



(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



### Impact Factor: 8.699

## Volume 14, Issue 5, May 2025

⊕ www.ijirset.com 🖂 ijirset@gmail.com 🖄 +91-9940572462 🕓 +91 63819 07438





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

#### Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405067|

## **Smart Aquaculture: An IoT-Based Water Quality Monitoring System in Fishery**

#### T.Ruba<sup>\*1</sup>, R.Tamilselvi<sup>2</sup>, M.Parisabeham<sup>3</sup>, R.Vishnu<sup>4</sup>, S.Dinesh<sup>5</sup>, M.Ponraj<sup>6</sup>

Assistant Professor, Department of ECE, Sethu Institute of Technology, Virudhunagar, Tamil Nadu, India<sup>1</sup>

Professor, Department of ECE, Sethu Institute of Technology, Tamil Nadu, India<sup>2,3</sup>

UG Student, Department of ECE, Sethu Institute of Technology, Virudhunagar, Tamil Nadu, India<sup>4,5,6</sup>

**ABSTRACT:** Water quality is a crucial factor in aquaculture, directly affecting fish health, growth, and farm productivity. Traditional manual monitoring methods are labor-intensive and inefficient. This project proposes an IoT-enabled water quality monitoring system that automates the measurement of key parameters such as pH, temperature, dissolved oxygen, turbidity, and conductivity. The system employs sensor-based data collection and wireless transmission to provide real-time monitoring for aquaculture farmers. A Raspberry Pi Pico microcontroller integrates multiple sensors to track water quality parameters, transmitting the data via GSM technology to a cloud-based IoT dashboard (Ubidots) for remote monitoring. This real-time system allows farmers to respond proactively to water quality changes, reducing fish mortality and optimizing environmental conditions. The system significantly reduces manual labor dependency while enhancing sustainability and efficiency in aquaculture. By providing automated alerts and historical data analysis, it enables better resource management and aligns with the global movement toward smart and eco-friendly fish farming practices.

KEYWORDS: Aquaculture, automatic, water quality monitoring, sensor, IoT

#### I. INTRODUCTION

India's fisheries sector has set an ambitious target to increase fish production to 22 million tonnes by 2024-25, up from 17.4 million tonnes in 2022-23. To achieve this, the Pradhan Mantri Matsya Sampada Yojana (PMMSY) aims to add 7 million tonnes to the annual fish production by 2024-25 [1,2]. The Internet of Things (IoT) is playing a pivotal role in realizing these objectives by enhancing aquaculture practices. IoT enables the deployment of sensor networks to monitor critical water parameters—such as oxygen levels, temperature, and salinity—thereby ensuring optimal conditions for aquatic life. These real-time data streams facilitate informed decision-making, leading to improved productivity and sustainability in fish farming [3,4].

The Water Quality Monitoring System is designed to ensure optimal aquatic conditions for fish farming by continuously monitoring key water parameters. This system integrates IoT technology to provide real-time data, minimizing manual intervention and improving fish health and farm productivity. The integration of Internet of Things (IoT) technology is reshaping aquaculture by introducing innovative solutions that enhance productivity, reduce labor dependency, and promote environmental sustainability. By enabling real-time monitoring of vital parameters such as water quality, oxygen levels, and feeding patterns, IoT improves fish health and optimizes growth rates. Additionally, automation of processes like feeding, cleaning, and harvesting minimizes manual intervention, significantly increasing operational efficiency.

The demographic shift in the agricultural workforce, characterized by an aging population, poses a significant challenge to the aquaculture industry. IoT technology can address this issue by modernizing operations and attracting younger generations to the field. By integrating cutting-edge technology into traditional practices, the industry becomes more dynamic and appealing, ensuring a steady influx of skilled talent.





