POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

IOT BASED AQUACULTURE WATER MONITORING SYSTEM

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JABATAN KEJURUTERAAN ELEKTRIK

SESI II 2022/2023

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This report submitted to the Electrical Engineering Department in fulfilment of the requirement for a Diploma in Electronic Engineering

JABATAN KEJURUTERAAN ELEKTRIK

SESI I 2022/2023

CONFIRMATION OF THE PROJECT

The project report titled "IOT BASED AQUACULTURE WATER MONITORING SYSTEM" has been submitted, reviewed and verified as a fulfills the conditions and requirements of the Project Writing as stipulated

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Date :

"I acknowledge this work is my own work except the excerpts I have already explained to our source"

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Registration Number : **08DEP20F2029**

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DECLARATION OF ORIGINALITY AND OWNERSHIP

TITLE: **IOT BASED AQUACULTURE WATER MONITORING SYSTEM**

SESSION: **SESSION I 2022/2023**

1. I, **Maisarah Zafirah Sham Binti Yunoos , Matric No :08DEP20F2029** is a final year student of **Diploma in Electrical Engineering, Department of Electrical, Politeknik Sultan Salahuddin Abdul Aziz Shah**, which is located at **Persiaran Usahawan,40140 Shah Alam Selangor Darul Ehsan**. (Hereinafter referred to as 'the Polytechnic').

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a) **MAISARAH ZAFIRAH SHAM BINTI YUNOOS**
(Identification card No: - 960825075436)

…..…………………………….
(MAISARAH ZAFIRAH SHAM BINTI YUNOOS)

In front of me, **NUR SURIYA BINTI MOHAMAD**

As a project supervisor, on the date:

…..…………………
(NUR SURIYA BINTI MOHAMAD)

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IOT BASED AQUACULTURE WATER MONITORING SYSTEM

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Abstract

The practise of carefully raising aquatic organisms, particularly for human consumption, is known as aquaculture. Aquaculture is a growing industry in several parts of the world. It aids in food production and the restoration of endangered species. Additionally, it has gained popularity as a protein-rich food source. Other uses for aquaculture production exist as well. For instance, algae have been grown as an alternative fuel source that is cleaner and easier to cultivate than fossil fuel. Similar to this, numerous other research and development projects are taking advantage of the expansion of aquaculture, and there are lots of promising prospects for the future. Aquaculture is practised in tanks, on land, in freshwater ponds, rivers, and ocean water. The Internet of Things is advancing in the 4.0 agricultural era, yet many countries and local fish farmers are still lagging behind in their adoption of this technology. The Internet-of-Things (IoT) is a technology that has made significant strides in recent years and can be applied to the development of more efficient, secure, and affordable systems with real-time capabilities. Briefly, this investigation explores design suggestions for a productive system. A number of sensors are used to measure a variety of factors. This project proposed sensors such as temperature, pH level and turbidity sensors. The ESP32 is used to execute all the programs that have been sketched and written on the Arduino IDE. Without a doubt, this research will help the growing industry of aquaculture and also anyone interested in fishkeeping and fellow aquarist.

(**Keywords**: Aquaculture, IoT, Water Quality Monitoring System, fish farming, Arduino, Sensors, pH, temperature, turbidity, esp32, Blynk)

ABSTRAK

Amalan memelihara organisma akuatik dengan teliti, terutamanya untuk kegunaan manusia, dikenali sebagai akuakultur. Ia adalah konsep yang serupa dengan pertanian, tetapi bukannya menggunakan tumbuhan, ia menggunakan ikan. Nama lain untuk akuakultur ialah ternakan ikan. Akuakultur diamalkan di seluruh dunia, termasuk dalam tangki, di darat dan di kolam air tawar, sungai, dan air laut. Akuakultur air tawar dilakukan di kolam ikan, kandang ikan, sangkar ikan, atau, dalam skala yang sangat kecil, di sawah padi. Internet of Things semakin maju dalam era pertanian 4.0, namun banyak negara dan penternak ikan tempatan masih ketinggalan dalam penggunaan teknologi ini. Internet-of-Things (IoT) ialah teknologi yang telah mencapai kemajuan yang ketara dalam beberapa tahun kebelakangan ini dan boleh digunakan untuk pembangunan sistem yang lebih cekap, selamat dan mampu milik dengan keupayaan masa nyata. Secara ringkas, penyiasatan ini meneroka cadangan reka bentuk untuk sistem yang produktif. Sebilangan penderia digunakan untuk mengukur pelbagai faktor. Projek ini mencadangkan sensor seperti suhu, tahap pH dan sensor kekeruhan. ESP32 digunakan untuk melaksanakan semua program yang telah dilakarkan dan ditulis pada Arduino IDE. Tidak dinafikan, penyelidikan ini akan membantu industri akuakultur yang semakin berkembang, atau penternakan ikan dan juga sesiapa yang berminat dalam pemeliharaan ikan dan rakan aquarist.

(Kata kunci: Akuakultur, IoT, Sistem Pemantauan Kualiti Air, penternakan ikan, Arduino, Sensor, pH, suhu, kekeruhan, esp32, Blynk)

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CHAPTER 1
1 INTRODUCTION

1.1 Introduction

The practise of carefully raising aquatic organisms, particularly for human consumption, is known as aquaculture. It's a concept akin to agriculture, but instead of using plants, it uses fish. Another name for aquaculture is fish farming. The seafood you buy at your neighbourhood supermarket is probably classified as farmed fish. Aquaculture is practised all around the world, including in tanks on land and in freshwater ponds, rivers, and coastal ocean water. The Internet of Things (IoT) is a modern technical innovation. It is influencing today's world and is applied in numerous fields to gather, monitor, and analyse data from distant locations. Smart cities are just the beginning of the IoT integrated network. The primary goal of all the studies was to create a system for monitoring water quality in real time that would be effective, affordable, and incorporate wireless sensor technology.

1.2 Background Research

Aquaculture is a growing industry in several parts of the world. It aids in food production and the restoration of endangered species. Additionally, it has gained popularity as a protein-rich food source. Other uses for aquaculture production exist as well. For instance, algae has been grown as an alternative fuel source that is cleaner and easier to cultivate than fossil fuel. Similar to this, numerous other research and development projects are taking advantage of the expansion of aquaculture, and there are lots of promising prospects for the future.

Additionally, the availability of "wild" fish from conventional sources of capture is decreasing. The decline in fish availability brought on by overfishing, pollution, and habitat destruction. These circumstances will lead to a rise in the demand for aquaculture products. Global fish consumption has increased by more than twofold since 1998. By 2050, the demand for seafood is anticipated to nearly treble due to population growth and increased consumption. The aquaculture market has witnessed more investment in recent years. According to a survey released by Allied Industry Research, the worldwide aquaculture market is anticipated to reach $378 billion by 2027 as a result of this increasing demand. A large increase in farmed seafood will be necessary to meet demand. Along with technological advances, some governments' initiatives, regulations, and strategies that promote the aquaculture industry's expansion only further prepare the path for future growth. In the foreseeable future, this increase will result in greater opportunities for important market participants and farmers, making aquaculture an industry to watch. Though so, aqualculture does faces some challenges, because farmed fish are raised on unnatural diets and in small enclosures they often breed disease, which can pass to wild populations. This is becoming an increasingly big problem, as are the solutions often used for these diseases. Some aquaculture productions rely on prophylactic antibiotics to prevent infections. The use of antibiotics can cause drug resistant bacteria to develop which can spread to wild populations. Waste products, including feces, uneaten food, and dead fish, are flushed (often untreated). With the advancment of technology, an issue like this can easily be manged from the start, a simple sensor like turbidy and pH can be used to detect cleaniness of water and uses of suitable temperature.

1.3 Problem Statement

Aqua farmers use manual testing to determine the state of the water's various parameters. However, manual testing takes a long time and produces inaccurate findings since the factors used to evaluate water quality are constantly changing. Another downside to traditional method of water testing requires human to be on site, this increases the danger and poses risk as human need to stay close to contaminated water. With current technology, all these issues can easily be managed. The fish farming sector requires tools that can objectively and in real time monitor fish welfare and health without harming or disturbing the fish or interfering with daily operations. The primary goal of utilising the Internet of Things' (IoT) capabilities is to help construct resilient and sustainable aquaculture systems that guarantee profitability, uphold healthy aquatic ecosystems, and increase capacity for climate change adaption.

1.4 Research Objectives

i) To develop a system that uses remote sensors to detect water characteristics such as pH, temperature, turbidity.

ii) To compile and transmitting data over the wireless channel once it has been collected from various sensor nodes.

iii) Routinely sending information to a designated individual when the detected water quality does not meet the predetermined standards so that the appropriate action can be taken.

1.5 Scope of Research

This project focus on domestic use and small-scale fish farming. The project is estimated to be completed within 10 months, cost of developing project is RM753.7, hardware resources are available in two months. The project also has the following limitations:

i) Difficulty in finding appropriate sensors and might take some time to get as order are from overseas.

ii) Need to find a temperature sensor that is waterproof.

iii) In circuito.io, sensors use in this project wasn’t in the library.

1.6 Project Significance

Using the Internet of Things(IoT) for water monitoring systems provides data in real-time. The proposed water quality monitoring system consists of a microcontroller and basic sensors. The system is compact and is very useful for measuring temperature, pH, and turbidity.

1) For small scale fish farming use- Local fish farmer can use this system as one of the ways to maintain an optimum level of water quality as effective water quality control produce high productivity and high-quality fish.

2) For inhome/offices/etc use- Fellow fishkeepers/ aquarists could benefit as this system provides around-the-clock coverage. When water quality parameters such as temperature, pH, and turbidity are not kept within a specific range, an instant update will be sent via smart phone to notify the alert.

1.7 Chapter Summary

In this chapter, an overview of aquaculture and the initial idea for starting this project were lay out as well as the difficulties that are present, especially considering water-related pollution. The objective for this project also outlined in this chapter. The main objective of this project is to develop a system that uses remote sensors to detect water characteristics such as pH, temperature and turbidity. Some limitations were highlighted and solutions were proposed on the following chapters. With the advancement of IoT and cloud technology it is hope that it can paved the way for more efficient and effective problem-solving methods.

