Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT-BASED WATER QUALITY MONITORING SYSTEM

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

2022

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Computer Engineering Technology (Computer Systems) with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this project report entitled “is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Student Name : MUHAMMAD DANIEL BIN MOHD NOOR

Date : 11/1/2022

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

Signature :

Supervisor Name : DR AMINAH BINTI AHMAD

Date : 11/1/2022

Signature :

Co-Supervisor Name (if any) :

Date :

DEDICATION

I would like to take this opportunity to express my deepest grateful appreciation to all wonderful people have continuously giving me support, advices, knowledge, understanding and contribution towards the successful completion of this Final Year Project. I wish to express my sincere appreciation to my supervisor, Dr Aminah Binti Ahmad for encouragement, guidance, critics, advices, suggestion and motivation on developing this project. Without her assistance and involvement in every step throughout the process, this paper would have never been accomplished. I would like to thank you very much for your support and understanding over these past years. I also would like to express my sincerest gratitude and deepest thankfulness to my parent and siblings for their love, support, and encouragement that they had given to me to make sure I could focus fully on this project. Besides that, I also would like to thank my friend and all my housemate who has help me a lot and support me throughout completing this project.

ABSTRACT

Water quality monitoring system is the most essential for continuity to get the pure water source. As water utilities face greater challenges, drinking water may become increasingly valuable to all people. These issues develop as a result of the high population, limited water resources, and other factors. As a result, many approaches are utilized to monitor water quality in real time. To ensure that water is distributed safely, a new approach based on the "Internet of Things (IoT)" has been proposed to monitor water quality in real time. With an expansion in the wireless device network technique in the IoT, real-time water quality observation is investigated through data collecting, method, and transmission. Microcontroller with the processed value remotely to the core controller, NodeMCU with a built-in Wi-Fi module protocol, is used to interface the measured value from the sensor. The water quality observation interface sensors with quality observation with IoT setting was projected in this way. Water Quality Monitoring (WQM) determines water parameters such as temperature, water level and water turbidity. The information is sent to the web server using this manner. The data on the server, which is updated at regular intervals, can be downloaded or accessed from anywhere in the world.

Keyword: IoT, Water Quality Monitoring, WQM, Turbidity

ABSTRAK

Sistem pemantauan kualiti air adalah yang paling penting untuk kesinambungan untuk mendapatkan sumber air tulen. Oleh kerana utiliti air menghadapi cabaran yang lebih besar, air minum mungkin menjadi semakin berharga bagi semua orang. Isu-isu ini berkembang akibat jumlah penduduk yang tinggi, sumber air yang terhad, dan faktor-faktor lain. Akibatnya, banyak pendekatan digunakan untuk memantau kualiti air dalam waktu nyata. Untuk memastikan air diedarkan dengan selamat, pendekatan baru berdasarkan "Internet of Things (IoT)" telah diusulkan untuk memantau kualiti air dalam waktu nyata. Dengan pengembangan teknik rangkaian peranti tanpa wayar di IoT, pemerhatian kualiti air masa nyata disiasat melalui pengumpulan, kaedah, dan penghantaran data. Mikrokontroler dengan nilai yang diproses dari jarak jauh ke pengawal teras yang merupakan NodeMCU dengan protokol modul Wi-Fi bawaan digunakan untuk menghubungkan nilai yang diukur dari sensor. Sensor adalah antara muka untuk pemerhatian kualiti air dengan pemerhatian berkualiti dengan tetapan IoT diunjurkan dengan cara ini. Pemantauan Kualiti Air (WQM) menentukan parameter air seperti suhu, paras air dan kekeruhan air. Maklumat dihantar ke server web menggunakan cara ini. Data di server, yang dikemas kini secara berkala, boleh dimuat turun atau diakses dari mana saja di dunia.

Katakunci : Iot, Sistem Pemantauan Kualiti Air, Kekerohan

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor Dr. Aminah Binti Ahmad for their precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) for the financial support through the faculty which enables me to accomplish the project. Not forgetting to all my fellow colleague and classmates for the willingness of sharing his thoughts and ideas regarding the project.

My highest appreciation goes to my parents Mr Mohd Noor Bin Mohd Awie Pn Zaimah Binti Leiman and not forgetting to all family members for their love and prayer during the period of my study.

Finally, I would like to thank all the staffs at the faculty, fellow colleagues and classmates, the faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

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LIST OF SYMBOLS

V	-	Volt
mV	-	miliVolt
˚C	-	Degree Celcius
A	-	Ampere
mA	-	miliampere
Cm	-	Centimeter
M	-	meter.
NTU	-	Nepholometric Turbidity unit

LIST OF ABBREVIATIONS

Iot	-	Internet of Things
V	-	Voltage
Cm	-	Centimeter
M	-	meter
RTC	-	Real-Time Clock
WQM	-	Water Quality Monitoring
NTU	-	Nephelometric Turbidity Unit
TTS	-	Total Suspended Solids

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CHAPTER 1

INTRODUCTION

1.1 Background

This chapter describes the content of this chapter generally regarding the water quality monitoring system, including the problem statement, objective, and scope. The few things that need to be achieved to solve the problem that arises are the project's objective and the problem statement related to how the problem that wanted to solve will occur. However, in this case, there will be a limitation in completing this project discussed in this chapter.

1.2 Project Background

The water supply system is an infrastructure of collecting, transmission treatment, storage and distribution of the water for the home, commercial, industry and irrigation. The provision of potable water is perhaps the most vital. Every person in this world will seek water for drinking, cooking, washing, waste carry, and other domestic needs. For this to happen, the water supply system must also need to meet the public, commercial, and industrial activities requirements. In this case, the water that comes from the water supply must fulfil the quality and quantity requirements.

In Malaysia, most of the state in was received good quality water supply. Some states were having difficulties receiving good quality and shortage of water supply due to pollution and low level at the water supply compound. The rivers provided the main water source for the Malaysians. About 97% water supply used for the domestic, industrial and agriculture came from rivers in Malaysia. The water source will go to the treatment before supply to domestically and industries. Monitoring the water supply is traditionally done by the department of the environment come to the river and using the test kit for the water quality testing. This process takes time to inspect every river that available in Malaysia. Sometimes, the inspector needs to go through the unpaved road due to river in Malaysia, sometimes in the countryside. The advanced way to monitor that is to set up the base equipped with a computer. This method will reduce the test that needs to conduct, but the availability for anyone to access is denied. The inspector still needs to go to the station to read the value from the computer.

The main purpose of this project is to develop the IOT based water level and quality monitoring system using NodeMCU to reduce time to test the water level and the quality of water. The data received from the sensor will be sent to the website that will display the value that the user can read. For this prototype, the system will sensor the water level and the turbidity of the water.

Water is a big role in supporting the communities. Without an existing water supply, there should not be able to run local business and industries from the array of pipes, canals and pumping stations managed by our public water systems that can bring the source of water to our taps each day. Source of water come to start as rain or snow, and it flows into our local lake, rivers, and stream or underground. We are lucky to have access to some of the safest treated water.

The usage of water come from the individual, community and business related. As for the individual, the water is used for daily life to surviving and for work done in daily life. Daily life water usage comes from drinking, cooking, shower, toilet and washing.

Then, water usage in the community comes from the water supply for the residential area for their daily use.

1.3 Problem Statement

The water quality monitoring system idea comes from a real situation. Most river in Malaysia still monitors the water quality by manual method. The inspector of the quality goes to the river and uses their kit to check the river. The problem will cause the inspection company's irregular and time-consuming inspection to inspect all the river that is available in Malaysia. The main purpose of this project is to develop an IoT-based water quality monitoring system that can reduce time and labour wastage has been conducting right now. In short, this study focuses on developing a prototype system that can help water quality inspector reduce their time and energy. This project will design and develop an IoT-based prototype and monitor the water quality monitoring system using NodeMCU.

1.4 Project Objective

The objectives of this project are as follows:

a) To develop a prototype of water quality monitoring system that able to measure the water level, water temperature and and water turbidity.

b) To analyze the performance of the water quality monitoring system using the IoT system by testing the prototype on river water.

c) To analyze the data for the water quality monitoring.

1.5 Scope of Project

The project will develop a prototype for a water quality monitoring system displayed on the website that allows the inspector to monitor it. This system will use NodeMCU as the central controller and a built-in ESP8266 module that will enable us to make the project IOT and send it to the website. The sensor used in this project was the turbidity sensor and the ultrasonic sensor that allowed us to check the turbidity and water level. The prototype will be placed on the water's surface, and the ultrasonic sensor for water level will be placed at the top and constant to measure the level of water. River water will test the prototype at Sungai Melaka to test the performance functionality of the prototype.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This literature review will explain and focus on the ideas and the information needed to complete the project. Besides, the advantage and disadvantage of previous research are reviewed and compared. There is also the research on the hardware component that is used in other projects also will be reviewed. Furthermore, by analyzing the previous projects, the possibilities that affect the quality of their project can be analyzed and reviewed. Lastly, some recommendation has been made to overcome the problem exist in the previous study.

2.2 Introduction to Water Quality

The chemical, physical, and biological content values of water are used to characterize its quality. Even when there is no pollution, the water quality of rivers and lakes varies with the seasons and geographical areas. There is no significant value that can help us obtain high-quality water. For example, drinking water can be used for farming or irrigation, but irrigation or farming water cannot be guaranteed to be suitable for drinking. A guideline exists that provides fundamental scientific information on water quality parameters and ecologically relevant toxicological threshold values to protect certain water uses. Sedimentation, runoff, erosion, pH value, temperature, pesticides, toxic and hazardous compounds, detergents, litter, and garbage are all factors that affect water quality. There were also substances in the air that influenced the rain that fell to the ground. Dust, volcanic gases, and natural gases like carbon dioxide, oxygen, and nitrogen will dissolve or become imprisoned in the rain. Meanwhile, other substances such as sulfur dioxide, hazardous chemicals, or lead are caught in the rain and rain to the ground, picking up any other substance as it flows from the hill to the river or lake. As a result, the quality of water that comes from natural sources such as rain and rivers will face challenges in meeting human water needs.

2.3 Overview of Water Quality Monitoring

When it comes to finding the best water quality, water can be used to process fish, wash fish, or ice making water meets drinking water standard, and it is considered safe or good quality[1]. The main reason is that contaminated water is the cause of the pathogen-loading of fish and can be hazardous to the consumer. In contrast, the detail of the sampling, testing and analysis was used to follow the general description of the significance of water quality test that was usually made. Testing procedure and parameter may be grouped into physical, chemical and bacteriological. First is the physical testing reveal qualities that can be detected by the sense. Then, chemical tests are used to evaluate the levels of mineral and organic substances that have an impact on the quality of water. And Bacteriological assays reveal the presence of germs that are typically associated with fecal contamination.

The colour, turbidity, total solids, dissolve solid, suspended solids, odor and tasted will be recorded in the physical test. For colour, the presence of the mineral such as manganese and iron or by other substance in vegetable bases such as algae or weeds. This substance will affect the colour of the water. Then, the turbidity of the water can be caused by suspended solids and colloidal matter. Then turbid also affected by the erosion of the soil in the water or due to the growth of the micro-organism. Then, a physical test also includes the odor and taste of the water to detect the presence of microscopic organisms or organic substances, including weed, algae, or any industrial waste containing ammonia, halogen, phenols, and hydrocarbons.

