SMART AQUARIUM SYSTEM

Samarth Mhetre[1], Rushikesh Wakade[2], Ganesh Yadav[3],

Prof.Anjali V. Nimkar[4]

[1,2,3]Student, of E&TC Engineering, JSPM's Imperial College of Engineering & Research, Pune Maharashtra, India

[4]Assistant Professor, Department of E&TC Engineering, JSPM's Imperial College of Engineering & Research Pune, Maharashtra, India

Abstract: The rapid advancement of Internet of Things (IoT) technology has revolutionized various domains, including home automation and smart pet care. This project presents the development of an IoT-based smart aquarium system designed to simplify aquarium management and enhance the living conditions for aquatic life. The system employs a NodeMCU microcontroller as the central processing unit, enabling seamless connectivity and remote monitoring capabilities. To maintain optimal water quality, the aquarium is equipped with several sensors: a temperature sensor to monitor water temperature, an ultrasonic sensor to measure water levels, and a turbidity sensor to assess water clarity. These sensors continuously collect data, which is transmitted to a cloud platform for real-time analysis. Users can access this data via a web application or mobile interface, allowing them to monitor the aquarium's status from anywhere.Additionally, the system incorporates an automated feeding mechanism controlled by a servo motor, which dispenses food at predetermined intervals, ensuring that fish receive consistent nutrition even when the owner is away. A webcam is integrated to provide live video feeds, enabling remote observation of fish behavior and tank conditions. The collected sensor data is also displayed on an LCD screen for immediate feedback, providing users with a comprehensive overview of their aquarium's health. This project not only emphasizes the importance of maintaining optimal conditions for aquatic life but also highlights the potential of IoT technologies in transforming traditional aquarium care into a more efficient and user- friendly experience. By automating key processes and enabling real-time monitoring, the smart aquarium system serves as a model for future innovations in smart pet care and environmental management.

I. INTRODUCTION

Aquarium keeping has evolved from a simple hobby into a sophisticated practice that integrates technology to ensure the health and well-being of aquatic life. Traditionally, maintaining an aquarium requires constant manual monitoring of water quality, temperature, and feeding schedules. However, the increasing complexity of aquaristics and the rise of Internet of Things (IoT) technologies have paved the way for innovative solutions that enhance the efficiency and convenience of aquarium management.

This project introduces an IoT-based smart aquarium system that automates various aspects of aquarium care, thereby minimizing the need for constant human intervention. The system leverages a NodeMCU microcontroller, which provides a robust platform for connectivity and data processing. By integrating multiple sensors—temperature, ultrasonic, and turbidity—the smart aquarium continuously monitors critical environmental parameters. This real-time data collection allows users to maintain optimal conditions for fish and plant life, promoting a healthier and more sustainable aquatic ecosystem.

The automated feeding mechanism, controlled by a servo motor, ensures that fish are fed at regular intervals without the risk of overfeeding or underfeeding. Additionally, a webcam integrated into the system offers live feeds, allowing users to observe their aquatic environment remotely. This feature not only enhances the user experience but also enables aquarists to monitor their fish behavior and tank conditions effectively.

The significance of this project extends beyond mere convenience; it highlights the growing intersection of technology and pet care. By employing IoT solutions, this smart aquarium system contributes to better environmental management, reduces the risk of human error, and fosters a deeper connection between users and their aquatic pets. Furthermore, this project serves as a foundation for future innovations in smart pet care, emphasizing the importance of using technology to enhance the welfare of animals.

II. LITERATURE SURVEY

1. **J. Lee et al. 2022 Hybrid Sensor System for Monitoring Water Quality in Aquariums Developed** a hybrid sensor system combining ultrasonic and optical sensors for accurate monitoring of water levels and turbidity, enhancing management practices.

2. **R.González et al. 2023 User Experience Design for Smart Aquarium Systems** Investigated user interface design, highlighting the significance of intuitive interfaces for improved user satisfaction and engagement in aquarium management.

