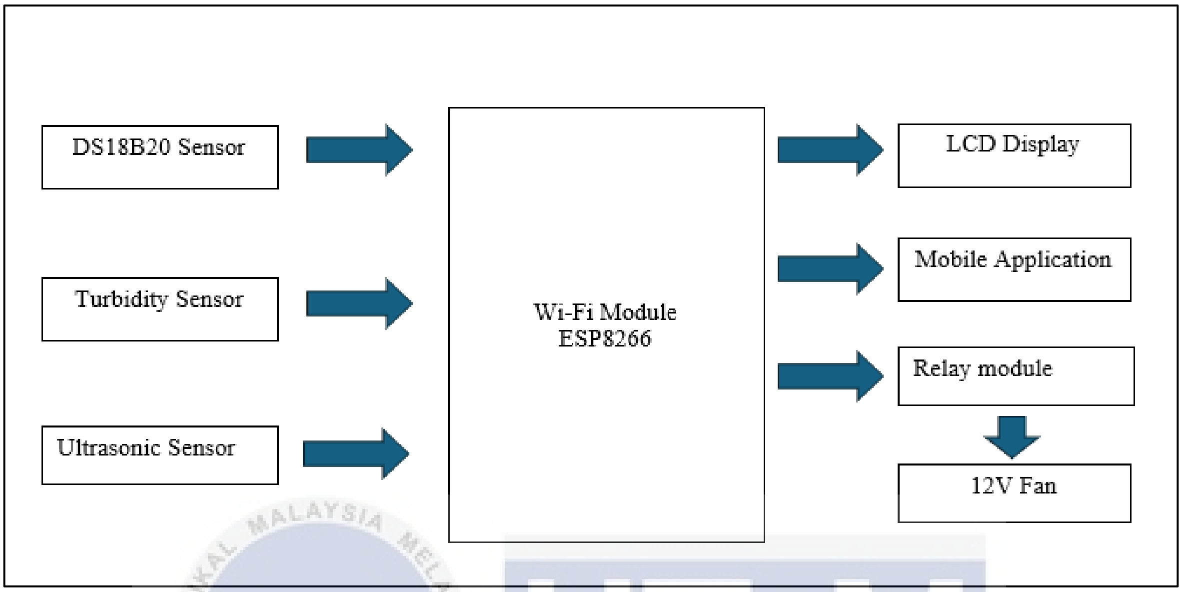


Figure 3.1 Block diagram of Fish Monitoring System

Based on Figure 3.1, the block diagram shows the various hardware components to ensure effective monitoring and control. The system employs sensors, including a turbidity sensor for water clarity assessment, a DS18B20 temperature sensor for monitoring water temperature, and an ultrasonic sensor to measure water depth. These sensors provide real-time data to a microcontroller (MCU), serving as the central processing unit of the system. The MCU processes the sensor data and communicates with actuators, such as a 12V fan controlled via a relay module, and an LCD I2C display for real-time data visualization. To enable user interaction and monitoring, the system integrates with a mobile app developed using Android Studio. The mobile app serves as the user interface, displaying relevant data such as temperature, turbidity, and water depth.

3.3.2 Flowchart

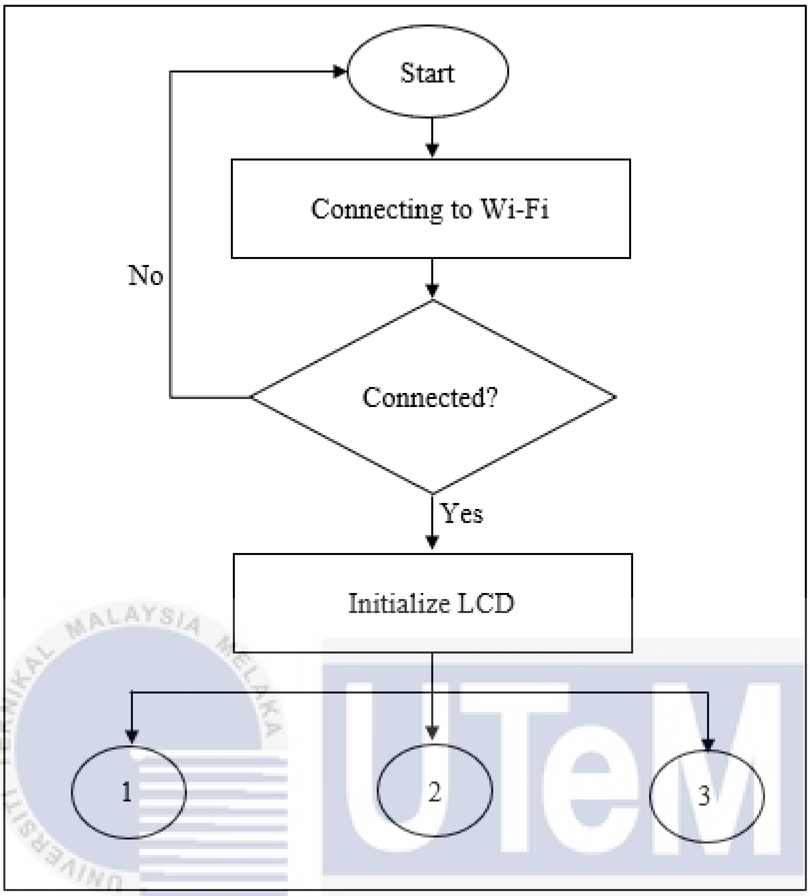


Figure 3.2 Flowchart to Connected Wi-Fi

Based on Figure 3.3, it shows the flowchart for the WiFi-connected fish monitoring system using the ESP8266 module begins with the initialization of the ESP8266 to establish a WiFi connection. Following this, the system checks whether the WiFi connection is successfully established. If the connection is successful, the system proceeds to the next step. If not, it loops back to the "Connecting to Wi-Fi" step to retry establishing the connection. Upon a successful WiFi connection, the system moves on to initialize the LCD display. Subsequently, the LCD displays a message indicating that the fish monitoring system is ready. After displaying the message, the system proceeds to another step in the fish monitoring process, which could involve tasks such as reading sensor data or displaying real-time information on the LCD.

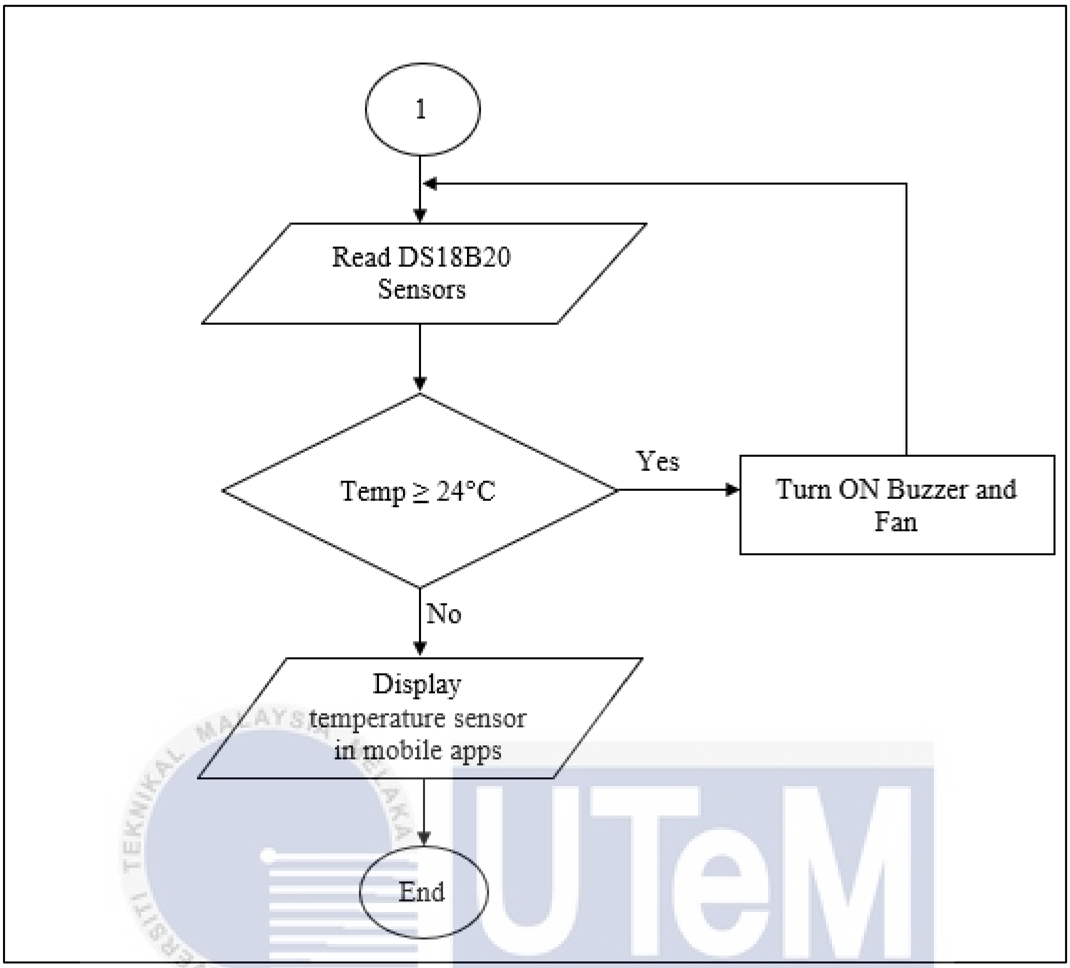


Figure 3.3 Flowchart for DS18B20 sensor

Based on Figure 3.4, it shows s process commences by reading the temperature from the DS18B20 sensor. A decision point follows, evaluating whether the temperature obtained is greater than or equal to 24 degrees Celsius. If the temperature meets this criterion, indicating elevated conditions, the system proceeds to activate both the buzzer for audible alerts and the fan for cooling. On the other hand, if the temperature is below 24 degrees Celsius, the system directs the flow to the next stage, where it transmits the temperature data to the mobile app for display. The flowchart concludes after executing these steps, providing a clear representation of the logic for responding to temperature conditions in the aquaculture environment.