Furthermore, in testing the water quality, a chemical test needs to be conducted in terms of pH value and Biological Oxygen Demand (B.O.D). The concentration of hydrogen ions is measured by ph. It is a measure of water's relative acidity or alkalinity. High alkalinity is indicated by readings of 9.5 and above, while the acidity is indicated by values of 3 and below. Low pH levels aid successful chlorination but cause corrosion issues. In the marine environment, values below 4 often do not support live creatures. The pH of drinking water should be between 6.5 and 8.5. The water level in the harbor basin can range from 6 to 9.

And lastly, the bacteriological test, Indicator organisms should be numerous in faeces but absent or present in modest numbers in other sources. They should be easy to isolate, identify, and count, and they should not develop in water[2]. They should also survive in the water longer than pathogens and be more resistant to disinfectants like chlorine. No one creature can meet all of these criteria in actuality, but coliform species, particularly Escherichia coli, may. Escherichia coli is the most important indicator of pollution by faecal material of human or animal origin.

2.3.1 Water Quality Monitoring with Arduino based sensor

In the previous work, monitoring water quality using Arduino has been conducted by a few researchers from Universiti Brunei Darussalam (UBD) in 2021. Wong Jun Hong, Norazanita Shamsuddin, Emeroylariffion Abas, Rosyzie Anna Apong, Zarifi Masri, Hazwani Suhaimi, Stefan Herwig Gödeke and Muhammad Nafi Aqmal Noh has developed low-cost water quality monitoring system based on the Arduino sensors[3]. The design of the prototype system that will fit the water quality monitoring system with the guidelines of the component, which is the sensors, collects the data from the environment. Then, Arduino Uno will read the analogue data to convert them to digital output. And lastly. The computer or laptop is used to read the value with the relevant software and present the data with can be read by the user. The computer and laptop will also power up the Arduino Uno microcontroller. The research is conduct at a small stream within Universiti Brunei Darussalam (UBD) campus ground. The research was conducted once in the morning and the evening every day in a month with a 2-min period to obtain the average reading or every parameter.

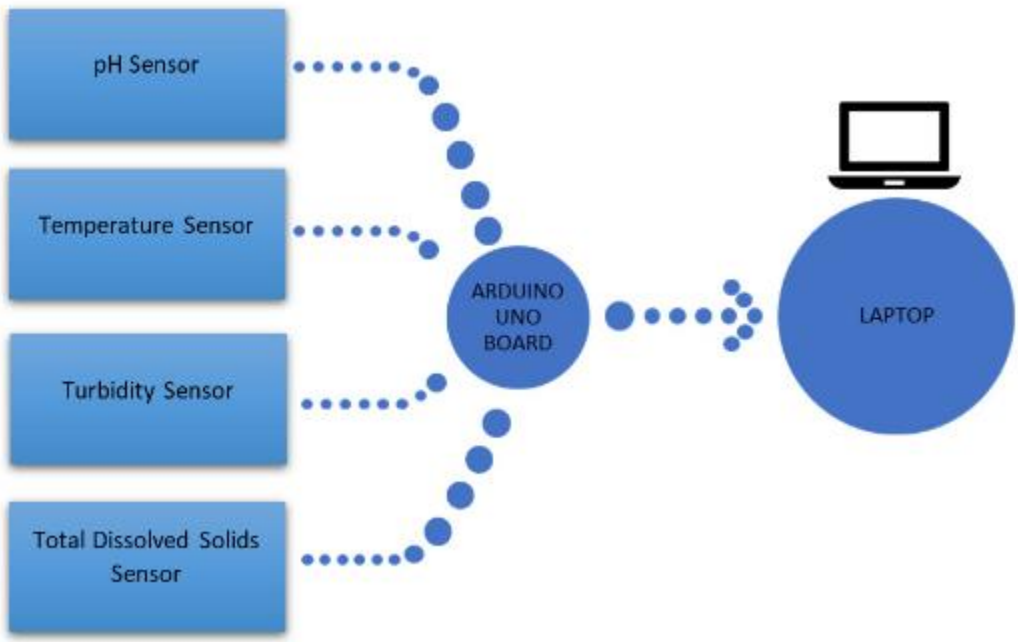

Figure 2.1 : Block diagram of water quality monitoring using Arduino based sensor[3]**.**

2.3.2 Monitoring Water quality using gsm modul

Dr Nageswara Rao Moparthi, Ch Mukesh, and Dr P. Vidya Saga (2018) develop a water quality monitoring system that can be sent to the phone with active call numbers. The system will obtain all the value of the sensor as same on the simple water quality monitoring by using Arduino, and then the system will send all the value to the database. At the same time, it will trigger the GSM module to send to the purpose mobile number according to the time they set, which is at an interval of 30 min[4].

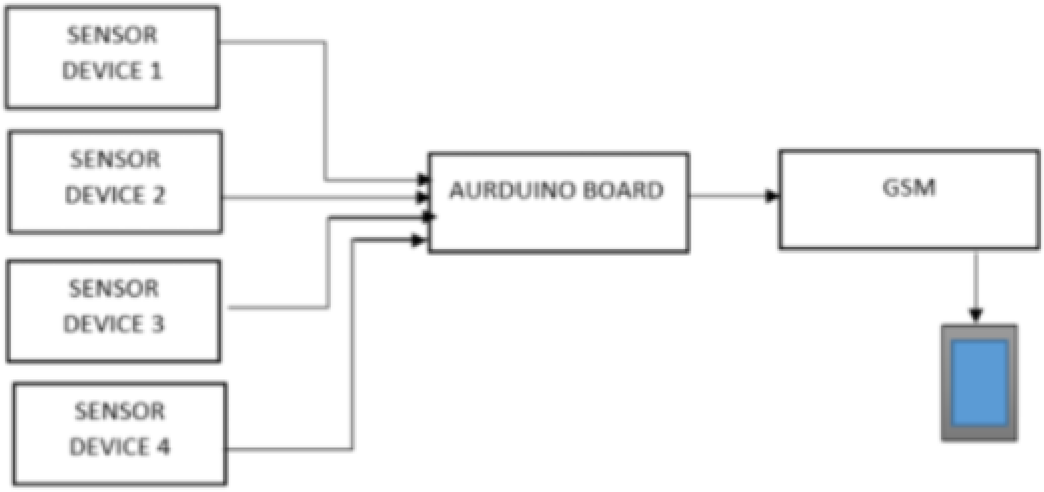

Figure 2.2 : Water quality monitoring using IoT block diagram methodology by Dr Nageswara Rao Moparthi, Ch Mukesh, Dr P. Vidya Saga (2018) [4].

Based on Akexander T.Demetillo, Michelle V.Japitana, Evelyn B.Taboada (2019), the water quality system main goal is to detect water quality in the large aquatic area. It can measure and store information in a database in a real-time scenario. It has a mechanism to deliver a timely notification to managers, authorities, and system users. This project states that the suggested water quality monitoring system's operation with the system will initialize the SD card and the real-time clock after a node is installed (RTC). The GSM module will also be prepared for data transmission. The system will begin collecting data via the onboard electrodes after a few seconds (pH, DO and temperature). The data will be transferred to the base station or a pre-identified cell phone number using a GSM transceiver[5]. In addition, data will be kept in the RTC as a backup data storage format that is identical to that of the base station. In the absence of a GSM signal, data is immediately saved to the RTC and is ready to be sent to the base station's database. To save energy, the device will automatically turn off and wait for a 30 minute time interval after transmission and data backup through the RTC. If the sensor reaches the required time interval of 30 minutes, it will be awakened by a separate timer circuit. The cycle will repeat itself till the required task is completed.

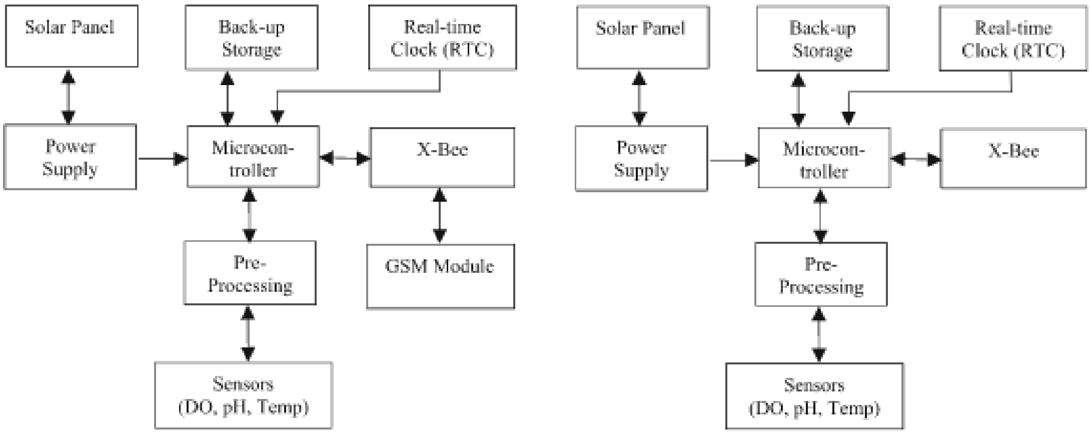

Figure 2.3 : Water monitoring system architecture (Akexander T.Demetillo, Michelle V.Japitana, Evelyn B.Taboada, 2019) [5].

Furthermore, another research was already published by A.N.Prasad, K.A. Mamum, F. R. Islam. H. Haqva in 2017. Sensors, an analogue to digital converter (ADC), a microcontroller, SD storage, and a GSM module make up the system as a whole. The acquired data can be saved onboard via SD card or transferred to a File Transfer Protocol (FTP) server or a cloud server[6]. For this project, data analysis is performed using a cloud server in conjunction with a local workstation. Libelium provided a complete bundled set for this project that includes the sensors, microcontroller, and GSM connectivity. Furthermore, because the deployment is planned to last for months, power conservation is critical, if not years. To accomplish this, the system's design includes a sleep mode, in which the device sleeps for 15 minutes after an hour of continuous measurements. Furthermore, idle modules have been turned off to extend battery life even further. When an SD card operation is completed, for example, the SD module turns off. The GSM and serial communication systems work in the same way. Additionally, alarms have been enabled to remind the user of particular conditions, such as battery life and progress reporting.

