Aquatic Life Monitoring System Using Diy Do Sensor

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Abstract: The Aquatic Life Monitoring System Using DIY Dissolved Oxygen Sensor is a smart solution designed to monitor and maintain water quality for aquatic ecosystems. It uses sensors to measure dissolved oxygen, temperature, and pH levels, sending real-time data to the cloud via a WiFi-enabled ESP32 module. The system employs a random forest classification module for fault detection, triggers a motor to restore oxygen levels when necessary, and sends push notifications for critical alerts. This project ensures proactive water quality management, enhancing aquatic life sustainability.

Key words: Aquatic Life Monitoring, Dissolved Oxygen Sensor, Water Quality Monitoring, DIY Sensors, Temperature Monitoring

CHAPTER 1: INTRODUCTION

Water quality is a critical factor in maintaining the health and sustainability of aquatic ecosystems. Fluctuations in dissolved oxygen (DO) levels, temperature, and pH can significantly impact aquatic life, leading to habitat degradation and species loss. Traditional water monitoring systems often lack real-time functionality and are cost-prohibitive for widespread adoption.

This research introduces a cost-effective and smart **Aquatic Life Monitoring System** that integrates a DIY dissolved oxygen sensor, temperature and pH sensors, and modern IoT technologies. The system employs an ESP32 microcontroller to collect and transmit real-time data to a cloud database using WiFi. A random forest classification algorithm is utilized for fault detection, providing accurate and timely insights into water conditions. To maintain optimal oxygen levels, a motor is activated automatically when DO levels drop below a threshold, ensuring the well-being of aquatic organisms. Additionally, users are alerted via push notifications to take immediate action during critical situations.

By leveraging low-cost components and advanced machine learning techniques, this project aims to provide an accessible and efficient solution for monitoring and managing aquatic environments, with potential applications in aquaculture, water reservoirs, and environmental conservation.

CHAPTER 2: LITERATURE REVIEW

Water quality monitoring has been a critical area of research due to its importance in maintaining aquatic ecosystem health and ensuring the survival of aquatic organisms. Several technologies and methodologies have been explored in this domain, but significant gaps remain in terms of cost, scalability, and real-time responsiveness. This literature survey explores various existing approaches and their limitations, forming the foundation for the proposed system.

1. Traditional Monitoring Methods

Traditional water quality monitoring relies on manual sampling and laboratory analysis. Studies, such as those by *Meybeck and Helmer (1989)*, emphasize that these methods provide accurate results but are time-consuming and resource-intensive. Manual processes are unsuitable for real-time monitoring and often result in delayed responses to critical changes in water conditions.

2. Use of Commercial Sensors

Commercial sensors for measuring dissolved oxygen (DO), pH, and temperature are widely used in aquaculture and environmental monitoring. According to *Lewis et al. (1995)*, these sensors are accurate but prohibitively expensive for small-scale or community-level applications. Furthermore, these systems often require frequent calibration and maintenance, which adds to their operational cost.

3. IoT-Based Water Quality Monitoring

Recent advancements in the Internet of Things (IoT) have enabled the development of real-time water quality monitoring systems. Research by *Pradeep et al. (2017)* highlights the integration of IoT sensors for real-time data collection and transmission. However, these systems often depend on proprietary sensors and complex infrastructure, limiting their scalability and affordability.

4. DIY Sensor Development

The use of DIY (Do-It-Yourself) sensors is gaining traction as a cost-effective alternative to commercial systems. Studies such as *Williams et al. (2020)* demonstrate that DIY sensors can provide reliable measurements of water parameters when properly calibrated. Despite their potential, DIY systems require further research to optimize accuracy and ensure robustness for long-term use.

5. Automated Response Systems

Automated systems for maintaining water quality, such as aerators and water circulation mechanisms, have been explored in aquaculture. Research by *Zhou et al. (2018)* emphasizes the effectiveness of these systems in preventing oxygen depletion. However, existing solutions lack integration with real-time monitoring systems, leading to inefficiencies in response times.

6. Cloud-Based Data Analytics

Cloud computing has revolutionized data storage and analysis in environmental monitoring. Studies by *Rao et al. (2021)* highlight the advantages of using cloud platforms for aggregating and analysing sensor data. Despite this, many cloud-based systems lack AI-driven capabilities to learn and optimize responses over time.

