Automatic Aerator System (AquaDox)

Project Exhibition-1

Submitted in partial fulfillment for the award of the degree of

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Submitted to

VIT BHOPAL UNIVERSITY (M.P)

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CANDIDATE'S DECLARATION

I hereby declare that the Dissertation entitled **"Automatic Aerator System"** is my own work conducted under the supervision of Dr.PR Buvaneswari , at VIT University, Bhopal. I further declare that to the best of my knowledge this report does not contain any part of work that has been submitted for the award of any degree either in this university or in another university / Deemed University without proper citation.

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Date: 19-12-2024

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CERTIFICATE

This is to certify that the work embodied in this Project Exhibition -1 report entitled **“Automatic Aerator System”** has been satisfactorily completed by **Ms. Konduri Sarala Florence, Shivaraman T, Ankita Soni. Registration No**. **23BAC10007, 23BAC10009, 23BAC10032** in the School of Electrical & Electronics Engineering of Electronics and Communication Specialization in AI & Cybernetics at VIT University, Bhopal. This work is a bonafide piece of work, carried out under my/our guidance in the School of Electrical and Electronics Engineering for the partial fulfilment of the degree of Bachelor of Technology.

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Executive Summary

The Automatic Aerator System with Bluetooth Control is an eco-friendly solution for enhancing aquaculture. Powered by a battery, it boosts dissolved oxygen levels to improve water quality, ensuring healthier aquatic environments. The system's Bluetooth connectivity allows users to remotely control and monitor operations via a mobile app, enabling adjustments to settings and scheduling of aeration times. This innovative design reduces reliance on electricity, promotes sustainability, and supports energy-efficient aquaculture practices. By combining convenience with environmental benefits, the project addresses critical challenges in aquaculture while advancing modern, sustainable technology for water management and aquatic ecosystem health.

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List of Symbols & Abbreviations

AquaDox - Automatic Aerator System measuring Dissolved Oxygen level, temperature and pH of water for Aquatic organisms in Aquarium.

Note: All Abbreviations and symbols that appear in the report should be listed alphabetically. First give all roman symbols, then Greek symbols. Order: ASCII ordering, to the extent possible. Subscripts and superscripts should be listed separately if these are not an intrinsic part of the variable name.

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Introduction

Aquaculture plays a critical role in supporting global food security and providing livelihoods. However, a key challenge in aquaculture is maintaining optimal water quality, especially the levels of dissolved oxygen (DO), which is essential for the survival and growth of aquatic organisms. Insufficient DO can lead to stress, poor growth, or mortality, making aeration systems indispensable in aquaculture management. Traditional aeration systems, while effective, often rely on electricity and manual operations, leading to high energy consumption and limited flexibility. This calls for a sustainable, energy-efficient, and smart solution to address these challenges.

The *Automatic Aerator System with Bluetooth Control* aims to address these issues by integrating eco-friendly practices with advanced technology. The system is designed to operate on battery power, reducing dependency on conventional energy sources. Its Bluetooth-enabled control feature allows aquaculture practitioners to monitor and manage the aeration process remotely through a mobile application, offering convenience and flexibility. This project combines sustainability with innovation, contributing to the development of healthier and more efficient aquatic environments.

The objective of this project is to design and develop a battery-powered aeration system that enhances dissolved oxygen levels in aquaculture ponds. By integrating Bluetooth connectivity, the system enables remote monitoring and control, allowing users to adjust aeration settings and schedule operations seamlessly. The project aims to promote sustainable aquaculture practices, minimize energy consumption, and ensure healthier aquatic ecosystems.

LITERATURE REVIEW

1) Max Angelo D. Perin Maria Jussel A. Cuaton Apple Joy T. Rapirap. Automated Aerator system for controlling dissolved oxygen and monitoring acidity and temperature in aquatic systems .College of Engineering and Architecture BOHOL ISLAND STATE UNIVERSITY Main Campus, Tagbilaran City, Bohol , Philippines.