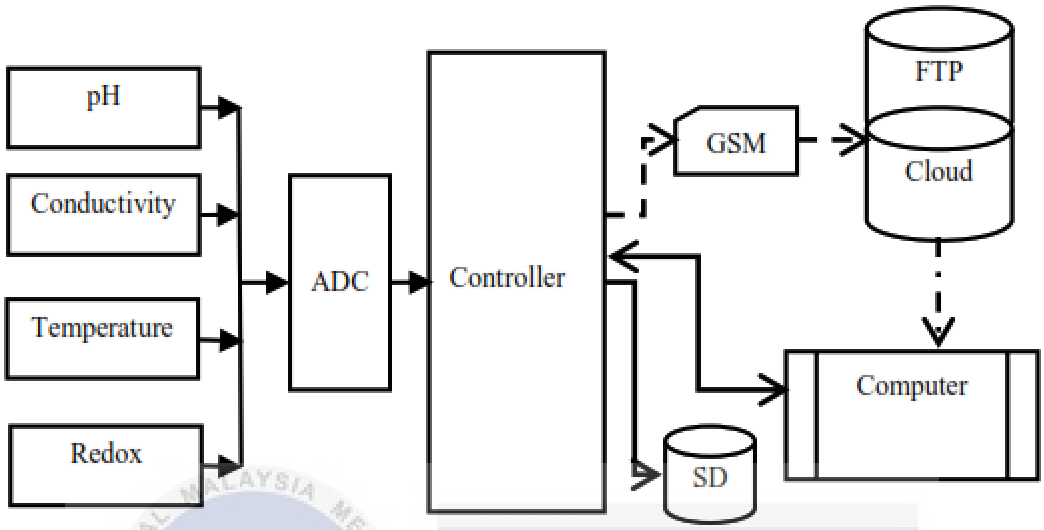

Figure 2.4 : Smart quality monitoring system (A.N.Prasad, K.A. Mamum, F. R. Islam. H. Haqva in 2017) [6].

2.4 Background Studies on IoT

In recent years, the Internet of Things has emerged as one of the most significant technologies of the twenty-first century. Now that everyday items, such as household appliances, cars, thermostats, and baby monitors, can be connected to the internet through embedded devices, seamless communication between people, processes, and things is possible. Thanks to low-cost computers, the cloud, big data, analytics, and mobile technologies, physical objects can exchange and gather data with little human involvement. In today's fast changing world digital systems can record, monitor, and change every interaction between connected objects[7]. Although the physical and digital worlds intersect, they complement one other. Then, IoT also allows anyone, at any time and location, to connect to anything at any time and location. With technological advancements, we are moving closer to a society in which everything and everyone is connected. The Internet of Things (IoT) is thought to be the future evaluation of the Internet, as it enables machine-to-machine (M2M) learning[8].

The number of Internet-connected gadgets is rapidly expanding. Personal computers, laptops, tablets, smartphones, PDAs, and other hand-held devices are among these devices. The majority of mobile devices contain various sensors and actuators that can sense, compute, make intelligent judgments, and broadcast relevant data over the Internet. Using a network of these devices with various sensors can result in a plethora of incredible applications and services that can provide major personal, professional, and economic benefits.

In the twenty-first century, researchers have become more interested in water quality monitoring. As a result, numerous works have been completed or are now being completed on this topic, concentrating on various elements. All of the initiatives were focused on developing an efficient, cost-effective, real-time water quality monitoring system that integrated wireless sensor networks and the internet of things.

2.4.1 Water Quality Monitoring Using Cloud

Arjith Jerom B, Manimegalai R , Hayaraja V (2020)[9] has develop the IoT-Based water monitoring system using cloud. The system will read the value of dissolved oxygen, temperature, humidity, pH, Co2, and soil moisture (for water conductivity) using NodeMCU built in ESP8266. Then the value collected by the microcontroller will be sent to the database, which is Firebase that provided by Google. Finally, the output displays to be monitored from the firebase database.

The database for data aggregation from the wireless sensor node and the data analyzer for processing the sensor data and providing feedback on the acquired data, including alert messages, warning signals, and contamination reports, make up the real-time data acquisition system[9]. The water quality analysis is automated with the help of a cloud server that provides reliable and remote monitoring. Then, in automation and process monitoring, the communication interface is extremely important. For such adverse environmental measurements, the chosen embedded controller is equipped with an IoT module. It necessitates a higher bandwidth and a more economical data rate for real-time monitoring. The wireless module, controller, and battery are encased in a watertight container that makes up the sensor node. The container's design as a floating buoy allows for easy deployment and a wide range of applications. The floating buoy was raised above the water's surface to collect data and form a communication network with nearby nodes. The buoy system is a generic system containing sensors for monitoring various water quality characteristics such as seawater temperature, salinity, water level, and dissolved oxygen. By rowing the buoy across different surfaces of the water bodies, measurements are acquired. The buoy is made out of a floating substrate that is surrounded by air-filled balls. The wireless module on the buoy substrate allows for continuous data and biochemical parameter collection from the sensors to the cluster header.

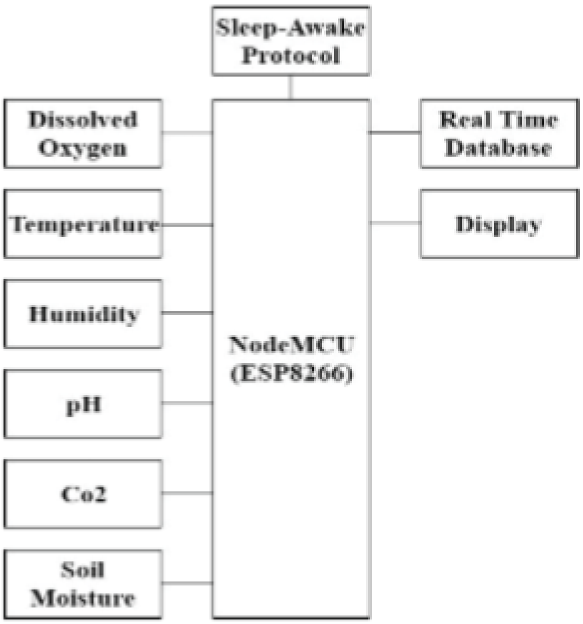

Figure 2.5 : Water quality monitoring system using cloud Arjith Jerom B, Manimegalai R , Hayaraja V (2020) [9].

2.4.2 Water Quality Monitoring using Android app

In 2017, an android app project to monitor water quality were developed by Vaishnavi V. Daigavane and Dr M.A Gaikwad. Several sensors (temperature, pH, turbidity, and flow) are coupled to the core controller in this proposed block diagram. The sensor values are accessed by the core controller, which processes them before sending the data over the internet. As a core controller, Ardunio is used. On the internet Wi-Fi system, the sensor data can be accessed. All the value obtained from the sensor used will be sent via Wi-Fi system to be sent to the BLYNK app[10].

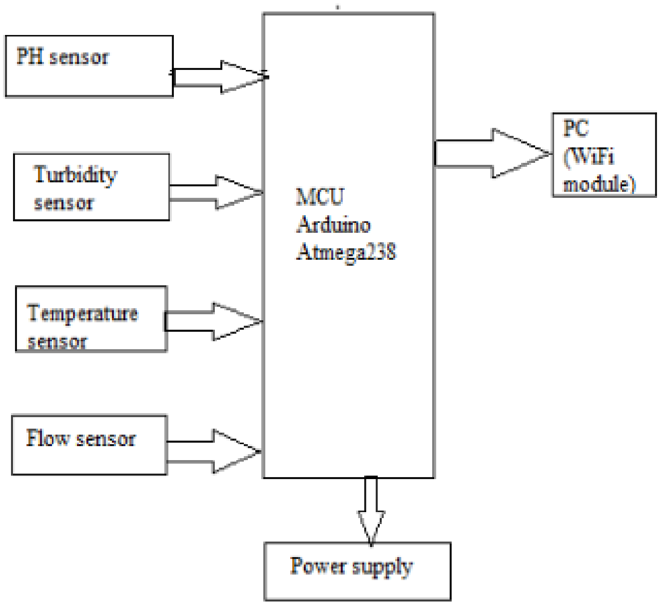

Figure 2.6 : Water quality monitoring system using android app (Vaishnavi V. Daigavane and Dr M.A Gaikwad, 2017) [10].

2.5 Comparison Water Quality Monitoring System

Table 2.1 : Comparison water quality monitoring system

No.	Author & Year	Project Title	Sensor Used	IoT Platform	Additional Feature
1	Wong Jun Hong, Norazanita Shamsuddin, Emeroylariffion Abas, Rosyzie Anna Apong, Zarifi Masri, Hazwani Suhaimi, Stefan Herwig Gödeke and Muhammad Nafi Aqmal Noh (2021)	Water quality monitoring with Arduino based sensor[3]	• pH Sensor • Temperature Sensor • Turbidity Sensor • Total dissolved solids sensor	• None	
2	Dr Nageswara Rao Moparthi, Ch Mukesh, Dr P. Vidya Saga (2018)	Water Quality Monitoring System Using IOT[4]	• pH Sensor	• ZigBee Technology	• GSM • LCD Display
3	Alexander T.Demetillo, Michelle V.Japitana , Evelyn B.Taboada (2019)	A system for monitoring water quality in a large aquatic area using wireless sensor network technology[5]	• pH Sensor • Temperature Sensor • Dissolve Oxygen Sensor	• ZigBee Technology	• GSM • Buoy System

Table 2.2 : continued

No.	Author & Year	Project Title	Sensor Used	IoT Platform	Additional Feature
4	A.N.Prasad, K.A. Mamum, F. R. Islam. H. Haqva (2017)	Smart Water Quality Monitoring System[6]	• pH Sensor • Conductivity • Temperature Sensor Oxydation-Reduction Potential (ORP) Sensor	Lebelium	GSM
5.	Arjith Jerom B, Manimegalai R , Hayaraja V (2020)	An IoT Based Smart Water Quality Monitoring System using Cloud[9]	• Dissolve Oxygen Sensor • Temperature Sensor • Humidity Sensor • pH Sensor • Co2 Soil Moisture	• ZigBee Technology	• Firebase by Google
6.	Vaishnavi V. Daigavane and Dr. M.A Gaikwad (2017)	Water Quality Monitoring System Based on IOT[10]	• pH Sensor • Temperature Sensor • Flow Sensor	• BLYNK app	• Android app

2.6 Summary

There were various methods to develop the water quality monitoring system and each of the previous projects had developed its system with different features. Based on the comparison, each of the following methods had its advantage as well the disadvantage. From the previous project, some authors used Arduino sensor-based water quality monitoring system without any IoT feature. This research was an upgrade from the traditional method with is the manual for water quality monitoring. Then, an improvised the project with the GSM feature which the data can be sent to the active mobile call number. This was a good approach to the private system to monitoring. Then, some researcher was implementing the IoT feature, sending the data to the cloud and the android app. So mean the feature once again improvised. For IoT based research, they implementing the anywhere and anyone can be access to monitor the water quality.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter shows the procedure and the method of how the project is done. It includes the software used and all the components needed in the development process, which is last combined in this project. In this topic, also explain how the analysis process of the project gets the best output. This chapter will give an overall overview of how this project is approached to build an IoT-Based water quality monitoring system. The development of this project is described and can be seen throughout this chapter.

3.2 Project Methodology

Block diagram and flowchart are used in designing and documenting the simple process of the system. In this part, the block diagram and flowchart will represent a process for the IoT based water quality monitoring system. Using block diagram and flowchart, it helps to understand the step and how the process will be done. This chapter will explain the methodology and the process of this project. This approach refers to the steps taken during the research process to meet the goals and produce the best results. This chapter is significant since it will explain the entire procedure before moving on to the following chapter, which will focus on finding and analyzing information.

