



**An-Najah National University**

Faculty of Engineering and Information Technology

Computer Engineering Department

Graduation Project 2

## **FISH-TECH**



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# Disclaimer Statement

This report was written by a team consisting of two students at An-Najah National University, Department of Computer Engineering, Jaber Darawsheh and Mahmoud Barmawi. We continue our studies at An-Najah National University. The authors acknowledge full responsibility for any errors identified within. The ideas, suggestions, findings, and opinions expressed in this paper solely belong to the authors and do not reflect the viewpoint of An-Najah National University.

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# Chapter 1

## Abstract

The FISH-TECH project is the design and development of a smart fish tank that helps improve fish care inside the tank and aims to provide a safe, healthy, and comfortable aquatic life for the fish through continuous inspection and monitoring throughout the day to work to reduce problems and errors as much as possible, using a set of sensitive and effective sensors.

The sensors are part of a collaborative model group for water quality monitoring and assessment. This is done to inform the controller when an abnormal condition has been sensed in the water so it can act accordingly and keep a healthy and safe environment for fish. Such sensors consist of a temperature sensor, a water pH sensor, and a water tank level.

To offer the fish a healthy environment, we developed this water filtration system that operates continuously in order to clean and enhance the water. In this aquarium, There are bubbles generated inside the water by the air and oxygen generation system in advance automatically, for fish respiration.

An automatic feeding system works to provide the fish with food every specific period of time. An automatic filling and drainage system according to the condition of the water inside the tank, to ensure its cleanliness and health.

The smart aquarium is controlled by the Arduino board. A mobile application has been provided for smart aquarium users, making it easier for them to track and monitor the fish tank.

# Chapter 2

## Introduction

### 2.1 Statement of the problem

Many people own aquariums, whether in their homes or elsewhere. The process of maintaining a healthy environment inside the aquarium is difficult and necessary for aquarium owners in terms of constantly monitoring water quality, feeding times, and supplying fish with oxygen. Traditional methods often take a long time to do this and expose it to human error, which negatively affects the health of fish. The project aims to solve these problems and risks, which ensures a safe and healthy life for fish and reduces the effort on the owner.

### 2.2 Objectives of the work

Designing and developing a smart aquarium to make it easier for the owner of the fish, which provides a safe and healthy life for fish. an aquarium that takes care of temperature, acidity, and solids dissolved in water and is designed to removing impurities from the water regularly and feeding fish according to certain times. Traditional methods can be more difficult in terms of scheduling, cleaning, and knowing the state of the water inside the aquarium.

### 2.3 Scope of the work

The scope of this project includes the design, development, and implementation of a fish tank where the amount of water inside the aquarium is maintained by monitoring the existing water level according to the size of the aquarium.

In addition to the cleaning system to get rid of any impurities or plankton, provide the water in which the fish are present with a sufficient amount of oxygen, and feed the fish through an arm that spray food according to certain time intervals. It also contains sensors to monitor the quality and condition of water and ensure that it is renewed as needed. Then develop an app to allow the owner to track the status of the aquarium. A schedule was made for the compatibility between the parts of the aquarium.

## 2.4 Significance of our work

The development of a fish care tank is an important initiative that can provide many benefits to humans. It will enable the owner of these fish to deal with them in a planned and organized manner in terms of time, water quality, and food. In addition, the aquarium will keep the water clean of any impurities and will also be monitored. Store the amount of food and the substance of increasing acidity in the event that the acidity of the water falls below the normal limit and send it to the application so that the owner of the fish can be able to fill it. This facilitates dealing with fish in a way that maintains a safe and healthy life, especially since traditional methods may cause some problems such as not maintaining the water level inside the aquarium, maintaining its quality, maintaining fish feeding times, or even cleaning water.

## 2.5 Organization of the report

There are several sections to this report. This section gives a brief view of the project points to be covered in this project. The section afterwards describes the substance and boundaries of this research. After that, the third part presents our approach and methodology and provides you some steps on how to execute this project. The fourth part presents the results (and findings), including any problems encountered while thwarting them. The fifth section explores the importance and possible effects of this project. At last, the conclusion presents a recap of what has been discussed in addition to providing recommendations for other projects. The appendices have a number of select additional resources that provide lists and some detailed information about the project.