Abstract :

The main purpose of this study was to develop and design a system that monitors the pH level and temperature with dissolved oxygen control in an artificial aquatic system. The probes of the sensors in pH, D.O. and temperature were immersed inside the aquatic tank to monitor their values. Using experimental methods in testing the functionality of the different sensors, results show that the system was able to successfully monitor these factors. Information coming from the system such as the pH, dissolve oxygen and temperature readings were then displayed to an android mobile phone the Bluetooth serial module stored and displayed to the system software. To control the levels of dissolved oxygen two valves were attached to the tank. Valve 1 serves as the intake valve and valve 2 as the discharge valve. When the acidity of the water reaches a reading of 6.4 or below the two valves open. Valve 2 flushes out the acidic water out of the tank and valve 1 replaces it with non-acidic water. When the acidity of the water reaches 6.5 up to 9.0, the two valves close which signifies that acidity of water is normal. The study confirmed that a minimum of 3 psi of pressure is needed to operate the valve effectively. The pH reading was used to trigger the valve since most species cannot tolerate acidic water. Results show that by replacing the water, not only the acidity was lowered but the dissolved oxygen content was either maintained or increased.

The research focuses on the need for an automated system to monitor and control water quality, particularly pH, dissolved oxygen, and temperature, in aquatic systems. Manual monitoring is time-consuming and prone to errors, which can lead to suboptimal conditions for aquatic life, affecting their growth and survival. This study aims to address these challenges through automation, ensuring consistent water quality.

The Key parameters include dissolved oxygen (7.0-11.0 mg/L), pH (6.5-9.0 for freshwater and 7.5-8.5 for marine species), and temperature (25-31°C). These values are crucial for maintaining aquatic health. The system uses Arduino Mega 2560, programmed with C#. Sensors include Atlas Scientific Dissolved Oxygen Sensor, DS18B20 Temperature Sensor, and pH sensor. The development environment included Visual Studio for data handling and Android IDE for the mobile app, allowing real-time monitoring and control of water parameters.

The main Advantage is that this Automated control of water quality, cost-effective, and allows remote monitoring via a mobile app. Also Requires training for users and may need more robust components for larger systems. The system is suited for small-to-medium scale applications but may need upgrades for larger tanks.

The system successfully automated monitoring and control of water quality, maintaining ideal conditions across the water bodies. It ensured stable dissolved oxygen, pH and temperature levels. Future enhancements include integrating artificial intelligence for predictive water quality control, scaling the system for larger setups, and improving data processing capabilities by upgrading the microcontroller's memorFuture enhancements include integrating artificial intelligence for predictive water quality control, scaling the system for larger setups, and improving data processing capabilities by upgrading the micro

PROBLEM FORMULATION

Problem formulation in research is the foundational process of clearly defining the issue or question that the study seeks to address. This involves identifying a specific problem, contextualizing it within the existing body of knowledge, and stating clear research questions or objectives. The researcher reviews relevant literature to understand the broader context, ensuring that the chosen problem is both relevant and significant in the field. Articulating the significance of the problem is crucial, as it justifies the need for investigation and outlines potential contributions to knowledge or applications. Additionally, the scope and limitations of the research are defined to set realistic expectations. In cases where applicable, hypotheses may be formulated to predict relationships between variables. A well-crafted problem formulation not only guides the entire research process but also ensures that the study addresses a meaningful issue with clarity, purpose, and a clear understanding of its potential impact on the academic or practical landscape.

Aeration is a critical process in maintaining water quality in various applications, including aquaculture and wastewater treatment. Manual operation of aerators can lead to inefficiencies, such as over-aeration, under-aeration, and unnecessary energy consumption. An automated aerator system addresses these issues by using sensors, controllers, and actuators to monitor and regulate oxygen levels in real-time. The goal is to design a system that ensures optimal oxygen levels, minimizes energy usage, and operates with minimal human intervention. The system should dynamically adapt to environmental changes, such as temperature, pH, and biological oxygen demand, providing a sustainable and cost-effective

METHODOLOGY

The methodology for developing an automated aerator system begins with requirements analysis. This involves identifying the specific application for aquaculture or and determining the critical parameters that need monitoring, such as dissolved oxygen (DO) levels, water temperature, and pH. Additionally, target oxygen levels and operational constraints like energy efficiency and noise levels are defined to guide the system's design. Next, sensor selection and integration are carried out. Suitable sensors for measuring DO, temperature, and pH are chosen based on accuracy, durability, and compatibility with the control system. These sensors are integrated using appropriate communication protocols.