3.3 Project Working Flowchart

Working flowcharts represent how the whole system process will need to be followed to help the step in process and how it will be done. The figure below shows the flowchart of methodology that contains 4 phase that needs to be followed and done. The first phase is to design the system with the software and hardware assigned to it, for hardware that was the different sensor that needs to be used to monitoring the water quality. Then for the software, there is Arduino code to get the value of the sensors used to be sent by NodeMCU and sent to the cloud. After the first is done, the second phase will continue by developing the system of the water quality monitoring system. Development starts with assembling the circuit and developing the Arduino code that can be sent to the cloud. In this part, many trial and error may occur until we get the best result and the system to be run and fully function as proposed. Then, in phase three and four, which is the post project development. In this part, we obtain the data that align with the sensor and from the data, we can analyze either the project were effective with the purpose.

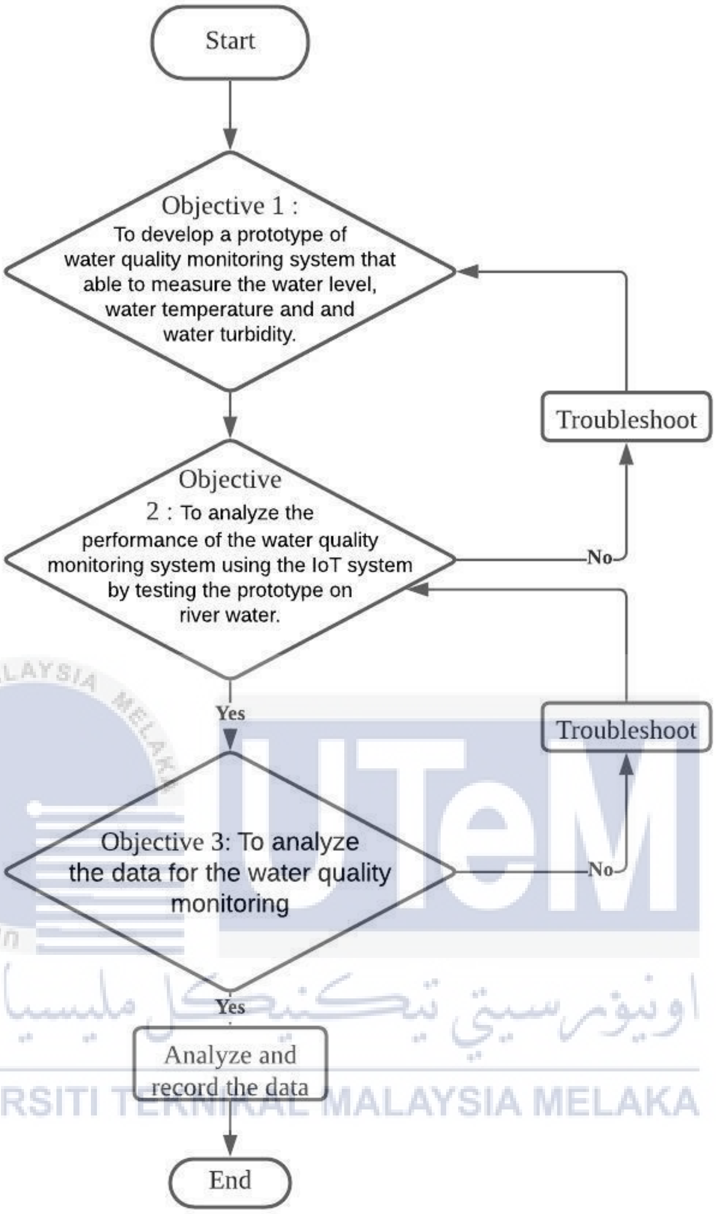

Figure 3.1 : Project Working Flowchart

3.4 Block Diagram of Project

As shown in the figure below, there was 3 input for the water quality monitoring system: an ultrasonic sensor used to measure the water level, and turbidity sensor is to get the turbidity value of the water and lastly is the water temperature sensor. The main microcontroller used in this project is NodeMCU built in ESP-8266, And the output will be displayed on the web for the user to monitor.

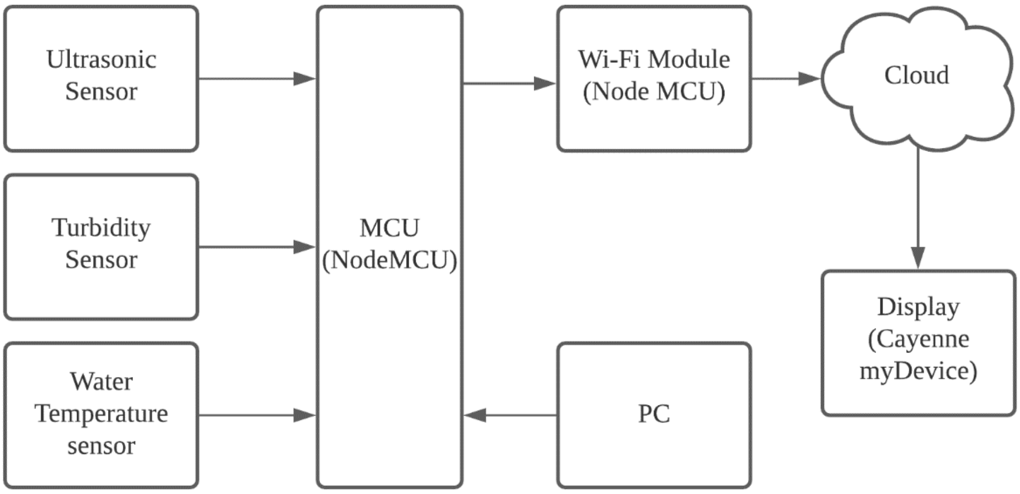

Figure 3.2 : Block Diagram of purposed system

3.5 Hardware and Software for Water Quality Monitoring System

3.5.1 Software Implementation

3.5.1.1 Arduino IDE

The Arduino software is free and open-source, including an integrated development environment (IDE) designed specifically for electronic art. This program is used to program Arduino and Arduino-compatible boards. The figure below shows the Arduino software that used in this project. When the project built to implement in the NodeMCU board, the window 10 operating system is used. The software is used by uploading the code into the board. The software will check if any error occurs before uploading to the board. Arduino platform offers open-source hardware and software that is easier for anyone to use and for this project. Arduino code also not difficult as another programming language. Arduino software uses basic C, C++ and Java as the programming language.

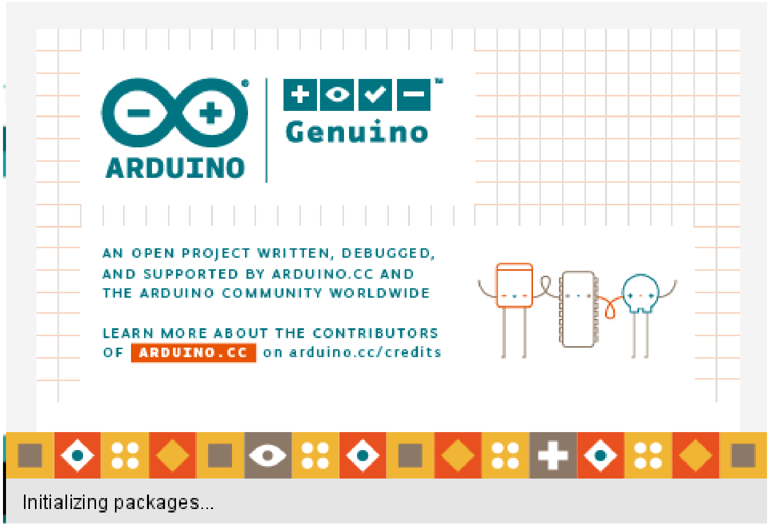

Figure 3.3 : Arduino Software

Figure 3.4 : Arduino IDE in Windows 10 OS

3.5.1.2 Cayenne myDevice

Cayenne myDevices created a strong IoT platform that enables businesses to connect devices, view data, apply sophisticated algorithms, and communicate with their connected customers quickly and easily. Cayenne is an easy-to-use, drag-and-drop tool that extends myDevices' adaptable device and connectivity agnostic platform launched in October 2015 to the developer and maker communities. Cayenne's revolutionary capabilities include automatic device and sensor discovery, which allows Cayenne to be up and running in 7 minutes; drag-and-drop widgets, which allow developers to easily visualize real-time and historical data online or via a mobile app; triggers, which allow one sensor, motor, or actuator to trigger an action on another device and triggers. Threshold alerts send emails or SMS messages based on defined criteria; and the ability to schedule when lights, motors, valves, and actuators switch on and off on certain days and times.

Figure 3.5 : CayenneMydevice Dashboard example

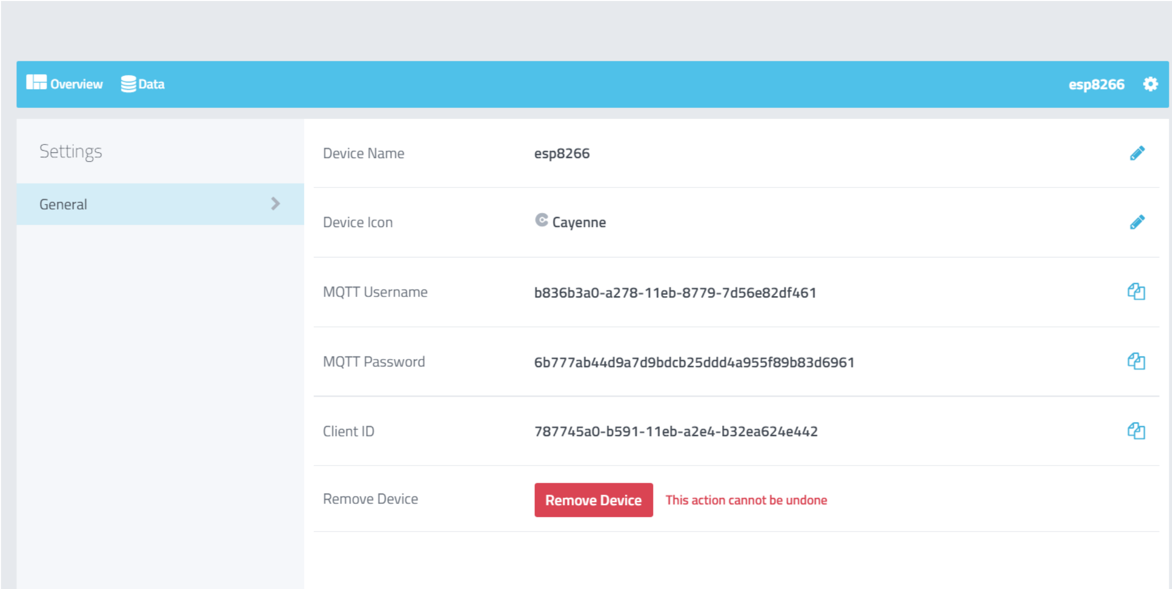

Figure 3.6 : CayenneMydevice Setting

From figure above, to make the connection from the NodeMCU and the cayenneMydevice, the MQTT Username, MQTT Password and Client id need to be declared on the Arduino code that shown on figure below.


```
#include "Ultrasonic.h"
#define SENSOR_PIN 2
#define VIRTUAL_CHANNEL 3

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

Ultrasonic ultrasonic(14,12);

char ssid[] = "AlwaysOnMyGrind";
char wifiPassword[] = "dendaniel97";

char username[] = "b836b3a0-a278-11eb-8779-7d56e82df461";
char password[] = "6b777ab44d9a7d9bdcb25ddd4a955f89b83d6961";
char clientID[] = "787745a0-b591-11eb-a2e4-b32ea624e442";
```

Figure 3.7 : Arduino code to established the connection between board and cayenneMyDevice dashboard

3.5.2 Hardware Implementation

3.5.2.1 NodeMCU

In this project, the microcontroller used is NodeMCU. This hardware consists of ESP8266 (LX106) Wi-Fi SoC from Espressif Systems as a CPU for this board. And this board is based on the ESP-12 module. Then this board consist 128kBytes of memory and 4Mbytes. This board can be powered up by using a USB because it contains a Micro USB port. Table 1 shows that NodeMCU pin to its corresponding function.