CHAPTER 3: OBJECTIVES

The primary objectives of the **Aquatic Life Monitoring System Using DIY Dissolved Oxygen Sensor** are:

1. **Real-Time Monitoring**: To develop a system capable of continuously monitoring critical water quality parameters, including dissolved oxygen (DO), temperature, and pH, in real time.
2. **Fault Detection**: To employ a random forest classification algorithm for accurate detection of anomalies or faults in water quality.
3. **Automated Response**: To implement an automated motor system that activates when dissolved oxygen levels drop below a predefined threshold, ensuring the sustenance of aquatic life.
4. **User Notifications**: To provide instant push notifications to users during critical situations, enabling timely intervention and preventive action.
5. **Low-Cost and Scalable Solution**: To design a cost-effective and scalable system using DIY sensors and IoT technology, making it accessible for diverse applications such as aquaculture, water reservoirs, and environmental monitoring.

CHAPTER 4: SCOPE OF THE PROJECT

The scope of this project encompasses the development of an affordable and scalable water quality monitoring system suitable for various applications, including:

- **Aquaculture:** Maintaining optimal water conditions for fish and other aquatic organisms.
- **Environmental Monitoring:** Monitoring the health of natural water bodies such as lakes, rivers, and ponds.
- **Research and Education:** Providing an accessible tool for water quality research and teaching purposes.

The system leverages modern technologies such as IoT, cloud computing, and AI to enable:

1. Real-time monitoring of DO, humidity, and temperature levels.
2. Automated corrective actions through motorized oxygenation mechanisms.
3. Data-driven insights through cloud-based storage and analytics for better water quality management.

CHAPTER 5: METHODOLOGY

The methodology for the **Aquatic Life Monitoring System** focuses on integrating low-cost sensors, IoT technologies, and machine learning to create an efficient water quality monitoring and management system. The following steps outline the approach:

1. System Design

- **Sensors Selection**: Identify and integrate sensors for measuring dissolved oxygen (DO), temperature, and pH levels. A DIY dissolved oxygen sensor is designed to reduce costs.
- **Microcontroller**: Use the ESP32 module for sensor data acquisition and WiFi-enabled data transmission to the cloud.
- **Cloud Infrastructure**: Establish a cloud database for real-time storage and retrieval of water quality data.

2. Data Acquisition

- Sensors continuously measure water quality parameters and transmit analog signals to the ESP32 microcontroller.
- The microcontroller processes these signals, converts them to digital form, and prepares the data for transmission.

3. Data Transmission

- The ESP32 microcontroller sends real-time sensor data to the cloud database over a WiFi connection. This ensures remote access to water quality information.

4. Automated Actuation

- Implement logic within the ESP32 to activate a motor when dissolved oxygen levels drop below a critical threshold.
- The motor aerates the water to restore oxygen levels, ensuring the well-being of aquatic life.

5. User Notification

- Integrate push notification functionality in a React Native mobile application.
- Alerts are sent to users in case of anomalies, motor activation, or other critical conditions, enabling timely intervention.