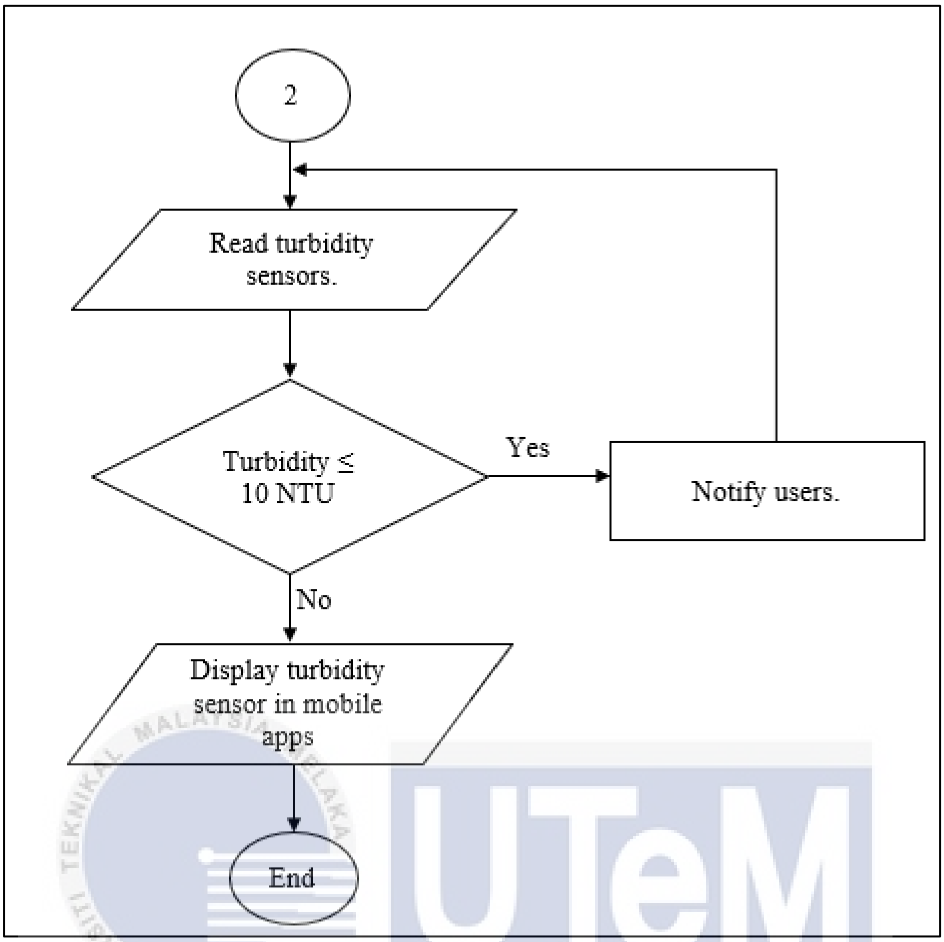


Figure 3.4 Flowchart for Turbidity

Based on Figure 3.5, the flowchart for reading the turbidity sensor involves a straightforward process to notify users based on the turbidity level. The system begins by reading the turbidity value from the sensor. If the turbidity is less than or equal to 10 NTU (Nephelometric Turbidity Units), the system triggers a notification to alert the users about the clear water conditions. On the other hand, if the turbidity exceeds 10 NTU, the system proceeds to display the current turbidity value and its status on the mobile app. This notification and display mechanism ensures that users are promptly informed when water clarity falls outside the desired range, promoting effective monitoring and timely response to changes in turbidity levels within the aquaculture system.

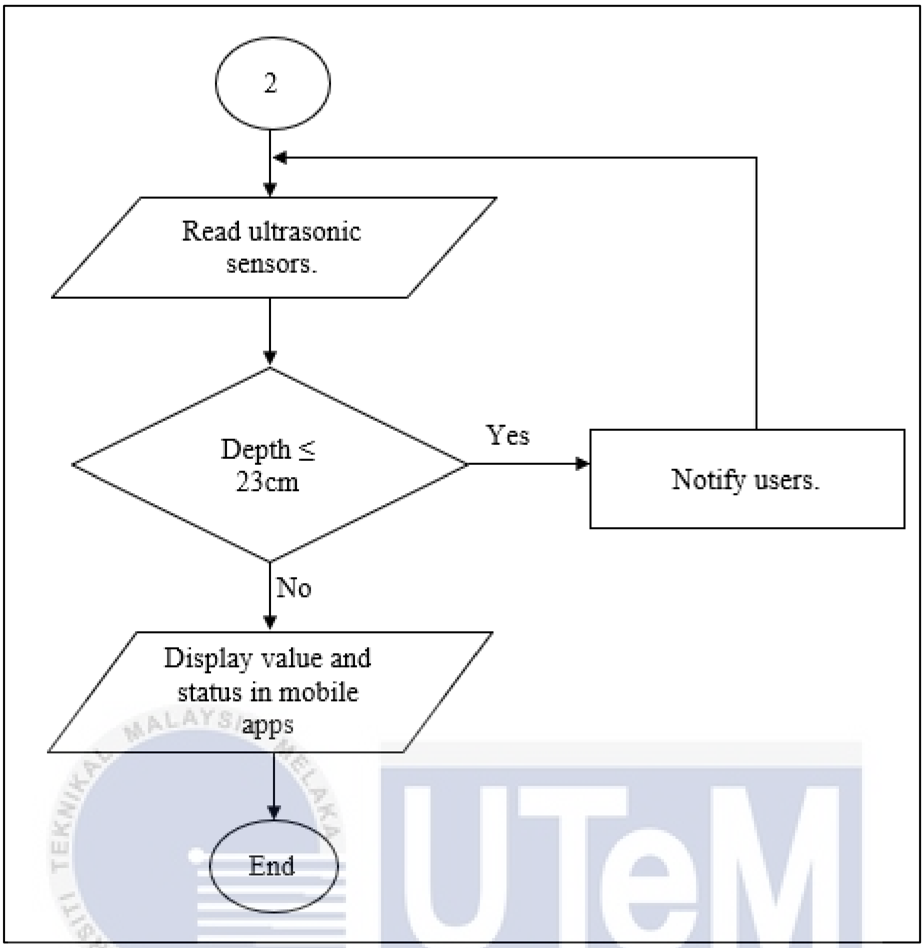


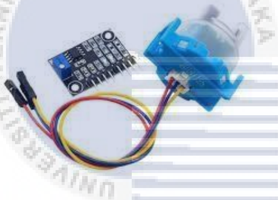
Figure 3.5 Flowchart to display depth of water

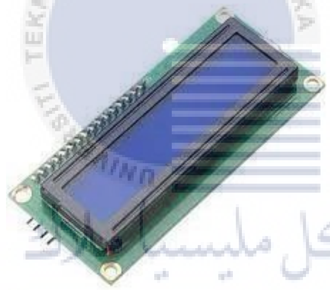
Based on Figure 3.6, it shows the flowchart for reading the ultrasonic sensor to ensure effective communication of water depth status. When the system initiates the ultrasonic sensor reading, it checks if the depth is less than or equal to 23cm. If the condition is met, the system proceeds to notify the users. This notification could be in the form of an alert or a message to convey the critical depth situation.On the other hand, if the depth is greater than 23cm, the system proceeds to display the current depth value along with its status on the connected mobile app. The depth value provides users with real-time information about the water depth. In summary, the flowchart serves to evaluate the depth reading from the ultrasonic sensor and takes different paths based on the depth condition.

3.4 Equipment Requirements

3.4.1 Hardware Equipment

Table 2 List of Components

No.	Components	Description	Quantity
1.	Temperature Sensor DS18B20 	The DS18B20 is a digital thermometer that measures temperatures between -55°C and +125°C with a 9-bit to 12-bit resolution.	1
2.	Turbidity Sensor 	Uses light to measure the light transmittance and scattering rate, which varies with the total suspended solids (TSS) content of the water and can be used to detect suspended particles in the water.	1
3.	Ultrasonic Sensor 	An ultrasonic sensor uses sound waves to measure distance or detect objects by sending and receiving high-frequency waves. Common in robotics, it calculates distance based on the time it takes for the waves to return, making it versatile for tasks like obstacle avoidance.	1
4.	Resistor 220 ohm 	A 220-ohm resistor is an electronic component that is used to resist the flow of electricity in a circuit.	3

5.	Buzzer 	A particular class of electrical gadget that emits tones, alarms, or other sounds. It has a straightforward design, is lightweight, and is often inexpensive.	1
6.	LED 	LED stands for light emitting diode. LED lighting products produce light up to 90% more efficiently than incandescent light bulbs.	3
7.	LCD Display 16x2 	A type of flat panel display known as an LCD (Liquid Crystal Display) operates primarily using liquid crystals.	1
8.	Wi-Fi Module ESP8266 	ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.	1

9.	12V Adapter 	A 12V DC power supply is an adapter designed to supply precisely 12 Volts of direct current to a device. The voltage supplied must precisely match the requirements of the equipment.	1
10.	Relay Module  	A relay is an electrically operated switch that can be turned on or off, letting the current go through or not, and can be controlled with low voltages, like the 5V provided by the Arduino pins.	1
11.	12V Fan 	It is a 12V DC fan with 0.15A. It has two wires (positive and negative) with connector to connect with the source. It is used for cooling operations in computer devices.	1

