Module Code & Module Title
CC5068NT– Cloud Computing & IoT

Aquarium Water Monitoring system

Assessment Type

Semester
2023 Spring

Group members

London Met ID	Student Name
22085385	Anish Jaiswal
22085435	Sahisha Karki
22085411	James Shrestha
22085396	Bibek Chapagain

Assignment Due Date: 12 January
Assignment Submission Date: 12 January
Word Count: 3408

I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

Acknowledgment

We the group '**AI'** like to convey our sincere thanks to our module teachers Ujjwal sir and Itahari International College, and all the academic team for providing us a place to complete this project. The help provided by our module instructor, **Mr. Ujwal Neupane**, and the Academic team was truly valuable for completion of our project. We thank our module leader for his thoughtful and timely advice. I am grateful to everyone who helped making this Project a success. We would also like to express our gratitude for your understanding and patience while we resolved any issues that came up along the way. Your encouragement and support were helpful in keeping us motivated and focused.

Also, we sincerely show our gratitude to all our friends and family for their support and guidance to share their invaluable technical expertise and experiences, as well as to our parents for their moral and material support.

Abstract

An innovative method for maintaining aquarium ecosystems is the "Aquarium Water Monitoring System". It provides real-time precision, safeguards, and user- friendly engagement through the employment of modern sensors, a microprocessor, and wireless connectivity. The Arduino UNO-programmed system, which has sensors for temperature, turbidity, and water level, is useful for aquatic life in a variety of contexts, including commercial aquariums, enthusiasts, and research and education. It takes care of temperature issues, which are important in cold climates and helps in context of ideal circumstances for aquatic health and welfare. In general, this research encourages appropriate ecosystem management while preserving the health of aquatic species.

Contents

Table of Figure

Table of Tables

1. Introduction

An aquarium, designed to take care of aquatic life, requires careful maintenance for optimal visual appeal and the well-being of its inhabitants. To solve this, the "Aquarium Water Quality Monitoring System" makes use of Bluetooth connectivity and modern sensor technology to provide real-time accuracy in detecting changes in water quality. By quickly resolving problems, this smart system constantly maintains stable conditions, reducing the dangers of stress, sickness, and injury to aquatic life. The project offers a new approach to aquarium management by combining aquaculture with the Internet of Things, allowing beginners as well as experts to create healthier habitats for fish.

1.1 Current Scenario

The current scenario in aquarium management involves unexpected challenges related to poor water quality, leading to bacterial blooms and potential harm to aquatic life. Existing techniques suffer from delayed monitoring of changes in water quality, require costly human testing, and lack real-time precision. (Animal city, 2024). And it is difficult to prevent future issues when there are no specific procedures in place. By addressing current weaknesses, the proposed project aims to improve aquarium care by delivering a real-time, predictive, and user-friendly monitoring system.

1.2 Problem Statement

Current existing methods in context of Aquarium management rely on time-consuming human testing, lack actual time accuracy, and suffer from delayed monitoring of changes in water quality. The lack of accurate measures makes it more difficult to prevent future problems. Furthermore, there are issues with remote monitoring, limited modification options, and unfriendly user interfaces. By creating an innovative system that offers real-time, predictive, and user-friendly monitoring, our project aims to address these problems and promote an approach to aquarium care that is more effective and responsive.

1.3 Project as a solution

To deal with all the challenges in aquarium management, our project proposes solutions to transform the Aquarium Water Monitoring System. The integration of the latest sensors ensures accurate and timely real-time monitoring of temperature, turbidity, and water level changes. Another crucial function is that when the aquarium water is rising, it generates an alert to notify users right away and reduce the chance of any uncertainty. The final approach uses an LCD display and a mobile app connected over Bluetooth to increase configurable options and user-friendliness. The goal of this broad approach is to improve the aquarium administration's overall user experience, adaptability, and efficiency.

1.4 Aim and Objectives

The primary aim of the "Aquarium Water Monitoring System" is to increase aquarium health through advanced real-time monitoring of several important water quality parameters within a user-friendly interface facilitated by Bluetooth technology.

The objective are as follows:

- To be able to develop accurate turbidity detection.
- To be able to implement precise water temperature monitoring.
- To establish water level detection capabilities.
- To incorporate an LCD screen to see the water quality in real time.
- To be able to alert the system if the water level rises too much when adding water.
- To enable wireless communication through Bluetooth to ensure a smooth integration with aquarium maintenance.

2. Background

This project is designed to maintain optimal aquarium conditions by monitoring water level, turbidity, and temperature. And through a user-friendly Bluetooth interface, users can also conveniently access real-time readings, contributing to the well-being of aquatic life. The system's aims to ensure the health of the aquarium environment by easing potential risks associated with changeability in water parameters.

2.1 System Overview

The "Aquarium Water Monitoring System" offers a modern and user-friendly solution for ensuring optimal aquarium conditions by continuously monitoring necessary water conditions. This integrated system uses the latest sensors, such as turbidity, temperature, and ultrasonic sensors, to offer real-time data for maintaining a stable and healthy aquatic environment. The system, which is connected to the Arduino microcontroller via a breadboard, shows the temperature and turbidity values on an LCD display. Users can easily access and analyse the data thanks to a smooth Bluetooth interface. Buzzer-activated alerts rapidly tell users of high turbidity levels and water height, allowing for quick action to protect aquatic life.

a. **Sensor Integration:** For thorough water quality monitoring, three essential sensors are used: temperature, turbidity, and ultrasonic.
b. **Arduino Microcontroller:** The Arduino microcontroller functions as the central processing unit and is smoothly connected to the sensors with a breadboard.
c. **LCD Display:** The system provides a user-friendly interface by displaying temperature and turbidity values on an LCD display.
d. **Bluetooth Connectivity:** Data transmission can be made easier through a simple-to-use Bluetooth interface, allowing users to access and analyse real-time data effortlessly.
e. **Alert System:** A buzzer has been implemented to send notifications when turbidity and water height surpass predetermined parameters, ensuring a proactive response to changes in water quality.

2.2 Hardware Architecture

The system’s hardware architecture is essential to maintaining and improving the water quality in aquariums. It creates an overall structure that makes it possible for users to regularly check significant parameters, ensuring the aquatic environment's continued health and well-being. Below is the figure of our system’s hardware architecture:

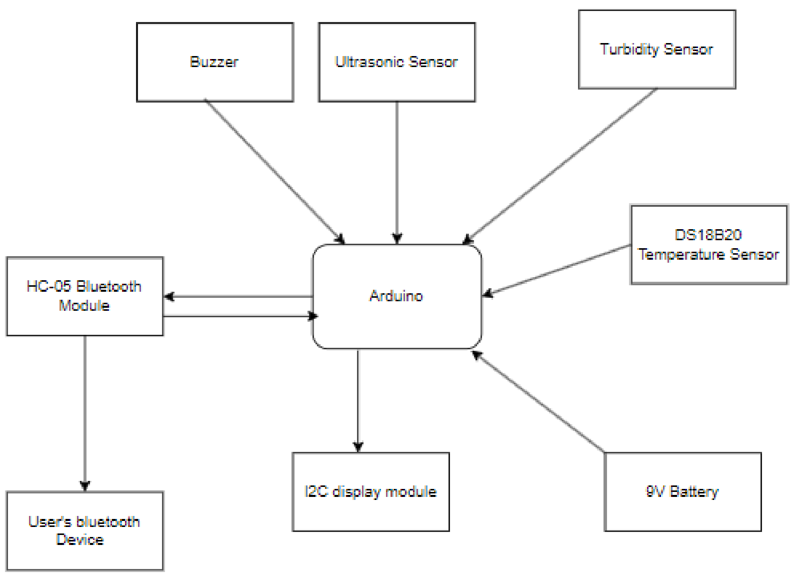


Figure1: Hardware Architecture for the project.