6. System Testing and Validation

- Test the sensors, cloud integration, and fault detection model in controlled environments to verify the accuracy and reliability of the system.
- Evaluate system performance under various conditions, including low oxygen levels, extreme pH, and temperature variations.
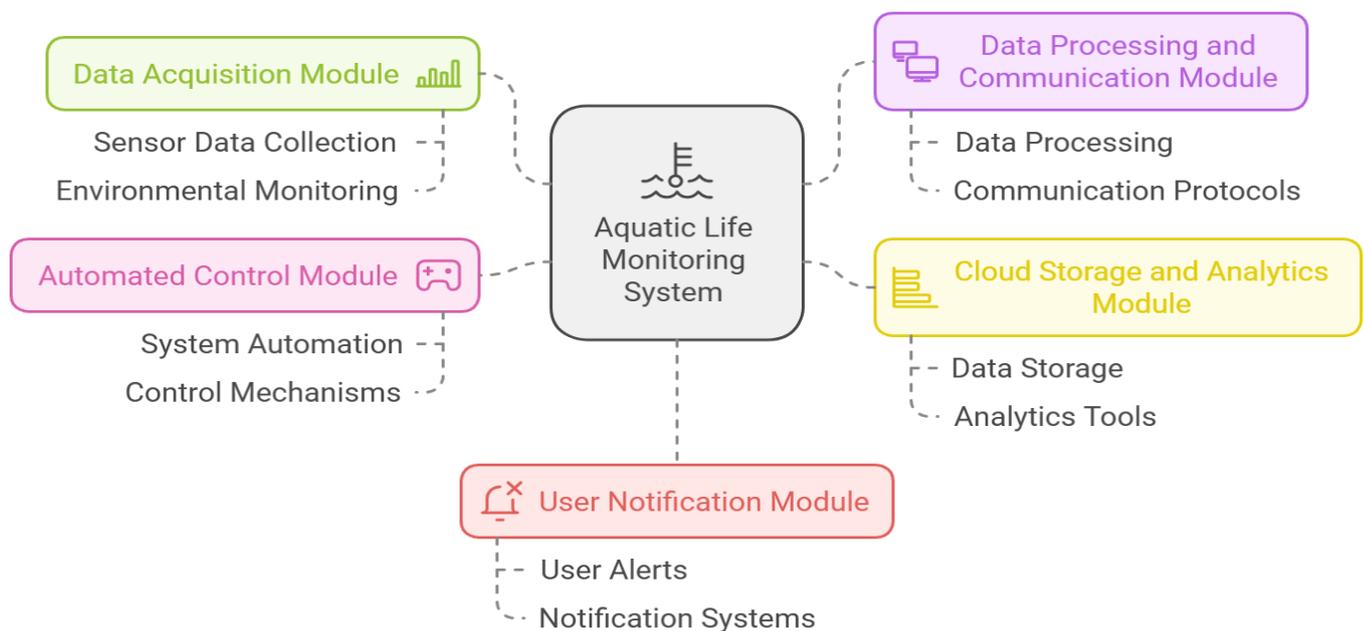
Fig: 5.1 Use Case Diagram

CHAPTER 6: IMPLEMENTATION

The implementation of the **Aquatic Life Monitoring System** involves integrating hardware components, developing software modules, and deploying the system for real-time water quality monitoring and management. The following steps outline the implementation process:

1. Hardware Integration

Sensors Setup:

- A DIY dissolved oxygen sensor is designed using low-cost materials and calibrated for accurate readings.

- Commercially available temperature and pH sensors are connected to the system for monitoring additional water parameters.

Microcontroller:

- The ESP32 module is configured to read data from the sensors and handle WiFi-based communication with the cloud.

Actuator:

- A motor is integrated into the system to aerate the water when dissolved oxygen levels drop below the critical threshold.

2. Software Development

Microcontroller Programming:

- The ESP32 is programmed using Go to process sensor data, execute control logic, and communicate with the cloud database.

Machine Learning Model:

- A random forest classification model is developed and trained on a dataset of water quality parameters.
- The trained model is deployed to identify anomalies and classify water quality conditions as normal or faulty.

Cloud Integration:

- A cloud database is set up to store real-time sensor data. IoT protocols are used to ensure seamless communication between the ESP32 and the cloud.
- **Mobile Application**:
- A React Native-based mobile application is developed to provide real-time visualization of water quality data.
- Push notifications are implemented to alert users of anomalies or system interventions.

3. System Calibration and Testing

- The sensors are calibrated in controlled environments to ensure accuracy and reliability in data collection.
- The fault detection algorithm is tested with simulated data to validate its performance.
- The motor is tested to verify its ability to restore dissolved oxygen levels effectively.

4. Deployment

- The system is deployed in an aquatic environment (e.g., a fish pond or water reservoir).
- Continuous monitoring is performed to collect real-world data, ensuring the system's robustness and reliability.

5. Performance Evaluation

- The system's performance is evaluated based on its ability to detect faults, respond to low oxygen levels, and notify users in real time.
- Long-term data is analyzed to assess the system's impact on maintaining optimal water quality and supporting aquatic life.