3.4.2 Software Equipment

3.4.2.1 Arduino IDE

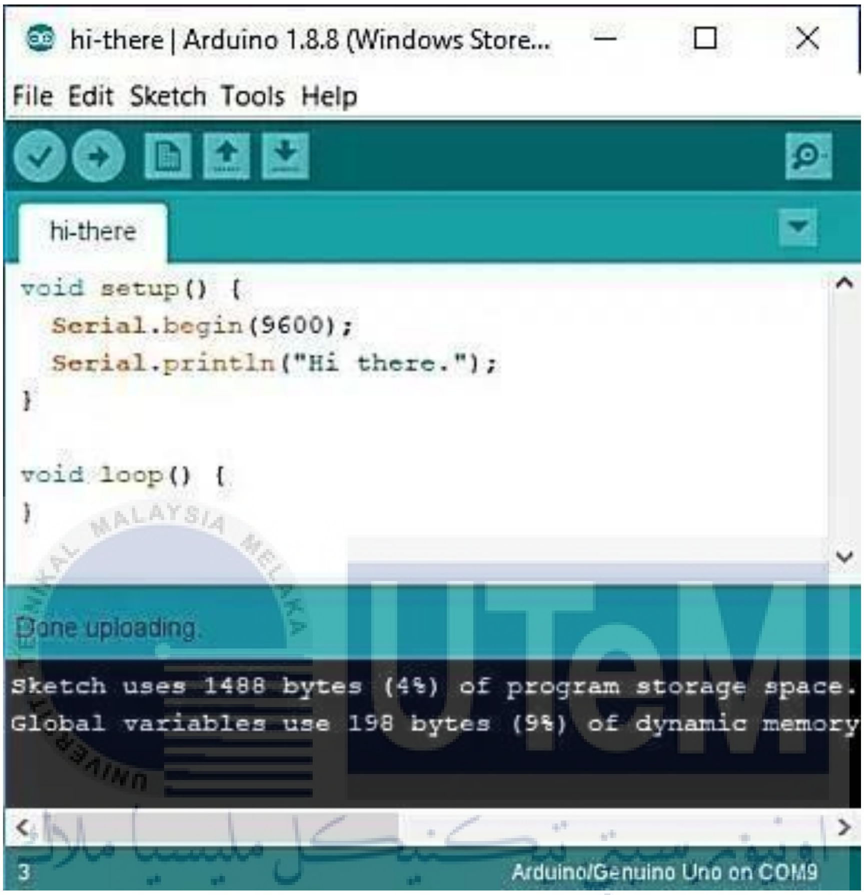


Figure 3.6 Arduino IDE interface

Figure 3.7 show the Arduino IDE (Integrated Development Environment) that is a programming software tool for Arduino microcontroller boards. It has an easy-to-use interface that allows both novice and experienced programmers to write, compile, and upload code to an Arduino board.The Arduino IDE is intended to make developing and uploading code for Arduino projects easier. It supports the Arduino programming language, which is a simplified version of C++ with extra libraries and functions designed specifically for Arduino boards.

When we launch the Arduino IDE, a text editor will appear to allow us to write the code where its consist of two functions such as setup() and loop(). When the Arduino board is powered on or reset, the setup() function is executed once, and it is typically used to initialise variables, set pin modes, or configure any necessary settings. The loop() function is then called again and again, allowing you to define the behaviour of your Arduino project.

The compilation process checks your code for errors and converts it to a machine-readable format that the Arduino board can understand. If there are any errors in your code, the IDE will highlight them to make them easier to find and fix. After successfully compiling the code, you can upload it to your Arduino board. This process transfers the code from your computer to the microcontroller on the Arduino board, allowing it to execute the instructions you've written. The Arduino IDE handles communication between your computer and the Arduino board, making uploading simple and painless.

In summary, the Arduino IDE is a software tool that makes programming Arduino boards easier. It has an easy-to-use interface, code editing capabilities, compilation, uploading, and additional serial communication features. The Arduino IDE provides a convenient and accessible environment for developing your Arduino projects, whether you are a beginner or an experienced programmer.

3.4.2.2 Android Studio

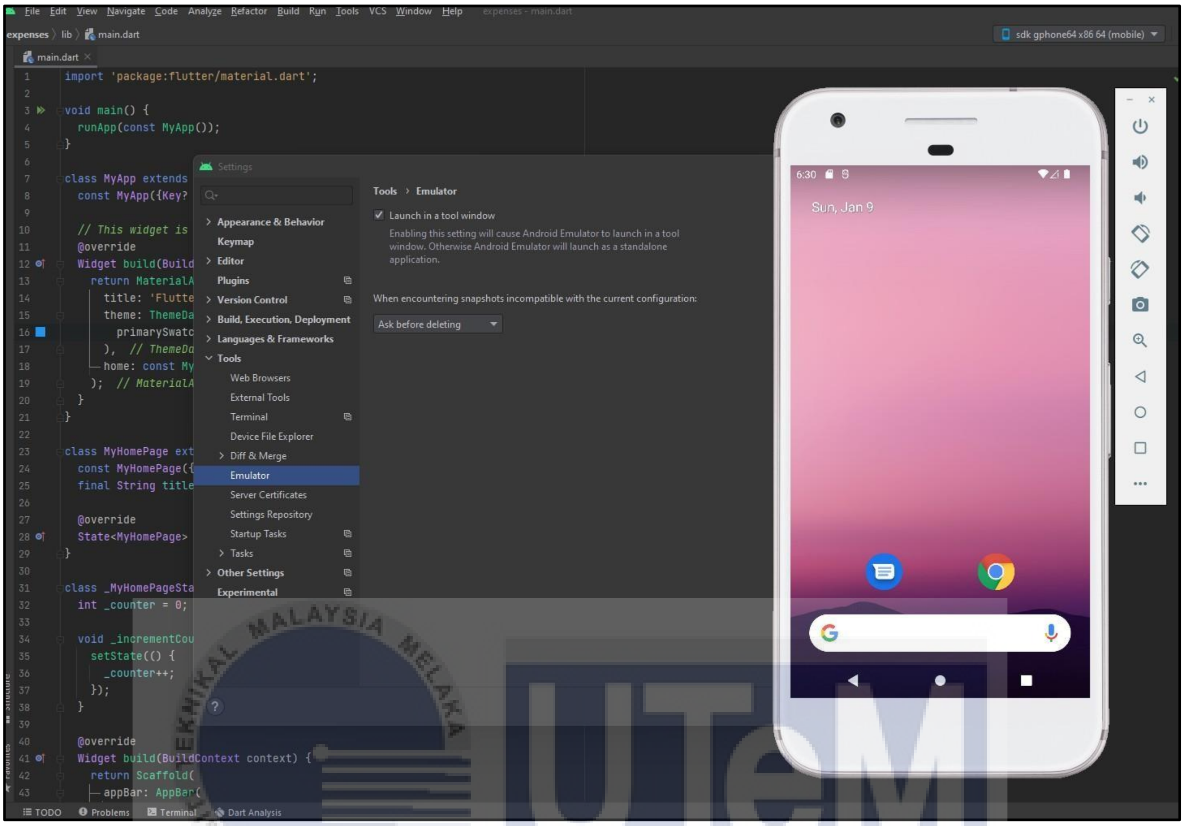


Figure 3.7 Interfacing Android Studio

Android Studio serves as the primary integrated development environment (IDE) specifically designed for Android app development. Developed by Google, it offers a robust set of tools and features to streamline the entire application development lifecycle. The IDE includes a user-friendly visual designer that facilitates the creation of app interfaces through a drag-and-drop interface, allowing developers to design their app layouts intuitively.

The code editor in Android Studio supports multiple programming languages, primarily Java and Kotlin, providing developers with flexibility. It incorporates features such as syntax highlighting, auto-completion, and error checking, enhancing the coding experience. Android Studio also seamlessly integrates with the Android Software Development Kit (SDK), ensuring that developers have access to the latest APIs and resources for building cutting-edge Android applications.

One noteworthy feature is the built-in emulator, which enables developers to test their applications on various virtual devices with different screen sizes and Android versions. This aids in identifying and addressing compatibility issues early in the development process. Additionally, Android Studio supports real-time code changes and instant deployment, allowing developers to see the effects of their code modifications immediately.

The IDE provides robust debugging tools, allowing developers to identify and fix issues efficiently. It supports version control systems like Git, facilitating collaborative development. Android Studio is regularly updated to align with the evolving Android platform, ensuring developers have access to the latest tools and capabilities for creating high-quality Android applications. Overall, Android Studio stands as an essential and comprehensive environment for developers looking to create feature-rich and visually appealing Android apps.

