

FISHIFY

An IoT Water Monitoring, Treatment, and Feeding System

¹Sreetha Sreedhar K, ²Nithin C, ³Abhay Rithik, ⁴Sana T P, ⁵Sheik Muhammad Sahad

¹assistant professor, ²HOD, ³Student, ⁴Student, ⁵Student

Department of Electronics and Communication Engineering, St Thomas college of engineering and technology, Mattannur, Kannur, India

¹sreetha@stthomas.ac.in, ²nithinc@stthomas.ac.in, ³abhayrithik107@gmail.com,
⁴Sanasanatp95@gmail.com, ⁵sheikmuhammadsahads@gmail.com

Abstract— The IoT Water Monitoring and Automatic Fish Feeding System using the Android Application is an integrated and innovative aquaculture system that monitors vital water quality parameters, such as ammonia (NH₃), pH, and temperature, to ensure a healthy aquatic environment. The system, in its base, utilizes a NodeMCU to receive data in real-time through a network of sensors and transmit them to a cloud system where processed data are transmitted to an Android application to alert farmers to check water conditions and take necessary precautions. The system, designed to anticipate and prevent water contamination, maintains fish health and maximizes yields. Working on an aquaponic system concept, it utilizes fish waste to provide nutrients to plants, and vice versa, plants cleanse water, thus maintaining a natural recirculating system and minimizing wastage while keeping fish and crops healthy. In addition, an app-controlled motorized fish-feeding system makes automated timed feeding possible to ensure optimal nutrition and growth. The system, by automating vital aspects of fish rearing and providing insight in real-time, improves productivity, reduces labor, and makes aquaponic practices possible in a sustainable way.

Index Terms— Smart Aquaponics Management System, pH, Ammonia Level, Temperature, Feeding System

I. INTRODUCTION

Automated monitoring systems are increasingly essential in fish farming, helping maintain optimal water quality, feeding schedules, and temperature levels to support fish health and productivity. Traditional methods often struggle to meet the high demands of consistent water quality and feeding, leading to issues like water pollution and inefficient resource use. Leveraging the Internet of Things (IoT) and automation, modern systems enable real-time monitoring and control of these critical parameters, allowing farmers to manage operations remotely. IoT sensors track metrics like pH, oxygen, and temperature, while automation controls feeding and filtration, improving efficiency and reducing manual labor. In aquaponics, where fish farming is integrated with hydroponics, these advancements create a closed-loop ecosystem where fish waste fertilizes plants, and plants filter the water in return, making it a sustainable solution gaining traction in resource-limited areas like India. An Android application further enhances this system by providing farmers with real-time alerts and remote access to monitor and adjust conditions as needed, making management convenient and effective, even on the go.

II. PROBLEM STATEMENT

The core issue in fish farming and aquaponics systems stems from the inability to consistently maintain optimal environmental conditions, a challenge that directly impacts fish health, plant growth, and overall productivity. Traditional methods are often labor-intensive and rely on manual monitoring and intervention, which can lead to inefficiencies such as water pollution, inconsistent water quality, suboptimal feeding practices, and inadequate waste management. These challenges not only increase operational costs and labor demands but also make it difficult to ensure a stable environment conducive to maximizing fish and plant yields. With growing environmental concerns and the need for more sustainable food production systems, there is a pressing demand for advanced solutions that can reduce resource use and improve system efficiency. An automated system capable of real-time monitoring and management is essential to address these challenges effectively. Leveraging the Internet of Things (IoT) and automation technologies, such a system can monitor critical parameters like pH levels, temperature, oxygen, and nutrient levels, allowing for timely adjustments and consistent control over the aquaponics environment. Additionally, remote access via an Android application can provide fish farmers with the convenience of monitoring and adjusting system settings from anywhere, thereby reducing on-site labor requirements and the risk of human error.