CHAPTER 7: TESTING

1. **Unit Testing**

Table 7.1 Unit Testing Result

Test Case ID	Test Description	Input	Expected Outcome	Results
UT001	Test DO sensor readings	Simulate various DO levels (e.g., 4 ppm)	Correct DO level is displayed (e.g., 4 ppm)	Passed: DO sensor validated
UT002	Test temperature sensor readings	Simulate different temperatures (e.g., 25°C)	Correct temperature is displayed (e.g., 25°C)	Passed: Temperature sensor validated
UT003	Test humidity sensor readings	Simulate humidity levels (e.g., 60%)	Correct humidity is displayed (e.g., 60%)	Passed: Humidity sensor validated
UT004	Test ML model classification	Provide sample data inputs	ML model outputs correct classification	Passed: Classification validated
UT005	Test aeration activation logic	Simulate DO level < threshold (e.g., 3 ppm)	Aeration system activates	Passed: Aeration logic works

2. Integration Testing

Table 7.2 Integration Testing Result

Test Case ID	Test Description	Modules Involved	Expected Outcome	Results
IT001	Test sensor to backend communication	Sensors, Backend	Sensor data is sent to backend successfully	Passed: Seamless communication
IT002	Test backend to app communication	Backend, React Native App	App displays real-time sensor data	Passed: Data displayed correctly
IT003	Test aeration activation via app	App, Backend, Aeration System	Aeration activates when triggered by the app	Passed: Aeration controlled via app
IT004	Test end-to-end workflow	Sensors, Backend, App, Aeration System	Complete workflow functions as expected	Passed: End-to-end workflow validated

3. System Testing

Table 7.3 System Testing Result

Test Case ID	Test Description	Scenario	Expected Outcome	Results
ST001	Validate real-time data flow	Continuous data flow from sensors to app	Real-time data is displayed on app dashboard	Passed: Real-time data flow validated
ST002	Verify performance under load	Simulate 500+ concurrent requests	System handles load without delays or crashes	Passed: Load testing successful
ST003	Test system recovery after failure	Simulate network or sensor failure	System resumes operations post-recovery	Passed: Recovery mechanism validated