3.5 Experimental/ Study Design

3.5.1 Simulation

- Water level sensor using Tinkercad

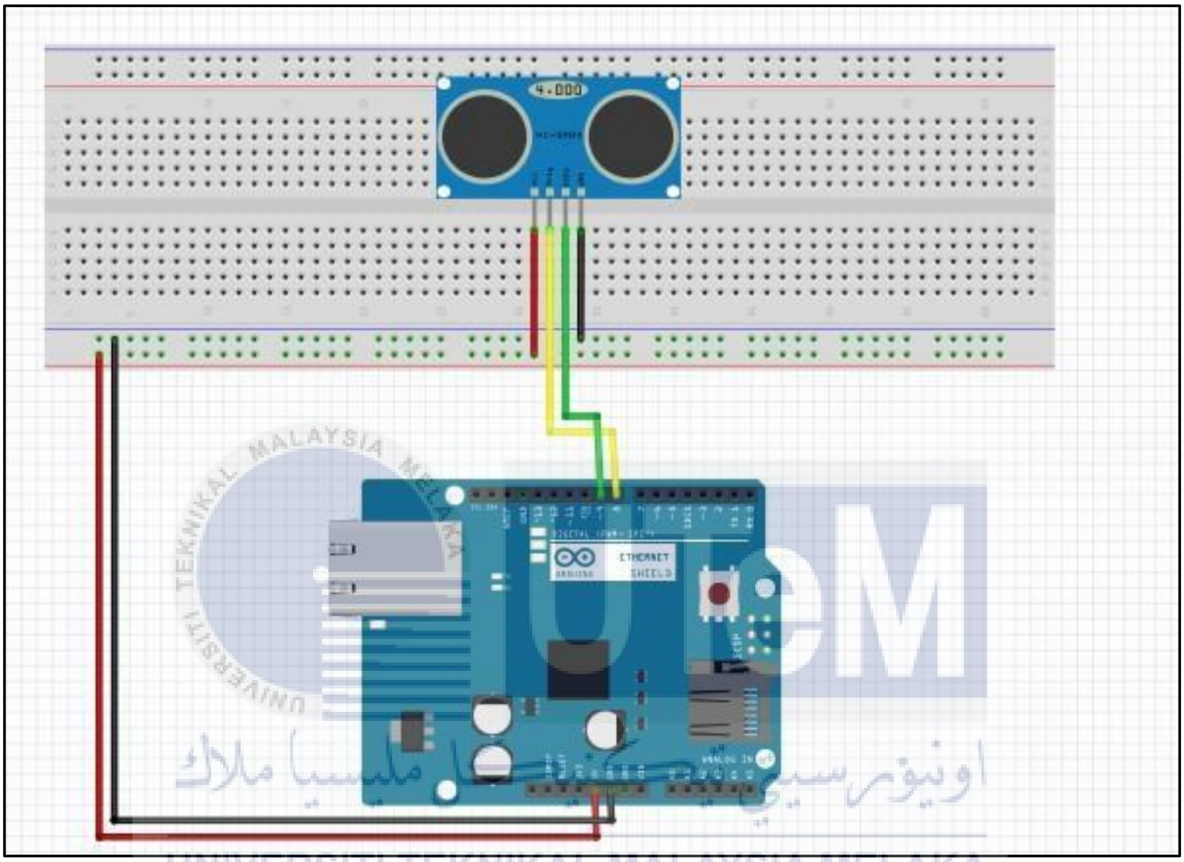


Figure 3.8 Simulation of water level system

In Figure 3.9 show the simulation of water level sensor by using Arduino Uno R3. In this simulation, we can use 3 LEDs such as red,green and yellow leds that react as condition of water inside the aquarium. The water level sensor will detect the level of water inside the aquarium whether it in NORMAL,HIGH or LOW condition. In case the water are in high condition and low condition, thus buzzer will react as alarm for user and red led will turn ON for high condition water level while yellow led will turn ON for low condtion water level. If let say the water level inside the aquarium are normal, then only green led will turn on. So that how the water level sensor and Arduino Uno R3 will operate.

- Simulation of temperature sensor using Wokwi

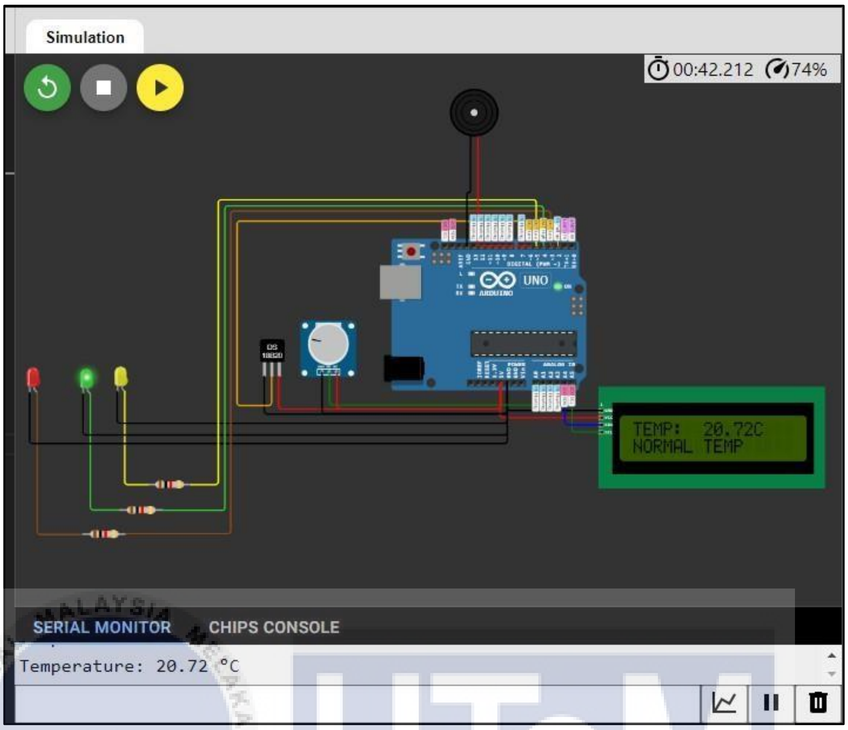


Figure 3.9 Output shows temp value 20.72C, NORMAL temp and green LED on

Based on Figure 3.10, the output shows "Temp: 20.72°C, NORMAL temp" with the green LED on indicates that the temperature reading is 20.72 degrees Celsius, which falls within the normal temperature range. The system is displaying this information to indicate that the temperature is at an acceptable level. The green LED being turned on is a visual indicator that the temperature is within the normal range. It serves as a confirmation that the system is operating correctly and there is no need for any immediate action or adjustments.

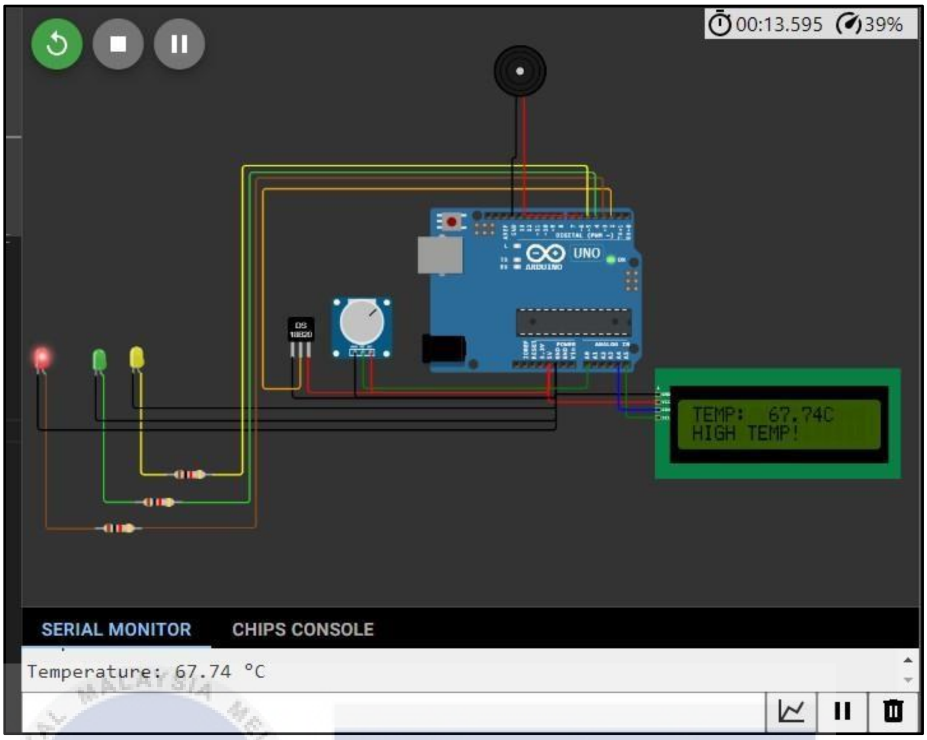


Figure 3.10 Output shows temp value 67.74C, HIGH temp and red LED on

Based on Figure 3.11, the output shows "Temp: 67.74°C, HIGH temp" with the red LED on, along with the activation of the buzzer and fan, indicates that the temperature reading is 67.74 degrees Celsius, exceeding the desired or safe temperature threshold. The system is providing a clear and audible alert to signify the high temperature condition. In addition to the red LED being turned on as a visual warning, the buzzer is activated to produce a loud sound, attracting immediate attention. The buzzer's sound serves as an audible alarm, ensuring that the high temperature situation is noticed even if the user is not actively monitoring the system. Simultaneously, the actuator fan is turned on to dissipate heat and lower the temperature. The fan's operation, combined with the visual and audible warnings, aims to quickly address the high temperature condition and prevent any further escalation.

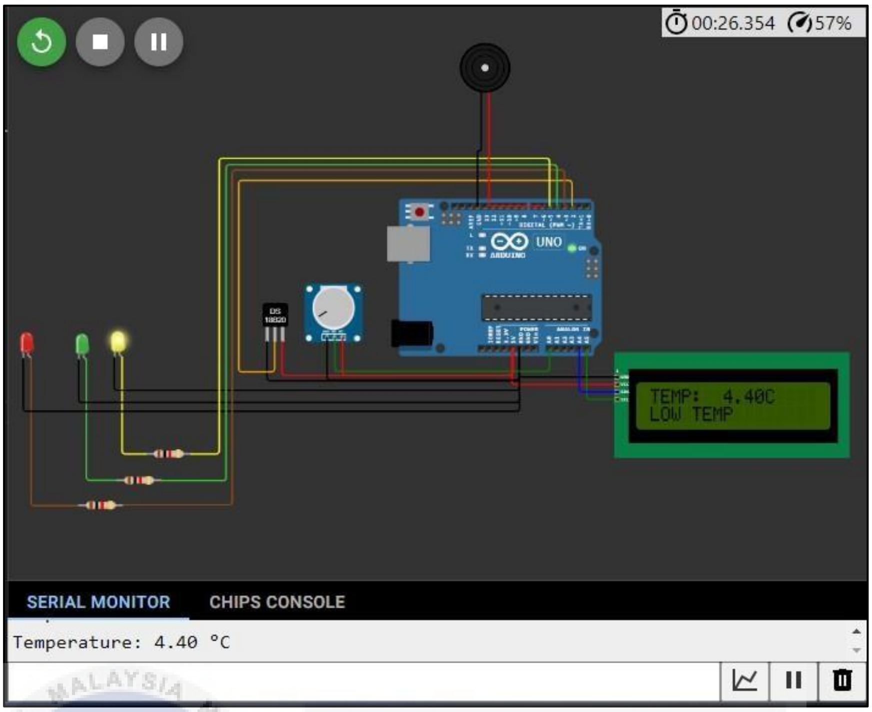


Figure 3.11 Output shows temp value 4.40C, LOW temp and yellow LED on

By referring Figure 3.12, the output shows "Temp: 4.40°C, LOW temp" with the yellow LED on indicates that the temperature reading is 4.40 degrees Celsius, which falls below the desired or expected temperature range. The system is indicating that the temperature is too low and requires attention or adjustment. The yellow LED being turned on serves as a visual indicator that the temperature is below the acceptable range. It alerts the user or system operator that immediate action may be needed to address the low temperature condition.