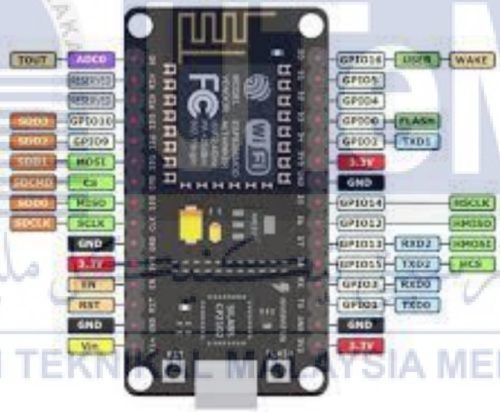

Figure 3.8 : NodeMCU Pin Layout

Table 3.1 : NodeMCU Pin Description

Pin Category	**Name**	**Description**
Power	Micro-USB	To power up the NodeMCU using the port.
	3.3V	Regulate 3,3V can be supplied to this pin to power the up

	GND	Ground pins
	Vin	External Power supply
Control Pins	EN, RST	The pin and button reset the microcontroller
Analog pin	A0	Used to measure analogue voltage in the range of 0-3.3V
GPIO	GPIO1 – GPIO16	NodeMCU has 16 general purpose input-output
SPI Pins	SD1, CMD, SD0, CLK	Four pins available for SPI communication
UART Pin	XD0, RXD0, TXD2, RXD2	Two UART interface, UART0 (RXD0 & TXD0) and UART1 (RXD1&TXD1). UART1 used to upload the firmware/program

3.5.2.2 Ultrasonic Sensor (HC-SR04)

Ultrasonic Sensor HC-SR04 is used to determine the distance to an object like bats or dolphins do. It offers excellent noncontact range detection with high accuracy and stable reading. It can detect from 2cm to 400 cm or 1-inch to 13 feet. The speciality of this sensor is not affected by sunlight or black material like other range finders. To activate the sensor, it needs +5V DC and 15mA. Any item in front by less than 30˚ from the middle can be detected by it. In this project, the ultrasonic sensor was used to detect the level of the water.

Figure 3.9 : Ultrasonic Sensor (HC-SR04)

3.5.2.3 Turbidity Sensor

The turbidity sensor measures turbidity, or opaqueness, to determine water quality. It measures light transmittance and scattering rate, which fluctuates with the amount of total suspended solids (TSS) in water to identify suspended particles in water. The level of liquid turbidity rises as the TTS rises. Water quality in rivers and streams, wastewater and effluent measurements, control instruments for settling ponds, sediment transport research, and laboratory measurements all use turbidity sensors. This liquid sensor can output both analogue and digital signals. When in digital signal mode, the threshold can be adjusted. The unit uses to measure the turbidity, or the presence of a suspended particle in the water, is NTU, a Nephelometric Turbidity Unit. Turbidity sensor work with operating voltage between 3.3VDC to 5VDC. The value of NTU that this sensor can detect is between 0 to 1000 NTU.

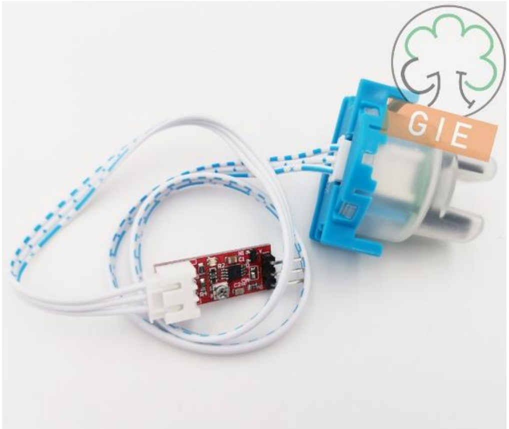

Figure 3.10 : Turbidity Sensor

3.5.2.4 Temperature Sensor DS18B20 (Waterproof)

In this project, the water temperature cannot be collected using normal temperature sensors such as dht11 or dht22. DS18B20 is a temperature sensor that can immerse in the water with the metal probe and rubber coated wire that can withstand the water. With this temperature sensor, the data of the water temperature can be reading accurately. This sensor will power up by 3v to 5.5v power supply, and it can detect temperature from -55 to 125 °C. The accuracy of the sensor can detect at ±0.5°C.

Figure 3.11 : Waterproof Temperature sensor

3.6 System Algorithm

In the system algorithm, the figure below illustrates the process starts with the will initialize the esp8266 module and Cayenne myDevice server. The ultrasonic sensor will be located above the water as it is not a waterproof feature. The ultrasonic sensor will read as the component can read the digital value from the sensor. For the turbidity sensor, only its probe will be located on the water's surface; meanwhile, the temperature sensor will submerge in the water as it has a waterproofing feature. This DS18B20 also can be read using the digital pin of the microcontroller. Then turbidity sensor will then read the analogue value and convert the value into NTU value to read the turbidity unit measurement. The data will be sent to the microcontroller. From the voltage value, the microcontroller will convert all the voltage value into data corresponding to the sensor. The microcontroller will send the data to the server, which is Cayenne myDevice, for the display for the user.

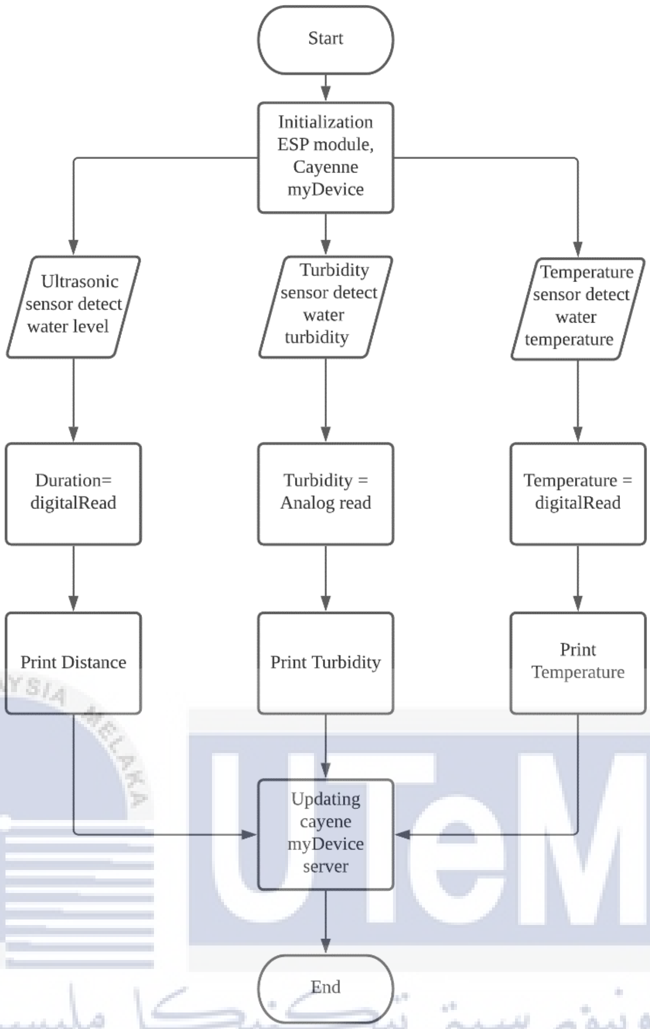

Figure 3.12 : Overall Algorithm for the purpose system.

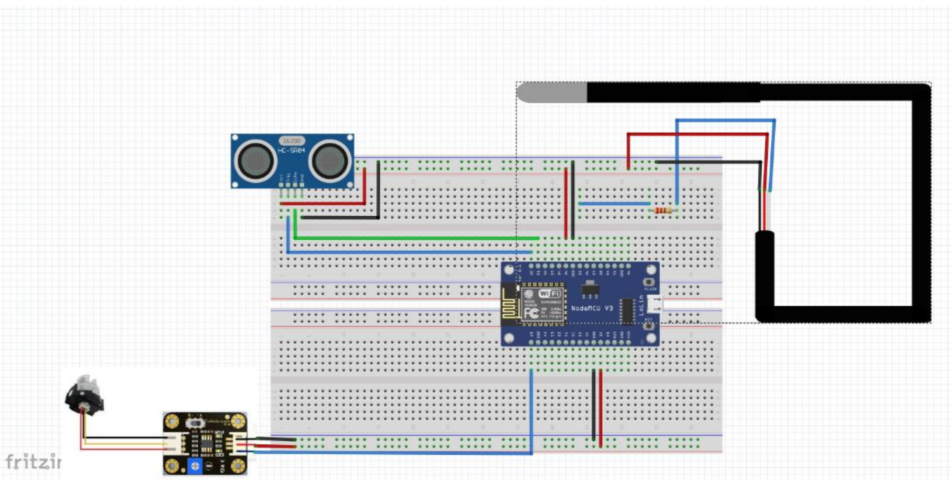

Figure 3.13 : Hardware Design Using Fritzing™ Software

3.7 Prototype Testing

To testing whether the project is working well with the objective. The location for testing is Sungai Melaka and the area is at Durian Tunggal. The coordinate of the location is 2.3032581518742763,102.26274096658645. The location were choosen as the location is the water gate after releasing the water.

Figure 3.14 : Location used for testing the prototye

Figure 3.15 : Prototype testing on water with turbidity and temperature sensor

Figure 3.16 : Ultrasonic for water level sensor

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Introduction

In this chapter, the application of the circuit and the result analysis of the project are discussed. Data collection and results are recorded and discussed in this chapter. Problem faced during conduction the project and recommendation are also included.

There are two parts for this project which is hardware andwebsite dashboard. For the hardware, the circuit consist of NodeMCU, Ultrasonic sensor (HC-SR04) as the to detect the water level, DS18B20 as water temperature sensor and turbidity sensor to detect the water turbidity.