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

#### Volume 14, Issue 5, May 2025

#### |DOI: 10.15680/IJIRSET.2025.1405067|

**II. RELATED WORKS** 

Maheshi Jayasinghe, Awasha Wet tewa, Bhagya Senanayake, Sashintha Dasanayake, Sanjeevi Chandrasiri, Suriyaa Kumari (2024) [5]

This research introduces a low-cost water quality monitoring system that measures key parameters including turbidity, total dissolved solids (TDS), temperature, pH, and dissolved oxygen using sensors integrated with IoT technology. The system, powered by a solar-charged lead-acid battery, stores data locally on a micro-SD card and provides real-time updates accessible via a mobile device. Data was collected over three weeks from three different bodies of water during the autumn to winter transition. Key findings include a gradual drop in temperature, an inverse correlation between pH and temperature, a decrease in TDS levels during rainy periods, and fluctuations in turbidity linked to varying weather conditions. Additionally, fish growth detection is performed to identify different growth stages of 1-6-month-old goldfish, and the ResNet50 achieved 85.5% accuracy. By integrating all three aspects, the proposed approach aims to provide a comprehensive and cost-effective solution for aquarium care, thus enhancing environmental management and water resource monitoring.

Chiung-Hsing Chen, Yi-Chen Wu, Jia-Xiang Zhang, and Ying-Hsiu Chen (2022) [6] The study addresses the challenges faced by Taiwan's aquaculture industry, such as typhoons, cold snaps, and labor shortages. The researchers developed a system using wireless transmission technology and sensors to monitor crucial water quality parameters (temperature, pH, water level, and sensor life expectancy) in fish farms. The data is transmitted to mobile devices via the Internet of Things (IoT), enabling remote monitoring. To overcome the limitations of current pH sensors, which cannot be submerged for long periods, this system allows for continuous 24-hour operation, reducing resource loss and human error while improving efficiency in aquaculture management.

Anamika Yadava ,et.al( 2022) [7] A smart aquaculture management system (SAMS) based on the Internet of Things (IoT) has recently gained much attention for fulfilling the growing demand for aquaculture products. The SAMS uses cutting-edge sensing technologies with a modern networking system to continuously monitor water quality, animal health, and feeding behavior to improve production yield. This review aims to comprehensively summarize and discuss the recent advancements in IoT-based technologies, e.g., sensor nodes, software interfacing, artificial intelligence, cloud computing, and storage, to develop reliable and robust SAMS for small- and large-scale aquaculture production modules. A future perspective section is included at the end of this review to recommend the needed research to scale up the related digital technologies for application in aquaculture farms. The knowledge in this thorough review can be useful for the scientific community for advancements in IoT technologies and for aquaculture farmers to adopt modern SAMS for improving benefit-cost ratios.

Juan Huan, et al. (2020) [8] Developed a water quality monitoring system for aquaculture ponds using Narrowband IoT (NB-IoT) technology to enable remote data collection, intelligent control, and centralized pond management. The system employs an STM32L151C8 microcontroller and multiple sensors to measure temperature, pH, and dissolved oxygen, transmitting data to an IoT telecom cloud platform for real-time monitoring. It integrates Keil software for wireless communication formatting and Java-based applications for cloud access, device control, and local data processing. The system can send HTTP requests for cloud data retrieval and issue commands for controlling equipment like aerators. Tested in Changzhou, Jiangsu, China, the system demonstrated high accuracy: temperature ( $\pm 0.12^{\circ}$ C, 0.15% error), dissolved oxygen ( $\pm 0.55$  mg/L, 2.48% error), and pH ( $\pm 0.09$ , 0.21% error). The results confirmed stable operation, real-time accurate data transmission, and strong support for aquaculture management and water quality regulation.

**Muhammad Iskandar Dzulqornain, et al. (2018) [9]** Discuss the rapid growth of IoT technology and its application in aquaculture to address challenges in water quality monitoring. Their proposed system integrates real-time monitoring and control using the If This Then That (IFTTT) model and cloud computing. It consists of a smart sensor module (measuring dissolved oxygen, pH, temperature, and water level), a smart aeration system (using a NodeMCU microcontroller, relay, power supply, and propeller for oxygenation), a local network, and client visualization via web and mobile applications. The system enables customizable and automated control of water conditions, making aquaculture monitoring more efficient, dynamic, and scalable.