The control system design involves an arduino nano . Smart algorithms are implemented to decide when to activate or deactivate the aerator, maintaining optimal oxygen levels while minimizing energy consumption. Thresholds for operation are set, with provisions for dynamic adjustments based on environmental changes.

BLOCK DIAGRAM

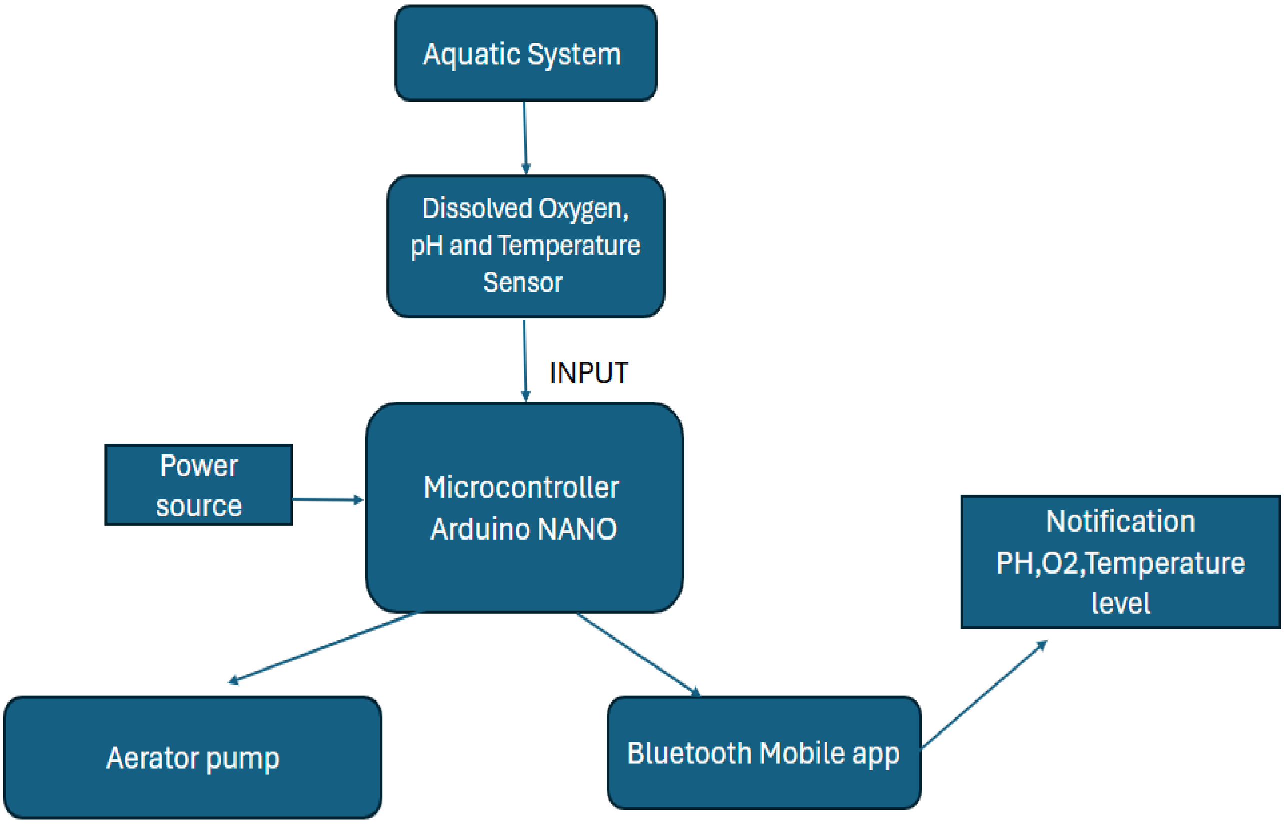

Fig: 2.1.1 Block Diagram

CIRCUIT DIAGRAM

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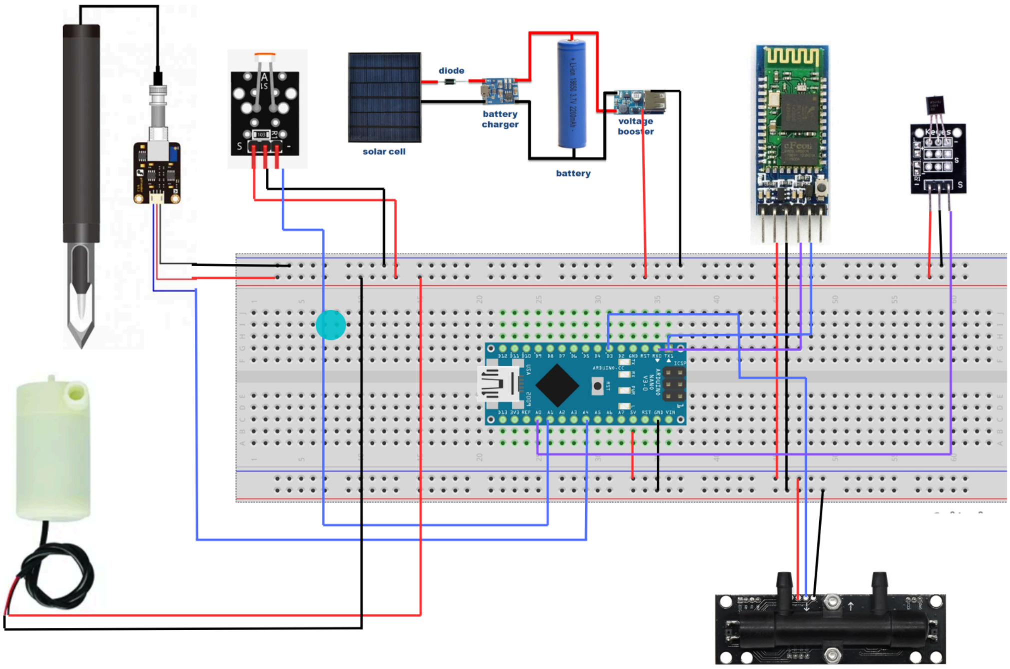


Fig: 2.1.2 Circuit Diagram

COMPONENTS DESCRIPTION

Arduino Nano