CHAPTER 8: RESULTS

Fig 8.1 Onboarding screen
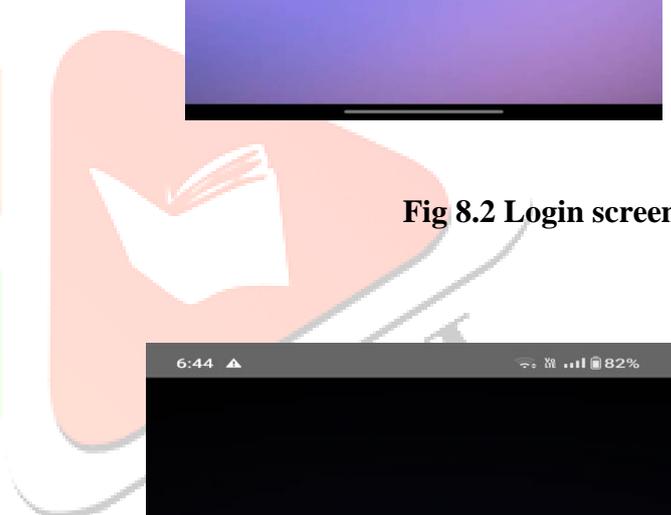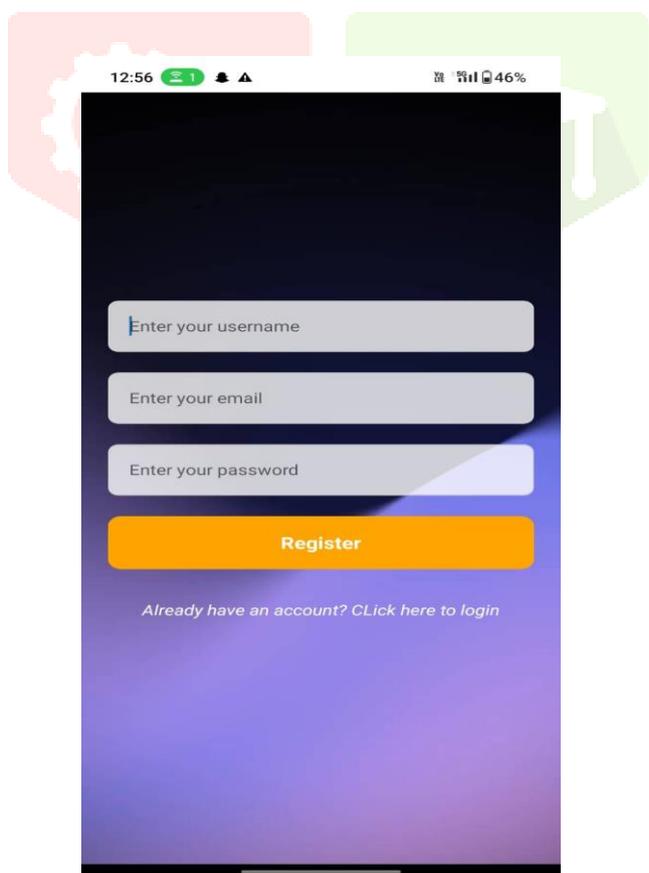
Fig 8.2 Login screen
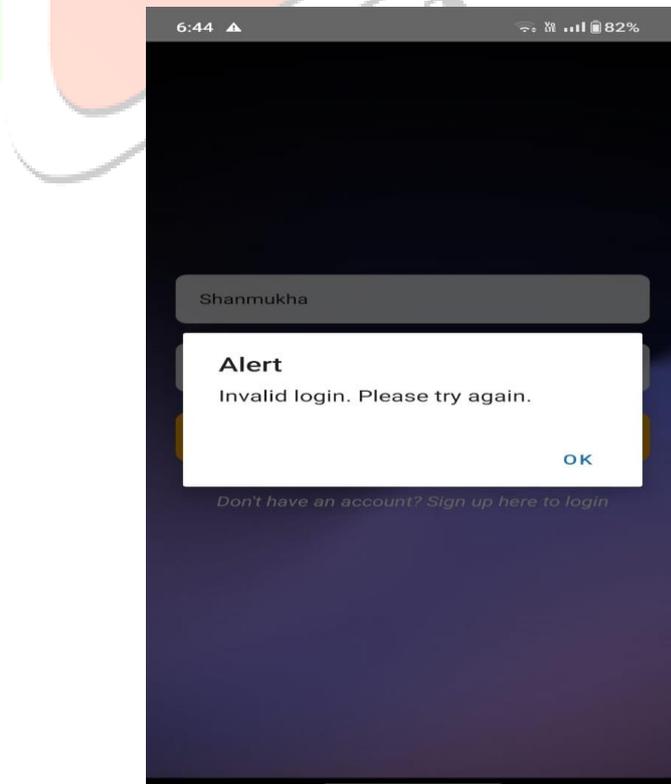