## Chapter 3

# Constraints, Standards/Codes and Earlier course work

### 3.1 Constraints and limitations

1. **Time limitation:** We faced big challenges while finishing this project in the summer term, as it was our first time building a complete big system with many mechanical and electronic parts we hadn't worked with before. These parts needed a lot of power and different voltage levels (3.3 V, 5 V, 12 V, 240 V). We had to figure out the overall system structure, pick the right parts, and learn how to use them. We also had to get familiar with Arduino and write code for the hardware, then put together the whole system.
2. **Project Size and Weight:** Due to the relatively large scale of the design, we encountered an issue of not being able to transport it and carry out the work elsewhere apart from the university. After installing most of the mechanical components in their respective positions, our main work was scheduled during specific hours, including university working hours, which caused some delays in our progress to some extent.
3. **Safety and Security:** Due to the project's concept, we were compelled to utilize water as a fundamental element in representing the project. Additionally, mechanical and electrical components were employed that only operate at a voltage of 220. Therefore, testing the project, given its inclusion of potent liquids and electricity, was a delicate matter that required precision and attention.
4. **Precision and Attention:** Our project includes various processes such as water heating at low water temperature inside the aquarium, purification of water from impurities, supply of the aquarium with the necessary oxygen, fish feeding system, and accurate process calibration of many mechanical components. Such accuracy is necessary for its proper functioning due to the great variety of components used. In addition, we crafted the design of the project by hand using wooden and plastic pieces. The project is designed with precision, safety, and skill.

5. Power Distribution:As we talked about earlier, this is the first time we've taken on such a big project. This led to a problem with powering all the parts we're using to build it. These parts need different amounts of electricity and voltage. For example, we employed three valves that operate at 12 volts and six pumps that also operate at the same voltage: sensors operate at 5 volt , oxygen pump operate at 240 volt , and peltier operates at 12 volt However, the amount of current drawn was substantial and insufficiently supplied by the power source. It's worth noting that we also incorporated components with varying voltage levels. So to solve the problem, we used a switching control power supply.
6. Limited Resources: This project concerns fish owners, which are currently a small category, and most of them adopt traditional methods of fish farming and avoid the use of smart fish ponds, and therefore we faced challenges in accessing sources that adopt modern methods of raising fish in a modern and sophisticated way.

## 3.2 Standards and Codes

A developed Arduino program is one of the software components of the project. Numerous libraries and functions are integrated into this application, including Servo.h, Arduino.h, GravityTDS.h, Keypad.h, LiquidCrystalI2C.h, wire.h, OneWire.h, DallasTemperature.h, and SPI.h. Furthermore, web platform was used in the creation of the UI. Standards and recommendations relevant to the industry were followed in the design and implementation of the system's software components.

## 3.3 Earlier coursework

Enrolling in the Microcontroller Using PIC Controller course was really beneficial since it enhanced our understanding of microcontroller programming, which was essential for designing our contraption that used an Arduino Mega.

We learned how to use tools like I2C for LCDs and interact with different components. We were able to efficiently construct the code for the aquarium, which contained the necessary algorithm. In order to build the aquarium, it was also important for us to take an Arduino course because it gave us the abilities to operate with the Arduino Mega board. The course provided us with practical training in programming and debugging the Arduino board, which was essential for creating the control system.

Also, one of the most important things that helped us to think correctly to build the project is the course of critical thinking and research skills, which helped us in the process of discovering problems and solving them at the lowest costs. And also some important courses, such as the design of digital electronic circuits, which enabled us to distribute the appropriate voltage to the electronic parts that make up the project.

## Chapter 4

# Literature Review

In previous studies about smart aquarium systems, an extensive analysis has been conducted on the IoT aspect to include remote monitoring and control within the aquariums. Two research papers have been conducted that provide useful information and valuable insights in this area. They are “Smart Aquarium: An IoT-based System for Remote Monitoring and Control” (Khan et al., 2019) and “Automatic Fish Feeder and Aquarium Water Level Monitoring via Telegram” (Dewantara et al., 2023). The authors explain how different types of sensors and actors including temperature, pH, and automatic feeding systems are used to provide and maintain precise conditions to support life in the water. They also propose a user-friendly mobile application to interact with the aquarium components in case of its remote location. Dewantara’s research paper focused on the automation of fish feeding and water level monitoring in aquariums by leveraging Telegram. By integrating a fish feeder with a Telegram-based monitoring system, the authors have presented a system that provides real-time tracking and convenience for aquarium lovers.