The Arduino Nano is a compact microcontroller board based on the ATmega328P, ideal for small projects and prototyping.
Working: It performs tasks based on programmed instructions, interfacing with sensors and actuators.

Specifications:

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Digital I/O Pins: 14 (6 PWM outputs)
- Analog Input Pins: 8
- Clock Speed: 16 MHz
- Communication: UART, I2C, SPI

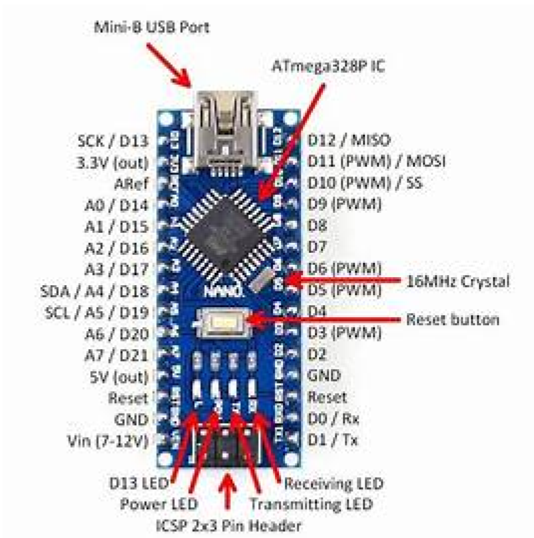


Fig:3.2.1.1 Arduino nano

Breadboard

A breadboard is a solderless platform for prototyping circuits, allowing electronic components and wires to be connected easily without soldering.
Specifications:

- Grid Size: Standard 830 tie-points (typical size)
- Rows: Marked for easy pin connections
- Voltage Rails: Separate power and ground buses

- Reusable and modular for circuit building

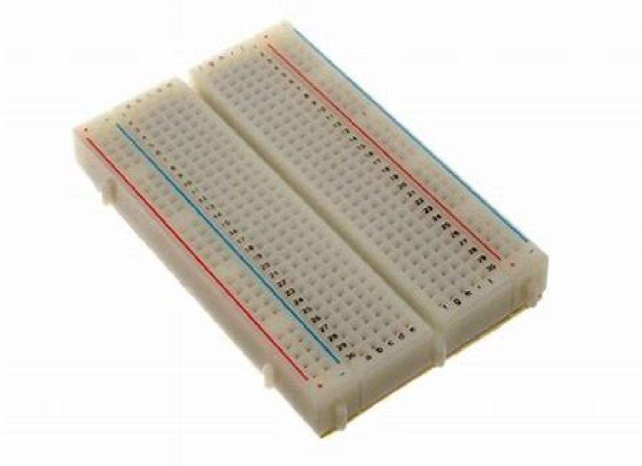


Fig:3.2.1.2 Breadboard

Crowtail pH Sensor

The Crowtail pH sensor is designed to measure the pH value (acidity/alkalinity) of aqueous solutions. It is widely used in water quality monitoring applications.
Working: It uses an electrode to generate a voltage proportional to the solution's pH, which is converted to a readable value.
Specifications:

- pH Range: 0–14
- Output: Analog voltage (proportional to pH)
- Accuracy: ±0.1pH
- Operating Voltage: 3.3–5V

Fig:3.2.1.3 Crowtail pH sensor

ASAIR AOF1010 Ultrasonic Oxygen Sensor

The ASAIR AOF1010 is an ultrasonic oxygen sensor designed to measure dissolved oxygen in aquatic environments.
Working: It uses ultrasonic technology to detect the concentration of oxygen in water, providing real-time dissolved oxygen levels.
Specifications:

- Operating Voltage: 3.3–5V
- Measurement Range: 0–20 mg/L
- Accuracy: ±0.3 mg/L
- Output: Analog or Digital Signal
- Suitable for aquatic and industrial monitoring

Fig:3.2.1.4 ASAIR AOF 1010 Ultrasonic oxygen sensor

DS18B20 Waterproof Temperature Sensor

The DS18B20 is a digital temperature sensor that measures temperature with high precision and provides digital output. Its waterproof design makes it suitable for aquatic or harsh environments.
Working: It uses the 1-Wire communication protocol to transfer temperature data to a microcontroller. It can measure temperatures from -55°C to +125°C.
Specifications:

- Operating Voltage: 3.0–5.5V
- Temperature Range: -55°C to +125°C
- Accuracy: ±0.5°C (from -10°C to +85°C)
- Waterproof casing with cable

Fig:3.2.1.5 DS18B20 Waterproof Temperature sensor

Li-Po Rechargeable Battery

A Li-Po (Lithium Polymer) battery is a lightweight rechargeable battery that delivers high power density and stable output voltage, ideal for portable electronics.
Specifications:

- Voltage: 3.7V nominal per cell
- Capacity: Varies (e.g., 500mAh, 1000mAh, etc.)
- Charge Voltage: 4.2V (maximum)
- Discharge Cutoff: 3.0V
- Compact, lightweight, and safe with proper protection circuits.

Fig:3.2.1.6 Li-Po rechargeable battery

Bluetooth Module HC-05

The HC-05 is a wireless Bluetooth module that enables serial communication between microcontrollers and other devices. It supports both master and slave modes.
Working: The module communicates using UART (Universal Asynchronous Receiver-Transmitter) protocol to send and receive data wirelessly.
Specifications:

- Operating Voltage: 3.3–5V
- Communication Protocol: UART
- Default Baud Rate: 9600
- Range: Up to 10 meters (Class 2 device)
- Modes: Master/Slave