2.3 Circuit Diagram

A circuit diagram is a visual representation of the project's electrical connections, and this diagram below shows the visual depiction of the 'Aquarium water monitoring system.

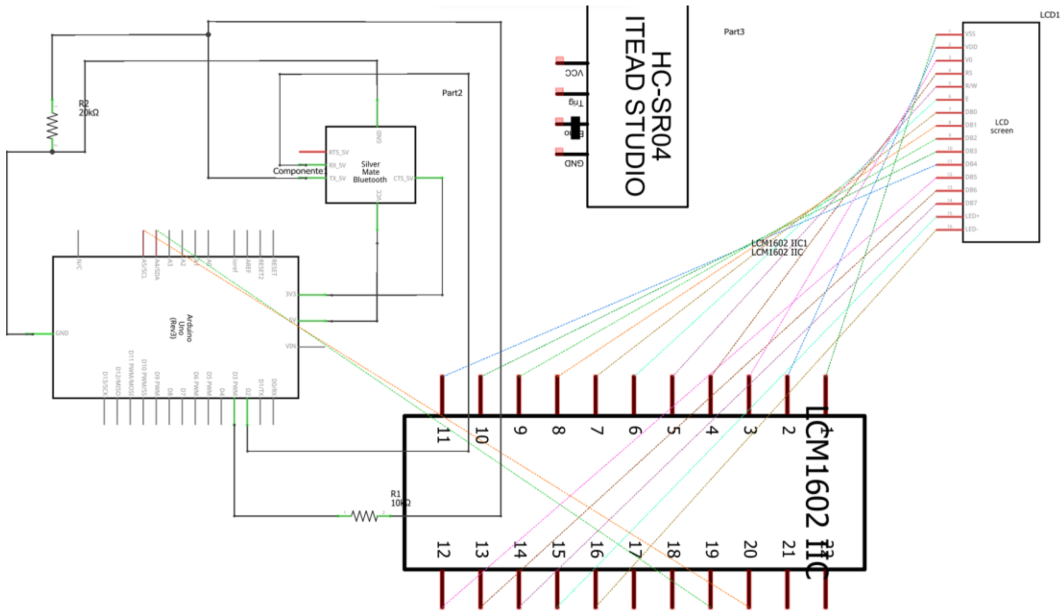


Figure 2: Circuit diagram for the project.

Here, the main component, the Arduino Uno, serves as the control hub for all the sensor and the LCD display. The sensor determines how long it takes sound waves to reach an item and back since it is made for measuring distances. This calculated time is then shown on the LCD panel. The Bluetooth module connects the Arduino Uno to other devices, such as smartphones, to enable remote modifications. This allows for easy time setting and adjustments. And the circuit diagram offers a thorough explanation of how all these parts work together to provide an affordable and easy-to-use aquarium water quality monitoring system.

2.4 Flowchart

A flowchart is a diagram that each step of a process in sequential order. it is a generic tool that may be used for a wide range of purposes and used to explain various processes. it is very easy to draw flowchart and using only very few symbols, complex problem and steps can be represented in flowchart.

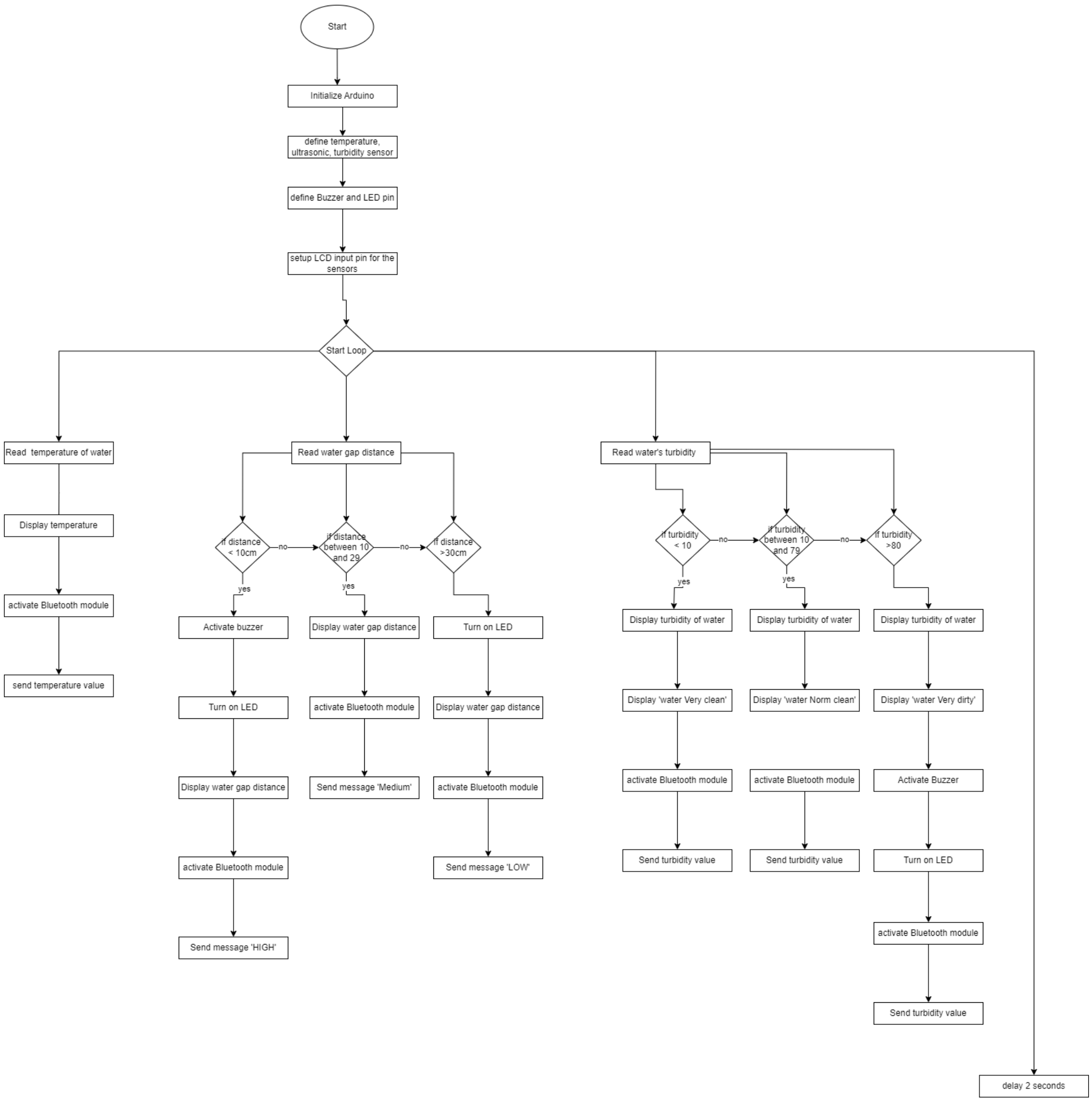


Figure 3: Flowchart of the project.