# Chapter 5

## Methodology

The hardware components utilized to construct the system, their connections, and the overall system design will all be covered in this chapter. We will also go through how the system functions, as well as how the software and mobile app.

### 5.1 Hardware Components

#### 5.1.1 Microcontrollers

1. Arduino Mega 2560

The Arduino Mega stands as a microcontroller platform established upon the ATmega2560. It encompasses 54 pins designed for both receiving and transmitting digital signals, (with 14 of these capable of serving as outputs for pulse-width modulation). Moreover, it integrates 16 analog inputs, boasts 256k of Flash Memory, and accommodates 4 UARTs for hardware-based serial communication, houses a 16 MHz crystal oscillator, features a USB link, and incorporates a power jack, incorporates an ICSP header, and incorporates a reset button. The Mega 2560 R3 version introduces further enhancements, such as the inclusion of SDA and SCL pins positioned adjacent to the AREF pin. Furthermore, two novel pins have been introduced near the RESET pin. One of these is labeled IOREF and serves to enable shields to adjust their voltage requirements in accordance with the board. The second pin remains unconnected and has been reserved for prospective applications. The Mega 2560 R3 is fully compatible with all existing shields while also being adaptable to upcoming shields designed to make use of these supplementary pins.

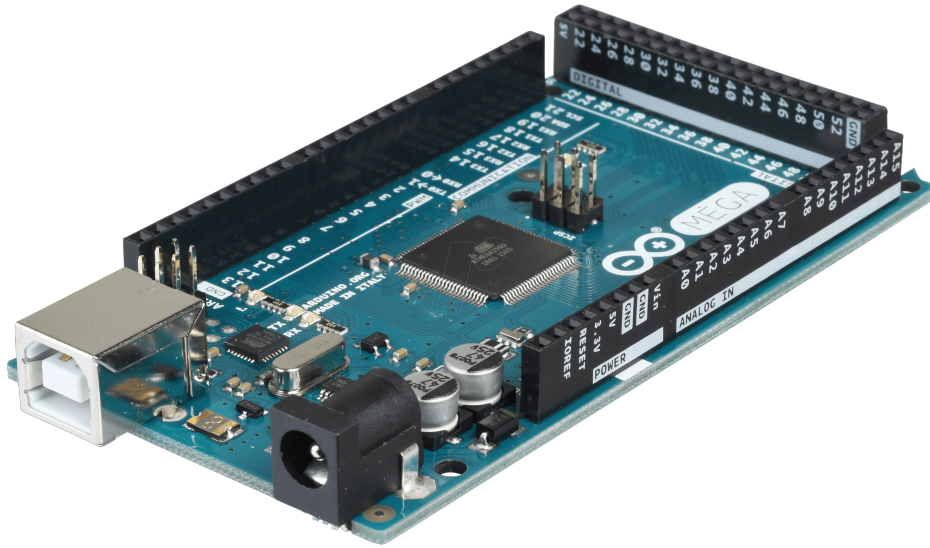


Figure 5.1: Arduino Mega2560.

## 2. WiFi ESPWROOM 32

Within the project, a connection was established between microcontroller ESP and Arduino Mega, through that we built a mobile application to help and facilitate the owner of the aquarium to access the aquarium and monitor the state of the water and lighting.

The ESP-WROOM-32 is a multipurpose and influential Wi-Fi and Bluetooth module established by Espressif Systems. It contains a dual-core ESP32 microcontroller that can burn up to 240 MHz and yield robust performance for multiple applications. This module receives both Wi-Fi (802.11 b/g/n) and Bluetooth (classic and BLE) signals besides, so, it's the most suitable for IoT projects as well as wireless communication tasks. Its tremendous GPIOs, ADCs, DACs, and in-built multichannel serial port (I2S) interface along with support for different communication protocols make these devices very flexible for developers. The ESP-WROOM-32 is well-suited for popular development designs like the Arduino IDE and ESP-IDF, which facilitate the transformation of the creation to deployment of applications. With its low power consumption and high processing power, it is a very good choice for both battery-powered and main-powered projects.



Figure 5.2: WiFi ESP.