CHAPTER 2

2. LITERATURE REVIEW

2.1 Introduction

The country of Malaysia has a total area of 329,847 km2 and is divided into West Malaysia (sometimes referred to as Peninsular Malaysia) and East Malaysia. The nation's coastline is 9,323 km, and its exclusive economic zone covers 198,173 km2 in total. The fisheries industry plays a crucial role in Malaysia's economy and food security since it supports rural development by generating employment opportunities and provides a significant amount of animal protein. Fish consumption was 57.80 kg/capita in 2019, with 0.91% of the nation's GDP coming from fishing. The transition of a sustainable and competitive fisheries in the nation is being spearheaded by the Department of Fisheries Malaysia, an agency of the Ministry of Agriculture and Food Industries. Aquaculture and marine capture fisheries (offshore and coastal) make up the two main segments of the fisheries industry. In terms of production of capture fisheries globally and aquatic plant aquaculture globally, Malaysia came in at position 16 and 7, respectively, in 2019. The production from inland fisheries is quite minor, and the majority of fish landings come from capture fisheries and aquaculture.

2.2 Challenges faced in Aquaculture

With 521,000 tonnes of overall aquaculture production, knowing the industry's history and present problems is essential if we want to succeed as a global producer. The methodology entails searching for various sensors that are related and can be used. That includes temperature sensors, pH sensors and turbidity sensors. The most recent technological applications will be suggested in conjunction with these discoveries.

2.3 Previous Research

Articles/ Journals	**IoT based smart water quality monitoring system**	**Smart water quality monitoring system with cost-effective using IoT**	**IoT Based Aquaculture Monitoring and Control System**	**IoT Based Real-time River Water Quality Monitoring System**	**Aquaculture monitoring and control system: An IoT based approach**	**IoT based Aquaculture system with Cloud analytics**
Sensors	pH sensor, Conductivity sensor, Temperature sensor, Water flow sensor, Turbidity	pH, turbidity, ultrasonic, DHT-11	Ultrasonic, Temperature, Salinity, Dissolved oxygen, and Ammonia sensor.	pH, dissolved oxygen, turbidity, conductivity,	Temperature, Water level, Turbidity, pH	Temperature, water level, pH and turbidity
Hardware	Atmega328p, LCD 16x2, Ic7805 Esp8266	ESP8266 Wi-Fi module (NodeMCU), Arduino Mega,	NodeMCU	16x2 LCD Wi-Fi module (ESP8266) Arduino Atmega	Raspberry Pi 3	Arduino ATMega ESP 8266,

NO	TITLE/AUTHOR	OBJECTIVE	METHOD	RESULT
1	➢ **IoT based smart water quality monitoring system** ➢ Varsha Lakshmikantha , Anjitha Hiriyannagowda, Akshay Manjunath, Aruna Patted,Jagadeesh Basavaiah, Audre Arlene Anthony ➢ (2021)	• To measure perilous quality metrics like physical, chemical and microbial properties. • To find the deviations in measured metrics and give timely warning in recognition threats or hazards. • To provide real-time analysis of the sensor data and recommend appropriate corrective measures.	The core controller is integrated with various sensors such as pH sensor, conductivity sensor, temperature sensor, turbidity sensor and many sensors. The sensor leads are placed in the water to be tested. The sensor values will be processed by ADC and the core controller reads the value and it will be uploaded on the cloud. The values will be monitored continuously by checking whether the sensor value is greater than threshold or not. If the sensor value is greater than threshold, then it will be communicated to the concerned end user for further action. If sensor value is lesser than threshold, then the parameters are again checked for different water source.	The developed model is tested with three different water samples and the results are tabulated in Table. From the analysis, water sample 1 is drinkable and other two samples are not drinkable
2	➢ **Smart water quality monitoring system with cost-effective using IoT** ➢ SathishPasika, Sai Teja Gandla ➢ (2020)	The proposed water quality monitoring system is consisting of a microcontroller and basic sensors, is compact and is very useful for pH, turbidity, water level detection, temperature and humidity of the atmosphere, continuous and real-time data sending via wireless technology to the monitoring station	The proposed system uses four sensors which are pH, turbidity, ultrasonic, DHT-11, microcontroller unit as the main processing module and one data transmission module ESP8266 Wi-Fi module (NodeMCU). The microcontroller unit is a significant part of the system developed for water quality measurement because The Arduino Mega consumes low power, and it is a small size, where the size is a good use for a crucial point-of-sale technology criterion. Among four sensors, two of the sensors collect the data in the form of analog signals; the MCU has an on-chip	The experimental setup consists of an MCU with a sensor network that takes samples for every 10s from the water storage tank and the parameters are displayed on the Arduino IDE serial display. For the real-time monitoring, a Wi-Fi module used which will be updating the ThingSpeak server forever 20s with different parameters. The water sample from Hyderabad

			ADC that translates the sensor analog signals into the digital format for further study. So, to get this analog output from the sensor, the sensor's analog output of will be connected to the MCU's analog pins. Whereas the other two sensors output directly connected to the digital pins of the MCU units. All the sensors data processed by the MCU and updated to the ThingSpeak server using the Wi-Fi data communication module ESP8266 (NodeMCU) to the central server (Daigavane & Gaikwad, 2017).	Metropolitan water supply and sewerage board and groundwater tested.
3	➢ **IoT Based Aquaculture Monitoring and Control System** ➢ Nikitha Rosaline, Dr.S.Sathyalakshimi. ➢ (2019)	The main purpose of the project is to observe the farming system remotely by using different sensor for the water parameter, this will mainly reduce time, labour, cost & also the risks.	The system designed runs in of Arduino connected with sensors to it. The farming system can be monitored remotely with internet. The hurdle towards the establishing the aqua farm is based upon IOT for monitoring the real environment, the sensors will be accordingly interfaced and works automatically by giving the values in -Distance -NH3 (ppm) - Temperature -Salinity	The application of this technology in aquaculture will provide the following benefits: 1. Improved environmental control. 2. Lowering of damage caused by major disasters. 3. Reduction of environmental management costs. 4. Improves the growth of aquatic products.
4	➢ **IoT Based Real-time River Water Quality Monitoring System** ➢ Mohammad Salah Uddin Chowdurya, Talha Bin Emran ,	Following are the aims of idea implementation (a) To measure water parameters such as pH, dissolved oxygen, turbidity, conductivity, etc. using available	The design of Wireless Sensor Network (WSN) [4-7] that assists to monitor the quality of water with the support of information sensed by the sensors dipped in water. Using different sensors, this system can collect various parameters from water, such as pH,	It continuously senses the values of pH, temp, turbidity, and ORP and the resulting values are displayed to the LCD, PC or mobile in real-time. If the acquired value is above the threshold

	Subhasish Ghosha , Abhijit Pathaka , Mohd. Manjur Alama , Nurul Absara , Karl Anderssonc , Mohammad Shahadat Hossain ➢ (2019)	sensors at a remote place. (b) To assemble data from various sensor nodes and send it to the base station by the wireless channel. (c) To simulate and evaluate quality parameters for quality control. (d) To send SMS to an authorized person routinely when water quality detected does not match the preset standards, so that, necessary actions can be taken.	dissolved oxygen, turbidity, conductivity, temperature, and so on. The rapid development of WSN technology provides a novel approach to real-time data acquisition, transmission, and processing. The clients can get ongoing water quality information from far away	value, comments will be displayed as 'BAD'. If the acquired value is lower than the threshold value comments will be displayed as 'GOOD'. A bar/line graph will also be shown for perfect understanding.
5	➢ **Aquaculture monitoring and control system: An IoT based approach** ➢ Ijariit Journal, Mallikarjun B. C ➢ (2019)	The goal of this project is to design and execute a distributed system for aquaculture water quality care through remote observing of turbidity, temperature and pH.	(a) Effective measurement of water quality parameters: These sensors are fixed on Raspberry Pi and are used for detecting the water parameters all the time. (b) Monitoring: The sensor data has been monitored using the thing speak cloud. (c) Control: Based on the sensor data and threshold values the aqua pond can be controlled. (d) Ease of access: The data can be effectively accessed using the cloud and it can be observed and controlled using the mobile apps.	In an aqua-pond, the proposed system was implemented and results were obtained using different sensors for 24 hours. Results were obtained with time for varying parameters of water quality and the variation of temperature with time.

6	➢ **IoT based Aquaculture system with Cloud analytics** ➢ Abir Tawfeeq, Hanin Ali Saif Al Wahaibi, and Dr.K.Vijayalakshmi. ➢ (2019)	The proposed system will attract fish farmers in the Sultanate of Oman who are not having enough power source in their farming place and also it will give facility to monitor aquaculture system remotely using their smart phone.	The system is controlled through Arduino At Mega microcontroller. The controller monitors temperature, pH and turbidity through sensor readings and automate switching on/off heater and pump based on sensor readings. The system is connected to internet through Wi-Fi and sensor readings are also sent to the cloud database. Furthermore, the cloud data can be viewed by fish farmers on their mobile and in web application.	The water level of the tank is also dependent on the factors like turbidity, pH and fish density. It was observed that the fish had increased movements when the tank was full and very less movement when the tank was half filled. Other factors are pH and turbidity that change with water level. The pH readings has shown that fish have better stability when pH is stable for long and the pH is not too acidic(<6) or too basic(>9). For turbidity in very clear water fish did not have much activity and very turbid water gave strong stench which indicated water is polluted. Only at slightly high turbidity fish was seen to have better growth and activity therefore for good growth a neutral pH and moderately turbid water is sufficient

2.4 Control System

The ESP32 is connected to three sensors namely temperature, pH and turbidity as per the circuit design shown in figure 2. The ESP32 checks if the temperature is within the specific range. If it is less than 25degrees the water is too cold for the fish therefore alert will be sent via internet. If it is above 30degress the water is too warm therefore alert will send. For pH of the water 6.5 to 8 is suitable for the fish therefore a change greater than 8 will cause an alert to be send automatically to the person in charge via internet. For turbidity the measurement is in NTU and if it is less than 100 NTU the water is still in acceptable turbidity but if it is above the water is too murky. To send data to cloud the ESP32 is connected to the Wi-Fi. The reading is then shown on Blynk app.

2.4.1 Measuring Temperature

This sealed digital temperature probe lets you precisely measure temperatures in wet environments with a simple 1-Wire interface. The DS18B20 provides 9 to 12-bit (configurable) temperature readings over a 1-Wire interface, so that only one wire (and ground) needs to be connected from a central microprocessor.