3. Requirement Analysis

3.1 Hardware

a) Arduino UNO:

The Popular Arduino Uno is the ideal choice for aquarium water monitoring due to its simplicity, user-friendliness, and affordability. Its versatility allows seamless integration with various sensors and actuators, making it suitable for both beginners and experienced individuals, as well as for hobbyist and educational projects.

Figure 4: Arduino UNO.

b) LCD Display:

Picking an LCD (Liquid Crystal Display) for the project arises from the need to give clients a user-friendly interface that is visually appealing. Effective aquarium management is made possible by the clear presentation of vital data made possible by this easy and affordable system.

Figure 5: LCD Display.

c) Solderless Breadboard:

Breadboard acts as a safety net, ensuring the security of components attach in it. So, using a solderless breadboard in designing and optimizing our project offers numerous benefits. This approach is both logical and straightforward, especially in the early stages of building and refining the project.

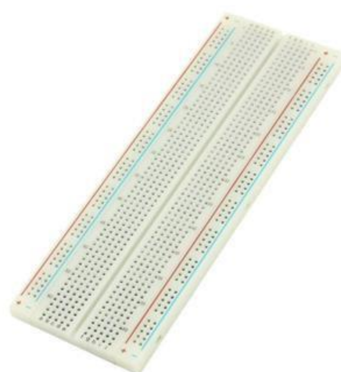


Figure 6: Solderless Breadboard

d) 9v Battery

The 9V battery is known for its small size and widespread availability, is well-suited for low-power circuits commonly found in many projects. Employing a 9V battery as a power source in our project will provides a lightweight and user-friendly solution for the sensors.

Figure 7: 9V Battery

e) Turbidity Sensor:

A turbidity sensor is a vital part in this project that measures the haziness of the water's surface caused by suspended particles. It operates by emitting light into the water and detecting whether the light is scattered or absorbed by floating particles maintaining a perfect level of water's quality in aquariums which is vital for the good health of the fish in them.

Figure 8: Turbidity Sensor.

f) I2C display module:

I2C (Inter-Integrated Circuit) facilitates the users straightforward communication between the display module and other components, such as sensors or microcontrollers. The I2C display module offers a user-friendly interface, presenting real-time water quality data in an easily understandable format. Its compact design allows seamless integration into the project without occupying excessive space.

Figure 9 I2C display module.

g) Resistor (1K, 4.7K):

The use of resistors, mainly 1K and 4.7K types, in an aquarium water monitoring system is vital to obtaining the take and monitored electric value inside the circuit.

The 1K resistor can be used to manage flow or alter voltage levels in a variety of components, providing the sensor or other electronic device values are accurate and correct.

In contrast, the 4.7K resistor, with its higher resistance value, can be used for activities such as pull-up or pull-down processes in digital circuits, which enhances data quality.

Figure 10: Resistor

h) Jumper wires:

Jumper wires are essential parts in the building of electronic circuits, especially aquarium water monitoring systems. These wires, that are often flexible and sealed, serve as links between numerous parts on a breadboard in a circuit. Jumper wires in aquarium monitoring systems enable simpler for connecting sensors, resistors, screen parts, and other electronics together.

Figure 11: Jumper wires.

i) DS18B20 Waterproof temperature Sensor Module.

The DS18B20 waterproof temperature sensor can be helpful to track aquarium health as it allows take and current time temperature of the water measurement. This information is vital to maintaining ideal conditions of marine organisms. The sensor's digital nature allows connection with microcontrollers like Arduino and allows for easy connection with other monitoring system parts.

Figure 12: Temperature Sensor Module.

j) Ultrasonic sensor.

The ultrasonic sensor is an essential part in aquarium water monitoring systems, giving a flexible and indirect methods for measuring distances and detecting water levels. Ultrasonic sensors can be used in aquariums to evaluate the water level, providing useful information for monitoring and maintenance. An ultrasonic sensor works by producing ultrasonic waves and measuring the time it takes for the waves to reflect after hitting a surface.

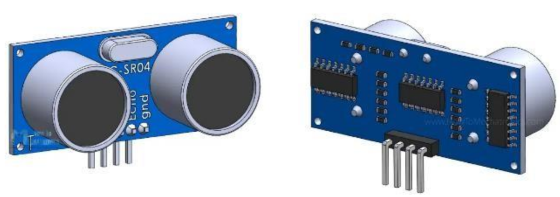


Figure 13: Ultrasonic Sensor

k) Buzzer:

In this project, a buzzer serves as a sound alerting part which is being used into the system to alert due to certain circumstances for example, if the water temperature rises beyond a certain level, the buzzer will ring to warn the users. This sound feedback is useful, especially in environments where visual monitoring is difficult.

Figure 14: Buzzer.

l) HC 05 Bluetooth module

The HC-05 Bluetooth module is a helpful supplement to aquarium water monitoring systems as it enables a wireless link. The HC-05 module enables users to connect to and analyze data gathered by many different sensors in the aquarium using a Bluetooth-enabled device like a mobile device or desktop computers.

Figure 15: Bluetooth Module.

3.2 Software

a) Arduino IDE:

The Arduino IDE (Integrated Development Environment) is a software system for coding and developing apps for Arduino microcontrollers. It gives an easy interface enabling generating, compiling, and uploading code to Arduino boards. The IDE accepts Arduino, a C/C++-based programming language. The Universal Serial Bus (USB) link enables user to write code, access libraries, and transfer programs to the Arduino board.

Figure 16: Arduino IDE.

b) Bluetooth connectivity App:

A Bluetooth connectivity app application for mobile phones which links wireless to Bluetooth-enabled devices. Within the setting of an aquarium water monitoring system, a Bluetooth connectivity app can connect with Bluetooth-enabled modules, like the HC-05 Bluetooth module connected to an Arduino. This software allows users to connect to and control the water monitoring system from their smartphones or tablets.

Figure 17: Bluetooth connectivity app; Ardutooth

3.3 Group Member responsibilities:

Member Name	Responsibilities
Anish Jaiswal	• Participation in the project's coding phase. • Errors and exceptions handling. • Connecting all hardware parts together. • After doing research on IoT projects, that we choose to employ the Aquarium Water Monitoring System for our project.
Bibek Chapagain	• Solving problems relating to hardware. • Some part of documentation and contributed to the hardware section.
Sahisha Karki	• Creating the flow diagram, and wireframe for the system's initial phase. • Support with the hardware component and network-related problem solving.
James Shrestha	• Worked on the project report's documentation section in all of it. • Purchased the few items of hardware needed for the project at hand. • Engaged on putting the database into use monitoring the process of work. • Created the circuit design.

4. Development

Development refers to the process of creating, designing, and coding a computer program or any application. It includes a wide range of task so basically this section of the report is designed to give reader a brief understanding of how the project was developed from a scratch to final implementation.