### 5.1.2 Water Pumps and Valves

- Water Pumps

Six water pumps each operating at 12 volts, were used. The first pump is for pumping water from the water tank to aquarium, the second is for filling the filter container and the third pump is for pumping the aside to the aquarium when the water asidcy is abnormal , and the fourth pump is for filling the test container , and the fifth pump is for draining the test container, and lastly the last pump is for darining the fish aquarium for cleaning every two weeks .



Figure 5.3: Water Pump.

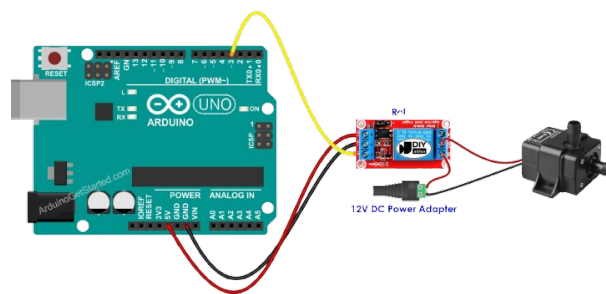


Figure 5.4: Water Pump Connection.

- Valves

Three water valves are used to control the flow of water and prevent its leakage, whether from the aquarium or from any container used.



Figure 5.5: Water Valve.



Figure 5.6: Water Valve connectors.

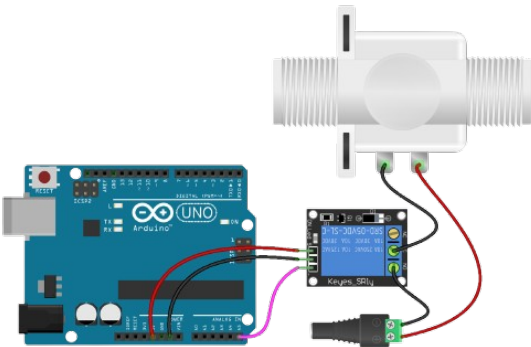


Figure 5.7: Water Valve Connection.

### 5.1.3 Oxygen Pump

We used an oxygen pump to supply the fish with the oxygen needed to sustain their lives.



Figure 5.8: Oxygen Pump.

### 5.1.4 Tank Sensors

- Ultrasonic sensors

We used three of them to check and monitor the water level in the aquarium, tank, and test container.



Figure 5.9: Ultrasonic sensor.

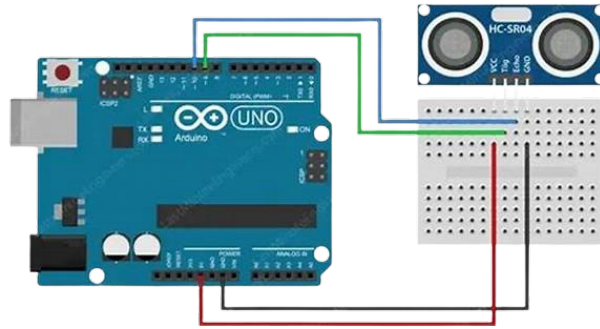


Figure 5.10: Ultrasonic sensor Connection.

- Waterproof 1-Wire DS18B20 Digital temperature sensor

We used a temperature sensor to monitor the temperature of the aquarium every certain period of time to make the appropriate decision according to the sensor's reading.



Figure 5.11: Temperature sensor.

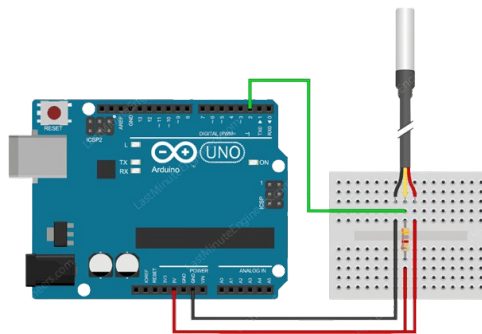


Figure 5.12: Temperature Sensor Connection.

- pH Sensor

Sensor uses acidity to monitor aquarium water, and according to its readers, if it is low, a pump will spray phosphoric acid to increase acidity, and if it is high, it will reduce aquarium water.



Figure 5.13: pH Sensor.

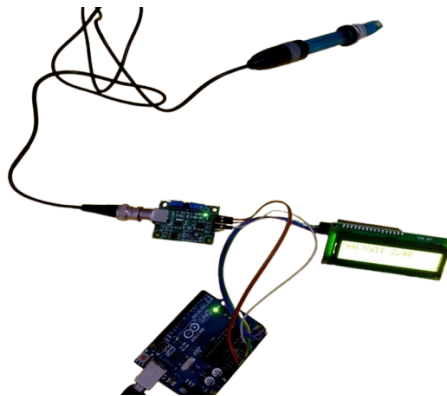


Figure 5.14: pH Sensor connection.