- Simulation to display “Fish Monitor System”

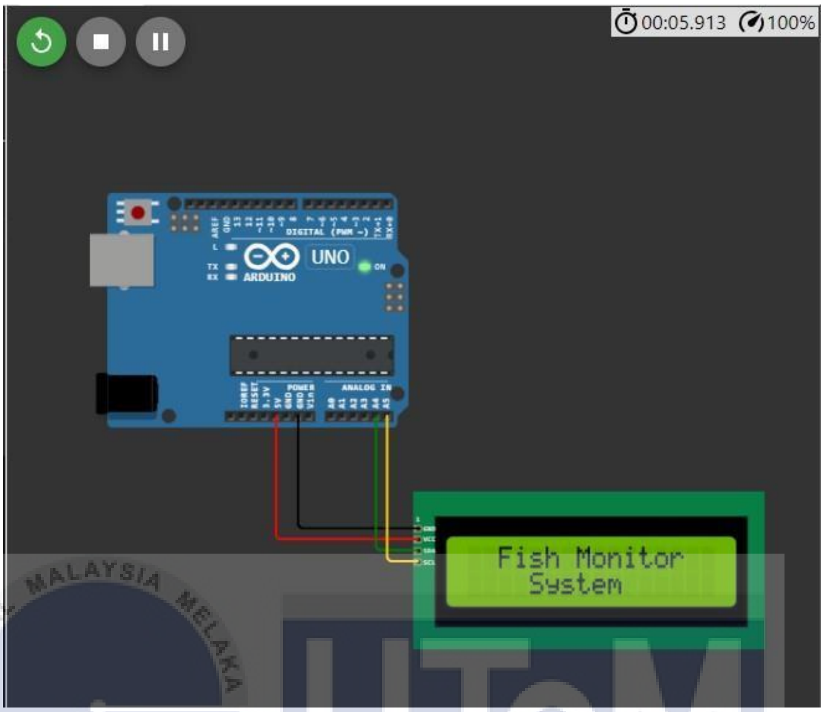


Figure 3.12 The output shows in LCD display

Based on Figure 3.13, the LCD (Liquid Crystal Display) in the fish monitoring system serves as an interface to provide real-time information about various parameters related to the aquaculture environment. The LCD display is connected to the microcontroller (MCU) in the fish monitoring system. The MCU receives data from various sensors such as the turbidity sensor, DS18B20 temperature sensor, and ultrasonic sensor for water depth. Once the MCU processes this data, it sends relevant information to the LCD display for visualization. The LCD serves as a user-friendly interface, providing aquaculturists and users with a quick overview of the key parameters affecting the fish environment.

3.5.2 Coding

a) LCD I2C to display “Fish Monitor System”

```
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27, 16, 2); // I2C address may vary, adjust accord

void setup() {
  lcd.begin(16, 2);  // Initialize the LCD display
  lcd.backlight();   // Turn on the backlight (if available)
  lcd.setCursor(2, 0);  // Set the cursor to the first column, first row
  lcd.print("Fish Monitor");  // Print the first line of text
  lcd.setCursor(4, 1);  // Set the cursor to the first column, second row
  lcd.print("System");  // Print the second line of text
}

void loop() {
  // The main program loop
  // You can add your monitoring logic here
}

```

Figure 3.13 Coding to display Fish Monitor System

Based on Figure 3.14, I create a simple fish monitoring system code for an LCD display using Arduino, firstly we need to include the necessary libraries for I2C communication and the LCD itself. Define the I2C address of the LCD, and create an instance of the LiquidCrystal_I2C class. In the setup function, initialize the LCD, display an initial message such as "Fish Monitoring System Initializing," and clear the LCD after a brief delay. In the loop function, replace the placeholder functions with actual sensor reading functions for temperature, turbidity, and water depth. Update the LCD with these sensor values, providing labels and units for clarity. Introduce appropriate delays between updates to ensure readability.

b) Water level sensor

```
sensorValue = analogRead(sensorPin);
// convert sensor value to water level
waterLevel = map(sensorValue, 0, 1023, 0, 100);

lcd.setCursor(0, 0);
lcd.print("Water Level:"); //display water level on LCD
lcd.print(waterLevel);
lcd.print("%"); //display the percentage of water level on LCD
lcd.setCursor(0, 1);
// print water level for debugging
Serial.print("Water level :");
Serial.print(waterLevel);
Serial.println("%\t");

// control LEDs based on water level
if (waterLevel == 0) { //condition if there is no water inside the container
  digitalWrite(redLed, LOW);
  digitalWrite(yellowLed, LOW);
  digitalWrite(greenLed, LOW);
  lcd.print("Condition:EMPTY");
  delay(1000);
}
else if (waterLevel <= 30) { //condition if water level is less than equal 30, so it will
  digitalWrite(redLed, LOW);  //display LOW condition
  digitalWrite(yellowLed, HIGH);
  digitalWrite(greenLed, LOW);
  lcd.print("Condition:LOW");
  delay(1000);
}
else if (waterLevel>30 && waterLevel<=50) { //condition if water level is greater than 30 and less
  digitalWrite(redLed, LOW);                //equal to 50, so it will display NORMAL condition
  digitalWrite(yellowLed, LOW);
  digitalWrite(greenLed, HIGH);
  lcd.print("Condition:NORMAL");
  delay(1000);
}
else if(waterLevel>50 && waterLevel<=100){ //condition if water level is greater than 50 and less
  digitalWrite(redLed, HIGH);              //than equal to 100, then it display HIGH condition
  digitalWrite(yellowLed, LOW);
  digitalWrite(greenLed, LOW);
  lcd.print("Condition:HIGH");
  delay(1000);
}
```

Figure 3.14 Coding for water level sensor

Based on Figure 3.16, we need to integrate ultrasonic sensor readings into the fish monitoring system code for the LCD display using Arduino, the code is enhanced with definitions for the ultrasonic sensor's trigger and echo pins. The `readUltrasonicDistance()` function is introduced, which triggers the ultrasonic sensor, measures the pulse duration on the echo pin, and converts it to a distance in centimeters. In the main loop, alongside temperature and turbidity readings, the ultrasonic sensor's data for water depth is obtained through the new function and displayed on the LCD.

3.6 Summary

This chapter describes and explains the methodology of 'Development of IoT-based Fish Monitoring System for Aquaculture'. Project methodology is one of the most significant chapters in handling a project to ensure that the project can be completed systematically guided by following the correct sequence of the project methods. In this part, I use several software such as TinkerCad, Wokwi and Arduino IDE to test whether the simulation and code can be run or not. Besides that, I also already list all hardware I use inside this chapter so that I can easily know what the function for each equipment in this project is. As a conclusion, the key part of this stage is the analysis and identification of all the components and control elements that related to this project.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

The implementation and Development chapter provides a detailed account of the integration of both software and hardware components in the "Development of IoT-based Fish Monitoring System for Aquaculture". This chapter is divided into three sections: Software Development, Hardware Development and Data Analysis.

4.2 Result & Analysis

4.2.1 Prototype Design

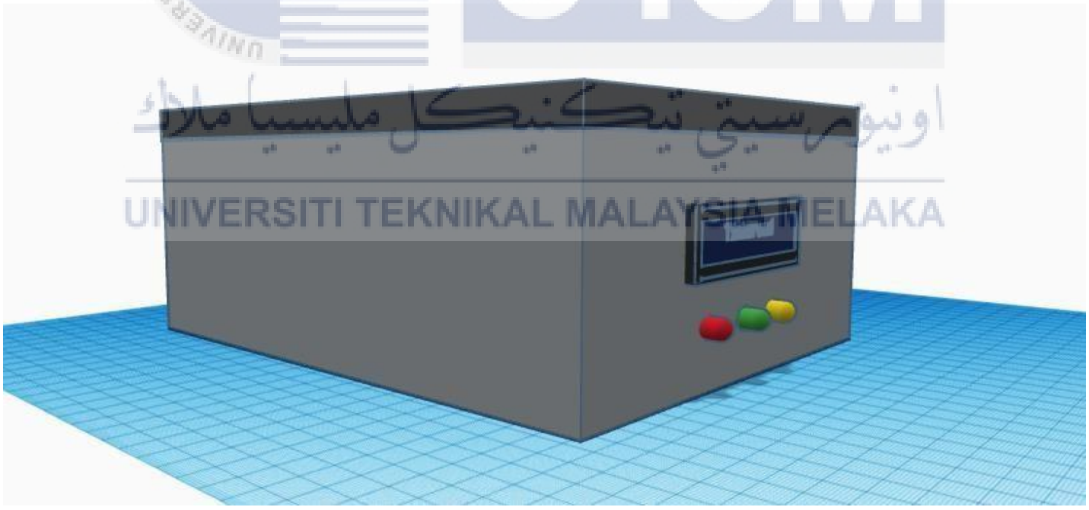


Figure 4.1 Prototype of the project

Based on Figure 4.1, we can see the design of the feeding mechanism by using Tinkercad same goes to the sensor box. The servo motor, acting as the powerhouse, is intricately integrated into the design to control the precise movement required for accurate and measured food distribution. The design ensures that the feeding process aligns with the specific needs of the aquatic environment, promoting a healthy and controlled feeding. The implementation of the automated feeding mechanism involves the precise dispensation of an optimal quantity of fish food at predetermined intervals.