Then, cayenneMydevice is to display the output of the sensor to user for the monitoring. myDevices creates middleware systems and application solutions for the Internet of Things that “simplify the connected world.” myDevices tailored solutions help organisations who produce, market and service connected devices to effectively connect items, manage data, and engage with their consumers. myDevices is the first platform of its type to provide a back-end linked device solution for the business and an interconnected front-end solution for the end user.

4.2 Hardware

In this section, the hardware of the circuit which involved all module were discussed. The circuit consist of NodeMCU, Ultrasonic sensor, water temperature sensor and turbidity sensor.

4.2.1 Prototype of water quality monitoring system

In project development, the NodeMCU is connected with the ultrasonic sensor, turbidity sensor and temperature sensor (DS18B20). The NodeMCU acts as the 'brain' of the system as the task can be done by giving instruction through the code that allows the NodeMCU to retrieve value from the sensors. Then, from the NodeMCU, the data can also be sent the cloud that acts as the IoT system that can display for the monitoring as the sensors act as the sense for their task. For ultrasonic can read the measurement to be used to detect the water level. Then, turbidity is to detect the turbidity of the water that able to read from the Cayenne dashboard. And the temperature sensor that able to get the value of the temperature underwater as it has a waterproof feature to get the accurate temperature value of the water. The figure below shows the full prototype connection of the circuit for the water quality monitoring system

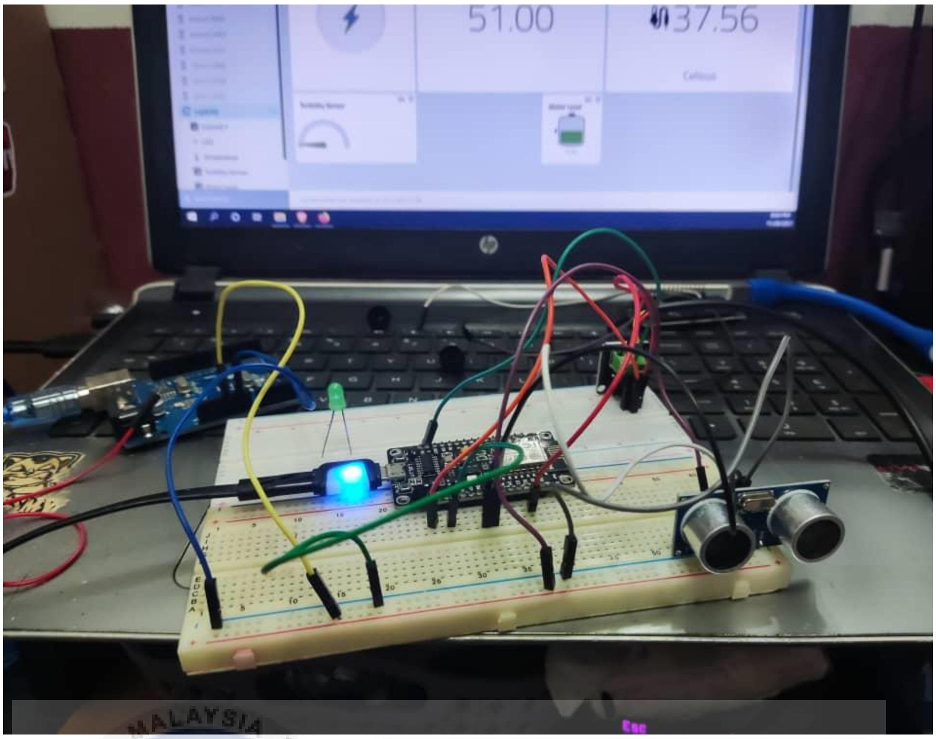

Figure 4.1 : Combination of all module

Figure 4.2 : Prototype of the project

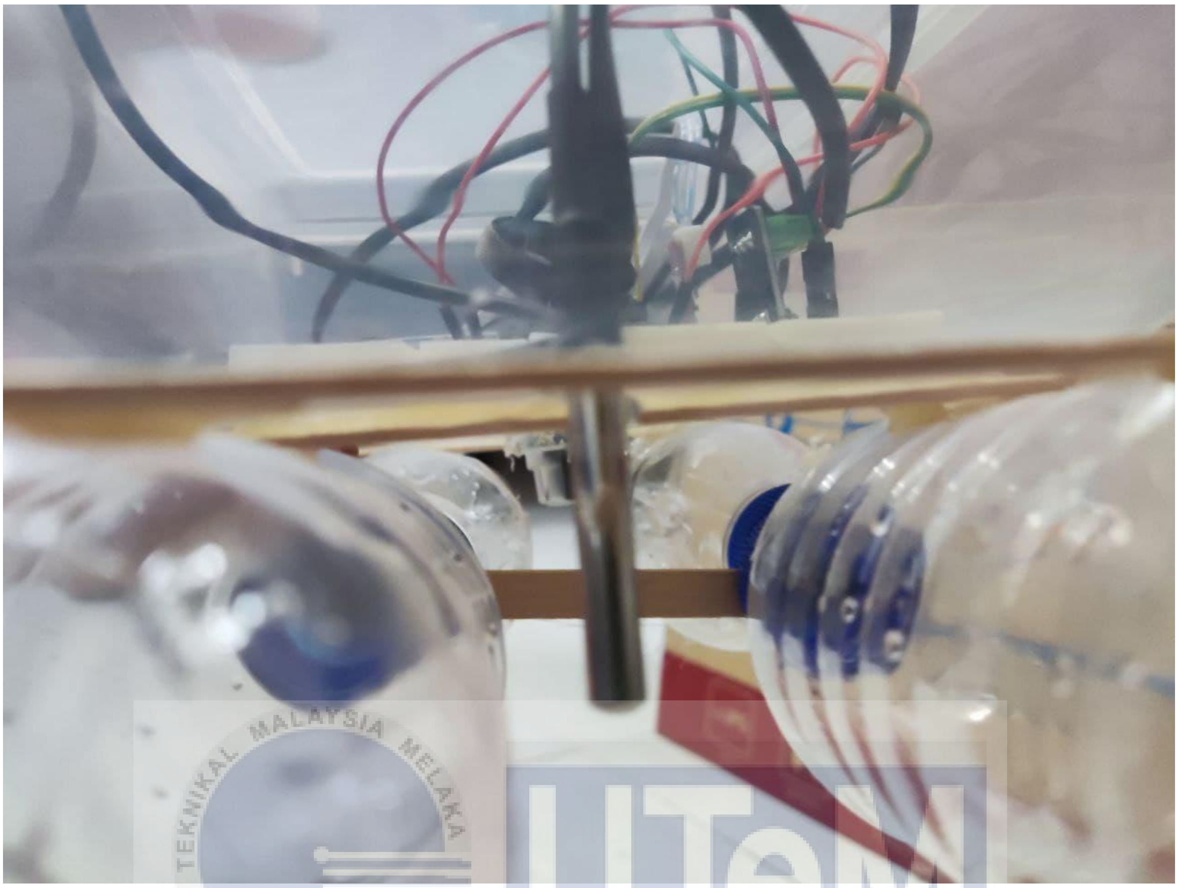

Figure 4.3 : Temperature sensor on prototype

Figure 4.4 : Turbidity Sensor on prototyp

4.2.2 Analysis of Temperature Data

Next,continued with collecting data from all the sensor which is water temperature sensor, water level sensor and water turbidity sensor. Following that, the water temperature data obtained can be viewed on the cayenneMydevice dashboard as show in Figure 4.3.CayenneMyDevice dashboard show data that were reading at the real time when the sensor were read the value with which is updated every second.

Beside that, cayenneMydevice also can able to view the data by the graph by clicking the graph icon with the sensor section.

Figure 4.5 : Data obtained from the sensor

Then,the temperature data is collected at Sungai Melaka for quality monitoring system is work. The purpose of analyzing the temperature data is to determine the range of water temperature that suitable for use and to prototype to work.

The temperature value that obtained from the sensor were analyze for 1 hour with 60 data The time is already in UTC +8 which is our local time which mean the data that were collected is real time.

The data in Figure shows that the temperature data are in between, 31.66℃ to 31.67℃ for 29.12.2021. The highest temperature that were recorded is 31.66757℃ (2021-12-29 15:28:11)meanwhile, the lowest temperature occured at 31.65725℃ (2021-12-29 16:21:44). The the average is 31.66188℃.

The temperature has a considerable effect on biological activity and growth in general. Temperature dictates the type of organisms that live in rivers and lakes. Fish, insects, zooplankton, phytoplankton, and other aquatic species have a preferred temperature range. If temperatures increase or decrease much above or below the species' optimal range, the species' population shrinks until none remains.

The temperature affects the chemistry of water, and so is crucial. Chemical processes tend to accelerate with rising temperatures. Increased temperatures enable water, particularly groundwater, to dissolve more minerals from the underlying rock, increasing electrical conductivity. When a gas, such as oxygen, is dissolved in water, the situation is quite different. Consider how much "bubblier" a cold Coca-Cola is compared to a warm one. Cold soda may contain more dissolved carbon dioxide bubbles than warm soda, giving it a fizzier look when drunk.

Warm stream water may affect the aquatic life in the stream. Warm water has less dissolved oxygen than cold water, and some types of aquatic life may perish without it. Certain compounds grow increasingly toxic to aquatic life as the temperature rises.