4.1 Planning and Design

In this project, we aimed to create an IOT-based ‘Aquarium water monitoring system’ that would help keep quality of life safe in a healthy, suitable, and growing environment. This project was planned to preserve the aquatic life that we keep in our house, as many of us love to keep aquariums, watch fish, and enjoy its beauty in peace. People often spend lots of money on aquariums these days, as research has also shown that watching fish helps keep people's minds at peace. It also helps overcome anxiety and depression. But we often forget to monitor the quality of water over time. So, our system will check the water quality for you and your small life inside.

Initially, the idea was to just create a water quality checker with the help of turbidity sensor, but as the project progressed, we decided to include several other modules, like a Bluetooth module that would send a direct message to the user via the app. A temperature module and an ultrasonic module that will check the water temperature and water level.

4.2 Resource Collection

A resource is an invaluable tool which main objective is to help in achieving the objectives of an event or project. So, unlike any project, resource collection played an important part in the successful development of the ‘Aquarium Water Monitoring System’. To complete this project various sensors, modules and a microcontroller was used. Our team managed the fundings required while making this project. We carefully assembled all required parts and equipment to ensure an effortless and effective development procedure. The tools that were required are given below:

- Arduino Uno
- DS18B20 Temperature Sensor
- Ultrasonic Sensor
- Turbidity Sensor
- Buzzer
- Led bulb.
- I2C lcd Display
- HC-05 Bluetooth module
- Jumper Wire
- 9V Battery

4.3 System Development

Once the planning and design phase were finished, we looked into the software development aspect of the project. And our team started coding the various modules required for the 'Aquarium Water Monitoring System.' Writing code for the Bluetooth, temperature, ultrasonic, and turbidity sensor all was part of the development process, so we used programming languages suitable it.

The system development begins with connecting the Arduino Uno to the laptop and learning to use the Arduino in IDE. we established a programming environment to code and upload the necessary drafts for our project. This step also ensured that the Arduino was ready to receive and execute the programmed instructions.

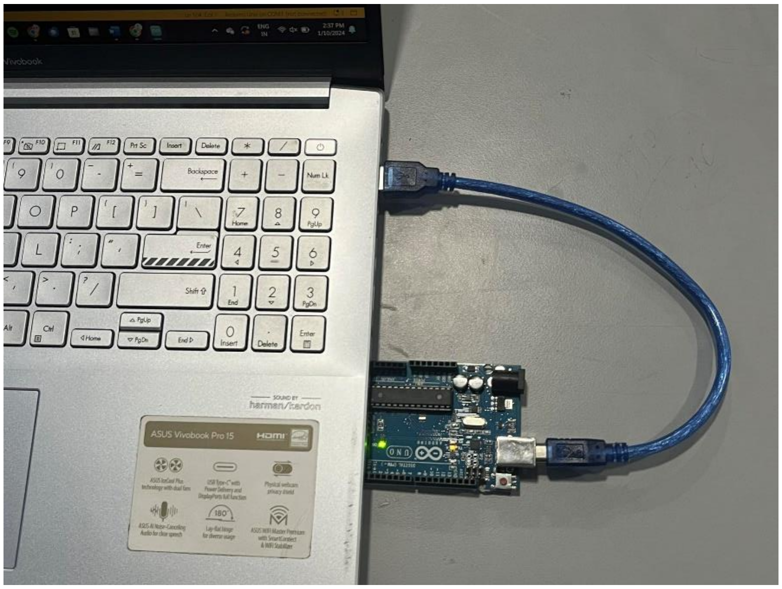


Figure 18: Connection between Arduino and Laptop.

After the initial stage of the project, the Temperature Sensor module and a buzzer were connected to the Arduino using a Breadboard. And to ensure proper functionality of the Temperature Sensor, a 4.7 K ohm resistor was incorporated into the circuit. The Breadboard facilitated a structured and temporary arrangement for secure connections during the developmental phase.

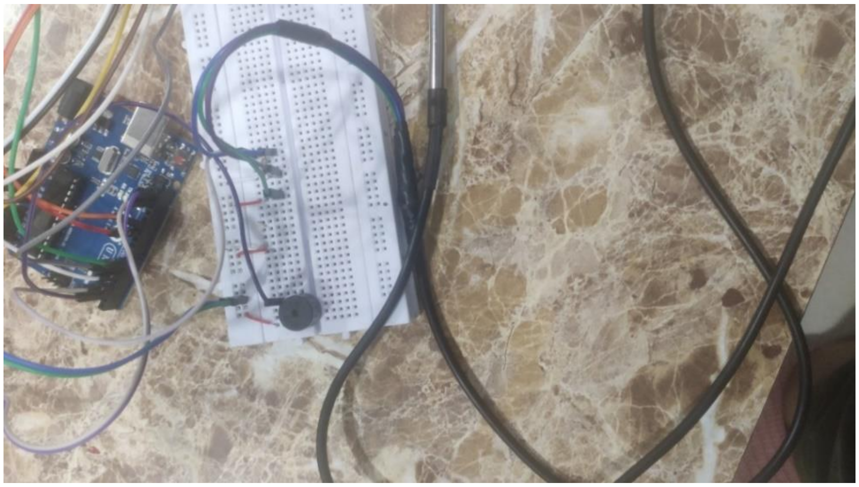


Figure 19: Connecting Arduino, Temperature sensor and a breadboard.

The HC-05 Bluetooth module installation came next once the Temperature Sensor was connected to the Arduino. This upgrade improved the system's accessibility and user interaction by allowing Bluetooth to display sensor values.

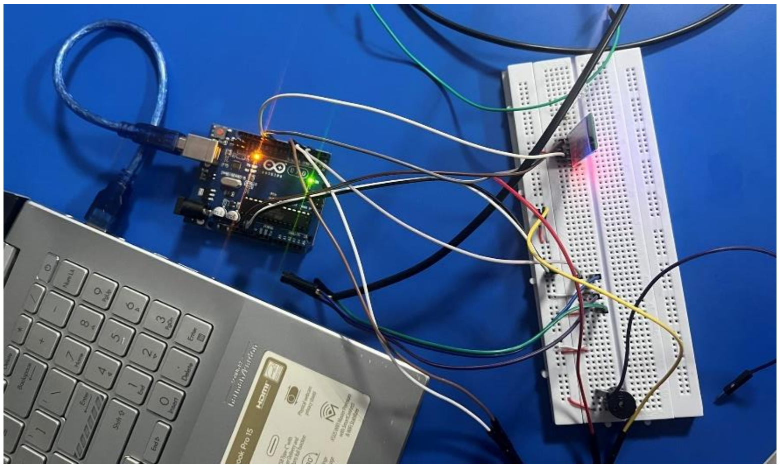


Figure 20: Connecting HC05 with the rest.

After the Bluetooth module was carefully incorporated into the existing setup, to establishing a wireless communication link between the Arduino and external devices, we added ultrasonic sensor with a bulb. The ultrasonic sensor, and its readings were programmed to trigger a response in the form of a buzzer, creating an audible alert.