This proposed IoT-enabled and automated solution aims to revolutionize aquaponics by making it more scalable, sustainable, and user-friendly. By integrating sensor technology, automated feeding, and water management controls, along with a user-friendly mobile application, the system can optimize resource use, enhance fish and plant productivity, and promote sustainable practices within the fish farming industry. Such a comprehensive solution addresses current challenges while advancing fish farming and aquaponics toward a more reliable, accessible, and environmentally friendly future.

III. SYSTEM DESIGN

1. Block Diagram

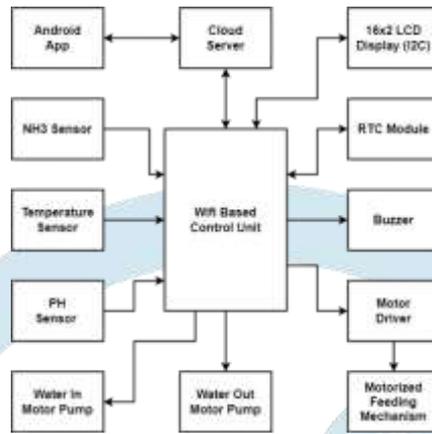


Figure 1: Block diagram

Based on the block diagram, Fishify's smart aquaponics management system integrates various components to automate and optimize fish farming operations. In the center of the system is a Wi-Fi-based control unit, which communicates with sensors, motorized mechanisms, and an Android app to ensure efficient operation. The system includes essential sensors for monitoring water quality, such as pH, ammonia (NH₃), and temperature sensors. These sensors provide real-time data that the control unit processes and transmits to the cloud server for storage and remote monitoring through the Android app.

Water management is handled by motor pumps for freshwater inflow and polluted water outflow, as shown in the diagram. A motorized feeding mechanism ensures timely and precise. The system includes essential sensors for monitoring water quality, such as pH, ammonia (NH₃), and temperature sensors. These sensors provide real-time data that the control unit processes and transmits to the cloud server for storage and remote monitoring through the Android app.

Water management is handled by motor pumps for freshwater inflow and polluted water outflow, as shown in the diagram. A motorized feeding mechanism ensures timely and precise.

2. Circuit Diagram

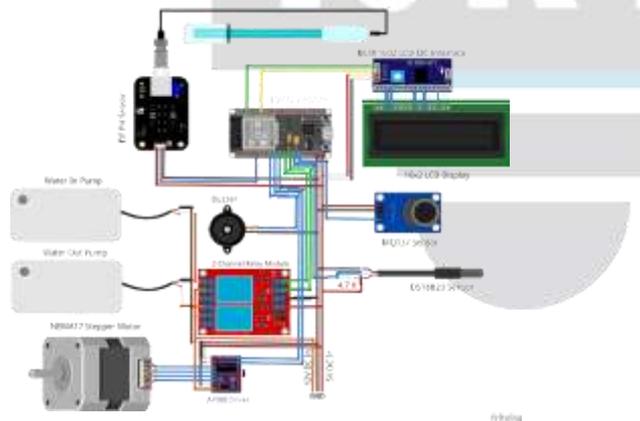


Figure 2: Circuit diagram

This circuit diagram illustrates a real-time, IoT-enabled water quality monitoring and management system for fish farms, using an ESP32 microcontroller as the central control unit. The system incorporates key sensors, including a pH sensor, an MQ137 ammonia sensor, and a DS18B20 temperature sensor, all of which provide vital data on the water's pH level, ammonia concentration, and temperature. When sensor readings indicate that water quality parameters are outside safe thresholds, ESP32 activates water pumps through a 2-channel relay module, which either adds or removes water to maintain optimal conditions. In addition, a NEMA17 stepper motor, driven by an A4988 motor driver, may serve as part of an automated feeding or cleaning mechanism. A buzzer alerts users to abnormal readings, while a 16x2 LCD connected via I2C shows real-time data locally. The Wi-Fi capability of ESP32 allows remote monitoring, allowing fish farm operators to track and adjust water quality from mobile devices or a cloud platform, making the system efficient, automated, and easily manageable.