Fig 8.3 User Regisration Screen

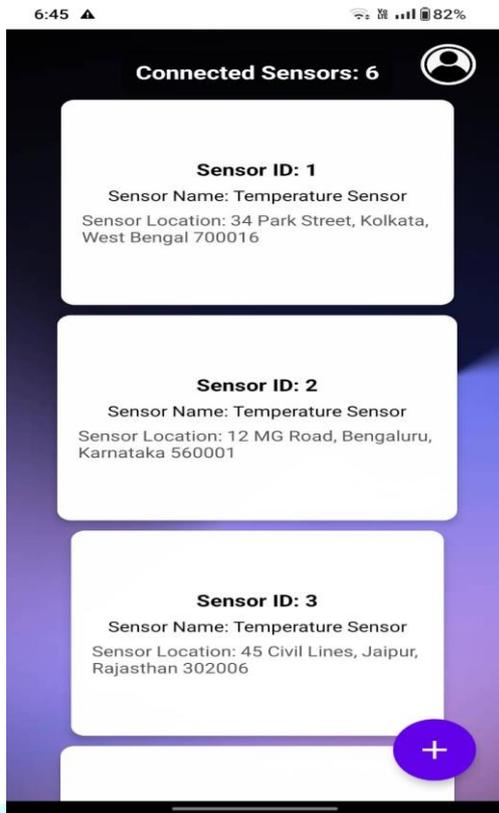**Fig 8.4 Invalid Login screen**

Fig 8.5 Sensor Cards screen

Moderate to the User

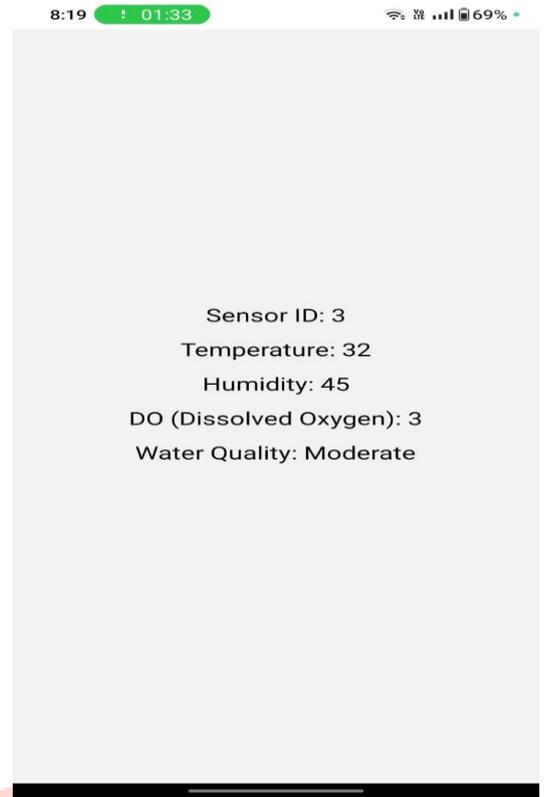**Fig 8.6 App indicating Realtime data and giving Water Quality feedback as**