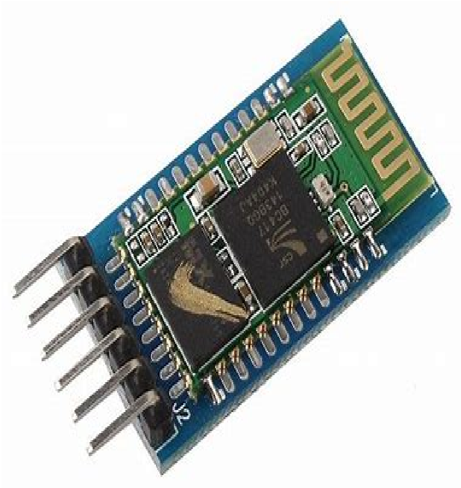


Fig:3.2.1.7 Bluetooth Module HC-05

Relay

A relay is an electrically operated switch used to control a high-power circuit with a low-power signal. It isolates the low-power control circuit from the high-power load circuit, ensuring safety and reliability.
Working: The relay consists of an electromagnet and mechanical contacts. When a small current flows through the coil, it generates a magnetic field that pulls the switch contacts, allowing the load circuit to be powered.
Specifications:

- Voltage Rating: 5V DC
- Control Signal: Digital (ON/OFF)
- Max Switching Voltage: 250V AC / 30V DC
- Contacts: Normally Open (NO) and Normally Closed (NC)

Fig:3.2.1.8 Relay

Mini DC Submersible Pump

A mini DC submersible pump is a small water pump designed to operate while submerged in water, commonly used in aquaponics and irrigation systems.
Working: When powered, the DC motor drives an impeller that forces water out through the outlet. It operates at low voltage for safety and efficiency.
Specifications:

- Operating Voltage: 3-6V DC
- Flow Rate: 120 L/hr (approx.)
- Power: 0.5-1.5W
- Submersion Depth: Up to 1 meter
- Outlet Diameter: 5-6mm