- TDS sensor

We used the percentage of dissolved solids in water to monitor the percentage of decomposition of food residues and fish waste with the length of use, so we change the aquarium water to keep it clean.

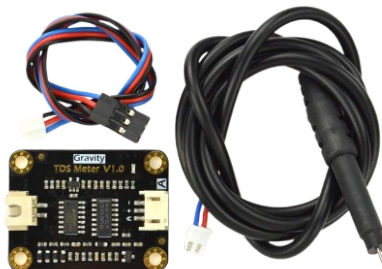


Figure 5.15: TDS Sensor.

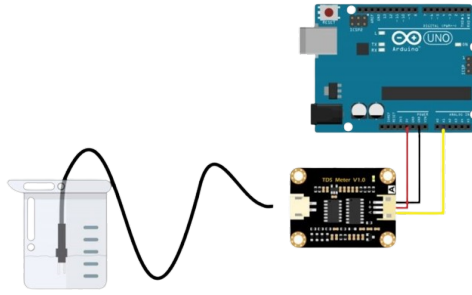


Figure 5.16: TDS Sensor Connection.

- Water Level Sensor

We used water level sensors to monitor pH container for water quality.



Figure 5.17: Water Level Sensor.

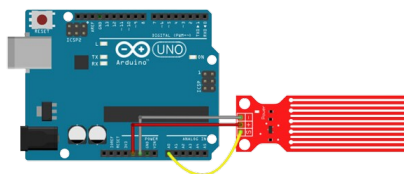


Figure 5.18: Water Level Sensor connection.

### 5.1.5 Input/Output Devices

- LCD 16\*4 with I2C

To display some of the necessary inputs and outputs, such as displaying the things that we have selected from the keypad, displaying the state that the aquarium has reached at this time.



Figure 5.19: LCD 16\*4 With I2C.

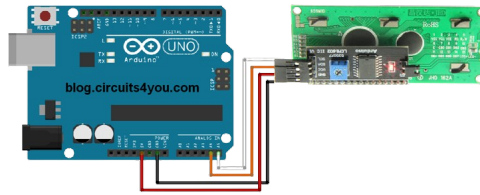


Figure 5.20: LCD 16\*4 With I2C Connection.

- Keypad

The user interface through which he enters commands for manual control of the aquarium in addition to entering the password for the aquarium.

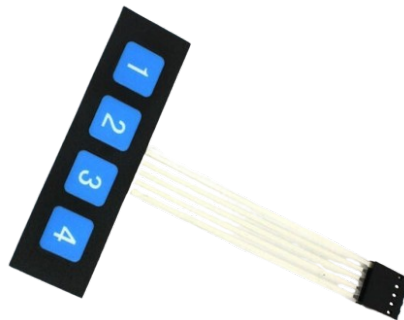


Figure 5.21: 4\*1 Keypad.

- Servo Motor

We used 5-volt servo motor in the fish feeding arm so that it sprays food for the fish from the food container according to a specific time period.



Figure 5.22: Servo Motor.

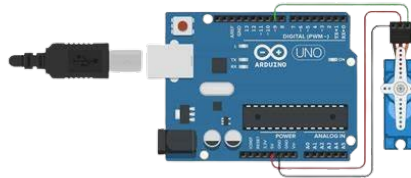


Figure 5.23: Servo Motor Connection.

- LED Strip

We used a 12-volt LED strip to provide the tub with the necessary lighting, which reduces the growth of algae in the aquarium with the long duration of use.



Figure 5.24: LED Strip.

- Peltier

The Peltier cooler side and heater side are used for increasing and decreasing the water temperature. When it connects to power 12 volts from the power supply, one side will be hot and the other side will be cold. We use the heater side to increase the water temperature when the aquarium water decreases.



Figure 5.25: Peltier.

- Relays

Since the Arduino operates on 5-volt, it can't control the 12-volt devices such as the pumps, solenoids, Peltier, and LED strip. But we can use a 5-volt relay to switch the high voltage and use the Arduino to control the relay. We used 11 relays, 6 of them to control the water pumps, one to control the LED strip, and one for Oxygen pump, one for heater, and one for water test container valve, and two channels for the valves filter and drain.