2.4.2 Measuring pH

Analog pH meter V2 is specifically designed to measure the pH of the solution and reflect the acidity or alkalinity. It is commonly used in various applications such as aquaponics, aquaculture, and environmental water testing. The pH is a value that measures the acidity or alkalinity of the solution. It is also called the hydrogen ion concentration index. The pH is a scale of hydrogen ion activity in solution. The pH has a wide range of uses in medicine, chemistry, and agriculture. Usually, the pH is a number between 0 to 14. Under the thermodynamic standard conditions, pH=7, which means the solution is neutral; pH<7, which means the solution is acidic; pH>7, which means the solution is alkaline.

2.4.3 Measuring Turbidity

Turbidity sensor TS-300B measures the turbidity (counter of suspended matter) in the wash water. Based on the optical principle, the sensor uses the light-emitting diode and phototransistor to receive the specific wavelength to measure the opacity or other substances of dirty water. concentration. By using phototransistors and light-emitting diodes, the light emitted by the sensor through the light-emitting diode source is reflected by the sewage, part of the light is transmitted to the phototransistor, and the turbidity of the water is calculated according to the amount of light received.

2.5 Chapter Summary

The first section of this chapter focuses on the challenges faced and ways to overcome and improve aquaculture in the scope of water monitoring systems. This chapter also provided case studies of previous works, including sensors and hardware used. The second portion reveals information regarding the technical elements, including the choice of sensors and controller used. This chapter also summarizes the analysis and explanation of the technologies or approaches employed by previous researchers to answer the problem statement.

CHAPTER 3

3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the methods that were used that are pertinent to the study. Hardware and software implementations, as well as the answer to the issue statement. The methodology will cover things like project design which involved the components used, block diagram, flowchart, schematic circuit and project operation.

3.2 Project Design and Overview

The installation of the proposed system is a very cost effective. Existing aquaculture systems and solutions can be enhanced by combining Arduino with a few precise sensors, as well as analytical techniques and cloud technologies. This system design is divided into two categories: hardware implementation and software implementation. The first part of the system is hardware implementation, which involves assembling and calibrating sensors and connecting them to an Arduino. The Arduino is used to execute all the programs that have been sketched and written on the Arduino IDE.

3.2.1 Block Diagram of the Project

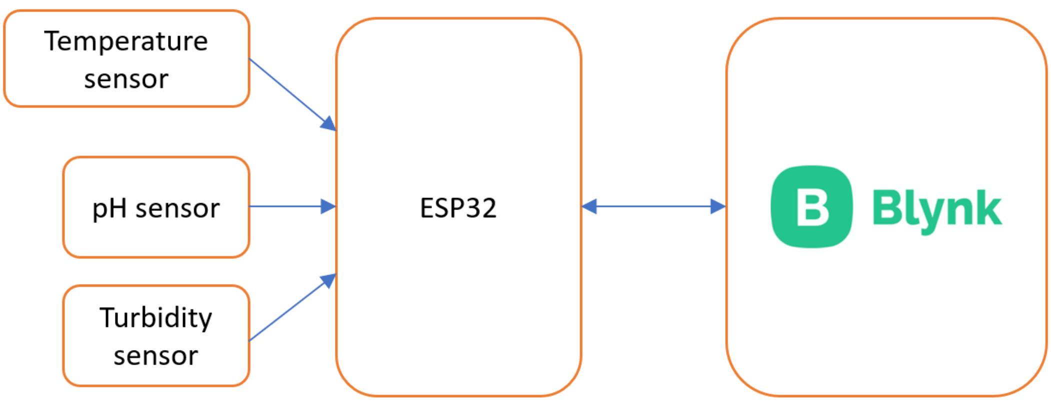


Figure 1. Shows the block diagram of the proposed system.

3.2.2 Flowchart of the Project

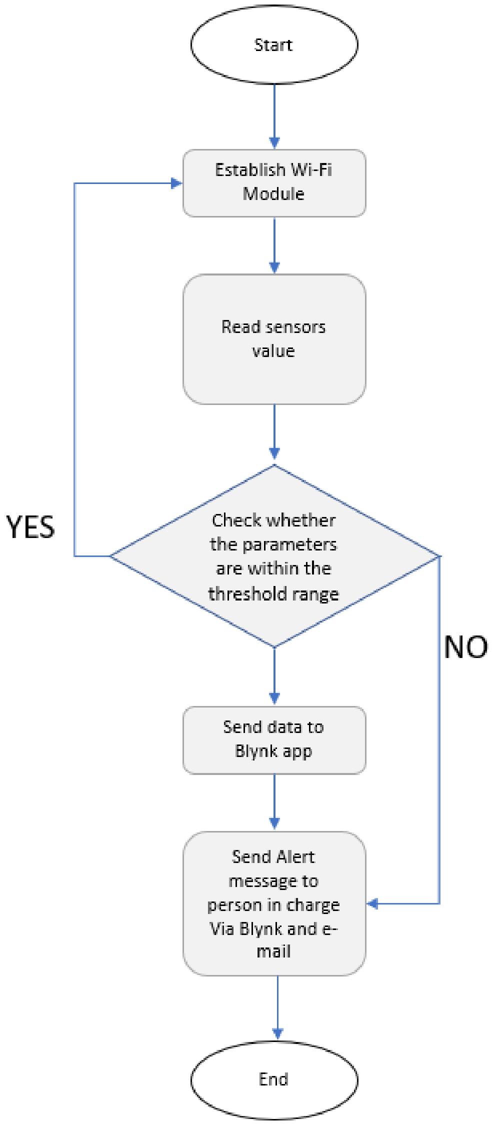


Figure 2. Flow Chart

3.2.3 Project Desription

The system is easy to use, and a mobile phone can be used to monitor the data. The system is also compact and portable.It is powered by a portable battery, allowing the user to take it anywhere even there is no power socket. It is practical and useful for many different things, including aquaculture and hydroponics.

3.3 Project Hardware

The hardware implementation of the system consists of an Arduino microcontroller, a temperature sensor, pH sensor and a turbidity sensor. Before assembling the sensors, they should be calibrated, and each sensor should be precisely checked using some standard techniques such as testing the pH sensor in buffer solution. Figure 7 shows the circuit diagram of the designed system and the connections of sensors that we have used in this system

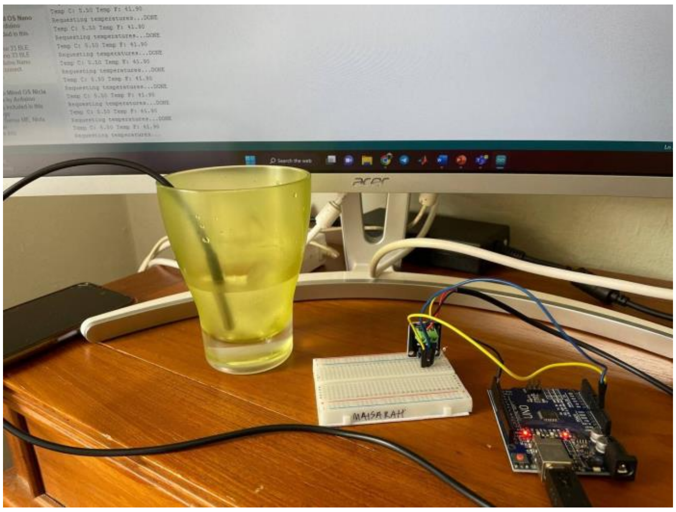


Figure 3. Physical model of water monitoring system

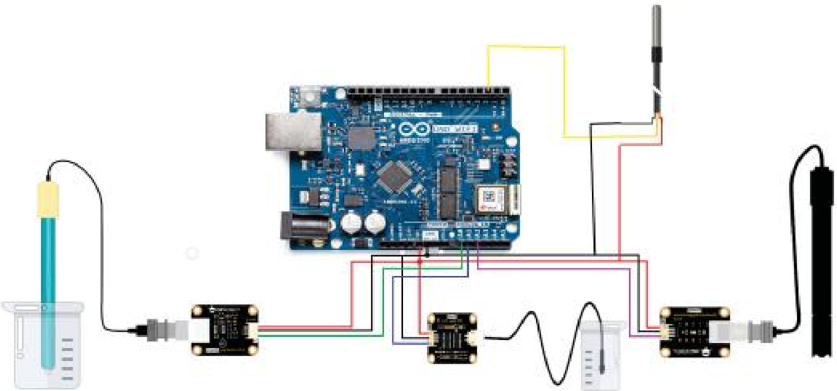


Figure 4. Circuit diagram illustrating connections of used sensors on Arduino.

3.3.1 Schematic Circuit

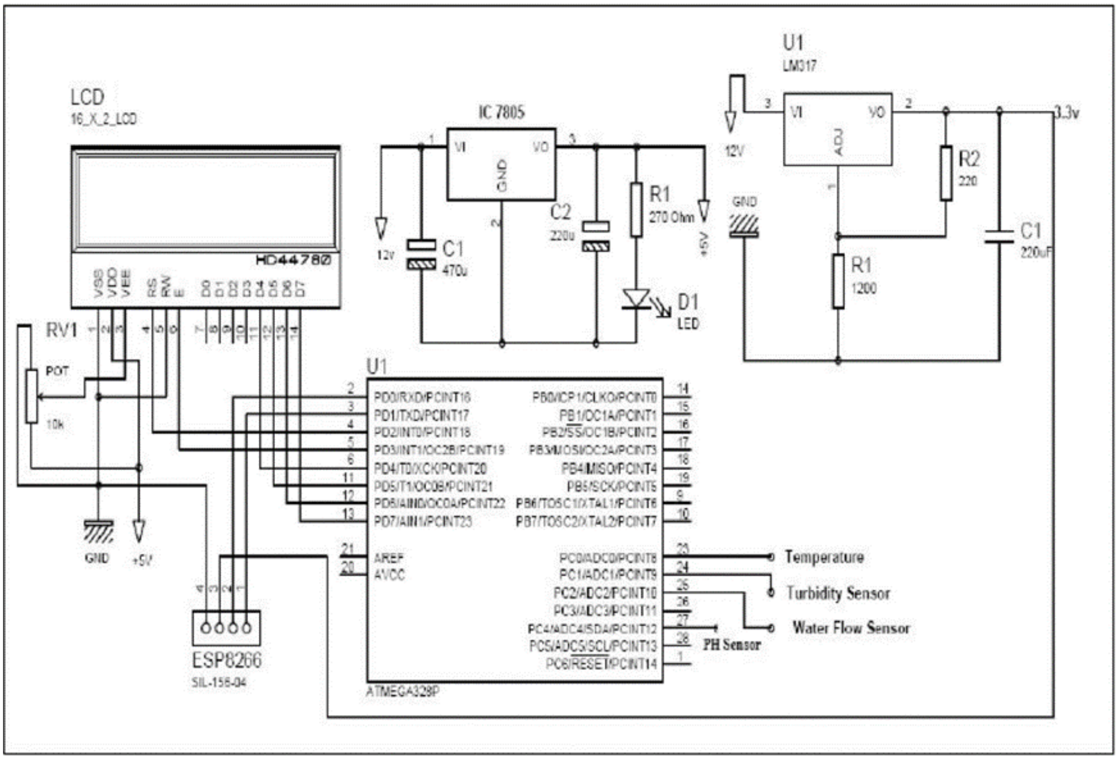


Figure 5. Schematic Circuit of IoT Based Aquaculture Water Monitoring System

3.3.2 Desription of Main Component

3.3.3.1 ESP 32

ESP32 is a low-cost, low-power Microcontroller with an integrated Wi-Fi and Bluetooth. It is the successor to the ESP8266 which is also a low-cost Wi-Fi microchip albeit with limited vastly limited functionality. It is an integrated antenna and RF , power amplifier, low-noise amplifiers, filters, and power management module. This board is used with 2.4 GHz dual-mode Wi-Fi and Bluetooth chips by TSMC 40nm low power technology, power and RF properties best, which is safe, reliable, and scale-able to a variety of applications.