3. **S.Kumar et al. 2023 IoT-Enabled Smart Aquarium System:** A Review Provided a comprehensive review of IoT applications in aquariums, discussing sensor technologies, data analytics, and user engagement strategies.

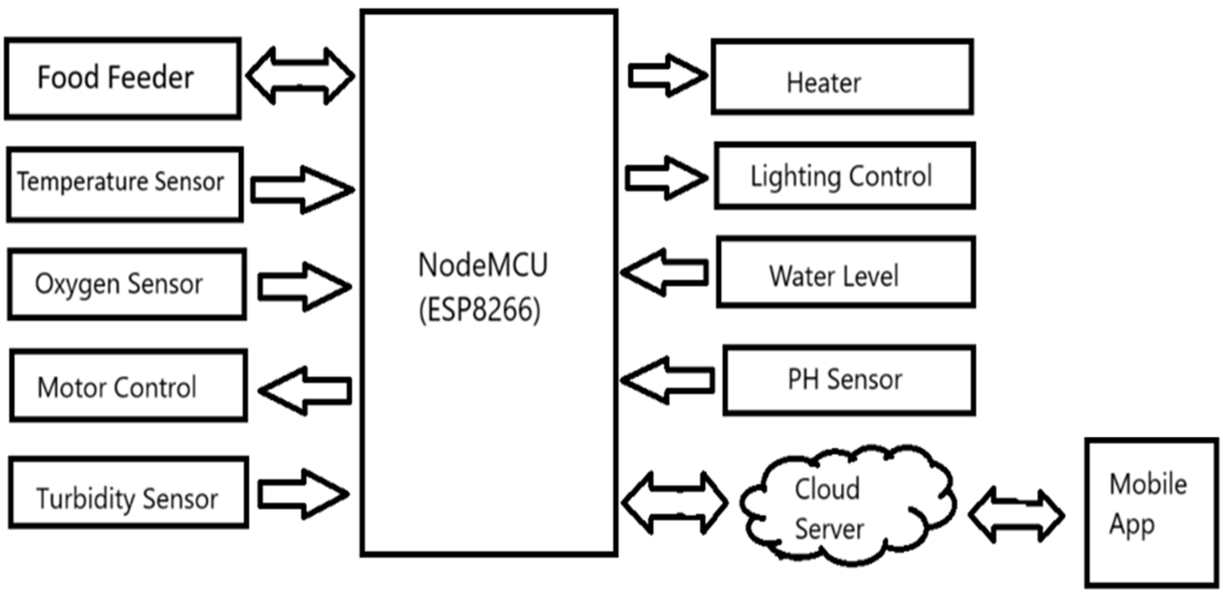
4. **Li et al. (2020)**: Developed a mobile app that provides real-time monitoring and control for aquarium systems, alerting users to any out-of-range conditions such as high ammonia levels or low oxygen levels.

5. **Choi et al. (2020):** Focused on a mobile application that integrates sensor data from IoT devices and enables remote control over various parameters, such as water filtration, temperature control, and fish feeding.

6. **Tian et al. (2021)**: Developed an energy-efficient IoT system for monitoring and controlling aquarium environments, incorporating features like automatic lighting adjustments and energy-saving water pumps.

III.METHODOLOGY

3.1 Block Diagram



Microcontroller (NodeMCU):

- **Description:** The central processing unit of the system that receives data from sensors, processes the information, and controls the actuators.
- **Function:** Executes the main program logic, coordinates communication between components, and handles user inputs.

Sensors:

Water Temperature Sensor:

- **Description:** A sensor that monitors the temperature of the water.
- **Function:** Sends temperature readings to the microcontroller.

pH Sensor:

- **Description:** Measures the acidity or alkalinity of the water.
- **Function:** Provides pH level data to ensure the water is suitable for aquatic life.