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

#### Volume 14, Issue 5, May 2025

#### |DOI: 10.15680/IJIRSET.2025.1405067|

**Vijayakumar Thangavel, et.al (2019) [10]** This paper proposes an IoT-enabled smart aquaculture system designed to improve water quality management, feed regulation, and fish health monitoring. The system consists of a sensor network deployed in water, fishponds, and even on fish, collecting real-time data. A Raspberry Pi-based gateway processes the data and uploads it to a cloud server, where farmers can access insights for better decision-making. The cloud server also employs machine learning algorithms to predict optimal feeding rates and diagnose fish diseases. Experimental results confirm the system's efficiency in monitoring water conditions, managing feed, and diagnosing diseases, ensuring sustainable aquaculture practices.

From these literature, it is clearly noted that the aquaculture has undergone significant technological advancements, with smart aquaculture emerging as a key trend for sustainable and automated fish farming. Water quality is a crucial factor that determines aquaculture success, as poor conditions lead to fish mortality, reduced productivity, and economic losses.

Oxygen depletion further threatens fish survival, requiring constant monitoring to maintain optimal conditions. Additionally, environmental factors, pollution, and ineffective management degrade aquatic product quality, affecting market value and long-term sustainability. Addressing these challenges requires an automated, real-time monitoring system capable of ensuring stable water conditions to promote fish health and farm efficiency.

#### **III. METHODOLOGY**

It comprises of various modules including sensor modules, controller, and LCD display module. This is explained in the following sections.

Water quality is a crucial factor in aquaculture, Traditional monitoring methods require manual sampling, which can be inefficient and time-consuming. Advanced Aquaculture Management System For Sustainable Fish Farming that provides real-time monitoring, automated alerts, and remote accessibility. The system integrates sensors, a microcontroller, power management modules, wireless communication, and a cloud-based dashboard to ensure continuous monitoring.One key feature of this system is its Ubidots Iot-Based Computer Dashboard, which provides a graphical representation of water quality parameters such as temperature, pH, turbidity, dissolved oxygen, and water level. This allows users to monitor water conditions remotely and respond to changes efficiently.



Fig 3.1 Water Quality Monitoring System

11844





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

#### Volume 14, Issue 5, May 2025

#### |DOI: 10.15680/IJIRSET.2025.1405067|

#### **3.3.1 SYSTEM ARCHITECTURE**

The system consists of several integrated components to ensure efficient monitoring and management of aquaculture conditions. At its core, the Core Processing Unit utilizes a **Raspberry Pi Pico**, responsible for collecting and analyzing sensor data. The Sensor Modules include **pH**, **Dissolved Oxygen (DO)**, **Turbidity**, **Temperature**, **and Water Level sensors**, which continuously monitor critical water parameters. To support uninterrupted operation, the Power Supply Components consist of a **solar panel**, Li-ion battery, and voltage regulators, ensuring sustainable and reliable energy. For seamless **Communication & Data Storage**, **a GSM module** enables remote data transmission, while an SD card stores data locally. The system also features Display & IoT Dashboard capabilities, incorporating an **OLED display** for on-site monitoring and an **Ubidots-based computer dashboard** for remote access and analysis. To enhance durability in harsh environments, the entire setup is housed in a Protective Enclosure made of PVC fitment boxes, safeguarding the components from external damage.

#### **3.3.2 SYSTEM COMPONENTS AND FUNCTIONALITY**

The proposed aquaculture monitoring system is designed with multiple hardware and software components to ensure efficient data acquisition, processing, and remote accessibility. Each component plays a crucial role in maintaining optimal water quality and detecting abnormalities in real time.

#### Core Processing Unit - Raspberry Pi Pico

The Raspberry Pi Pico is a compact and efficient microcontroller powered by the RP2040 dual-core Arm Cortex-M0+ processor, running at 133 MHz. It operates at 3.3V, features 26 GPIO pins with three analog inputs, and supports I2C, SPI, and UART communication. With low power consumption and MicroPython/C++ support, it is ideal for IoT, automation, and environmental monitoring, including aquaculture systems for data acquisition and processing



Fig 3.2 RPI Raspberry Pi Pico

#### SENSOR MODULES

**PH SENSOR** : The pH sensor measures the acidity or alkalinity of water, which is critical for the survival and growth of aquatic species. Most fish thrive in a pH range of 6.5 to 8.5. Extreme pH levels can cause stress, poor growth, and disease outbreaks. This sensor helps farmers adjust water chemistry using lime or acids to maintain an optimal environment.