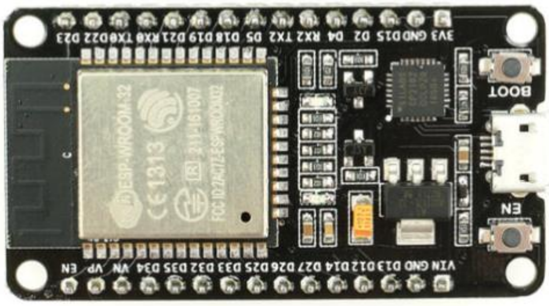


Figure 6. ESP 32

3.3.3.2 Temperature Sensor DS18B20

The DS18B20 waterproof temperature sensor is recommended for measuring the temperature of liquids or substances in wet conditions. It has a temperature range of -55°C to +125°C and can be powered by a 3.0 to 5.5V power supply. Because the sensor cable is PVC-coated, it is best to keep it below 100°C. The DallasTemperature.h library, which contains commands for reading temperature readings from the sensor, is required to use the DS18B20 with Arduino.

Voltage	3~5V
Measuring range	-55~+125 °C
Accuracy	±0.5°C
Conversion time	750ms at 12-bit

Table 1 : Specification of DS18B20

Pin Connections	
Temperature sensor wires	Arduino Pins
Red wire	5V
Black wire	GND
Yellow wire	2

Table 1.2 : Temperature sensor and Arduino pin connections

Fig 7. Temperature sensor

3.3.3.3 Analog pH Sensor

To determine the pH of the water, the DFRobot SEN0101 sensor were shoosen, which is accurate and ideal for water quality testing and aquaculture. The SEN0101 is an analog pH sensor, specially designed for the Arduino microcontroller and Raspberry Pi. The pH sensor works on the principle of electric potential produced by the solution. The potential difference between the measurement electrode and the reference electrode of the pH meter provides the pH value.

Voltage	5V
Measuring range	0~14 pH
Operating Temperature	0~60 ℃
Accuracy	0.1 pH (25 ℃)
Response Time	Less than 1 min

Table 2 : Specification of Analog pH sensor

Pin Connections	
pH sensor Module Pins	Arduino Pins
Signal/ A	AO
-	GND
+	5V

Table 2.1 : pH sensor and Arduino pin connections

Fig 8. pH sensor

3.3.3.4 Turbidity Sensor

The gravity arduino turbidity sensor detects water quality by measuring the levels of turbidity, or the opaqueness. It uses light to detect suspended particles in water by measuring the light transmittance and scattering rate, which changes with the amount of total suspended solids (TSS) in water. As the TTS increases, the liquid turbidity level increases. This liquid sensor provides analog and digital signal output modes. The threshold is adjustable when in digital signal mode.

Voltage	5V
Output Method	Analog output: 0-4.5V Digital Output: High/Low level signal (can adjust the threshold value by adjusting the potentiometer)
Operating Temperature	5℃~90℃
Accuracy	0.1 pH (25 ℃)
Response Time	<500ms
Insulation Resistance	100M(min)

Table 3 : Specification of Turbidity sensor

Fig. 9 Turbidity sensor

3.3.3 Circuit Operation

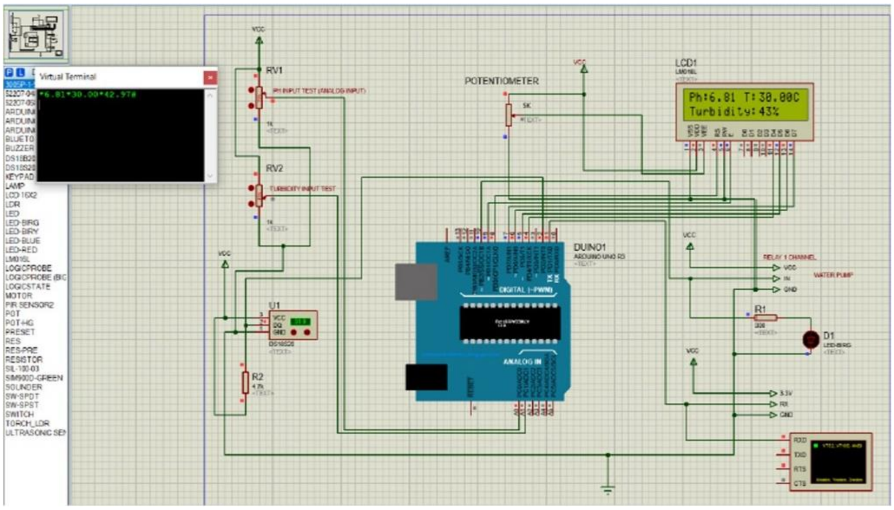


Figure 10. Circuit design drawn in Proteous Software

3.4 Software Implementation

Hardware has been programmed using Arduino IDE. Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Figure 11. Arduino IDE 2.

3.5 Chapter Summary

In this chapter, the project design and overview were covered in detail. A flowchart and a block diagram were also included. The components used in this project are also covered in this chapter. Three sensors will be part of the system, and ESP32 will be connected to them. This presents an effective IoT-based smart water quality monitoring system that continuously monitors the quality parameters. The system's brain is its core controller, it supervises operations, collects data from the sensors, compares it to a demand range, and then wirelessly transmits the results or notify alerts to the authorities or end users who need to know.

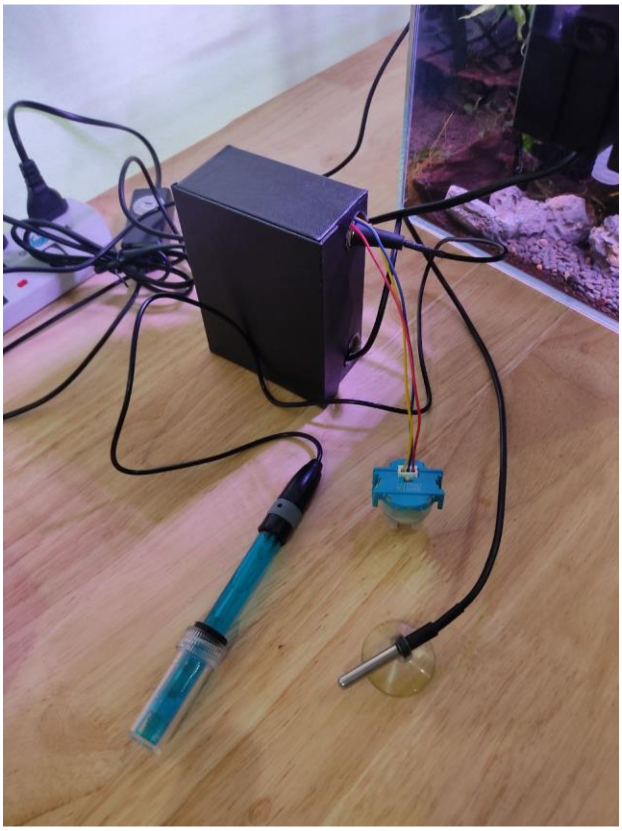
CHAPTER 4

4 RESULTS AND DISCUSSION

4.1 Introduction

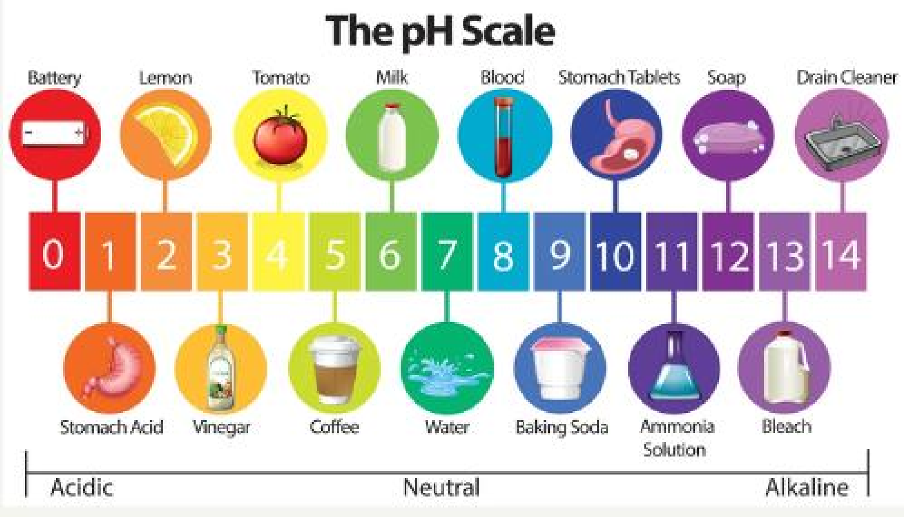
The implementation of an IoT-based aquaculture water monitoring system yielded significant findings and insights regarding water quality management and its impact on aquaculture productivity. This section summarizes the key results and discusses their implications in the context of the research objectives.