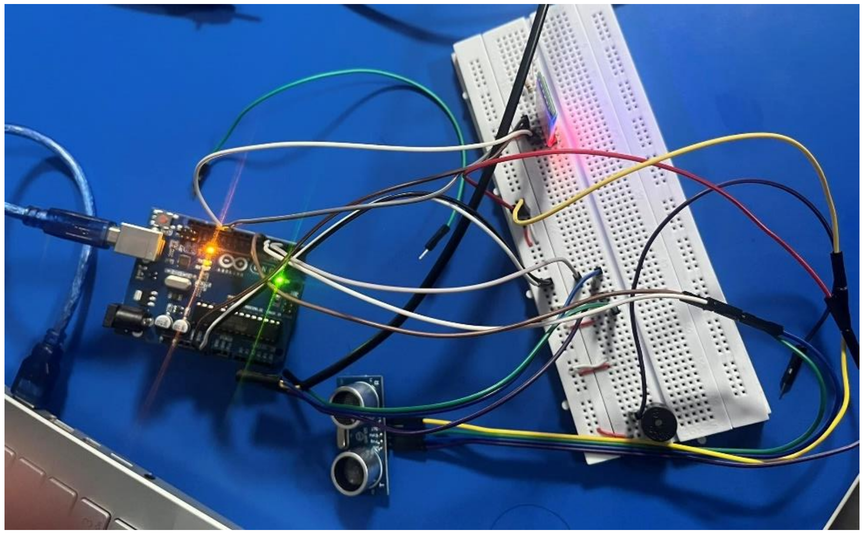


Figure 21: Connecting Ultrasonic sensor to the rest.

Now, we joined a turbidity sensor into the system by connecting it to the Arduino using a Breadboard. This step further expanded the monitoring capabilities of the project allowing us to assess the clarity of the water.

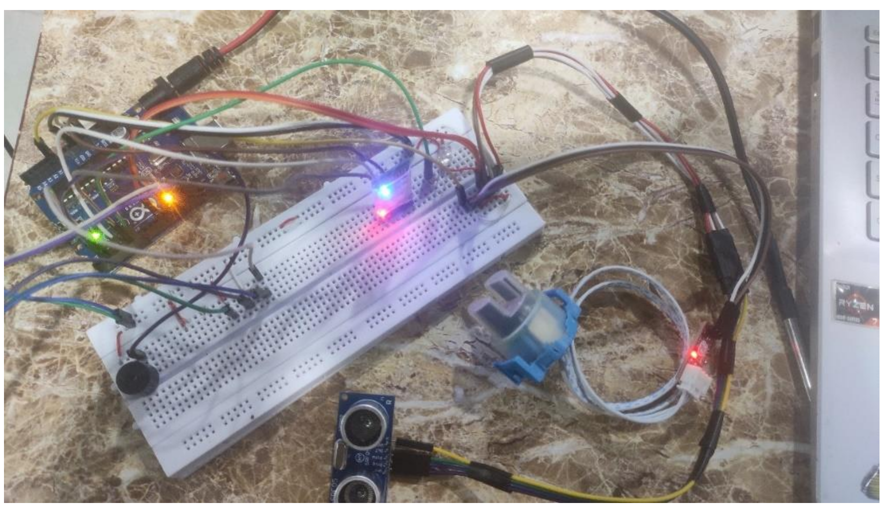


Figure 22: Connect turbidity sensor to rest.

After the successful integration of all the sensors, the next step involved displaying their values using an LCD display. The LCD, along with its module, was connected to the

Arduino using a Breadboard. Everything was successful and the sensors value was printed in the display. The connected picture is as shown below.

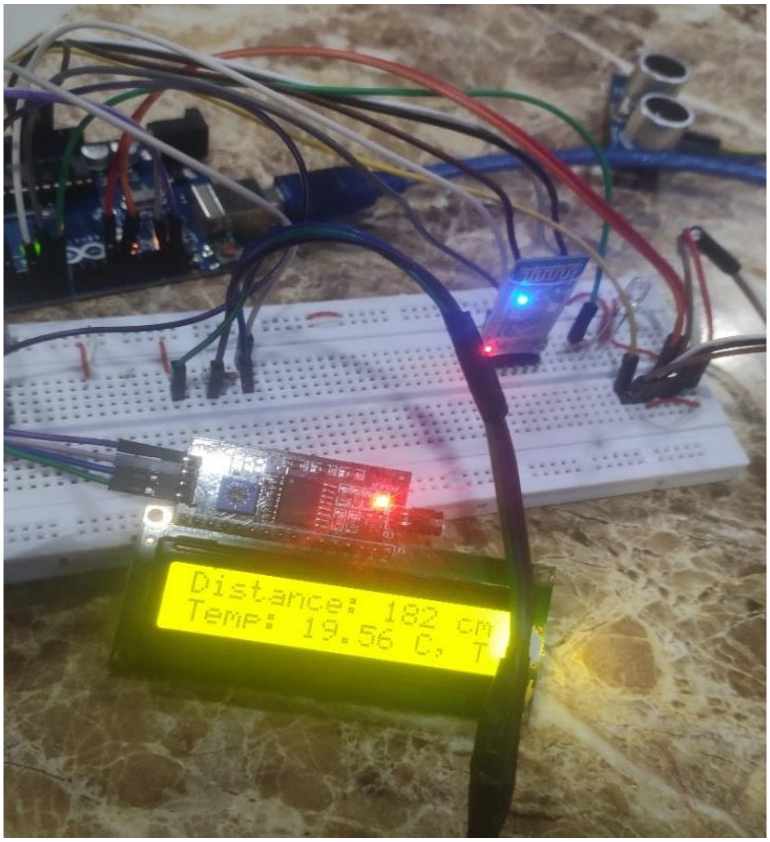


Figure 23 Displaying in the LCD

Now, to supply power to the system independently, a 9V battery was employed, as shown below. This battery served as a standalone power source, ensuring the uninterrupted functionality of the entire system.

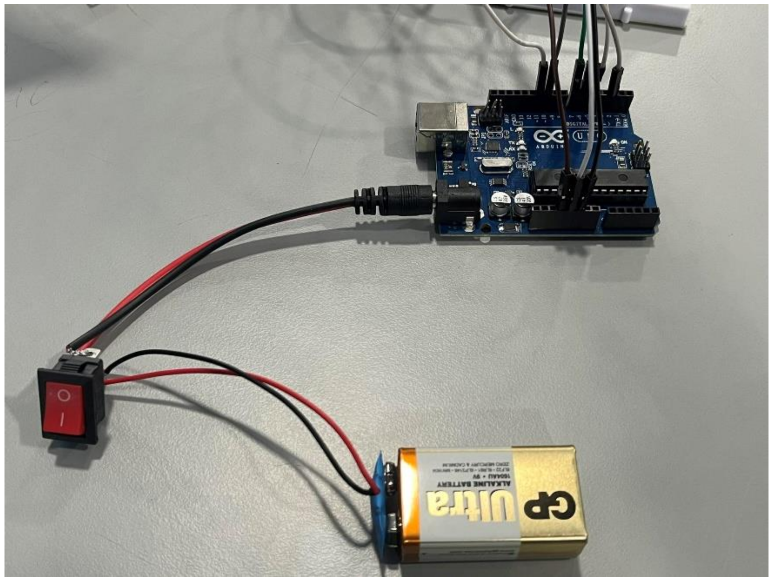


Figure 24 Adding Battery in Arduino.