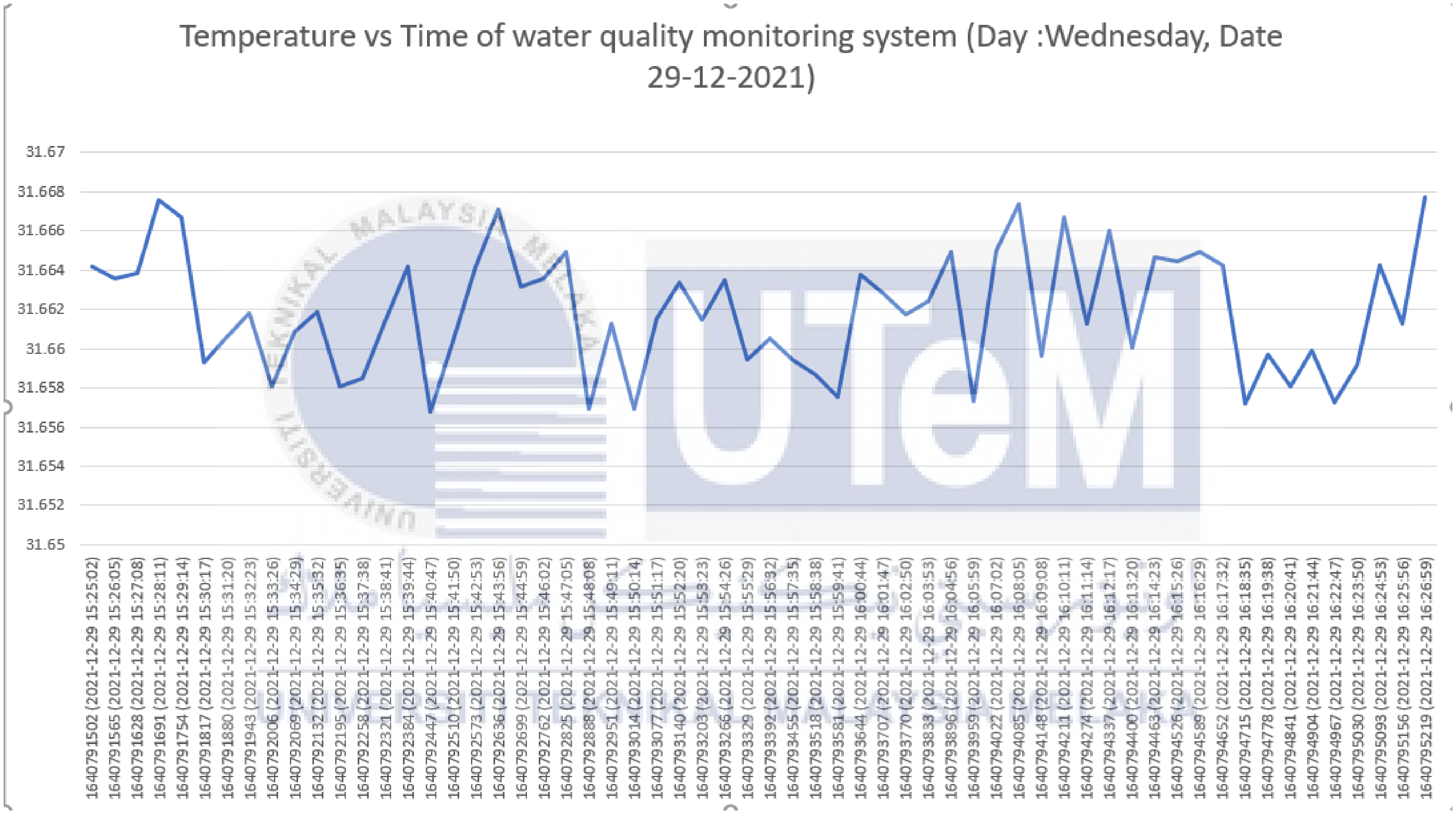

Figure 4.6 : Temperature data vs time (29-12-2021)

4.2.3 Analysis of Water Level Data

Water level data is obtained from ultrasonic sensor HC-SR04 that we place in top of the river and constant during the water level obtained in one hour. The data obtained can be viewed on the cayenneMydevice dashboard as show in Figure 4.3.CayenneMyDevice dashboard show data that were reading at the real time when the sensors were read the value with which is updated every second.

Furthermore, the collection of data is analyzed are using Microsoft Excel to generate graph and calculate average value of the data. Therefore the water level data were collected for an hour. The data that generate is generated between one minutes interval . Then data were collected has total of 60 data.

The data in Figure shows that the water level data are located between 64.12% to 68.95% from an hour of analysis the maximum peak for water level is at 68.95% (2021-12-29 15:32:23) meanwhile the lowest is at 64.12% (2021-12-29 15:34:29)).Next, the average value of the water level is 66.45%

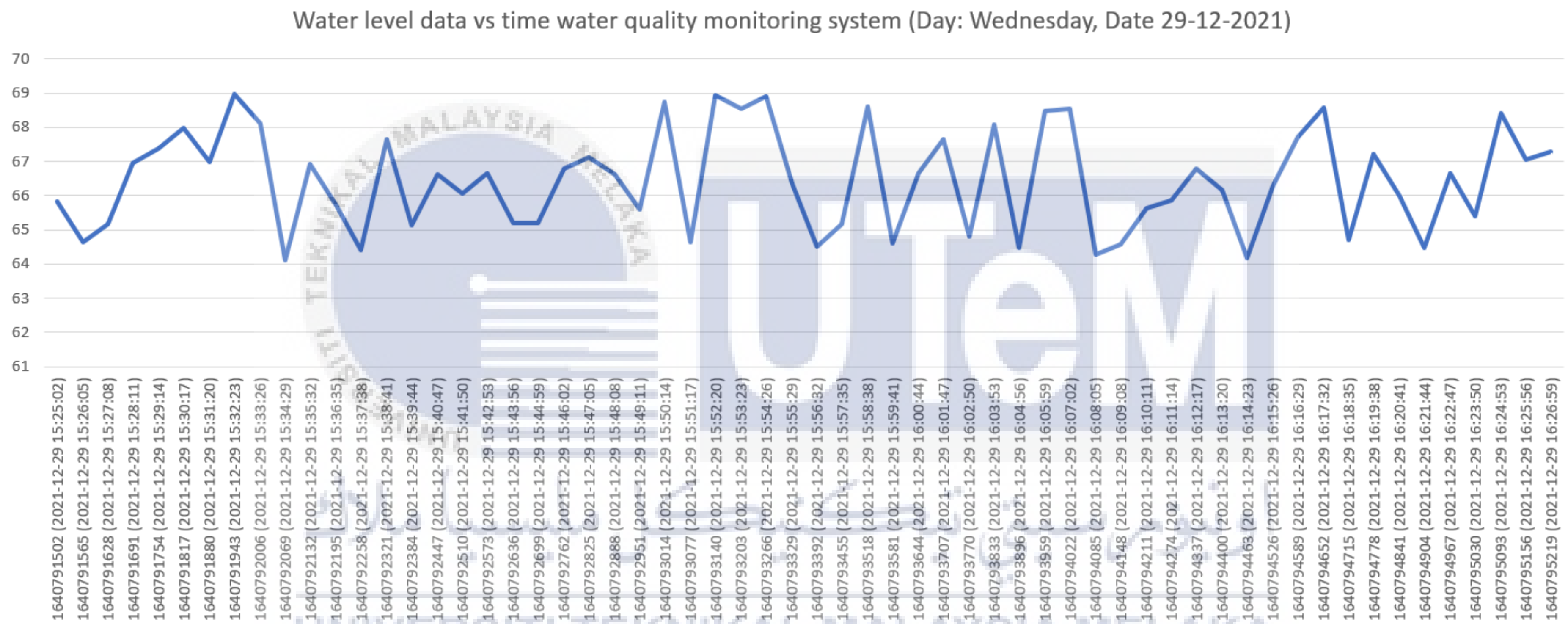

Figure 4.7 : Water level data vs time (29-12-2021)

4.2.4 Analysis of Water turbidity Data

The water turbidity were obtained from the water turbidity sensor which is taken from same river. The sensor is palced at the bottom of the prototype to enable it to submerge the sensor tip to read the water turbidity. This sensor is reading the voltage value which mean the NTU unit is later calculated of the data were obtained. The turbidity value also can be viewed in the cayenneMydevice dashboard for monitoring.

Furthermore, the collection of data is analyzed are using Microsoft Excel to generate graph and calculate average value of the data. Therefore the water level data were collected for 3hour (1hour per day) for testing the prototype. The data that generate is generated between one minutes interval . Then data were collected has total of 180 data.

For the analysis of the turbidity data show that the turbidity of the water is the almost the same as the turbidity of the water are not drastically change or smallest value during nearest days.

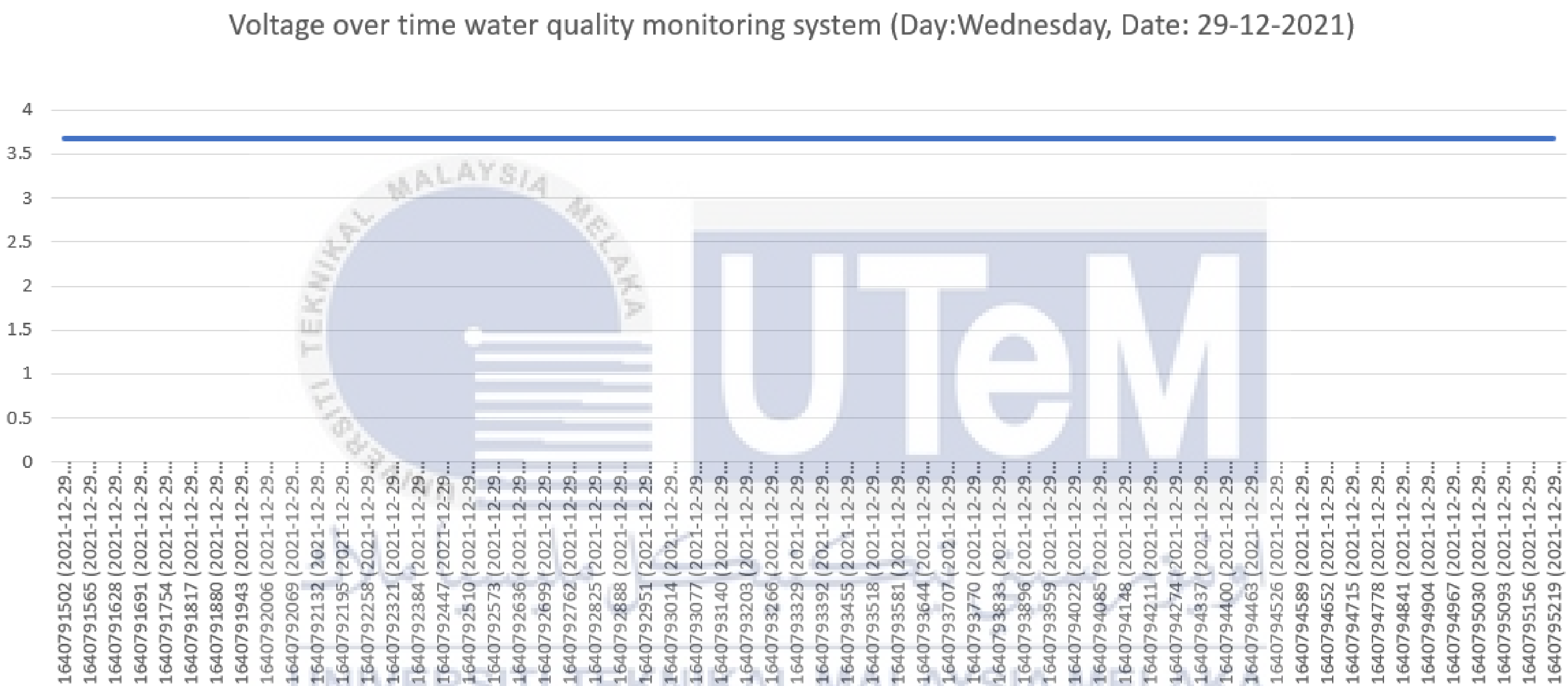

Figure 4.8 : Voltage vs time (29-12-2021)

Then, to convert the voltage value to the NTU unit . The NTU can be calculate by refering the graph from figure below.