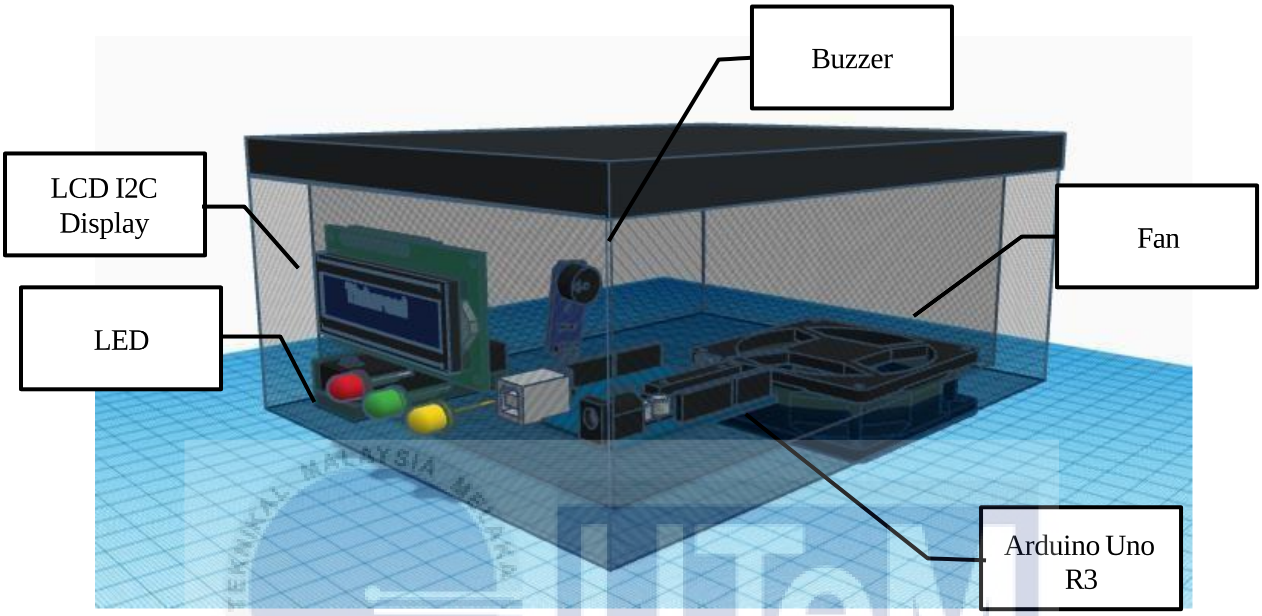


Figure 4.2 View inside the prototype

Based on Figure 4.2, we can see the sensor box which is like a shield for sensors, breadboard, and wires by using Tinkercad software. This section covers the construction and arrangement of components within the sensor box. It's designed not just to keep them safe but also to help them work together smoothly. We carefully construct this box, thinking about where each part goes and how they fit well. Inside, the sensors are shielded from the environment, and the breadboard and wires are organized for efficiency. This part of the system is all about creating a secure and orderly home for the components that keep an eye on the aquaculture conditions.

4.2.2 Software Development

This project uses the Arduino IDE and Andorid Studio. A software package called the Arduino IDE (Integrated Development Environment) is made to make it easier to programme and develop for Arduino microcontroller boards.. With the Arduino IDE, programmers can write code to read data from sensors such as temperature, water level, and turbidity sensors, enabling the system to collect crucial information about the fish tank.

a) Android Application Development

i) Splash Screen

Figure 4.3 Splash Screen GUI

Figure 4.3 show the Android application opens with an engaging splash screen, setting the tone for user interactions. This section outlines the design considerations and technical details behind the implementation of the splash screen.

ii) Main Page

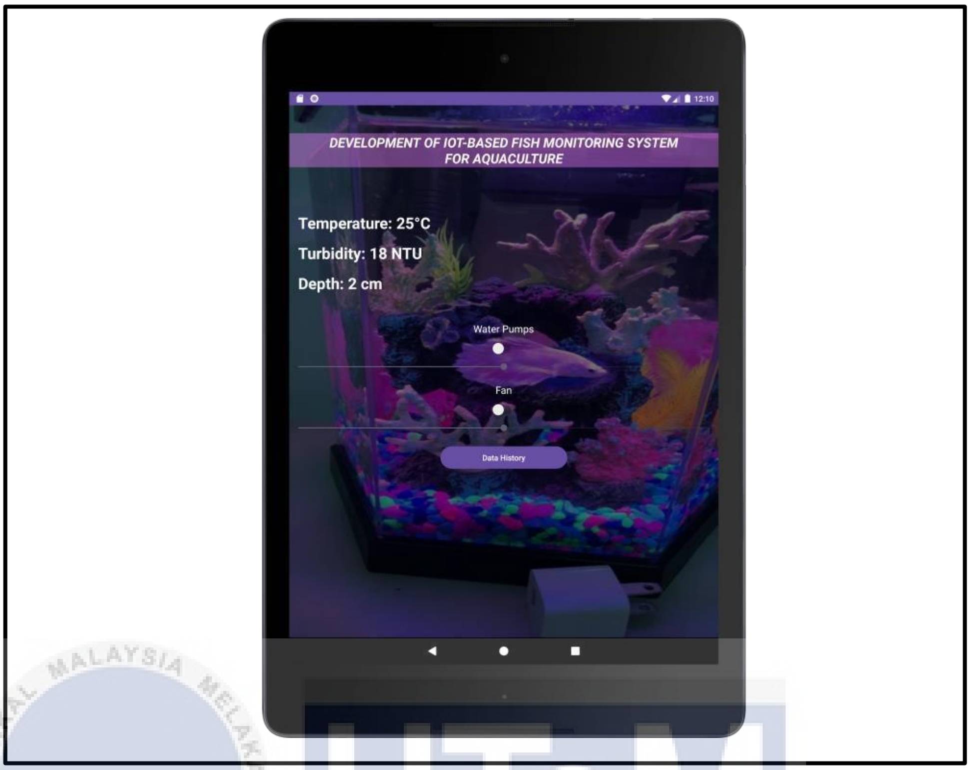


Figure 4.4 Main Page GUI

Figure 4.4 shows the main page serves as the central hub for users to monitor and control the aquaculture environment. Real-time sensor values for turbidity, temperature and water depth are prominently displayed. This section details the integration of sensor values, the user interface design, and mechanisms for real-time updates.

In the main page, it also has the intuitive controls for two water pumps where is pump on or off and a fan that are implemented, allowing users to toggle these actuators on/off and adjust speed settings. This section explores the development of the actuator control interface and its integration with the Arduino firmware.

iii) Data History

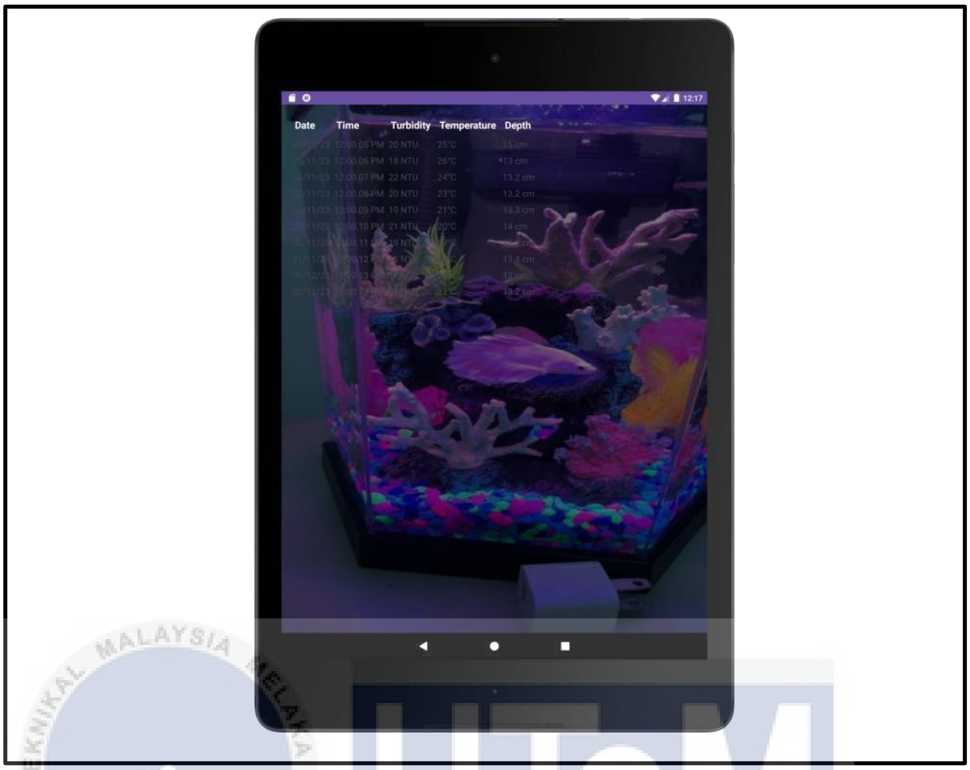


Figure 4.5 Data History GUI

Figure 4.5 shows Data History Page when user click “Data History” button on the main page GUI. It provides users with access to historical data for the past 10 days. This section elaborates on the implementation of the data history features, covering database design, data retrieval and visualization mechanisms.

The foundation of the “Data History” features lies in the efficient design of the database. A relational database is employed to store historical sensor data over time. Each entry in the database corresponds to a specific timestamp, capturing the sensor readings for turbidity, temperature, and water depth inside the aquarium.

4.2.3 Hardware Development

The hardware used in this project are Arduino UNO, servo motor, LCD Board, ultrasonic sensor, Temperature sensor, turbidity sensor, buzzer, 3LEDs such as green LED, red LED, and yellow LED. Figure 4.9 shows the circuit that I create for this system.