Hence, the whole project was patiently put together, including the Arduino Uno, a number of sensors, an LCD screen, a Bluetooth module, and a 9V battery to power everything. The development process has come to a completion with this thorough integration, producing an integrated and useful “Aquarium Water Monitoring System.”

5. Results and Findings

5.1 Results

Our project's completion has provided valuable knowledge into the workings of our aquarium water quality monitoring system. By combining multiple sensors, including as turbidity and temperature sensors, we have carefully tracked and analysed critical factors that affect the health of aquatic organisms. This section clarifies the specifics regarding the aquarium environment by providing a thorough summary of the findings from the collected data. Various test cases are presented in this section to demonstrate the project’s completeness.

Our results contribute to our understanding of the conditions inside the aquarium and serve as a basis for educated decision-making in the maintenance of optimal water quality.

5.2 Findings:

Below are the findings for the project.

Test 1

Test No.	1
Objective	To successfully execute the code in the Arduino UNO
Action	Compile and upload the code for Arduino uno.
Expected Result	The code would be successfully compiled with no errors.
Actual Result	The code was executed successfully compiled with no error.
Conclusion	Test was Successfully.

Table 1: Test 1.

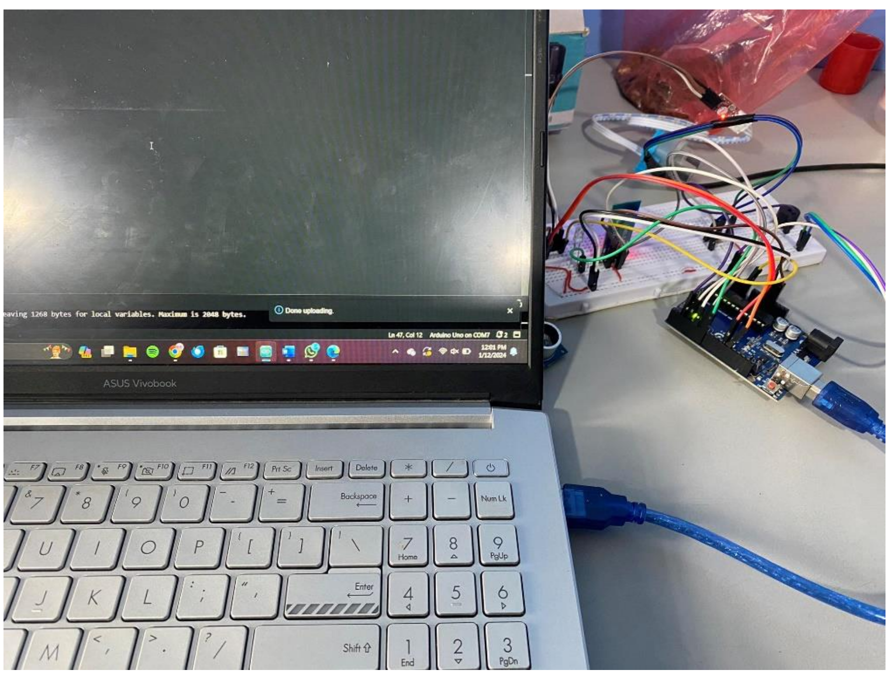


Figure 25: Uploading code.

Test 2

Test No.	2
Objective	To test the turbidity sensors and display the turbidity of water.
Action	The turbidity sensor was placed in the water (up till 80% of the sensor).
Expected Result	The turbidity sensor should display the turbidity of water in the display it in the serial monitor.
Actual Result	The turbidity of water was shown.
Conclusion	Test was Successful.

Table 2: Test 2.

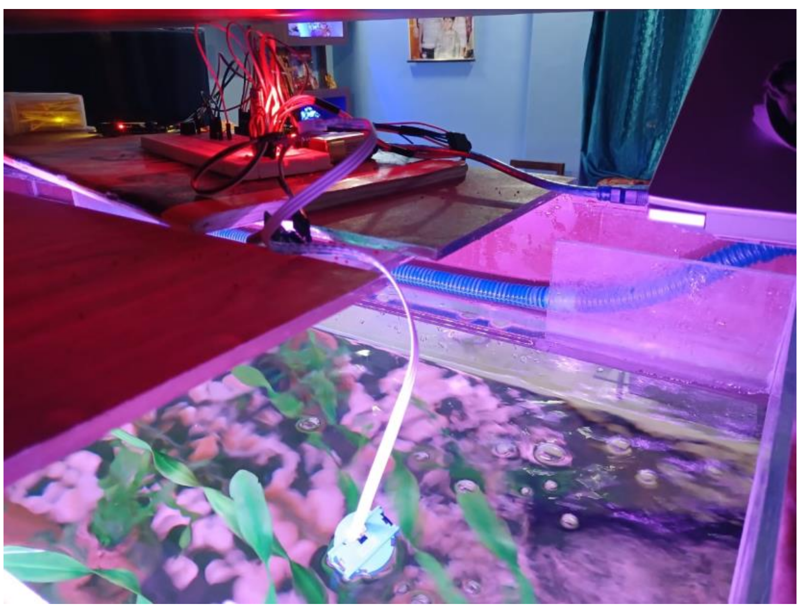


Figure 26: Test 2: Turbidity testing.

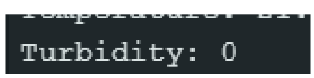


Figure 27: Test 2 Result.

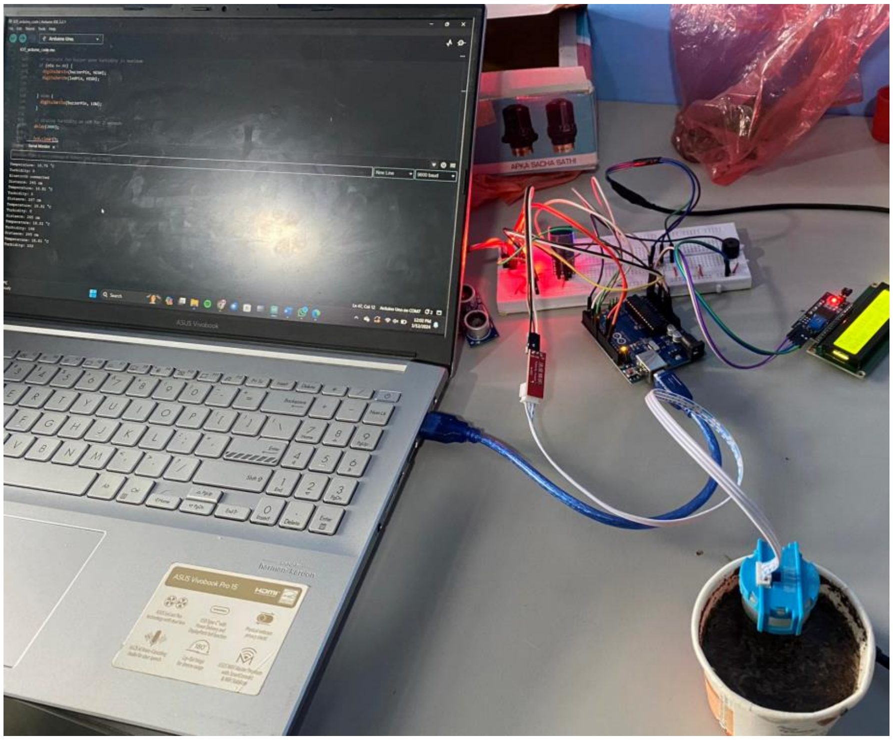


Figure 28 checking turbidity in dirty water.