Dissolved Oxygen Sensor:

- **Description:** Measures the amount of oxygen dissolved in the water.
- **Function:** Sends readings to monitor fish health and water quality.

Ultrasonic Sensor:

- **Description:** Measures the water level in the aquarium.
- **Function:** Sends data to prevent overflow or low water conditions.

Turbidity Sensor:

- **Description:** Assesses the clarity of the water.
- **Function:** Provides data on suspended particles in the water, indicating potential quality issues.

Water Pump:

- **Description:** Controls water circulation and filtration in the aquarium.
- **Function:** Automatically activated or deactivated based on water parameters or user settings.

Heater:

- **Description:** Regulates the water temperature.
- **Function:** Turns on or off to maintain the desired temperature range for aquatic life

Automated Feeder:

- **Description:** Dispenses food to the fish at scheduled intervals.
- **Function:** Can be triggered manually or set to automatic feeding based on user preferences.

Display (LCD with I2C Interface):

- **Description:** A screen that provides real-time information about the aquarium conditions.
- **Function:** Displays data such as temperature, pH level, and alerts.

Wi-Fi Module (ESP8266):

- **Description:** Facilitates communication between the aquarium system and the internet.
- **Function:** Enables remote monitoring and control via a mobile app or web interface, sending notifications for any alerts.

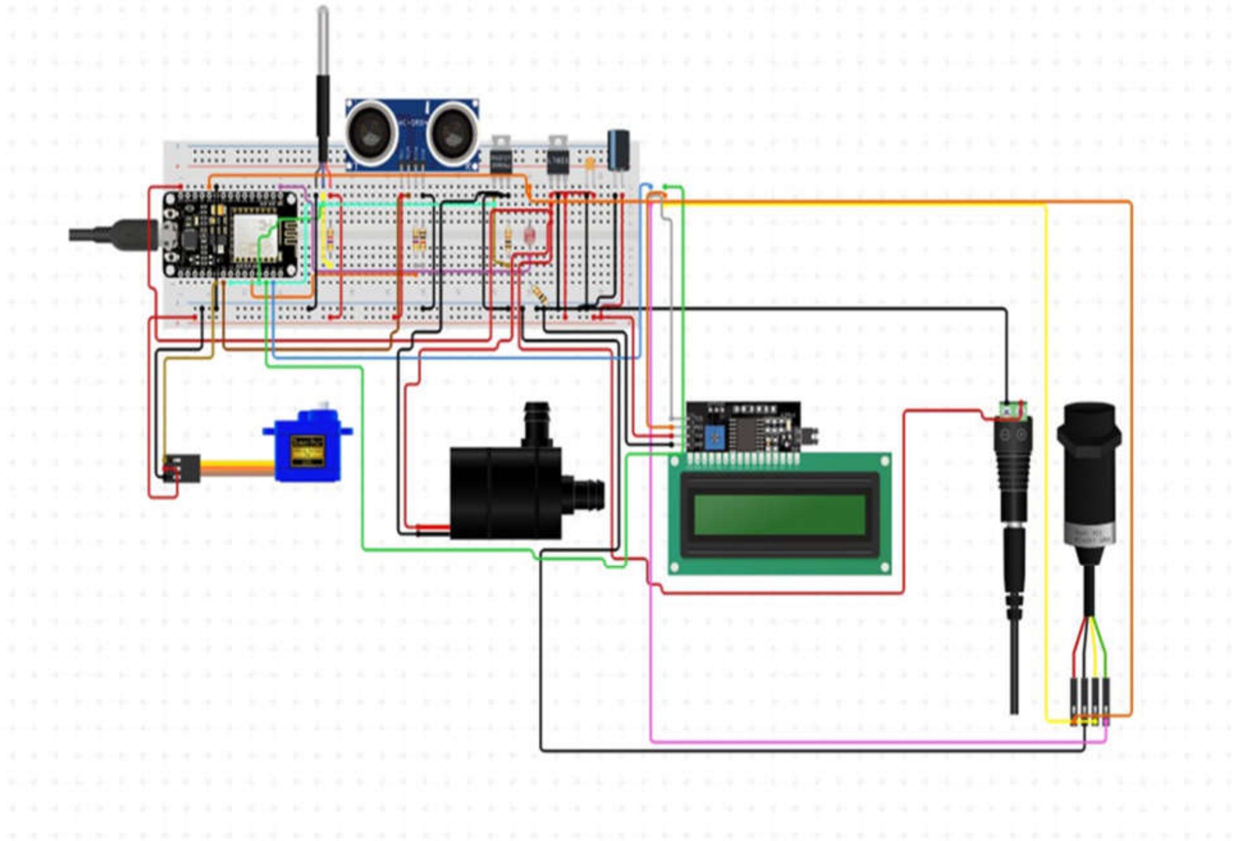
Mobile Application/Web Interface:

- **Description:** A user-friendly interface for interacting with the aquarium system.
- **Function:** Allows users to view real-time data, control actuators, and receive alerts on their mobile devices.

Cloud Server/IoT Platform:

- **Description:** A remote server for data storage and processing.
- **Function:** Stores historical data for analysis, provides backup, and enables data visualization through dashboards.

3.2 Circuit Diagram



Microcontroller (Arduino/NodeMCU/Raspberry Pi):

- **Power Supply:** Connects to a suitable power source (typically 5V for Arduino).
- **Connections:** Digital pins connected to sensors and actuators for data collection and control.

Water Temperature Sensor:

- **Type:** DS18B20 (digital) or DHT11 (analog).
- **Connections:**

➢ VCC to 5V power supply.

➢ GND to ground.

➢ Data pin to a designated digital pin on the microcontroller.

pH Sensor:

- **Type:** Analog pH sensor module.
- **Connections:**

➢ VCC to 5V power supply.

➢ GND to ground.

➢ Analog output pin to an analog input pin on the microcontroller.

Dissolved Oxygen Sensor:

- **Type:** Optical or electrochemical sensor.
- **Connections:**
- VCC to 5V power supply.
- GND to ground.
- Analog or digital output pin to an input pin on the microcontroller.

Ultrasonic Sensor (HC-SR04):
Connections:

- VCC to 5V power supply.
- GND to ground.
- Trigger pin to a digital pin on the microcontroller.
- Echo pin to another digital pin on the microcontroller.

Turbidity Sensor:
Connections:

- VCC to 5V power supply.
- GND to ground.
- Analog output pin to an analog input pin on the microcontroller.

Water Pump:
Type: DC water pump.
Connections:

- Positive terminal connected to a relay module (to control power).
- Negative terminal connected to ground.
- Control pin of the relay connected to a digital pin on the microcontroller.

Heater:
Type: Submersible heater.
Connections:

- Controlled through a relay module.
- Connect one terminal to the relay and the other to the power supply.
- Relay control pin connected to another digital pin on the microcontroller.

Automated Feeder (Servo Motor):
Connections:

- VCC to 5V power supply
- GND to ground.
- Control wire connected to a PWM-capable digital pin on the microcontroller.