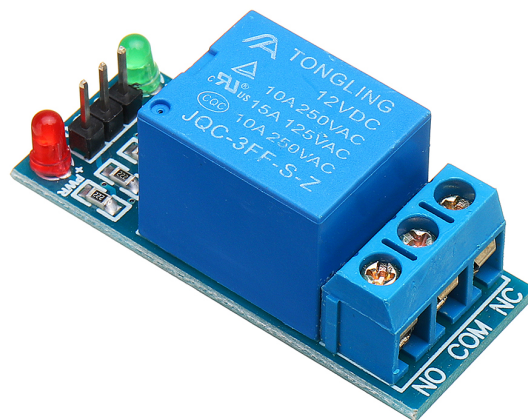


Figure 5.26: 5 volt Relay.

- Water tubes

Various types of it were used, with different sizes and fasteners for their installation.



Figure 5.27: Water tubes.

- Funnel

We used the funnel to fill the tank with clean water.



Figure 5.28: Funnel.

### 5.1.6 Power Devices

- Power supply

We decided to use a computer power supply since it can offer the required 5 volts for numerous devices and 12 volts for pumps, valves, Peltier and LED strips in order to meet the voltage specifications for our project. The power supply also provides a sufficient current output to suit the requirements of our project



Figure 5.29: Power Supply.

- For various connections, we used male-to-male, female-to-female, and male-to-female wires.



Figure 5.30: Electrical Wires.

- Battery base

To supply the servo motor with voltages



Figure 5.31: Battery base.

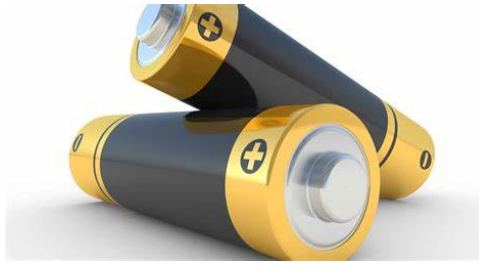


Figure 5.32: 5 volt battery.

## 5.2 Hardware Implementation

### 5.2.1 Water Test Unit

This container includes a group of sensors to monitor and maintain the quality of the aquarium water, and from these sensors the temperature sensor to maintain the temperature of the water at a normal level, so that if the temperature exceeds 34, we empty from 20 to 30 percent of the aquarium and we fill clean water instead, and if it drops below 17, the heater is turned on to heat the water. If the acidity is read low, the phosphoric acid chemical pump is operated to raise the acidity, and if it increases, it is discharged from 20 to 30 percent from the basin and clean water is filled instead, and the percentage of dissolved solids in water resulting from the decomposition of food residues and fish waste is removed, if the percentage rises, it is discharged from 20 to 30 percent from the aquarium, in addition to that, this unit automatically operates in a smart form every half an hour to monitor the state of the water continuously.

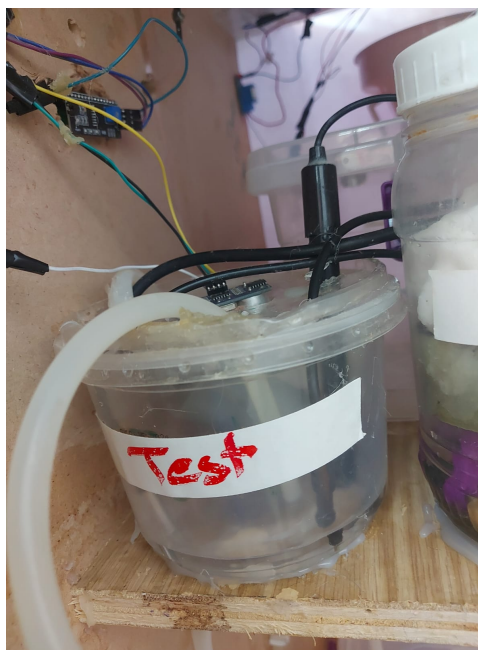


Figure 5.33: Water Test Container.

### 5.2.2 Input-Output Unit

We have the LCD and Keypad to allow the owner of the aquarium to enter his password to enter the aquarium functionality, and also for manual control by entering command Consisting of two digit allowing the user to manually control, In addition, the owner of the aquarium can track the daily status of the aquarium through the mobile application.