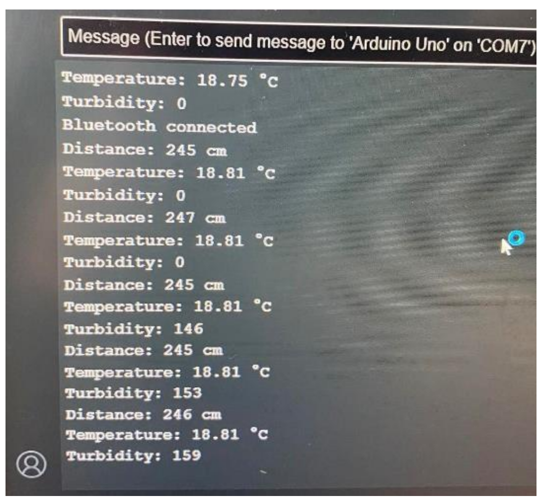


Figure 29 Turbidity value Increasing.

Test 3

Test No.	3
Objective	To test the temperature and ultrasonic sensor.
Action	Measure the water's temperature and height level.
Expected Result	The temperature and height of the water should be shown in the serial monitor.
Actual Result	The temperature and height of the water are showed.
Conclusion	Test was Successful.

Table 3: Test 3.

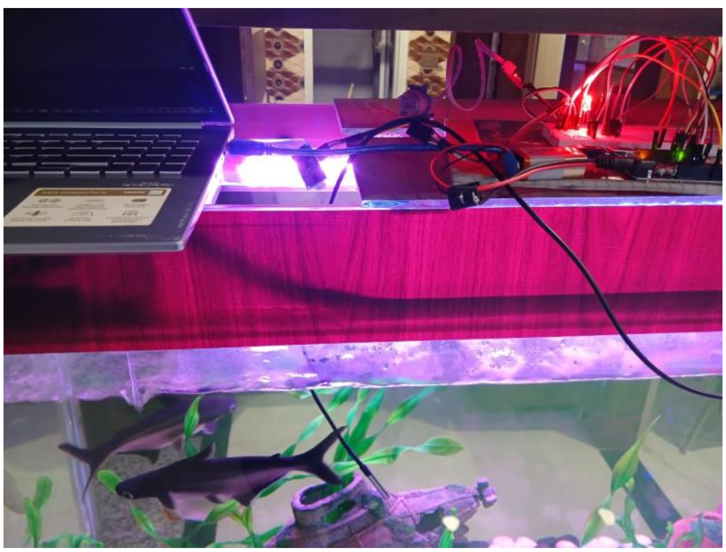
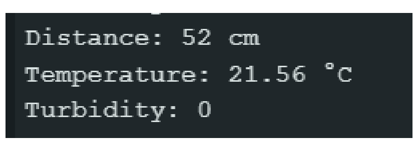


Figure 30: Test 3: Temperature and Height testing.



```
Distance: 52 cm
Temperature: 21.56 °C
Turbidity: 0
```

Figure 31: Test 3 Result.

Test 4

Test No.	4
Objective	To successfully display all the sensors value in the lcd display.
Action	Connect all the sensors with the help of Arduino and connect the Arduino to lcd display.
Expected Result	The sensors value is displayed in the lcd display and serial monitor.
Actual Result	The sensors values are displayed in the lcd display and serial monitor.
Conclusion	Test was successful.

Table 4: Test 4.

Figure 32: Test 4 displaying all sensor value in LCD.

Figure 33: Test 4 result.

Test 5

Test No.	5
Objective	To successfully display all the sensors value with the help of bluetooth module.
Action	Connect the Bluetooth module with the ArduTooth app via Bluetooth.
Expected Result	The sensors value is displayed in the mobile phone via Bluetooth
Actual Result	The sensors values are displayed in the lcd display and serial monitor.
Conclusion	Test was successful.

Table 5 : Test 5

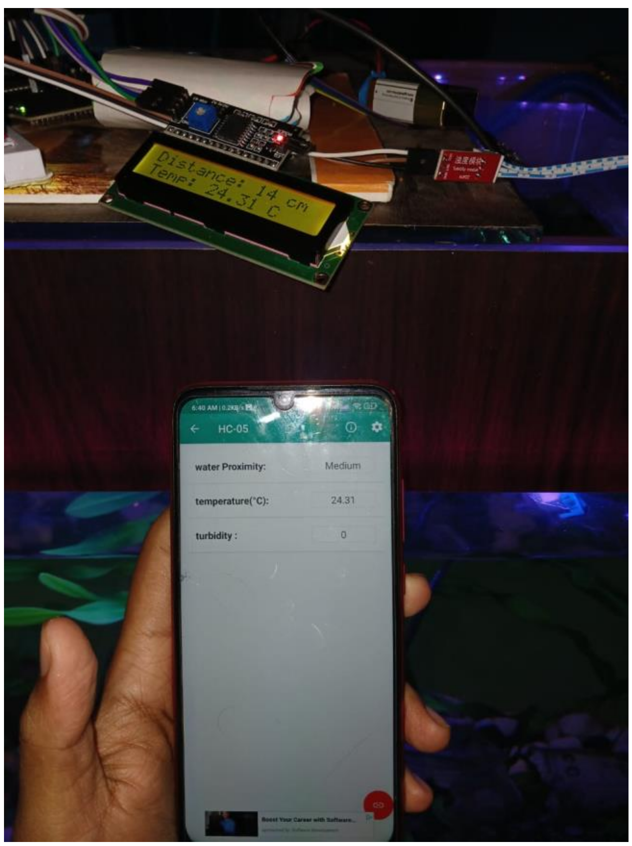


Figure 34: Test 5 Final results.

6. Future Works

A project's future work section describes potential directions for growth and expansion. The potential further development for the Aquarium Water Monitoring system is tremendous. To improve the precision of the system, further work for this aquarium water quality monitoring project may involve integrating advanced sensors for ions or microbial contaminants. pH Sensor, Dissolved Oxygen sensor could be used in the future to check the pH value and dissolved Oxygen rate inside the Aquarium. NH_3/NH_4^+ Sensors can also be used to measure the nitrogen value of the water.

A mobile app interface might be improved for clear data visualisation and remote-control features, and smart water quality control systems might automate changes to lighting, aeration, and filtration based on real-time sensor data. The project's accessibility, usability, and general efficacy in promoting healthy aquarium ecosystems can be further improved by incorporating user feedback, using iterative design techniques, and connecting it with home automation systems.

7. Conclusion

In conclusion, the development of the "Aquarium Water Monitoring System" has been an exhausting journey from concept to realization. We've developed a reliable and user-friendly system for aquarium enthusiasts using the HC-05 Bluetooth module, an Arduino Uno microprocessor, and other latest sensor technologies. The system is an invaluable resource for maintaining the health and well-being of aquatic life as well as being an accomplishment of technical intellect. It is capable of monitoring temperature and water levels. Each part, such as the LCD display, ultrasonic sensor, and temperature sensor DS18B20, has been connected and tested to create a became one and effective monitoring system. With the help of the user interface and Bluetooth connectivity, users can easily obtain real-time data, which promotes engagement and well-informed decision-making.