Fig:3.2.1.9 Mini DC submersible pump

SIMULATION

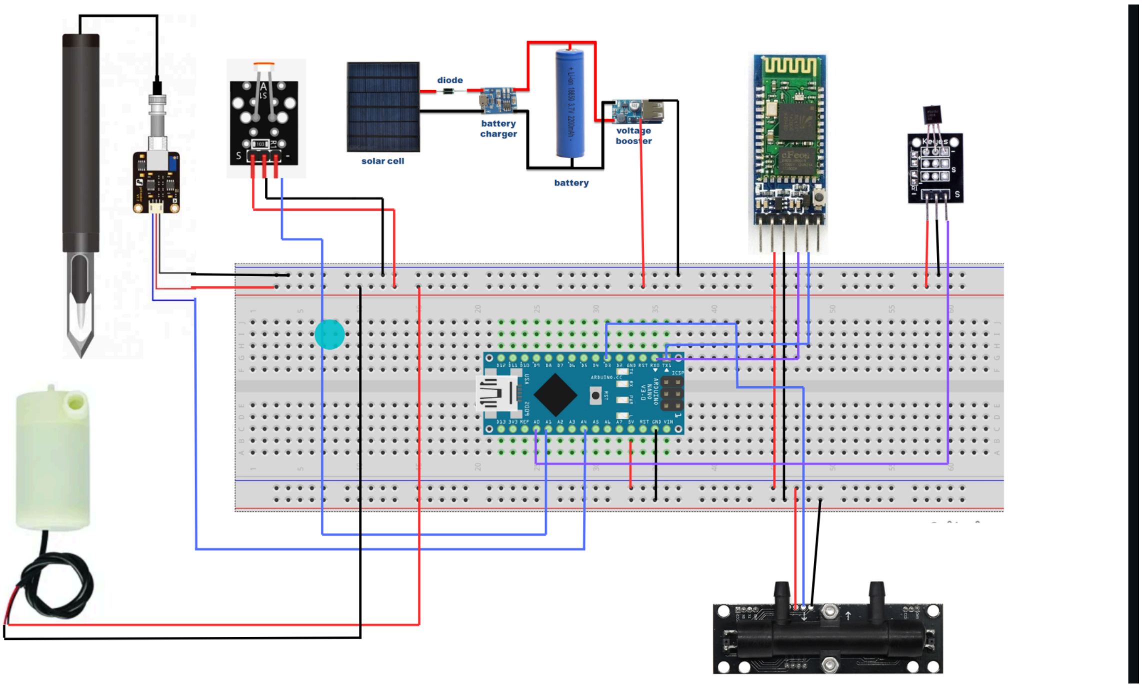
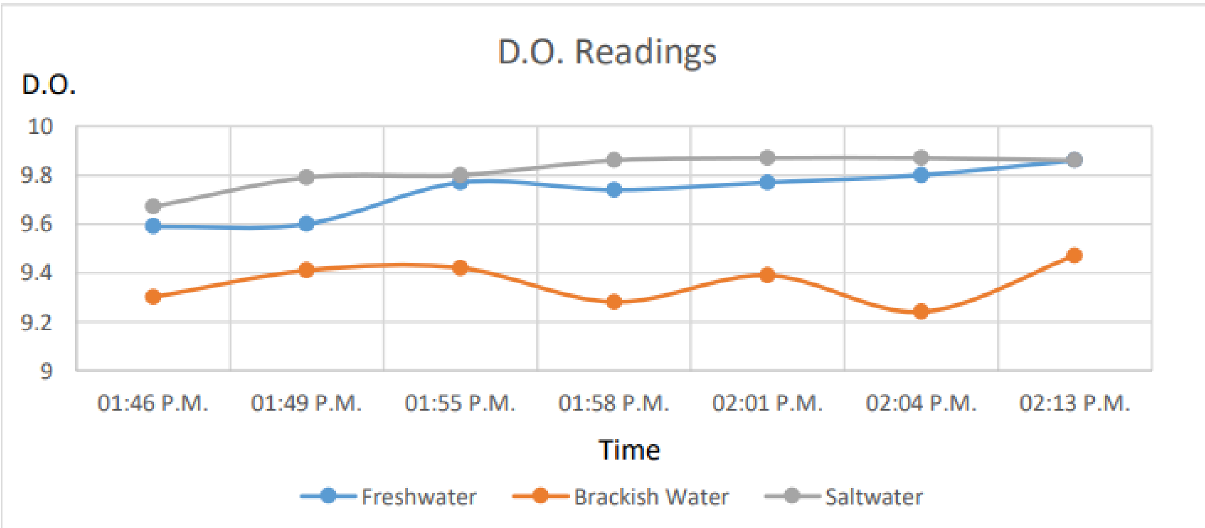


Fig:2.1.3 Simulation

RESULTS AND DISCUSSIONS

The Data was gathered, collated and tabulated in accordance to the specified questions. It is supported with tables that illustrate the responses of the study in the performance of the Automated Aerator System. There were some trials being conducted in order to meet the most reliable data. Freshwater, Brackish Water and Saltwater were tested and tallied their data using a system software (see Appendix C1-C3 for the complete table of the gathered data). The aquarium and other necessary tools and equipment were placed in the CEA computer laboratory during the experimentation. In order to maintain proper levels of pH and the other parameters , some water types are tested with some amount of water life like plants and rocks which often release toxic chemicals . Dissolved oxygen level can be determined by its water content using an Atlas Scientific Dissolved Oxygen sensor. A tumbler is used to create an environment of the aquatic system.

OBSERVATION TABLE :



The above observation table displays the relationship between the D.O. level readings against time. A water with some volume and with 0 oz. an acidic solution was observed for a few minutes. The median readings of the D.O. levels of the different types of water are as follows. Freshwater D.O. = 9.06, Brackish water D.O. = 8. 665 and Salt water D.O. = 9.9 . The volume of water was increased to 20 L and acid solution to 3 oz. and was observed for 27 minutes. The median readings of the D.O. levels are as follows. Freshwater = 9.77, Brackish water = 9.28 and Salt water = 9.86. Based on the results, as the system increases the volume of water it is able to either,maintain or increase the amount of dissolved oxygen content in the water.