Figure 5.34: Input-Output Unit.

### 5.2.3 Mobile Interface

Through the mobile application, the owner of the aquarium can monitor the condition of the aquarium from reading the sensors , aquarium functionality,and the state of the lighting, if it is working or not ,and the percentage of fish food in the container in the case of running out of quantity, so that he can fill it again.

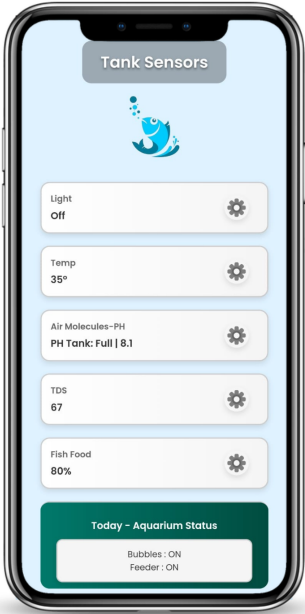


Figure 5.35: Mobile Interface.

### 5.2.4 Water Filter Unit

The filter works automatically every hour to purify the water from impurities, which ensures that the aquarium water remains pure and healthy for the fish.



Figure 5.36: Water Filter Unit.

### 5.2.5 Feeder Arm

Arm that sprays the fish food inside the tank every 6 hours.



Figure 5.37: Fish Feeder Arm.

## Chapter 6

# Results and Discussion

Our goal has been reached and the prototype of the smart aquarium has been designed and built with many sensors installed and we have actively made the aquarium to be smart enough to be monitored and taken care of efficiently. The sensors that we used in this project are pH, temperature and TDS. The results obtained from the sensor readings are displayed on an efficient and easy-to-use mobile application after each water sample is tested, enabling users to understand the condition of the water inside the aquarium and whether it is suitable for fish or not. Based on these values, the system automatically acts in case of any abnormal value or value outside the optimal value. For example, if the temperature is below 17, the water heater is turned on until the water temperature is suitable and at the same time ensures a safe life in the aquarium for fish. our smart aquarium system has changed the traditional way of aquarium into smart way that can monitor and maintain instantly and persistently, bringing you, as a user, long term convenience and enhance the living environment of aquatic organism.

# Chapter 7

## Conclusion and Recommendation

### 7.1 Conclusion

Several problems are solved by automation and remote monitoring because they require much less effort to manage an aquarium and allows access to important data at any time. This approach of integrating different hardware and software facilities affords a total and user-friendly system for smart aquariums which improves both the quality of life of the aquatic organisms. Adherence to coding standards helps to make the application's reliable and maintainable to use it in the distant future and expand it to new levels as high as possible.

### 7.2 Summary

On this note, our smart aquarium system has successfully demonstrated the feasibility of automation and control within aquariums. We have created different technologies and have made a lot of progress in the creation of a user-friendly efficient system. Automation aspects such as water changes, feeding times, and light control have proven to be efficient ways of minimizing the effort required while ensuring that the best conditions for the aquatic organisms are maintained.

### 7.3 Recommendations

1. Enhanced water quality monitoring: Using new sensors and technology to comprehensively improve water parameter analysis.
2. Backup Power Source: Add a side power source, such as a UPS, to keep the aquarium running during a power outage. This helps us maintain a stable environment for aquatic life and prevent any interruptions to the smart aquarium system.
3. Simplify wiring and connections: Use organized wiring to make setting up and maintaining your tank easier in the future. This reduces the chance of errors and makes it easier for us to troubleshoot quickly and with less effort.

## 7.4 What we have learned

1. **Hardware and Software Integration:** We managed to connect and synchronize various kinds of hardware devices with other types of software applications. This made improved our ability to diagnose and fix problems that are related to integration of hardware and software.
2. **Project Management and Time Allocation:** We realized how effective project management skills, especially in relation to time and tasks, are for a given project. This helped in understanding how to schedule and also control our resources so as to finish our projects on time.
3. **Team Collaboration and Communication:** Last but not least, this project also gets to emphasize the aspect of communication and cooperation within a group of people. Scheduler, reporting and role assignment were important aspects that enabled us to complete our project.

## 7.5 Future work

1. Use camera to monitor smart aquarium.
2. Develop mobile app to allow user to control aquarium.
3. Use more sensors to ensure aquarium water quality.

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