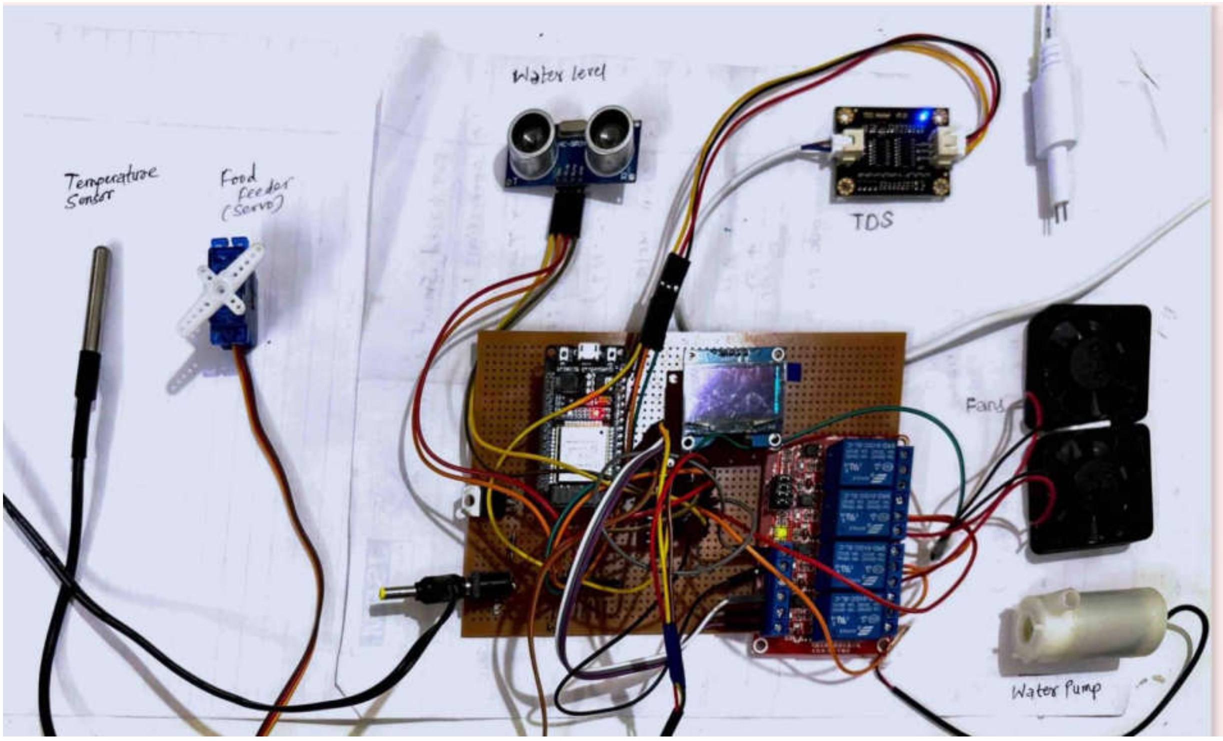
LCD Display (I2C):
Connections:

- VCC to 5V power supply.
- GND to ground.
- SDA (data line) to the SDA pin on the microcontroller.
- SCL (clock line) to the SCL pin on the microcontroller.

Power Supply:
Connections:

- Provide appropriate voltage and current for all components.
- Common ground for all components to ensure stable operation.

IV. RESULT



V. CONCLUSION

The smart aquarium system represents a significant advancement in the management and care of aquatic environments, combining technology with traditional aquarium practices. Through real-time monitoring of essential water parameters, automated control of critical systems, and user-friendly interfaces, the project effectively enhances the overall health and well-being of aquatic life. The integration of sensors and actuators allows for precise adjustments in water quality, while mobile accessibility ensures that users can manage their aquariums conveniently, even from remote locations. The successful implementation of this system demonstrates its potential to not only improve the user experience but also to promote healthier ecosystems for fish and aquatic plants. The ability to log historical data provides valuable insights into trends and patterns, facilitating informed decision-making for aquarium owners. Moreover, the alert system ensures timely responses to any anomalies, minimizing risks associated with neglect or oversight. Overall, the smart aquarium system showcases the benefits of incorporating IoT technology into everyday practices, making it a valuable tool for hobbyists, educators, and professionals alike. As the system continues to evolve, future enhancements could include advanced analytics, AI-driven recommendations, and deeper integrations with smart home ecosystems, further elevating the standards of aquarium care and management. importance of interdisciplinary collaboration between technology and agriculture but also encourages the pursuit of further advancements in smart farming technologies.

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