Fig 3.3 pH Sensor

#### **DISSOLVED OXYGEN SENSOR :**

Oxygen is essential for fish respiration and microbial balance. A DO sensor measures the oxygen content in water, ensuring adequate levels for fish survival. Low oxygen levels can lead to suffocation, reduced growth, and mass fish deaths. This sensor aids in controlling aeration systems to maintain optimal dissolved oxygen levels.





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

#### Volume 14, Issue 5, May 2025

#### |DOI: 10.15680/IJIRSET.2025.1405067|



#### Fig 3.4 Dissolved Oxygen Sensor

#### TURBIDITY / CONDUCTIVITY SENSOR :

The turbidity sensor assesses water clarity by detecting suspended particles like algae, dirt, and waste. High turbidity can reduce light penetration, affecting aquatic plant growth and leading to poor water quality. The conductivity sensor measures the dissolved salts and minerals, indicating changes in water composition due to contamination. These sensors help in filtering and water exchange processes to maintain a clean and healthy environment.



Fig 3.5 Turbidity Sensor

#### **TEMPERATURE SENSOR** :

Water temperature directly influences metabolism, oxygen levels, and immune responses in aquatic organisms. Fish species have specific temperature preferences, and deviations can cause stress, slow growth, and even mortality. The temperature sensor helps in maintaining the ideal range by triggering cooling or heating systems when necessary.



Fig 3.6 Temperature Sensor

#### WATER LEVEL SENSOR :

A water level sensor monitors the depth of water in ponds, tanks, or reservoirs. Fluctuations in water level can affect oxygen concentration, temperature stability, and waste accumulation, impacting fish health. This sensor prevents overflow and depletion, ensuring a stable habitat by automating water refilling and drainage systems.





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

#### Volume 14, Issue 5, May 2025

#### |DOI: 10.15680/IJIRSET.2025.1405067|



Fig 3.7 Water Level Sensor

#### **3.3.4 POWER SUPPLY COMPONENTS**

A stable power supply is crucial for uninterrupted system operation. The system utilizes a 3.7V Li-ion battery for consistent power, coupled with a TP4056 Charger Module to ensure safe charging and prevent overcharging. A 6V/3W solar panel provides renewable energy, reducing reliance on external power sources. Additionally, an XL6009B Buck Boost Converter regulates voltage to maintain consistent performance across all system components.

#### 3.3.5 COMMUNICATION & DATA STORAGE

The system incorporates a GSM module for wireless communication, allowing remote data transmission to cloud-based platforms and SMS alerts for abnormal water conditions. Additionally, an SD Card Reader Module with a 4GB SD Card is used for local data storage, ensuring sensor readings are recorded and available for offline analysis.

#### 3.3.6 IOT DASHBOARD AND DISPLAY

#### **On-Site and Remote Monitoring System**

To enhance accessibility and efficiency, the system integrates both on-site and remote monitoring capabilities. A 0.96" OLED Display provides real-time water quality updates directly at the site, ensuring immediate visibility of key parameters. Additionally, the Ubidots IoT Dashboard enables remote monitoring via smartphones or computers, offering a user-friendly interface with essential features such as date/time display, water temperature, pH levels, turbidity, conductivity, dissolved oxygen, and water level monitoring.

The dashboard also includes a map-based location tracking system for precise monitoring. With graphical data representation and automated alerts for unsafe conditions, the system ensures proactive management, helping maintain optimal aquaculture conditions while reducing manual intervention.

#### **IV. EXPERIMENTAL RESULTS**

The prototype of the water quality monitoring system is illustrated in Figures 5.1 and 5.2. It consists of sensor modules, a controller, LCD display, IoT Dashboard using UBIDOTS to monitor key water parameters such as pH, temperature, dissolved oxygen, and turbidity,water level. The system ensures accurate water quality assessment, providing essential data for maintaining optimal aquaculture conditions.