IV. METHODOLOGY

a) Data Collection

Fishify collects data from multiple sensors to monitor and manage the aquaponics environment efficiently. The key steps involved are as follows:

- **Sensor Measurement:**
 - pH Sensor: Continuously measures the acidity or alkalinity of the water.
 - Ammonia (NH₃) sensor: Detects ammonia levels to prevent toxic buildup.
 - Temperature Sensor: Monitors water temperature to maintain optimal conditions for fish and plant growth.
 - **Data Transmission:** The sensors are connected to a Wi-Fi-based control unit that captures the readings and prepares the data for further processing.
 - **Data Processing:** The control unit processes sensor readings, filters out anomalies, and converts raw data into meaningful values for decision-making.
 - **Cloud and App Integration:** The processed data is transmitted to a cloud server for storage and is made accessible through an Android app for remote monitoring in real-time by users.
- This efficient data collection setup ensures accurate and up-to-date information to maintain a balanced aquaponics environment while reducing manual monitoring efforts.

b) Data Processing

The data processing in Fishify involves several stages to ensure accurate and actionable insights for effective system management:

- **Data Acquisition:** The Wi-Fi-based control unit receives real-time data from sensors measuring pH, ammonia levels, and water temperature.
- **Data Filtering:** The system filters out noise and erroneous data, removing spikes or anomalies to maintain reliable information for decision-making.
- **Data Validation:** Sensor readings are cross-checked with predefined threshold ranges to ensure data accuracy and consistency.
- **Data Analysis:** The control unit analyzes the data to detect patterns, identify potential issues, and determine if corrective actions are needed, such as adjusting water levels or feeding schedules.
- **Triggering Actuators:** Based on analysis results, the system automatically activates water pumps for water exchange or the motorized feeding mechanism for scheduled feeding.
- **Data Storage:** Processed data is sent to a cloud server for storage, enabling historical tracking and analytics.
- **User Notification:** Alerts and notifications are generated for critical conditions and sent to the Android app for immediate user attention.
- **App Visualization:** Processed data is presented in a user-friendly format on the Android app, allowing farmers to monitor system performance and make informed decisions.

This systematic processing ensures that Fishify delivers accurate, actionable insights while automating essential functions for efficient aquaponics management.

c) Model Architecture

The Smart Aquaponics Management System integrates sensors, a control unit, motorized components, and cloud connectivity for automated fish farming and aquaponics management.

Key Components:

- **Sensor Network:** Includes NH₃, pH, and temperature sensors for real-time water quality monitoring.
- **Central Control (ESP32):** Processes sensor data, controls pumps, feeding mechanisms, and handles communication with external components.
- **Water Management:** Automated water exchange using motor pumps to maintain water quality.
- **Feeding Mechanism:** A motorized system controlled by the RTC module for precise, scheduled feeding.
- **User Interaction:** LCD for on-site monitoring, a buzzer for alerts, and an Android app for remote control and data viewing.
- **Cloud Integration:** Uploads data to a cloud server for real-time monitoring through the Android app.

Data Processing Flow: The ESP32 initializes, reads sensor data, checks water quality, controls pumps and manages feeding schedules. The system updates the cloud and app, providing real-time monitoring and alerts.

This architecture ensures efficient and sustainable aquaponics management with minimal human intervention.

V. CONCLUSION

In conclusion, Fishify represents a significant advancement in smart aquaculture systems, providing a comprehensive and automated solution for fish farm management. By integrating IoT-based sensors and intelligent control mechanisms, the system ensures real-time monitoring and maintenance of critical parameters such as water quality, feeding schedules, and environmental conditions. The user-friendly Android application enhances accessibility and allows remote monitoring, ensuring farm operations can be efficiently managed with minimal human intervention. The use of a cloud-based server for data storage and analysis empowers farmers to make informed decisions based on historical trends and predictive analytics. Automated water management and feeding systems not only reduce operational costs but also improve the overall health and growth of the aquatic stock. Furthermore, the system's scalable and modular design allows for customization to cater to the needs of various aquaculture setups.