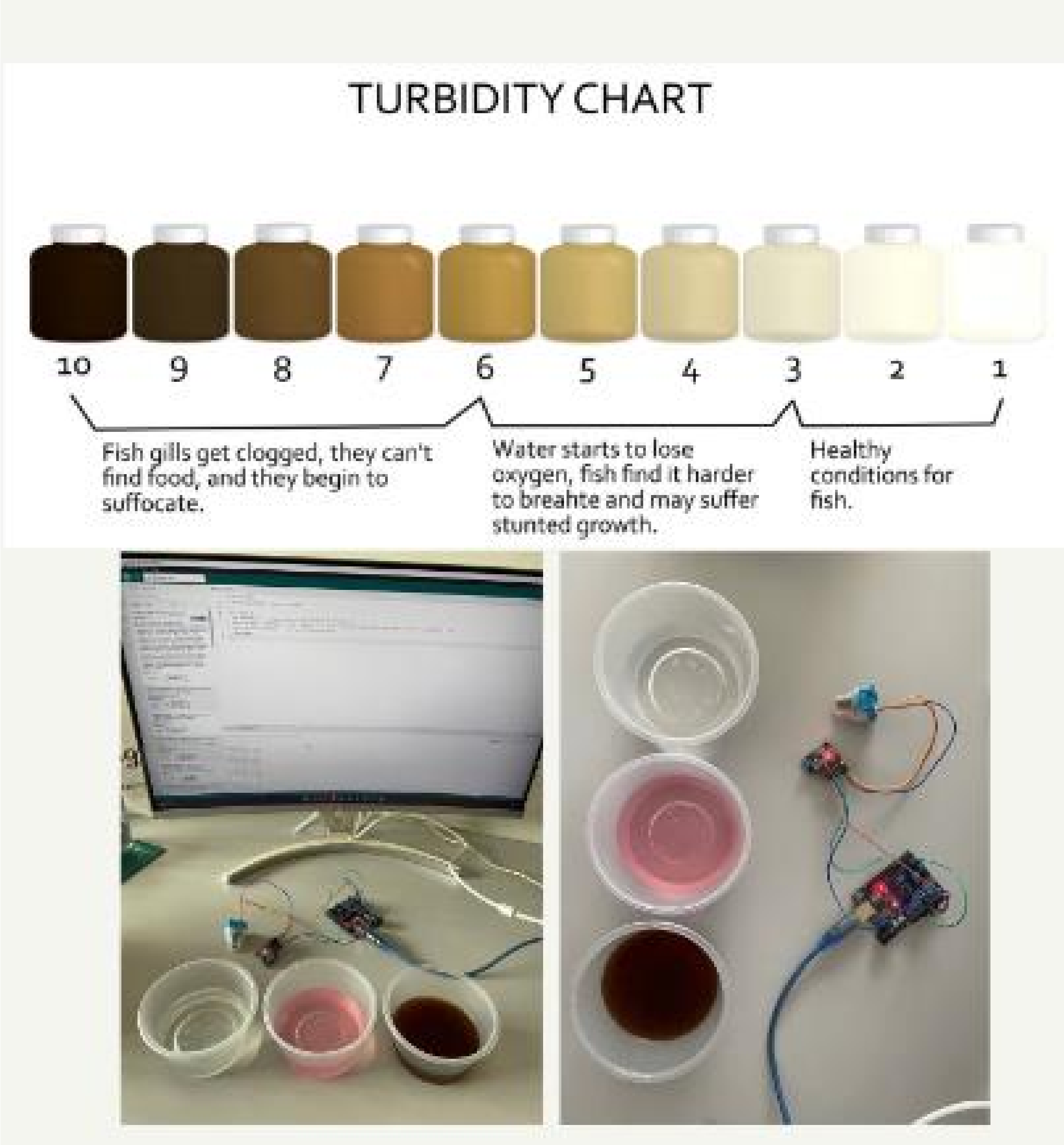
4.2 Results and Analysis

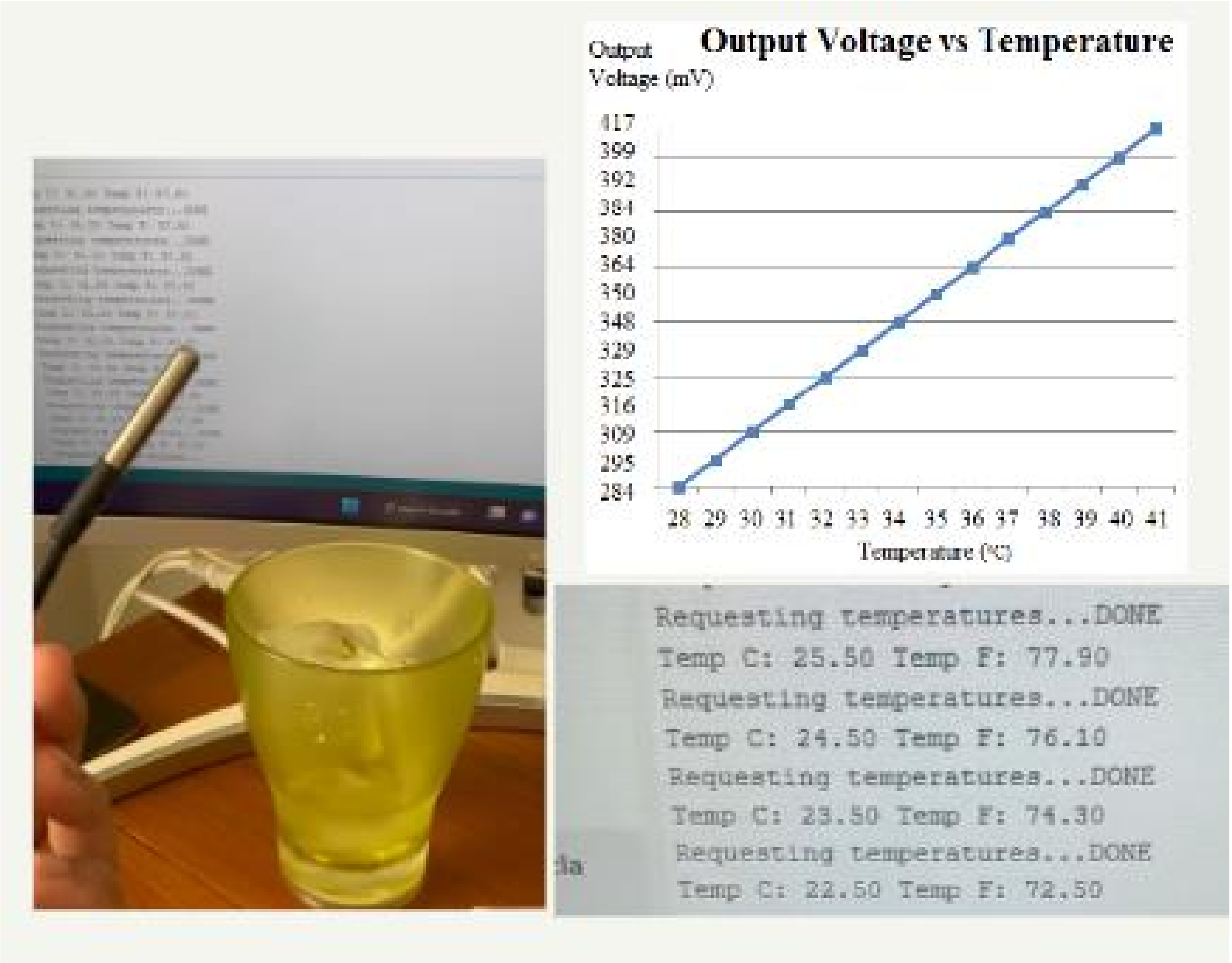


Sample	Parameter	Measured Value
Water Sample 1 Clean water	pH Turbidity Temperature	7.5 4 NTU 28°C
Water Sample 2 Murky water	pH Turbidity Temperature	9.3 35NTU 28°C
Water Sample 3 Clean water that is Acidic	pH Turbidity Temperature	3.2 6NTU 29°C

Type of fish/plants	Ideal Temperature	Ideal pH
Guppies	22°C - 28°C	6.8 to 7.8
Mollies	24°C -26.7°C	7.5 to 8.5
Gold Fish	20°C - 23°C	6.5 to 7.5
Most aquarium plants	23°C -26°C	6.5 to 7.8




TURBIDITY CHART
10 9 8 7 6 5 4 3 2 1
Fish gills get clogged, they can't find food, and they begin to suffocate.
Water starts to lose oxygen, fish find it harder to breahte and may suffer stunted growth.
Healthy conditions for fish.


Output Voltage vs Temperature
Output Voltage (mV)
417
399
392
384
380
364
350
348
329
325
316
309
295
284
28 29 30 31 32 33 34 35 36 37 38 39 40 41
Temperature (°C)
Requesting temperatures...DONE
Temp C: 25.50 Temp F: 77.90
Requesting temperatures...DONE
Temp C: 24.50 Temp F: 76.10
Requesting temperatures...DONE
Temp C: 23.50 Temp F: 74.30
Requesting temperatures...DONE
Temp C: 22.50 Temp F: 72.50

Monitoring Water Quality Parameters:

- The IoT system successfully monitored essential water quality parameters such as temperature, pH levels and turbidity.
- Real-time data collected by sensors were transmitted to ESP32, enabling continuous monitoring and analysis.

Relationship between Water Quality Parameters and Aquaculture Productivity:

- Analysis of the collected data revealed correlations between water quality parameters and aquaculture productivity.
- Optimal temperature levels (within a specified range) were found to positively influence fish growth and feed conversion rates.
- Maintaining appropriate pH levels promoted fish health and reduced stress.
- Controlling turbidity within recommended limits resulted in improved feed utilization and reduced disease prevalence.

Early Warning System for Water Quality Issues:

- The IoT-based system demonstrated its effectiveness as an early warning system for detecting water quality deviations.
- Threshold alerts were triggered when parameters exceeded predetermined ranges, enabling prompt corrective actions.
- Timely response to such alerts minimized the risks of fish mortality, disease outbreaks, and economic losses.

Remote Monitoring and Control:

- The IoT system enabled remote monitoring and control of the aquaculture environment, improving operational efficiency.
- Remote access to real-time data and control of water quality parameters facilitated immediate adjustments when deviations were detected.
- Personnel could remotely monitor and manage multiple aquaculture sites, reducing the need for physical presence and minimizing costs.

4.3 Discussion

Challenges and Limitations:

- Challenges encountered included sensor calibration, data transmission reliability, and power supply management for remote sites.
- The accuracy and reliability of sensor measurements were affected by environmental factors and sensor drift over time.
- Limitations included the need for periodic maintenance, system scalability for large-scale aquaculture operations, and cost considerations.

Future Directions:

- Further research is recommended to refine sensor calibration, enhance data transmission reliability, and address power supply challenges.
- Integration with machine learning algorithms and AI-based decision support systems could provide advanced analytics and predictive capabilities.
- Exploring the potential of integrating additional parameters, such as ammonia levels and nitrate concentrations, salinity , dissolved oxygen could improve water quality monitoring accuracy.