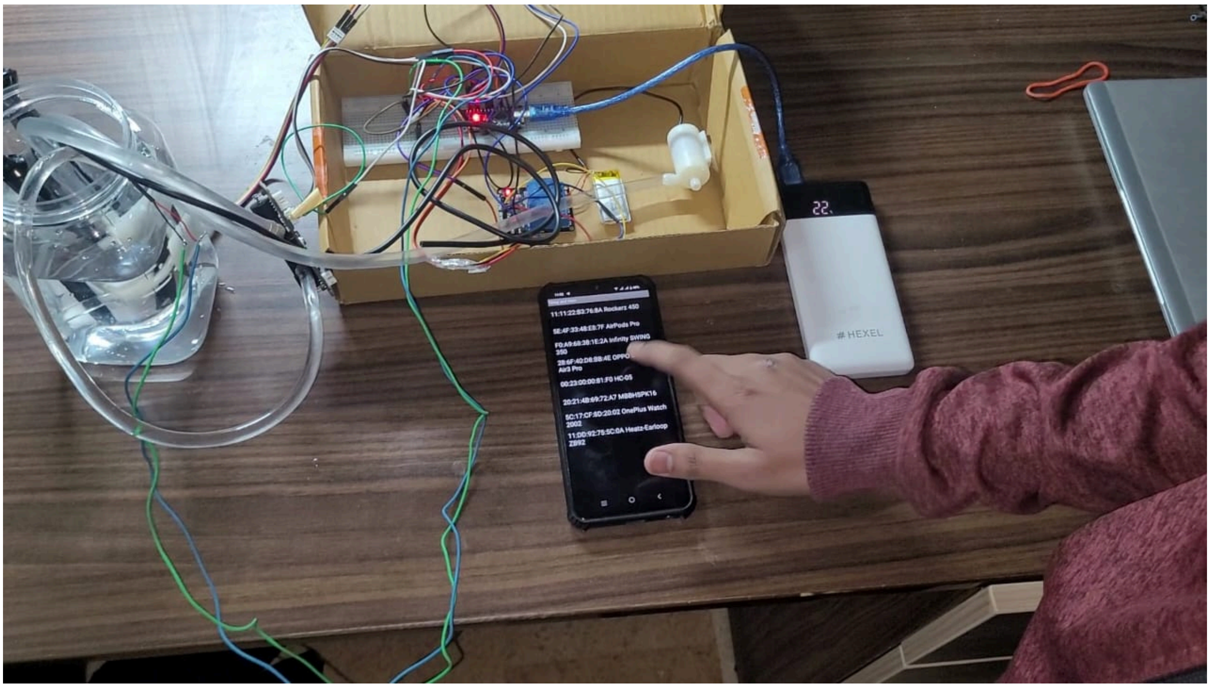


Fig:2.1.4 Result Figure

CONCLUSION AND FUTURE SCOPE

The automated Aerator System has successfully controlled the dissolved oxygen (DO) levels in various types of water, including freshwater, brackish water, and saltwater. By effectively regulating the DO content, the system significantly improves the water quality. Additionally, it efficiently monitors key parameters such as DO, pH, and temperature. During testing, when an acidic solution was added, the system detected a rapid decrease in pH levels, confirming that the aquatic environment became acidic. However, when good-quality water was continuously added to the contaminated water without increasing the amount of the acidic solution, the pH levels gradually rose, restoring the water quality to a more neutral state. The application software proved effective in displaying real-time data on an Android mobile phone while also storing historical monitoring data for future reference.

FUTURE SCOPE :

The future scope of aquatic aerator systems concentrates with significant potential in areas like water treatment, agriculture, and aquaculture. In wastewater management, advancements in energy-efficient aerators,real-time monitoring, and systems for treatment are driving innovation. In aquaculture, aerators are being developed for enhanced oxygenation, automated control, and sustainable practices to support healthier aquatic life. Agriculture benefits from aerated irrigation systems that improve soil health, water absorption, and promote eco-friendly farming. Additionally, the use of aerators in treated wastewater reuse aligns with global efforts toward water conservation and sustainability, ensuring a critical role for these systems in addressing environmental and resource challenges.

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