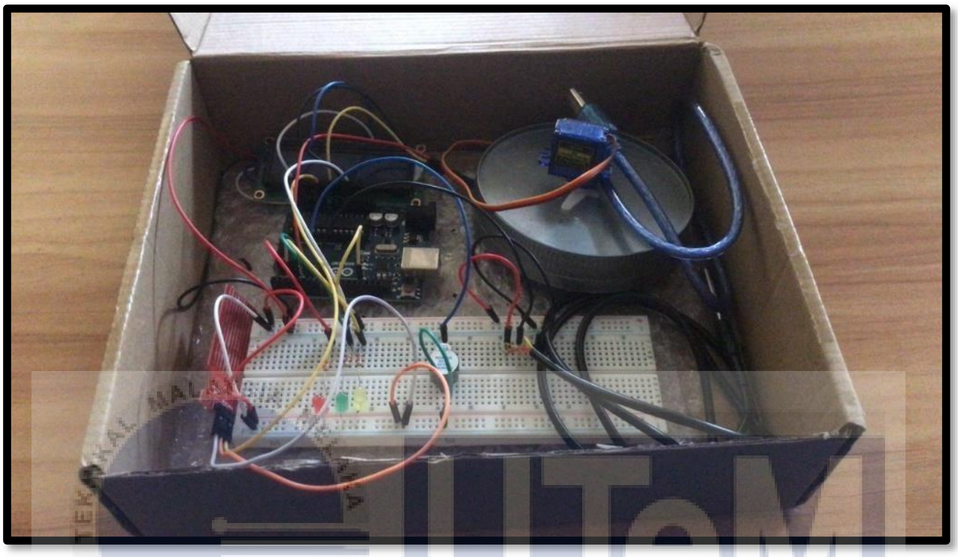


Figure 4.6 Circuit Wiring

Before we start to check the functionality of the sensor, we compile and verify the coding in Arduino IDE, so as we can see the a message will display on the LCD.

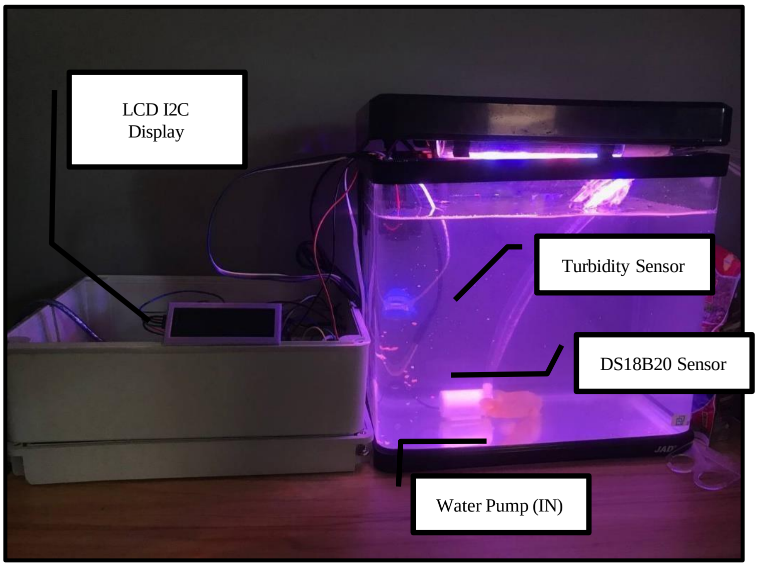


Figure 4.7 Aquarium and The Prototype

Figure 4.7 shows the prototype hardware involves a comprehensive examination of both the aquarium, serving as the controlled environment for aquaculture, and the integrated prototype components. The aquarium serves as the physical setting for the IoT-based Fish Monitoring System, simulating conditions relevant to aquaculture. Within this environment, the prototype hardware includes sensors, actuators, the Arduino microcontroller, and the Android application interface.

The sensors, strategically placed within the aquarium, capture essential data such as turbidity, temperature, and water depth, providing real-time insights into the aquatic environment. Actuators, comprising water pumps and a fan, are integrated to regulate and maintain optimal conditions. The Arduino microcontroller acts as the brain of the system, processing sensor data and facilitating communication between the hardware and the Android application.

Figure 4.8 LCD Display

Next, the fish feeding will start rotate in 180 degree from left to right and then back to its position to give food for fish.

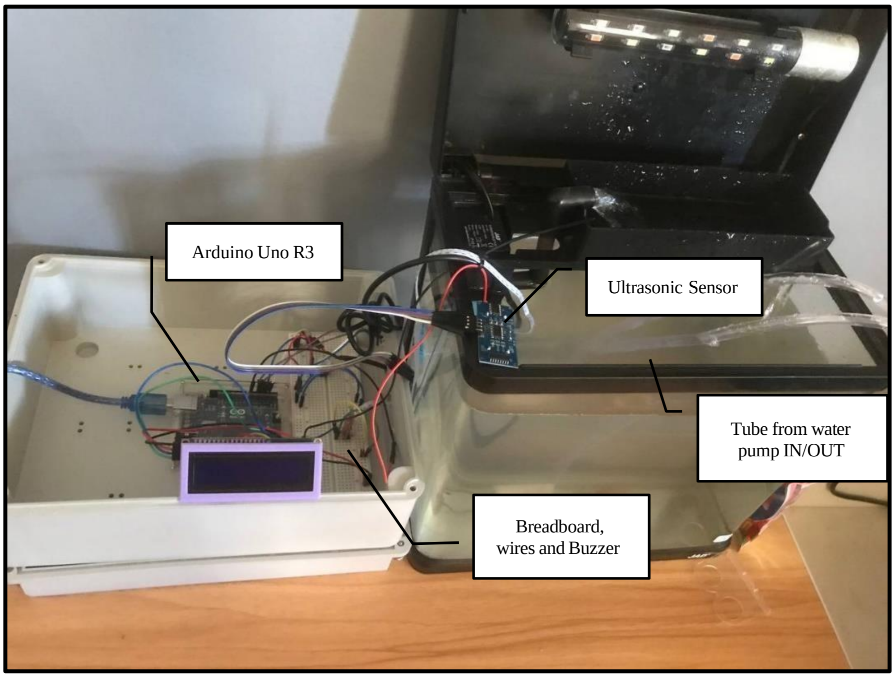


Figure 4.9 View from above and inside.

Figure 4.9 shows the view from above the aquarium provides a glimpse into the integral components of the IoT-based Fish Monitoring System. As we see, an ultrasonic sensor is prominently positioned to measure the depth of the water. This sensor providing real-time data on the water level within the aquarium, contributing to a comprehensive understanding of the aquatic environment.

Moving inside the prototype, a central hub is observed, comprising an Arduino Uno R3 microcontroller. This Arduino Uno R3 functions as the brain of the system, orchestrating the communication between various hardware components. It is complemented by a breadboard, jumpers, and wires, forming a cohesive network that facilitates the seamless integration of sensors and actuators. The breadboard serves as a platform for connecting and organizing electronic components, while the jumpers and wires create the necessary pathways for the flow of data and control signals. This internal perspective provides insight into the central processing unit of the prototype, highlighting the essential role played by the Arduino Uno R3 in managing and coordinating the entire IoT system.

4.2.4 Data Analysis

Table 4. 4 Result of Turbidity for 10 days

Date	Turbidity (NTU)
24/11/2023	20
25/11/2023	18
26/11/2023	22
27/11/2023	20
28/11/2023	19
29/11/2023	21
30/11/2023	19
1/12/2023	16
2/12/2023	17
3/12/2023	20

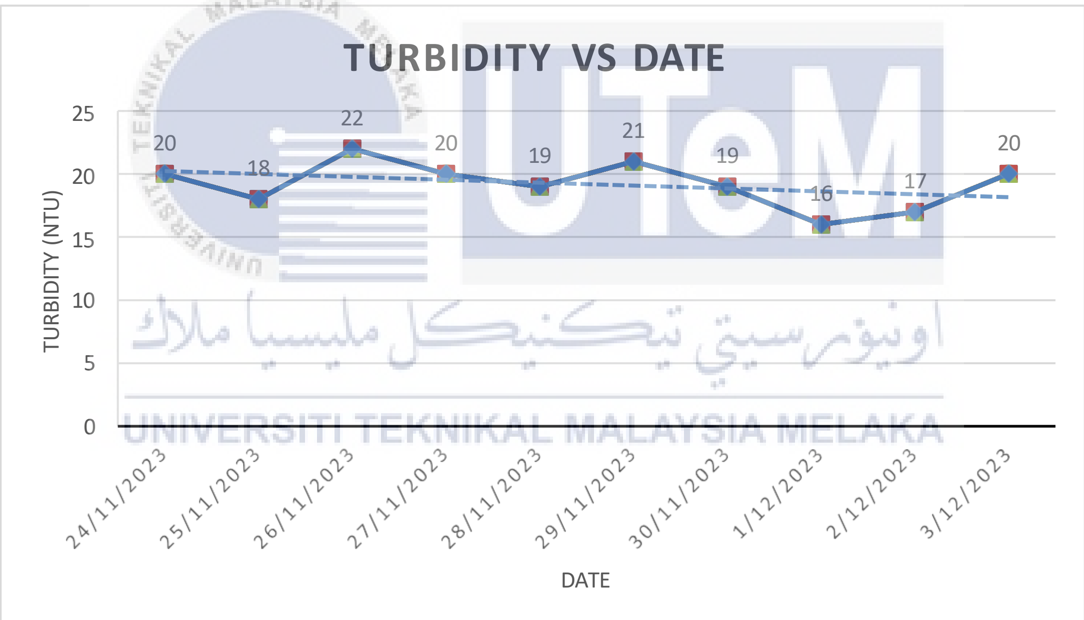


Figure 4.10 Graph of Turbidity data taken for 10 days.