4.4 Chapter Summary

Chapter 4 presents an in-depth exploration of an IoT-based water monitoring system and its results in various contexts. The implications and applications of the IoT-based water monitoring system are thoroughly examined in the chapter. It discusses the benefits of real-time monitoring, such as early warning systems for water contamination events based on accurate and up-to-date information. The chapter also explores the potential impact of the system on aquaculture. Furthermore, the chapter addresses the challenges and limitations encountered during the development and implementation of the IoT-based water monitoring system. It highlights issues related to sensor calibration, data transmission reliability, power supply management, data security, and system scalability.

CHAPTER 5

5 CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Chapter 5 serves as the conclusion and recommendations section of this research paper, summarizing the key findings and insights derived from the study. This chapter aims to provide a comprehensive overview of the research outcomes and present actionable recommendations based on the research results**.**

5.2 Conclusion

In conclusion, the IoT-based aquaculture water monitoring system demonstrated its effectiveness in real-time monitoring, early warning, remote control, and data analytics. The findings emphasize the importance of maintaining optimal water quality parameters for enhanced aquaculture productivity. Overcoming the identified challenges and exploring future directions can contribute to the development of more sophisticated and reliable IoT solutions for aquaculture water management.

5.3 Suggestion For Future Work

While the IoT based aquaculture water monitoring system presented in this study has shown promising results, there are several avenues for future research and system improvements. The following suggestions outline potential areas of focus for further enhancing the capabilities and effectiveness of the system:

i. Integration of Advanced Sensors: Explore the integration of advanced sensors capable of measuring additional water quality parameters relevant to aquaculture, such as ammonia levels, nitrate concentrations, or salinity. This expanded sensor array would provide a more comprehensive understanding of the aquaculture environment and enable more accurate monitoring and control.

ii. Machine Learning and Predictive Analytics: Investigate the application of machine learning algorithms and predictive analytics techniques to the collected data. By analyzing historical data and incorporating environmental factors, it would be possible to develop predictive models for forecasting water quality changes, disease outbreaks, or optimal feeding regimes. Such models can greatly assist aquaculture managers in making proactive decisions and mitigating risks.

iii. Remote Actuation and Automation: Enhance the IoT system's capabilities by incorporating remote actuation and automation features. This would enable the system to automatically adjust certain parameters, such as automatic tank cleaning/ self cleaning tank, feed dispensing, or pH regulation, based on real-time data and predefined thresholds. The integration of control mechanisms would reduce the reliance on manual intervention and further optimize aquaculture operations.

iv. Cloud-Based Data Management: Explore the utilization of cloud-based data management platforms for the IoT-based water monitoring system. Storing and analyzing data in the cloud would offer scalability, accessibility, and data security advantages. It would also facilitate the integration of multiple aquaculture sites and enable collaborative data sharing and analysis among stakeholders.

v. Energy-Efficient Solutions: Develop energy-efficient solutions for IoT devices and sensors used in the water monitoring system. This includes investigating low-power sensor technologies, energy harvesting techniques, or optimization algorithms to extend battery life and reduce energy consumption. Energy-efficient designs would enhance the system's sustainability and reduce operational costs.

vi. Field Testing and Validation: Conduct extensive field testing and validation of the IoT-based water monitoring system in diverse aquaculture settings. This would involve collaborating with aquaculture farms and researchers to assess the system's performance, robustness, and reliability under real-world conditions. Field trials would provide valuable insights into the system's effectiveness and identify any potential limitations or areas for improvement.

By focusing on these future research directions, it is possible to advance the capabilities of IoT-based aquaculture water monitoring systems, leading to improved water quality management, increased productivity, and sustainable aquaculture practices.

5.4 Chapter Summary

This chapter offers a set of recommendations based on the research outcomes. These recommendations are derived from the insights gained throughout the study and are designed to provide actionable guidance to practitioners, policymakers, or researchers in the field. The recommendations may address specific challenges, gaps, or opportunities identified during the research, and provide suggestions for future actions or areas of focus. Recommendations and potential solutions for overcoming these challenges are provided to guide future research and system improvements By presenting a comprehensive conclusion and recommendations section, this chapter not only summarizes the research outcomes but also provides valuable insights and actionable guidance for the practical application of the research findings. It serves as a crucial section in tying together the various components of the research paper and leaves the reader with a clear understanding of the study's implications and avenues for future work.

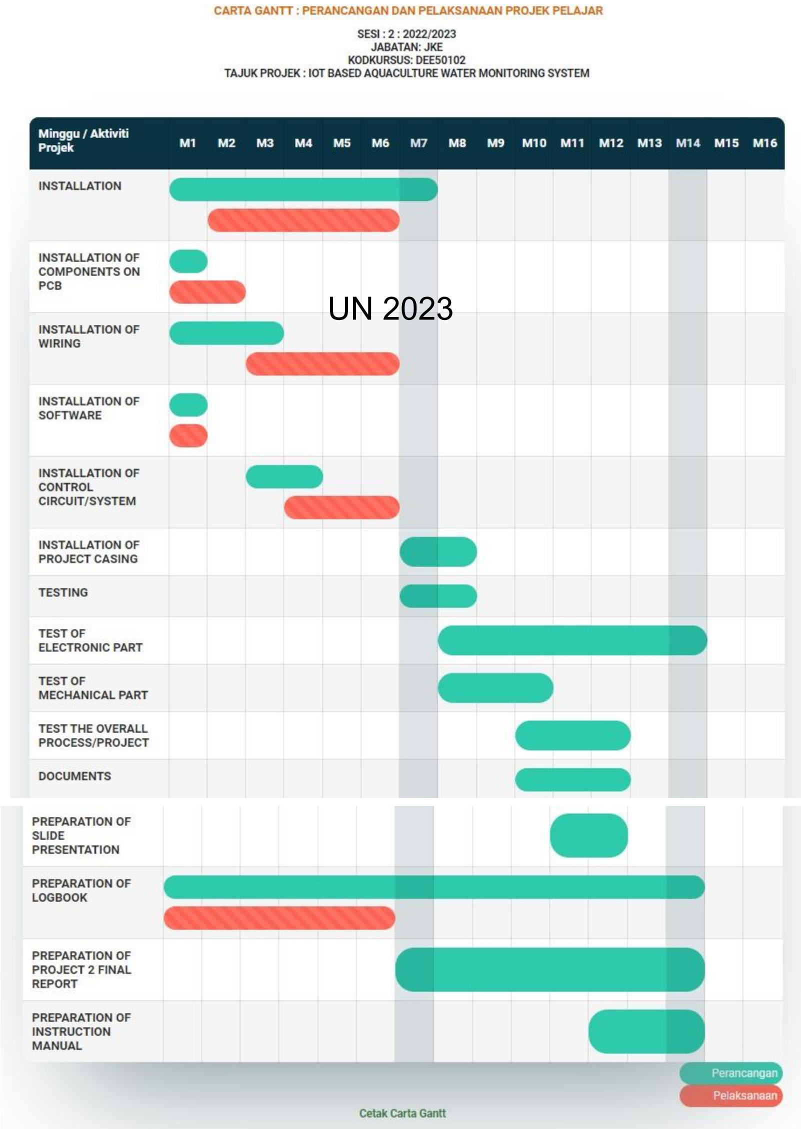
CHAPTER 6

6 PROJECT MANAGEMENT AND COSTING

6.1 Introduction

In this chapter, we explored the concept and application of Gantt charts in project management. Gantt charts are graphical tools that provide a visual representation of project schedules, tasks, dependencies, and progress over time. The chapter explained the key components and structure of a Gantt chart. It discussed the horizontal axis representing the project timeline, the vertical axis representing project tasks or activities, and the horizontal bars representing the duration and progress of each task.

6.2 Gant Chart and Activities of the Project



CARTA GANTT : PERANCANGAN DAN PELAKSANAAN PROJEK PELAJAR

SESI : 1 : 2022/2023
JABATAN: JKE
KODKURSUS: DEE40082
TAJUK PROJEK : IOT BASED AQUACULTURE WATER MONITORING SYSTEM

Cetak Carta Gantt

6.3 Milestone

Developing an IoT based aquaculture water monitoring system involves several key milestones to ensure successful implementation and deployment. The following milestones outline the major steps and achievements throughout the development process:

i. Project Initiation:

Define project objectives and scope: Clearly outline the goals and objectives of implementing the IoT-based water monitoring system in aquaculture operations.
Conduct a feasibility study: Assess the technical, financial, and operational feasibility of the project, considering factors such as infrastructure requirements, sensor compatibility, and data management capabilities.

ii. Sensor Selection and Integration:

Identify key water quality parameters: Determine the specific parameters to be monitored, such as temperature, pH, turbidity, based on aquaculture requirements and industry standards.
Research and select appropriate sensors: Explore available sensor options and select sensors that are reliable, accurate, and suitable for the aquaculture environment.
Integrate sensors with IoT devices: Establish communication between sensors and IoT devices to enable real-time data collection and transmission.

iii. Data Transmission and Storage:

Determine communication protocols: Select appropriate communication protocols, such as Wi-Fi, Bluetooth, or cellular networks, to ensure reliable and secure data transmission from the sensors to the central database.
Set up a centralized data storage infrastructure: Establish a secure and scalable data storage system that can handle high-frequency data from multiple sensors and enable efficient data retrieval and analysis.

iv. System Development and Deployment:

Develop a user-friendly interface: Design and develop an intuitive interface that allows users to access and visualize real-time water quality data, receive alerts, and control system parameters.
Test and calibrate the system: Conduct thorough testing of the IoT-based water monitoring system to ensure accuracy, reliability, and compatibility with aquaculture conditions. Calibrate sensors and fine-tune system settings as necessary.
Deploy the system in aquaculture facilities: Install the IoT devices and sensors at targeted aquaculture sites, ensuring proper connectivity, data transmission, and integration with existing infrastructure.

v. Data Analysis and Visualization:

Develop customized dashboards: Create user-friendly dashboards that display real-time data, historical trends, and key performance indicators relevant to aquaculture operations. Visualizations should be intuitive and facilitate informed decision-making.

vi. Performance Evaluation and Optimization:

Monitor system performance: Continuously evaluate the performance of the IoT based water monitoring system, including data accuracy, timeliness, and system reliability.
Identify areas for improvement: Analyze user feedback and system performance data to identify potential areas for optimization, such as sensor calibration and data transmission efficiency.

vii. Training and Knowledge Transfer:

Provide training and support: Conduct training sessions to familiarize aquaculture personnel with the IoT-based water monitoring system, its operation, and data interpretation. Offer ongoing support to address any issues or questions that arise.
Share knowledge and best practices: Share lessons learned, best practices, and success stories from the implementation of the IoT-based water monitoring system within the aquaculture community, through workshops, conferences, or industry publications.