Fig 8.7 App indicating Realtime data and giving data and giving

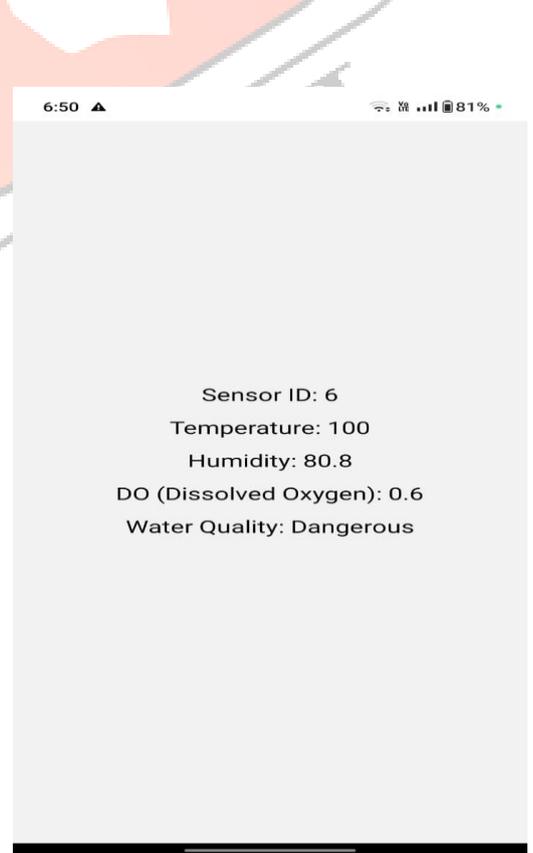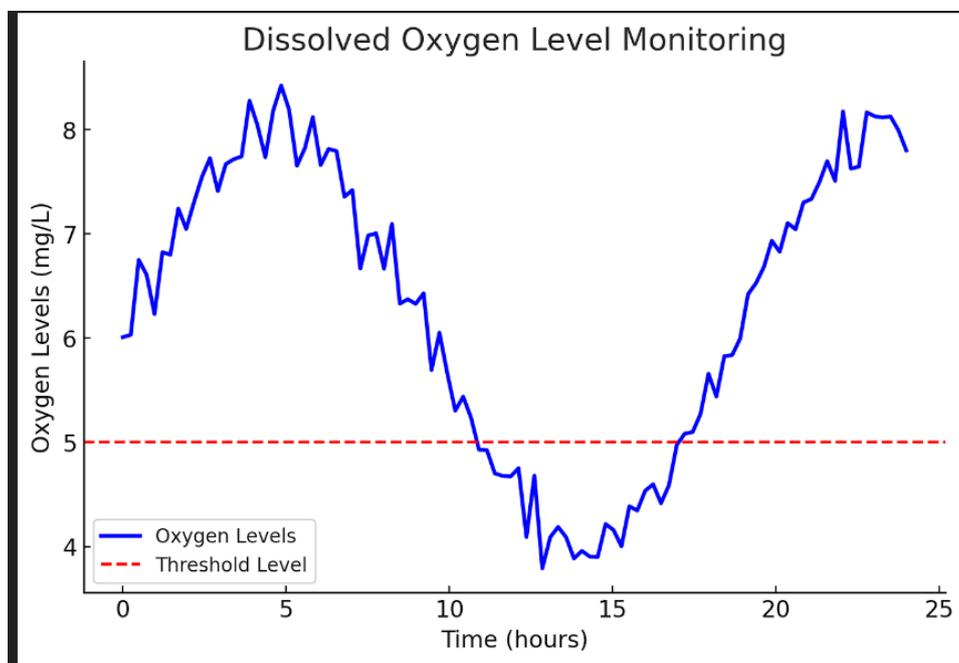**Water Quality feedback as Safe to the User to User**
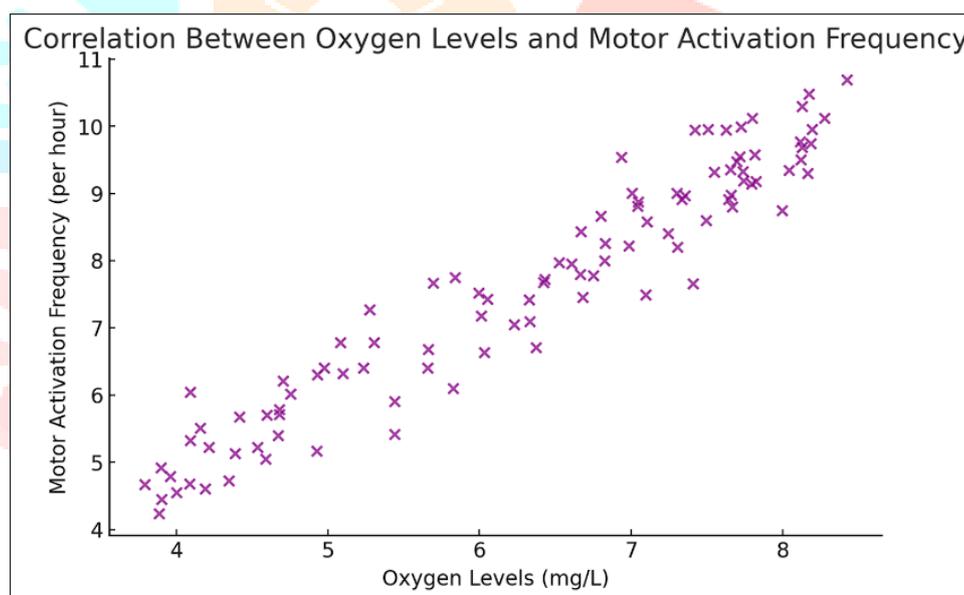
Fig 8.8 App indicating Realtime

Water Quality feedback as Danger

Fig 8.9 Dissolved Oxygen level over a period of 25 hours

Fig 8.10 Correlation between oxygen levels and Motot Activation Frequency

CONCLUSION

The **Aquatic Life Monitoring System** successfully addresses the challenges of maintaining water quality in aquatic environments through a combination of advanced sensors, automated motor control, real-time data transmission, and a user-friendly mobile application. The system provides reliable, accurate, and real-time monitoring of critical water parameters such as dissolved oxygen, temperature, and pH levels.

Key achievements of the project include:

- **Accurate Monitoring:** Reliable sensor readings and seamless integration with cloud storage for continuous data logging.
- **Proactive Alerting:** Timely push notifications and fault detection to minimize risks to aquatic life.
- **Automation and Efficiency:** Automated motor control for aeration, optimizing energy use while maintaining water quality.
- **User Engagement:** An intuitive mobile application for real-time monitoring, visualization, and control.

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