By offering a sustainable, efficient, and technologically advanced approach, Fishify has the potential to revolutionize traditional aquaculture practices and contribute significantly to the global demand for smart farming solutions. As the industry evolves, Fishify stands as a promising tool to enhance productivity, reduce resource wastage, and promote sustainable aquaculture practices.

Acknowledgment

We would like to express our heartfelt gratitude to Dr. Nithin C, Head of the Department of Electronics and Communication Engineering, and Ms. Sreetha Sreedhar K, Assistant Professor, for their constant support, valuable guidance, and encouragement throughout the development of this project.

We are also thankful to the faculty and staff of St. Thomas College of Engineering and Technology, Mattannur, for providing the resources and environment necessary to complete this work. Finally, we sincerely appreciate the efforts of all our team members for their dedication, collaboration, and continuous learning spirit which made *FISHIFY* a successful endeavor.

REFERENCES

- [1] Punya Prabha V1 , Sarala S M2 , Sharmila Suttur C3 "Robust Smart Irrigation System using Hydroponic Farming based on Data Science and IoT," IEEE Access, 08-10 October 2020, doi: 10.1109/B- HTC50970.2020.9297842.J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
- [2] Istiaque Aliamed, Abir Ahmed: "Design of Smart Biofloc for Real-Time Water Quality Management System" IEEE Access, vol. 11, pp. xxxx- xxxx, 01 February 2021, doi: 10.1109/ICREST51555.2021.9331166.K. Elissa, "Title of paper if known," unpublished.
- [3] Chiung-Hsing Chen Yi-Chen Wu, Jia-Xiang Zhang, and Ying- Hsiu Chen 2, "IoT-Based Fish Farm Water Quality Monitoring Sys- tem," MDPI Access, 5 September 2022, [ONLINE] AVILABLE: <https://doi.org/10.3390/s22176700Y>. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
- [4] Chen Kai, Zhu Weiweiv, Dou Lu, "Research on Mobile Water Quality Monitoring System Based on Underwater Bionic Robot Fish Platform, IEEE Access, OCT 2020, doi: 10.1109/AEECA49918.2020.9213466
- [5] Wu, Y.-C.; Chen, C.-H.; Kao, S.-E.; Chen, J.-J, "Fish Farm Man- agement System Based on IoT. In Proceedings of the IEEE Inter- national Symposium on Intelligent Signal Processing and Commu- nication Systems," 2023 4th International Conference for Emerging Technology (INCET), Belgaum, India, 2023, pp. 1-6, doi: 10.1109/IN- CET57972.2023.10170317.
- [6] Lin, J.-Y.; Tsai, H.-L.; Lyu,W.-H."An IntegratedWireless Multi-Sensor System for Monitoring the Water Quality of Aquaculture," Sensors 2021, 21, 8179. [PubMed]Inf. Process. Syst. (NeurIPS), 2019.
- [7] Sung, W.T.; Chen, J.H.; Wang, H.C. Remote fish aquaculture monitoring system based on wireless transmission technology. In Proceedings of the International Conference on Information Science, Electronics and Electrical Engineering, Sapporo, Japan, 26–28 April 2014.
- [8] Billah, M.M.; Yusof, Z.M.; Kadir, K.; Ali, A.M.M.; Ahmad, I. Quality Maintenance of Fish Farm: Development of Real- time Wa- ter Quality Monitoring System. In Proceedings of the IEEE In- ternational Conference on Smart Instrumentation, DOI: 10.1109/IC- SIMA47653.2019.9057294 Measurement and Application, Kuala Lumpur, Malaysia, 27–29 August 2019.
- [9] Chacko, V.; Bharati, V. Data Validation and Sensor Life Prediction Layer on Cloud for IoT. In Proceedings of the IEEE International Conference on Internet of Things IEEE Green Computing and Communications and IEEE Cyber, Physical and Social Computing and IEEE Smart Data, Exeter, UK, 21–23 June 2017.
- [10] Simbeye, D.S.; Yang, S.F.Water Quality Monitoring and Control for Aquaculture Based on Wireless Sensor Networks. J. Netw. 2014, 9, 840–849. [CrossRef] V