By following these milestones, stakeholders can effectively plan and execute the implementation of an IoT-based aquaculture water monitoring system, enabling continuous monitoring of water quality parameters and enhancing the productivity and sustainability of aquaculture operations.

6.4 Cost and Budgeting

No.	Component and materials	The unit price	Quantity	Total
1	ESP 32	RM 40	1	RM 40
2	Jumper wires	RM4	1	RM4
3	DS18B20 temperature sensor	RM9.30	1	RM9.30
4	Analog pH sensor	RM78.90	1	RM78.90
5	Turbidity sensor	RM56.50	1	RM56.50
6	Aquarium Tank	RM400	1	RM400
9	Other materials	RM 70	-	RM 70
			Total:	**RM 658.70**
	List of other costing			
1	Transportation	RM5	10	RM50
2	Postage	RM5	5	RM25
3	Internet	RM10	1	RM10
4	Miscellaneous	RM10	-	RM10
			Total:	**RM95.00**
			Overall total	**RM753.7**

6.5 Chapter Summary

The chapter begins by introducing the application of Gantt charts in project management. By employing Gantt charts, project managers can effectively visualize project schedules, coordinate tasks, and track progress, ultimately contributing to successful project execution and timely completion.

Next, the chapter delves into various cost elements involved in project management. It discusses direct costs, such as materials, and equipment, as well as indirect costs, including transportation , postage costs, and internet cost. The chapter emphasizes the importance of identifying and quantifying all cost components to develop a comprehensive and realistic project budget.

In conclusion, this chapter provides a comprehensive overview of costing in project management. It highlights the importance of accurate cost estimation and budgeting in project success.

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v. Ray, P. P. (2020). Internet of things: A hands-on approach. Wiley.

vi. Tacon, A. G. J., & Metian, M. (2013). Feed matters: satisfying the nutritional needs of farmed fish. Food and Agriculture Organization of the United Nations.

[3] IoT Platforms and Solutions Providers:

vii. Arduino, “Arduino,” Arduino.cc, 2018. https://www.arduino.cc/

viii. “Blynk,” Blynk.io, 2015. https://blynk.io/

[4] Case Studies and Whitepapers:

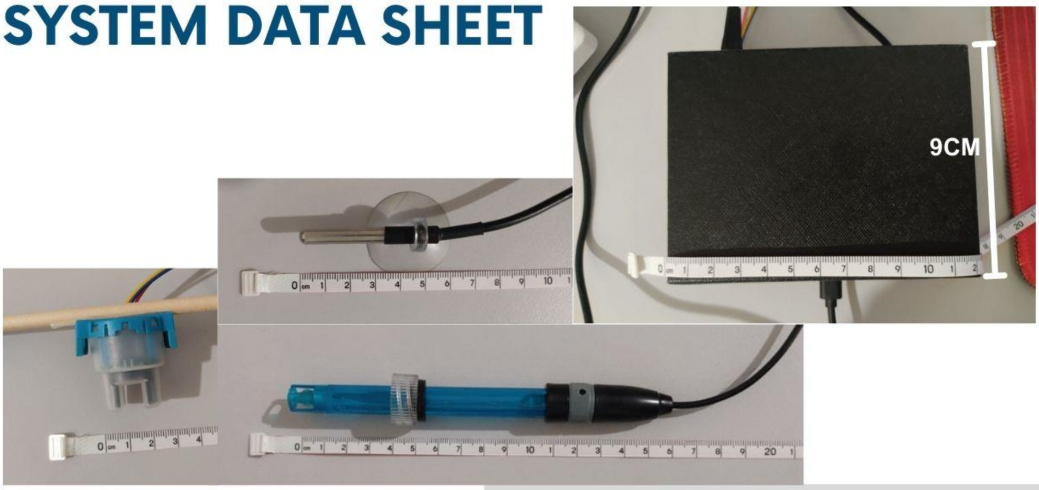
ix. Smart Water Monitoring with IoT by Cisco: https://www.cisco.com/c/en/us/solutions/industries/smart-water management.html

x. Smart Water Management with IoT by Libelium: https://www.libelium.com/smart-water-management/

7 APPENDICES

APPENDIX A – DATA SHEET

IOT BASED AQUACULTURE WATER MONITORING SYSTEM DATA SHEET



PRODUCT DESCRIPTION

The IoT Water Monitoring System is a state-of-the-art solution designed to accurately monitor and manage water parameter in various applications. It utilizes advanced Internet of Things (IoT) technology to provide real-time data and insights for effective water monitoring system

PRODUCT SPECIFICATIONS

- *Dimensions: As stated in diagram above*
- *Weight: ~520gram*
- *Connectivity: Wi-Fi, cellular (3G/4G/5G)*
- *Power Requirements: 240V supply voltage and 50Hz.*
- *Application use : Blynk Apps*

KEY FEATURES

1. Water Quality Monitoring: Continuously monitor key water quality parameters such as pH level, turbidity and temperature.
2. Real-time Data and Analytics: Collect and analyze data in real-time, enabling users to make informed decisions and take prompt action..
3. Customizable Alerts: Set customizable thresholds and receive alerts via email or Blynk apps when water parameters exceed defined limits.
4. Scalable and Modular: Easily expand the system to monitor multiple locations or integrate additional sensors as per requirements.

INSTALLATION AND SETUP

1. Mount the sensors at the desired locations.
2. Connect the IoT Based Aquaculture Water Monitoring System to a power source and ensure a stable network connection.
3. Configure the system settings through the web interface or mobile application.
4. Begin monitoring and managing water condition through the Blynk App.
5. Notifications will be send via email or a pop out in Blynk App. (if any parameter doesn't met)

MAINTENANCE AND CARE

1. Regularly inspect the system for any physical damage or sensor malfunctions.
2. Follow the provided maintenance guidelines for optimal performance and longevity.
3. Contact our customer support team for any maintenance-related queries or issues.

For technical assistance or support, please contact:

- Email: maisarahyunoos@gmail.com
- Phone: 011-26607655

APPENDIX B – PROGRAMMING

FINALYEARPROJECTMAISARAH.ino   debug_custom.json

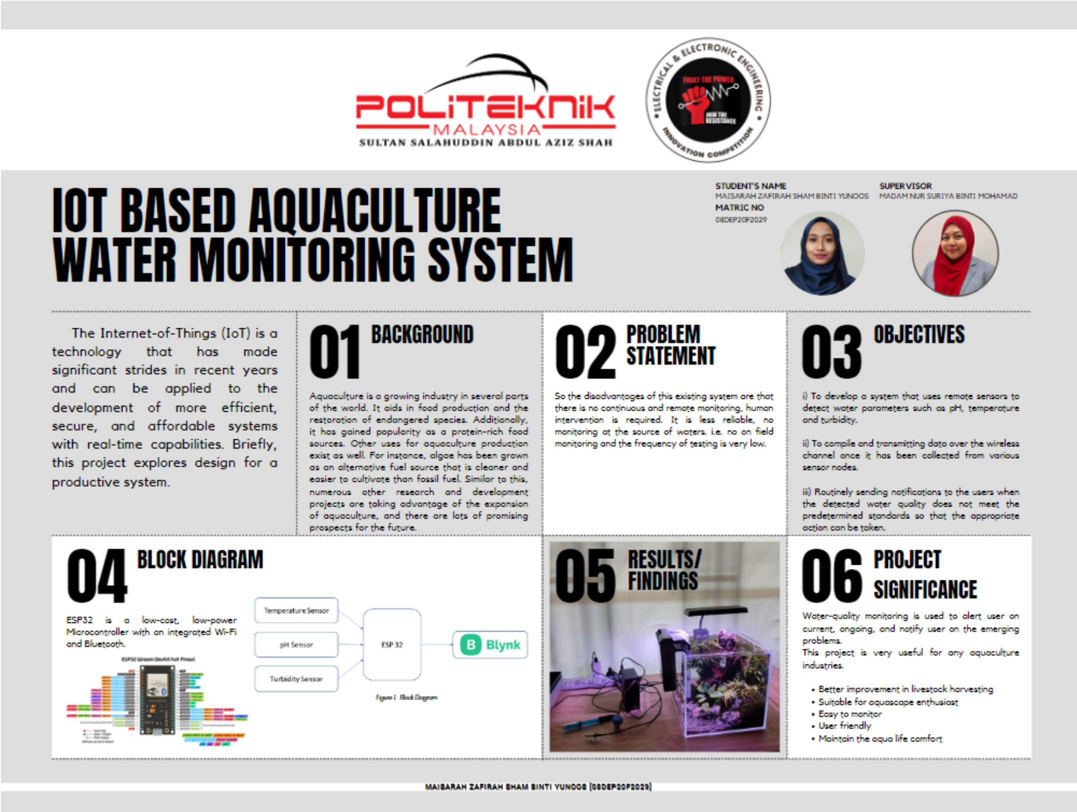
```
#define BLYNK_PRINT           Serial
#define BLYNK_TEMPLATE_ID    "TMPL6N1HbE2Z3"
#define BLYNK_TEMPLATE_NAME "AQUACULTURE MONITORING SYSTEM"
#define BLYNK_AUTH_TOKEN     "F1xePMashGkq-Gd1dp90Dl-FhNx5jBcL"
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>

char ssid[] = "Redmi Note 9S";   // wifi name(must 2.4ghz band)
char pass[] = "Alpha102";        // wifi password

#include <OneWire.h>
#include <DallasTemperature.h>
#include <Wire.h>

float calibration_value = 21.50 - 0.7;  // calib value for ph sensor
int phval = 0;
unsigned long int avgval;
int buffer_arr[10], temp;
float ph_act;

#define tempSensorPin 25   // temperature sensor pin

OneWire oneWire(tempSensorPin);
DallasTemperature sensors(&oneWire);

WidgetLED ledred1  (V3);
WidgetLED ledgreen1(V4);
WidgetLED ledred2  (V5);
WidgetLED ledgreen2(V6);

void setup() {
  Serial.begin(115200);
```