8. Limitation of the project

- The turbidity of water may be shown only if the water is too much dirty.
- The turbidity sensor only measures the haziness of water so sand particles.

References

Animal city. (2024, 01 05). Retrieved from Solving water quality issues: https://animalcityinc.com/blog/63327/solving-water-quality-issues-in-your-aquarium

java T point. (2024). Retrieved from https://www.javatpoint.com/arduino-uno: https://www.javatpoint.com/arduino-uno

Simplilearn. (2023, 01 10). *simplilearn*. Retrieved from simplilearn: https://www.simplilearn.com/what-is-requirement-analysis-article

9. Appendix

I.

1/12/24, 12:05 PM IOT-coursework_Documentation..docx

Originality report

COURSE NAME
Cloud Computing and IoT

STUDENT NAME
JAMES SHRESTHA

FILE NAME
IOT-coursework_Documentation..docx

REPORT CREATED
Jan 12, 2024

Summary

Flagged passages	3	2%
Cited/quoted passages	0	0%

Web matches

studypool.com	1	1%
dubai-sensor.com	1	0.3%
k15t.com	1	0.2%

1 of 3 passages
Student passage FLAGGED

I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I...

Top web match

CU6051NI Artificial Intelligence Module Code & Module Title CU6051NI - Artificial Intelligence Assessment Weightage & Type 20% Individual Coursework Year and Semester 2020-21 Autumn Student Name:...

SOLUTION: Module code module title - Studypool https://www.studypool.com/documents/3994685/module-code-module-title

2 of 3 passages
Student passage FLAGGED

No table of figures entries found.

https://classroom.google.com/g/sr/NjI3OTYwMjczNDgx/NjUzODg3MjcxMzA0/170qmTmNYTYrAgx7SYrz8LW0CMqHkjka1 1/2

Top web match

Add a Table of Figures ... Within the Word template it will now display, **No table of figures entries found**. Don't worry – this is because there aren't yet any ...

Creating a Table of Figures - K15t – Help Center https://help.k15t.com/scroll-word-exporter/5.12/cloud/creating-a-table-of-figures

---

3 of 3 passages

Student passage FLAGGED

…water level, providing useful information for monitoring and maintenance. **An ultrasonic sensor works by** producing ultrasonic **waves and measuring the time it takes for the waves to**

Top web match

An ultrasonic sensor works by emitting high-frequency sound **waves and measuring the time it takes for the** sound **waves to** bounce back from an ...

Ultrasonic Sensors: Harnessing the Power of Sound Waves for ... https://www.dubai-sensor.com/blog/ultrasonic-sensors-harnessing-the-power-of-sound-waves-for-accurate-detection-and-measurement/

II.

Code for Arduino

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include <SoftwareSerial.h>

LiquidCrystal_I2C lcd(0x27, 16, 2);  // I2C address 0x27, 16 columns, 2 rows

const int trigPin = 11;
const int echoPin = 12;
const int buzzerPin = 2;
const int ledPin = 7;
#define sensor_pin A0
const int turbidityPin = A0;  // Analog pin for turbidity sensor

int read_ADC;
int ntu;

// DS18B20 temperature sensor setup
OneWire oneWire(3);  // Connect DS18B20 data pin to digital pin 9
DallasTemperature sensors(&oneWire);

// Bluetooth module setup
SoftwareSerial bluetooth(6, 5); // RX, TX pins for Bluetooth (connect TX of HC-05 to pin 5, RX to pin 6)

void setup() {
  Serial.begin(9600);
```

```
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(buzzerPin, OUTPUT);
  pinMode(ledPin, OUTPUT);
  pinMode(sensor_pin, INPUT);

  // DS18B20 temperature sensor setup
  sensors.begin();

  // Bluetooth module setup
  bluetooth.begin(9600);
  Serial.println("Bluetooth connected");

  // LCD display setup
  lcd.init();       // Initialize the LCD
  lcd.backlight();   // Turn on the backlight
  lcd.setCursor(0, 0);
  lcd.print("Project");
  lcd.setCursor(1, 0);
  lcd.print("Group I");
  delay(2000);
  lcd.clear();
}

void loop() {
  // Trigger the ultrasonic sensor
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
```

```
digitalWrite(trigPin, LOW);

// Measure the echo duration
long duration = pulseIn(echoPin, HIGH);

// Calculate distance in centimeters
int distance = duration * 0.034 / 2;

// Print the distance to the Serial Monitor
Serial.print("Distance: ");
Serial.print(distance);
Serial.println(" cm");

// Check the distance and perform actions accordingly
if (distance < 10) {
  // If the distance is less than 10 cm, close proximity
  digitalWrite(buzzerPin, HIGH);
  digitalWrite(ledPin, HIGH);
  bluetooth.print("Close,");
} else if (distance >= 10 && distance < 30) {
  // If the distance is between 10 and 30 cm, medium proximity
  digitalWrite(buzzerPin, LOW);
  digitalWrite(ledPin, LOW);
  bluetooth.print("Medium,");
} else {
  // If the distance is 30 cm or more, far proximity
  digitalWrite(buzzerPin, LOW);
  digitalWrite(ledPin, HIGH);
  bluetooth.print("Far,");
}
```

```
// Read temperature from DS18B20 sensor
sensors.requestTemperatures();
float temperatureCelsius = sensors.getTempCByIndex(0);
Serial.print("Temperature: ");
Serial.print(temperatureCelsius);
Serial.println(" °C");

// Send temperature data over Bluetooth
bluetooth.print(temperatureCelsius);
bluetooth.print(",");

// Read turbidity from sensor
int read_ADC = analogRead(turbidityPin);
if (read_ADC > 208) read_ADC = 208;
int ntu = map(read_ADC, 0, 208, 300, 0);

// Print turbidity to Serial Monitor
Serial.print("Turbidity: ");
Serial.println(ntu);

lcd.setCursor(0, 0);
lcd.print("Turbidity: ");
lcd.print(ntu);
lcd.print("     l");
lcd.setCursor(0, 1);//set cursor (column by row) indexing from 0

if (ntu < 10)
  lcd.print("Water Very Clean");
else if (ntu >= 10 && ntu < 80)
```

```
  lcd.print("Water Norm Clean");
else
  lcd.print("Water Very Dirty");

// Activate the buzzer when turbidity is maximum
if (ntu >= 80) {
  digitalWrite(buzzerPin, HIGH);
  digitalWrite(ledPin, HIGH);



} else {
  digitalWrite(buzzerPin, LOW);
}

// Display turbidity on LCD for 2 seconds
delay(2000);

lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Distance: ");
lcd.print(distance);
lcd.print(" cm");

lcd.setCursor(0, 1);
lcd.print("Temp: ");
lcd.print(temperatureCelsius);
lcd.print(" C");

// Send turbidity data over Bluetooth
bluetooth.print(ntu);
```

```
  bluetooth.print(";");

  // Delay before the next measurement
  delay(2000);
}
```