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

#### Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405067|



#### Fig 5.1 Prototype of Water Quality Monitoring System

👀 ubidots	Devices • Data •	Apps 💿 - Dev Center -	💿 🛛 🔺 🕥 -
≡ Fish pond monitoring system			
Fish pond monitoring system	Date/Time 10:48:24 20/02/2025	Temperature   35.37°C   Last Updated: 02/20/20/5 10/29	Water level 11.00%
Water PH	Water Turbidity (NTU)	Water DO Lest voire O.O.O. peur Lest updates: condersons 1009	Pond location

#### Fig 5.2 Result of Water Quality Monitoring System

#### V. CONCLUSION

The IoT-enabled water quality monitoring system provides an efficient and automated solution for aquaculture, addressing challenges related to water quality, fish health, and farm productivity. By integrating real-time sensor data, automated alerts, and remote accessibility, the system enhances aquaculture sustainability while reducing manual intervention. Experimental results demonstrate the system's high accuracy in tracking water parameters, ensuring optimal environmental conditions for fish farming. The Ubidots IoT dashboard offers graphical insights, historical data analysis, and real-time alerts, allowing farmers to take proactive measures to maintain water quality. The adoption of this smart aquaculture system supports Sustainable Development Goals (SDGs) 8, 9, 12, and 14, promoting responsible fish farming, economic growth, and environmental conservation. Future advancements in AI-driven analytics, cloud-based monitoring, and predictive modeling can further enhance system capabilities, making aquaculture more efficient, scalable, and sustainable.





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

#### Volume 14, Issue 5, May 2025

#### |DOI: 10.15680/IJIRSET.2025.1405067|

#### REFERENCES

- 1. The scheme "Pradhan Mantri Matsya Sampada Yojana (PMMSY)" was launched by the Department of Fisheries, The Hindu Lines
- 2. https://www.fnbnews.com/Top-News/pradhan-mantri-matsya production-of-70-lakh-metric-tonnes-by-202425-8025 sampada-yojana-envisages-to-add-fish-
- 3. Commissioner of Fisheries Agriculture , Farmer & Welfare Department Gujarat Report .Last Updated 20/02/2025 .
- 4. Chaitanya & Chalalamala (June 2023) Unveiling the Internet of Things (IoT) Applications in Aquaculture: A Survey and Prototype Design with ThingSpeak Analytics Journal of Ubiquitous Computing and Communication Technologies.
- 5. Jayasinghe, M., Wettewa, A., Senanayake, B., Dasanayake, S., Chandrasiri, S., & Kumari, S. (2024). A Low-Cost IoT-Based Water Quality Monitoring System for Aquaculture. Sustainable Aquaculture & Fisheries Journal.
- 6. Chen, C.-H., Wu, Y.-C., Zhang, J.-X., & Chen, Y.-H. (2022). IoT-based Remote Monitoring System for Taiwan's Aquaculture Industry. Environmental Monitoring and Assessment, 194(2).
- 7. Yadava, A., et al. (2022). Smart Aquaculture Management System (SAMS) Based on IoT for Water Quality and Animal Health Monitoring. International Journal of Aquaculture Technology & Management.
- 8. Huan, J., et al. (2020). Water Quality Monitoring System for Aquaculture Using NB-IoT. IEEE Internet of Things Journal.
- 9. Dzulqornain, M. I., et al. (2018). IoT-based Aquaculture Water Quality Monitoring System Using Real-time Data and Cloud Computing. Proceedings of the IEEE International Conference on Smart Cities and Innovation.
- Thangavel, V., Verma, N. K., Packirisamy, M., & Teekaraman, Y. (2019). An IoT-Enabled Smart Aquaculture System for Water Quality Monitoring, Feed Management, and Fish Health Management. IEEE Internet of Things Journal. DOI: 10.1109/JIOT.2019.2933437.









# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY





www.ijirset.com