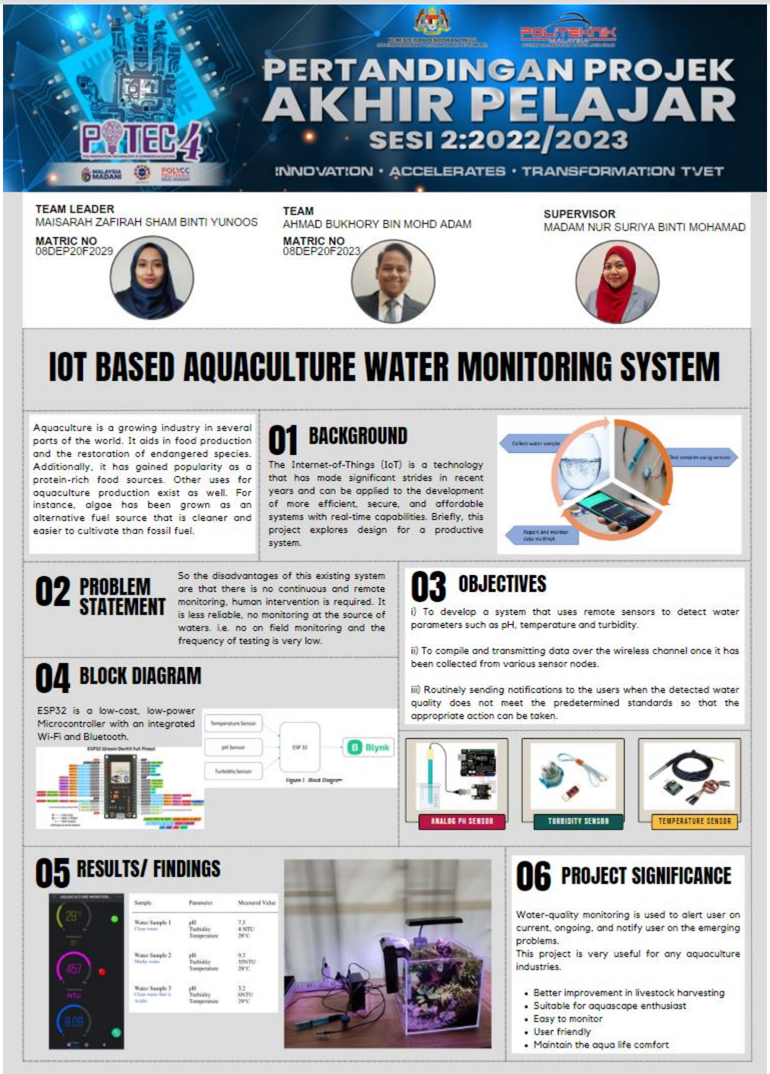
```
  Serial.begin(115200);
  sensors.begin();
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);
  ledred1.off();
  ledgreen1.off();
  ledred2.off();
  ledgreen2.off();
}

void loop() {
  Blynk.run();
  PHsensor();
  turbiditySensor();
  Temperature();
  Serial.println(" ");
  delay(1000);  // update to blynk app. 1000 = 1sec
}

void PHsensor() {
  for (int i = 0; i < 10; i++) {
    buffer_arr[i] = analogRead(35);
    delay(30);
  }
  for (int i = 0; i < 9; i++) {
    for (int j = i + 1; j < 10; j++) {
      if (buffer_arr[i] > buffer_arr[j]) {
        temp = buffer_arr[i];
        buffer_arr[i] = buffer_arr[j];
        buffer_arr[j] = temp;
      }
    }
```

```
  }
  avgval = 0;
  for (int i = 2; i < 8; i++)
    avgval += buffer_arr[i];
  float volt = (float)avgval * 3.3 / 4056.0 / 6;
  ph_act = -5.70 * volt + calibration_value;

  Serial.print("pH Val: ");
  Serial.println(ph_act);
  Blynk.virtualWrite(V1, ph_act);
}

void turbiditySensor() {
  int sensorValue = analogRead(39);
  int ntu = map(sensorValue, 1400, 2005, 500, 0);
  Serial.print("analog data : ");
  Serial.println(sensorValue);

  if (ntu > 500) {
    ntu = 0;
  } else {
    Serial.print("ntu : ");
    Serial.println(ntu);
    Blynk.virtualWrite(V2, ntu);
  }

  if (ntu > 100) { // adjust 100 value to whtevr you want
    Serial.println("Please clean the tank");
    Blynk.logEvent("attention", "Please clean the tank");
    ledred2.on();
    ledgreen2.off();
  } else {
    Serial.println("normal ntu");
    ledred2.off();
    ledgreen2.on();
  }
}

void Temperature() {
  sensors.requestTemperatures();
  Serial.print("Temperature: ");
  Serial.print(sensors.getTempCByIndex(0));
  Serial.println("°C");
  Blynk.virtualWrite(V0, sensors.getTempCByIndex(0));

  if (sensors.getTempCByIndex(0) > 30) {  // adjust 30 value to whtevr you want
    Blynk.logEvent("alert", "temperature is high");
    Serial.println("temperature is high");
    ledred1.on();
    ledgreen1.off();
  } else {
    Serial.println("normal temp");
    ledred1.off();
    ledgreen1.on();
  }
}

```

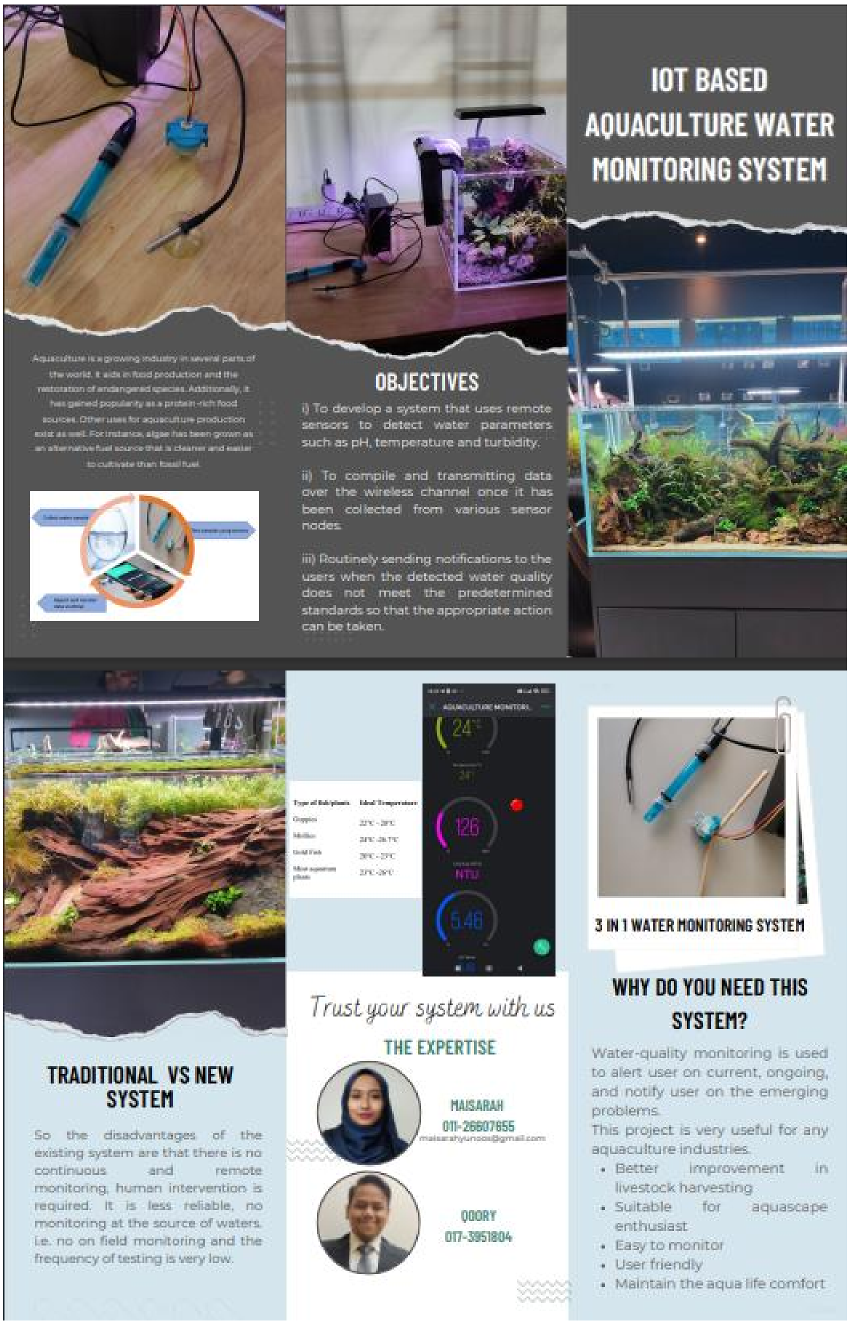
APPENDIX C – PROJECT MANUAL/PRODUCT CATOLOGUE

APPENDIX D – POSTER





APPENDIX E – BROCHURE



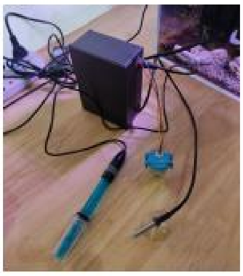
IOT BASED AQUACULTURE WATER MONITORING SYSTEM

01 BACKGROUND

The Internet-of-Things (IoT) is a technology that has made significant strides in recent years and can be applied to the development of more efficient, secure, and affordable systems with real-time capabilities. Briefly, this project explores design for a productive system.

02 PROBLEM STATEMENT

So the disadvantages of this existing system are that there is no continuous and remote monitoring, human intervention is required. It is less reliable, no monitoring at the source of waters. i.e. no on field monitoring and the frequency of testing is very low.



03 OBJECTIVES

i) To develop a system that uses remote sensors to detect water parameters such as pH, temperature and turbidity.

ii) To compile and transmitting data over the wireless channel once it has been collected from various sensor nodes.

iii) Routinely sending notifications to the users when the detected water quality does not meet the predetermined standards so that the appropriate action can be taken.

05 Contact

011-26607655

maisarahyunoos@gmail.com

Seksyen 9, Shah Alam,
40100, Selangor.

04 PROJECT SIGNIFICANCE

Water-quality monitoring is used to alert user on current, ongoing, and notify user on the emerging problems. This project is very useful for any aquaculture industries.

- Better improvement in livestock harvesting
- Suitable for aquascape enthusiast
- Easy to monitor
- User friendly
- Maintain the aqua life comfort