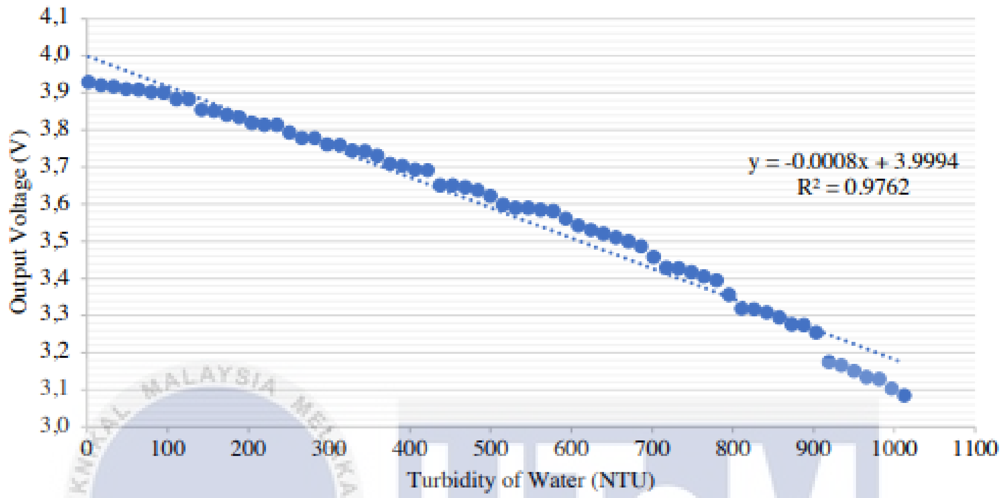

Figure 4.9 : Graph of the output Voltage to Turbidity of water[11].

Value the voltage that obtained from an hour of observing and testing were 3.68245 for 29.12.2021. Then, by referring to the graph the value of NTU will 400± NTU. From the graph also we can conclude that the relationship between the voltage and NTU is inversely proportional as the higher value of the voltage the lower the value of the NTU.

4.3 Software

The data from the sensor were sent to the database via NodeMCU through the internet. CayenneMydevice is a platform to receive, store and display the data that were obtained from the sensors.

4.3.1 Arduino IDE

Arduino IDE is the software that makes everything work in this project. It acts as the brain to instruct the input and the output. In figure below shows the code that is used to connecting the board to enable the make this project run as intended.

Figure 4.10 : Arduino Code

4.3.2 CayenneMydevice

CayenneMydevice is a platform to create and design a dashboard for IoT projects. CayenneMydevice will build the dashboard on one page to monitor this prototype easily. The data consist of the led button for testing the connectivity of the board, voltage value from the turbidity sensor, ultrasonic sensor and water temperature sensor..

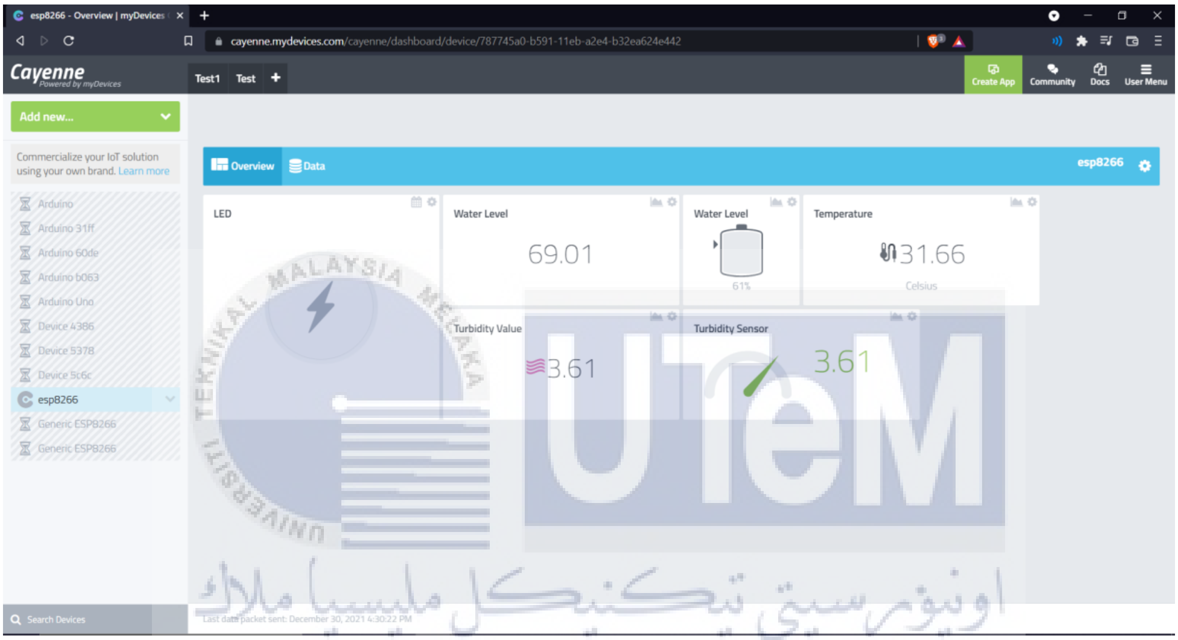

Figure 4.11 : CayenneMyDevice Dashboard

The main page is show in Figure 4.2 consist of all the value that will be used for the monitoring puposed. The dashboard were able to read or monitoring the data in real-time, As show on figure above. From this website also it able to export the data that obtained before and will be read in microsoft excel for the analysis.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter stated the conclusion of this project, where all objectives are justified, scope is reviewed, significant findings are discussed, and recommendations for further development of the project are explained..

5.2 Conclusion

Overall, this project's objective is achieved by the prototype of a water quality monitoring system developed and the design able to measure the water temperature, water level, and water turbidity using the IoT system. Moreover, the performance of the system is analyzed using the IoT system.

Furthermore, this project's scope is accomplished for both hardware and software development, where the water quality monitoring system prototype is constructed along with the website dashboard. In addition, the design for both software and hardware are fully functional and meet the objectives of this project.

Based on results and discussion in Chapter 4, this prototype can read the water temperature, water level and water turbidity and display on the cayenneMydevice dashboard. At the same time, this system received the data from the sensor and stored the data into middleware, which allowed the cayenne to display the data to the user. Besides, the data analysis proves that this prototype system shows a good performance. The entire process required the connection of the internet, which is one of the goals in developing the IoT system. Therefore, this project is succeeded since the objective of this project was achieved.

5.3 Future Works

There are a few recommendations that can be applied in future works. The recommendation is as follows:

- Add solar panel system to enable the prototype to able to run independently
- Improve and increase the feature by installing a camera which can view the surrounding in real-time
- Add feature for a mobile application to enable monitoring anywhere.
- Improve the housing material to enable it to withstand the rough weather

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APPENDICES

Appendices A : Gantt Chart of BDP1

Activity	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
Confirm the title	■			■	■	■								
Study Journal		■	■	■	■	■	■	■	■					
Drafting literature review		■	■	■	■	■	■	■	■					
Update literature review				■	■	■	■	■	■	■				
Methodology			■	■	■	■	■	■	■	■	■			
Introduction		■	■	■	■	■								
Report Chapter 1-4										■	■	■	■	
Slide preparation												■	■	
Presentation BDP 1														■

Appendices B : Gantt Chart of BDP2

Activity	W1	W2	W3	W4	W5	W6	W7	W8	W9	W 10	W 11	W 12	W 13	W 14
Progression of report	■	■	■	■	■	■	■	■	■	■	■	■		
Prototype development	■	■	■	■	■	■	■	■	■	■	■	■		
Analyze perfomance of the project			■	■	■	■	■	■	■	■	■	■		
Report Finalize												■	■	■
Poster preparation											■	■	■	■
Presentation BDP 2														■
Final BDP report submission														■

Appendices C : Code.ino

```
#include <CayenneMQTTESP8266.h>
#define CAYENNE_DEBUG
#define CAYENNE_PRINT Serial// Include library file for MQTT
#include <OneWire.h>
#include <DallasTemperature.h>
#include "Ultrasonic.h"
#define SENSOR_PIN 2
#define VIRTUAL_CHANNEL 3

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

Ultrasonic ultrasonic(14,12);

char ssid[] = "AlwaysOnMyGrind";
char wifiPassword[] = "dendaniel97";

char username[] = "b836b3a0-a278-11eb-8779-7d56e82df461";
char password[] = "6b777ab44d9a7d9bdcb25ddd4a955f89b83d6961";
char clientID[] = "787745a0-b591-11eb-a2e4-b32ea624e442";


int GIu_Ultrasonic_Dist_CM=0;
int sensorValue = analogRead(A0);
float turbidity = sensorValue*(5.0 / 1024.0);



void setup(){
   Serial.begin(9600);
   Cayenne.begin(username, password, clientID, ssid, wifiPassword);
    pinMode(2, OUTPUT); //pin 4 == d2
  digitalWrite(2, HIGH);
}

void loop()
  {
      delay(20);
      GIu_Ultrasonic_Dist_CM=ultrasonic.Ranging(CM);
      Cayenne.virtualWrite(V7, GIu_Ultrasonic_Dist_CM);
      Serial.print(GIu_Ultrasonic_Dist_CM);
      Serial.println(" cm" );

      sensors.requestTemperatures();
      Cayenne.celsiusWrite(VIRTUAL_CHANNEL, sensors.getTempCByIndex(0));
```

```
    Serial.print ("Temp:");
    Serial.println (sensors.getTempCByIndex(0));

    int sensorValue = analogRead(A0);
    float turbidity = sensorValue * (5.0 / 1024.0);
    Cayenne.virtualWrite(V5,turbidity);
    Serial.print ("Sensor Output (V):");
    Serial.println (turbidity);

    Cayenne.loop();
  }


CAYENNE_IN(0)
{
  digitalWrite(2, !getValue.asInt());

}
```

Appendices D : ultrasonic.h

```
#ifndef Ultrasonic_h
#define Ultrasonic_h

#if ARDUINO >= 100
  #include "Arduino.h"
#else
  #include "WProgram.h"
#endif

#define CM 1
#define INC 0

class Ultrasonic
{
  public:
    Ultrasonic(int TP, int EP);
   Ultrasonic(int TP, int EP, long TO);
    long Timing();
    long Ranging(int sys);

  private:
    int Trig_pin;
    int Echo_pin;
   long Time_out;
    long duration,distance_cm,distance_inc;
};

#endif
```

Appendices E : ultrasonic.cpp

```
#if ARDUINO >= 100
  #include "Arduino.h"
#else
  #include "WProgram.h"
#endif

#include "Ultrasonic.h"

Ultrasonic::Ultrasonic(int TP, int EP)
{
   pinMode(TP,OUTPUT);
   pinMode(EP,INPUT);
   Trig_pin=TP;
   Echo_pin=EP;
   Time_out=3000;  // 3000 Âµs = 50cm // 30000 Âµs = 5 m
}

Ultrasonic::Ultrasonic(int TP, int EP, long TO)
{
   pinMode(TP,OUTPUT);
   pinMode(EP,INPUT);
   Trig_pin=TP;
   Echo_pin=EP;
   Time_out=TO;
}

long Ultrasonic::Timing()
{
  digitalWrite(Trig_pin, LOW);
  delayMicroseconds(2);
  digitalWrite(Trig_pin, HIGH);
  delayMicroseconds(10);
  digitalWrite(Trig_pin, LOW);
  duration = pulseIn(Echo_pin,HIGH,Time_out);
  if ( duration == 0 ) {
   duration = Time_out; }
  return duration;
}

long Ultrasonic::Ranging(int sys)
{
  Timing();
  if (sys) {
   distance_cm = duration /29 / 2 ;
   return distance_cm;
   } else {
   distance_inc = duration / 74 / 2;
```

```
  return distance_inc; }
}
```