Based on the data collected in the Table 4.1, a line graph as shown in Figure 4.10 is plotted against the turbidity value vs date for 10 days using Excel. The turbidity trends in the provided dataset unveil a dynamic pattern in water quality. Initially experiencing fluctuations, exemplified by a spike on 26/11/2023, the turbidity values subsequently stabilize within a moderate range. This stable period is succeeded by a pronounced decrease, reaching its lowest point on 1/12/2023. This decline hints at an improvement in water clarity. A refinement observation is the slight upturn in turbidity on 3/12/2023, suggesting a subtle shift in the water quality dynamics.

Table 4. 5 Temperature values collected against time for 10 days

Date	Temperature(°C)
24/11/2023	25
25/11/2023	26
26/11/2023	24
27/11/2023	23
28/11/2023	21
29/11/2023	20
30/11/2023	19
1/12/2023	18
2/12/2023	20
3/12/2023	22

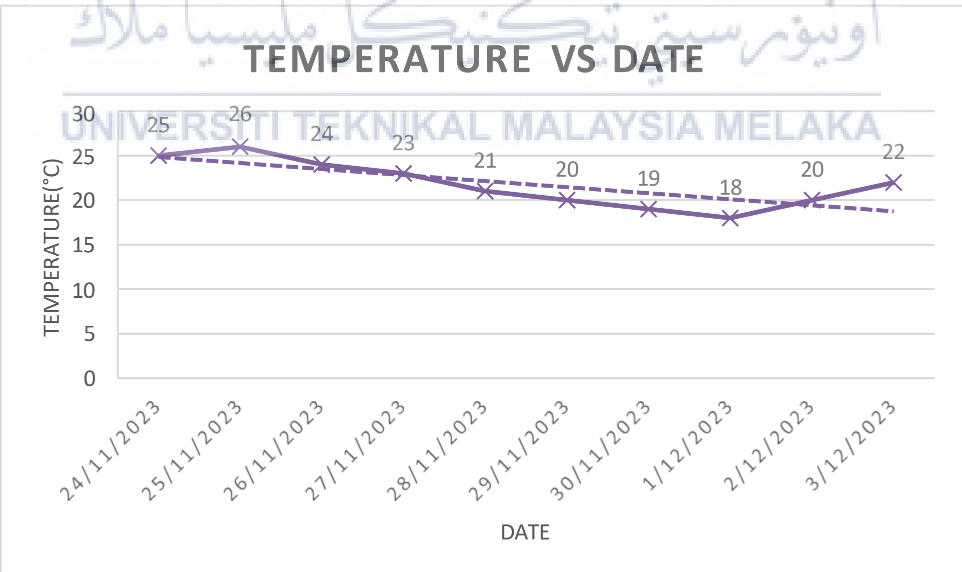


Figure 4.11 Graph temperature against date for 10 days.

Based on Table 4.2, we can conclude the data using the graph in Figure 4.11 that the temperature data over the recorded dates reveals discernible patterns in the aquatic environment. Initially, there is a notable decrease in temperature, with a drop from 25°C on 24/11/2023 to 21°C on 28/11/2023. This initial decline suggests a cooling trend in the water conditions. Following this decrease, the temperatures stabilize, hovering around 20°C to 21°C from 28/11/2023 to 29/11/2023, indicating a period of relative consistency. However, a further decrease is observed from 29/11/2023 (20°C) to 1/12/2023 (18°C), reflecting a sustained cooling trend. The temperature experiences a recovery on 2/12/2023, rebounding to 20°C, and demonstrates a more significant increase to 22°C on 3/12/2023.

Table 4. 6 Data collected for Depth of water against time for 10 days.

Date	Depth(cm)
24/11/2023	14
25/11/2023	14.2
26/11/2023	13.8
27/11/2023	13.5
28/11/2023	13.3
29/11/2023	13
30/11/2023	13.2
1/12/2023	13.4
2/12/2023	13
3/12/2023	13.2

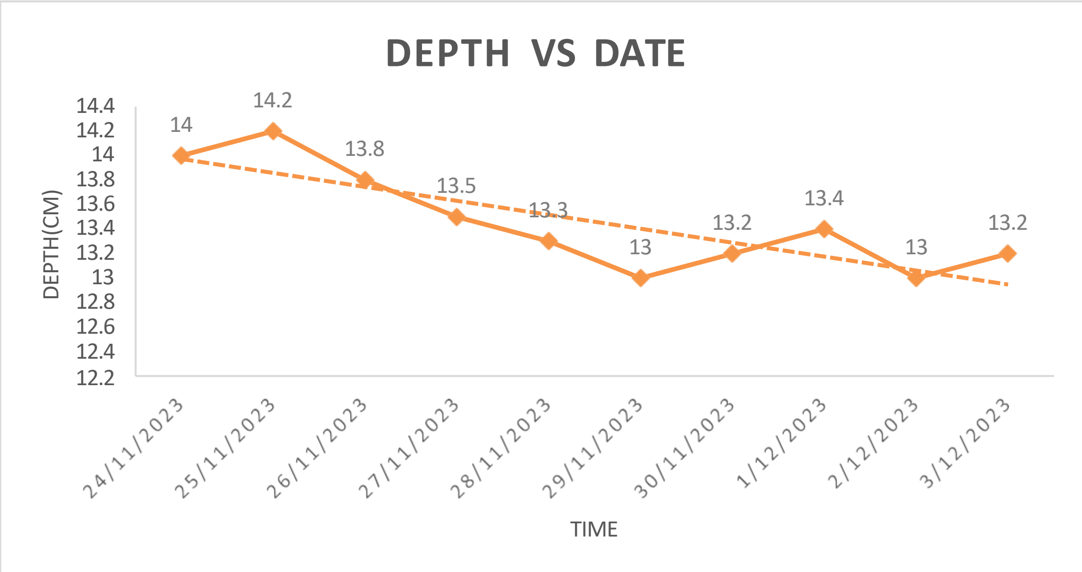


Figure 4.12 Graph of Depth vs Date Taken in 10 days.

By referring to Table 4.3, we can conclude that analyzing the depth data over the specified dates reveals a consistent pattern in the water level within the aquarium in Figure 4.12. The graph of the depth measurements indicates a relatively stable trend, with minimal fluctuations. The initial depth recorded on 24/11/2023 is 14 cm, followed by slight variations in subsequent days, such as 14.2 cm on 25/11/2023 and 13.8 cm on 26/11/2023. However, the overall trend suggests that the water depth remains within a narrow range, hovering around 13 cm for most of the recorded dates. This stability in depth values indicates a well-maintained aquatic environment with minimal disturbance, providing a conducive setting for the inhabitants of the aquarium.

4.3 Summary

This chapter explains all the final outcomes from the project. The result of constructing the fish monitoring system using related sensor circuit is included. Moreover, the results of the compiled coding also have been included as the prove to successfully collect the data without any troubleshoot.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The development of a fish monitoring system using IoT brings numerous benefits to fish owners and aquarists. By integrating sensors, IoT connectivity, cloud platforms, and remote monitoring capabilities, this system allows for real-time monitoring and control of essential parameters related to water conditions, and providing convenience. Users can remotely access and analyze data on water temperature, turbidity, and water level, ensuring optimal conditions for the fish. The inclusion of actuators and control features enables adjustments to be made remotely, while alerts and notifications provide timely updates on critical events or deviations from desired parameters, allowing for immediate action. Overall, this comprehensive and automated monitoring solution promotes the well-being of fish, empowering fish owners to effectively manage their fish tanks.

5.2 Future Recommendations

Based on the development of a fish monitoring system using IoT, there are several recommendations to consider.

1. Sensor Selection: Ensure the reliability, accuracy, and suitability of sensors chosen for fish monitoring, aligning them with specific requirements for scheduling and water condition monitoring.

2. User-Friendly Interface: Continuously improve and refine the user interface, making it more intuitive and user-friendly to enhance user experience and ease of interaction.

3. Power Consumption Optimization: Optimize the power consumption of system components, particularly for battery-powered devices or actuators, to extend operational lifespan and minimize environmental impact.

5.3 Project Potentials

Project Potentials for the IoT-Based Fish Monitoring System include:

1. Scalability: Explore opportunities to scale the system for broader aquaculture applications, accommodating varying farm sizes and environmental conditions.

2. Data Analytics Integration: Consider integrating advanced data analytics capabilities to extract valuable insights from the collected data, enabling trend analysis and predictive modeling for fish farming optimization.

3. Remote Monitoring: Explore the potential for implementing remote monitoring features, allowing users to access and manage the system from anywhere, enhancing convenience and real-time decision-making.

4. Integration with Aquaculture Management Systems: Investigate the integration of the fish monitoring system with broader aquaculture management platforms, streamlining data flow and providing a holistic approach to fish farm management.

5. Environmental Sustainability: Evaluate possibilities for incorporating eco-friendly components or energy sources, aligning the project with sustainability goals and minimizing ecological impact.

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APPENDICES

Appendix A Gantt Chart of BDP1

No	Project Activity	Week														
		1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Final Year Project briefing by JK PSM								MID SEM BREAK							
2	Topic confirmation and discussion with supervisor															
3	Meeting with supervisor for Introduction (Week 1)															
4	Study on project background and writing on Chapter 1															
5	Meeting with SV for chapter 1 correction and chapter 2 briefing															
6	Make a Research and Writing on chapter 2															
7	Meeting with SV for chapter 2 corrections and chapter 3 briefing															
8	Make a Research and Writing on chapter 3															
9	Report Draft Submission															
10	PSM Presentation															

Appendix B Gantt Chart of BDP2

No	Project Activity	Week														
		1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Final Year Project briefing by JK PSM								MID SEM BREAK							
2	Show latest progress to supervisor															
3	Design Prototype hardware															
4	Collect observed data from the project															
5	Submit data observation to supervisor															
6	Make video demo and shows to supervisor															
7	Complete chapter 4															
8	Update GUI of the project															
9	Submit draft report to SV and panel															
10	PSM Presentation															