Journal of Science Engineering Technology and Management Science
Volume 02, Issue 07, July 2025 *ISSN: 3049-0952*
www.jsetms.com *DOI:10.63590/jsetms.2025.v02.i07.465-470*

SMART AQUACULTURE A CLOUD-ENABLED IOT FRAMEWORK FOR REAL-TIME WATER QUALITY MONITORING AND MANAGEMENT

Shaik Imam Vali, Y. Vishwa Sri, Karthik Reddy Koppula, Saisharath Allivadha, Mekala Abhilash Reddy, Ramavath Parashuram
Department of Electronics and Communication Engineering, Kommuri Pratap Reddy Institute of Technology, Ghatkesar , Medchal, 500088.

To Cite this Article
Shaik Imam Vali, Y. Vishwa Sri, Karthik Reddy Koppula, Saisharath Allivadha, Mekala Abhilash Reddy, Ramavath Parashuram, "Smart Aquaculture A Cloud-Enabled Iot Framework For Real-Time Water Quality Monitoring And Management", Journal of Science Engineering Technology and Management Science, Vol. 02, Issue 07, July 2025,pp: 465-470, DOI: http://doi.org/10.63590/jsetms.2025.v02.i07.pp465-470
Submitted: 12-05-2025 *Accepted: 19-06-2025* *Published: 28-06-2025*

ABSTRACT
This research introduces an intelligent, IoT-enabled poultry farming system powered by the ESP32 microcontroller, aimed at automating and optimizing crucial environmental and operational parameters for efficient and healthy poultry production. The system integrates several input modules: an RTC (Real-Time Clock) for scheduling tasks, Bluetooth for wireless connectivity, a DHT11 sensor for monitoring temperature and humidity, a pH sensor for assessing water quality, and an ultrasonic sensor for measuring feed or water levels. These components continuously collect data, which is processed by the ESP32 in real-time.In response to the sensor inputs, the system activates output devices, including an LCD to display live environmental readings, a buzzer for alert notifications, and a servo-operated pump to automatically dispense water or nutrients as needed. Additionally, the system enables remote monitoring and control through IoT platforms, empowering farmers to manage their poultry environment from any location. This enhances farm efficiency, improves animal health and welfare, minimizes manual intervention, and reduces operational costs. The proposed system is scalable, energy-efficient, and adaptable for both smallholder and commercial poultry operations, offering a robust solution for modern poultry farm management.

Keywords: IoT, ESP32, Smart Poultry Farming, Real-Time Monitoring, DHT11, pH Sensor, Ultrasonic Sensor, Automation, Remote Control, Environmental Optimization.

INTRODUCTION

Aquaculture is a critical component of global food security, offering a sustainable method for producing fish and seafood to meet increasing population demands. However, conventional fish farming techniques often suffer from challenges such as labor-intensive monitoring, inefficient feeding practices, and inadequate water quality management, which can compromise both productivity and aquatic health. The emergence of the Internet of Things (IoT) and automation technologies offers transformative potential to modernize aquaculture through real-time, intelligent, and efficient systems.This project introduces a Smart Aquaculture System powered by the ESP-32 microcontroller, designed to automate environmental monitoring, feeding, and water management in fish farming operations. The ESP-32 serves as the central processing unit, integrating a suite of sensors and actuators to collect, process, and respond to real-time environmental data. Key components include temperature and humidity sensors for habitat monitoring, a turbidity sensor for assessing water clarity, a real-time clock (RTC) module to ensure scheduled feeding, and a Bluetooth module to facilitate local control. The system is complemented by an LCD display for real-time status updates and a motorized feeder to dispense food automatically. Water quality is regulated through inlet and outlet pumps, which operate based on sensor feedback to maintain optimal conditions.

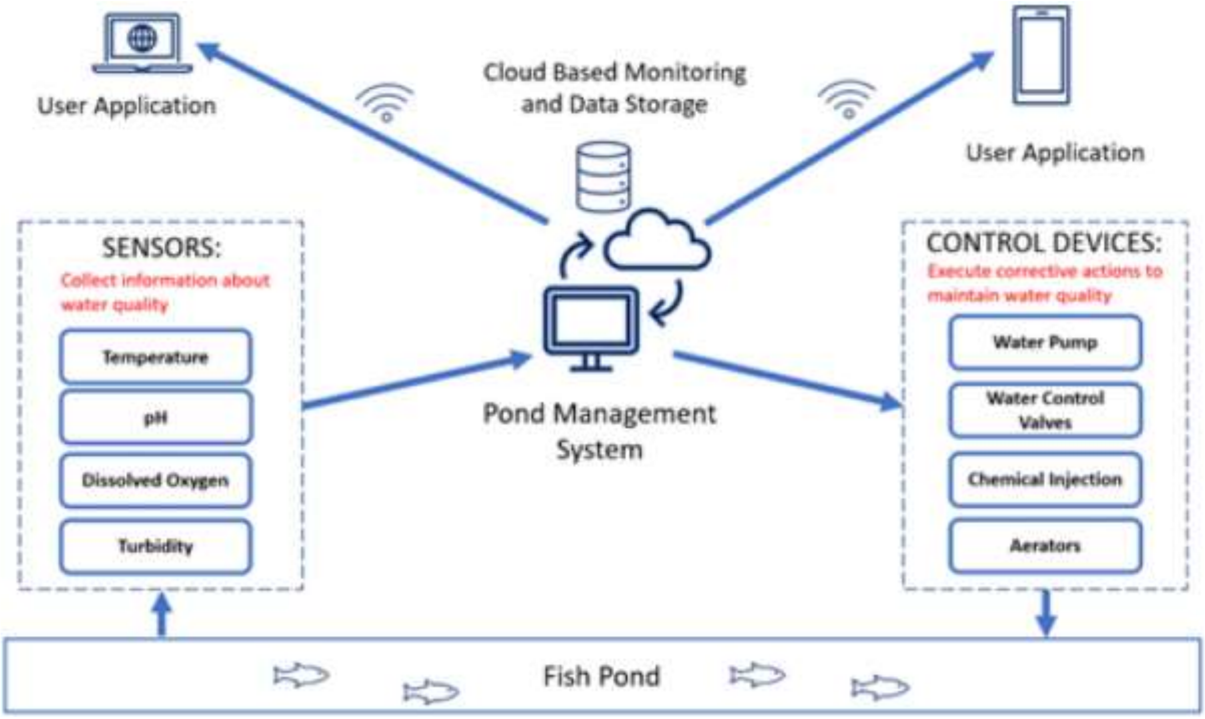

Fig. 1: Design and development of an Iot based intelligent water quality.

A regulated power supply supports stable system functionality, while Bluetooth connectivity ensures accessibility in remote areas lacking internet infrastructure. Farmers can interact with the system via mobile devices, modifying settings and receiving alerts on parameters such as water quality or feeding times. Additionally, IoT integration enables remote access, cloud-based data storage, and analytics, allowing users to monitor multiple sites, review historical data trends, and make informed operational decisions.One of the system's core benefits lies in its ability to significantly reduce manual labor and human error. Automated feeding schedules reduce overfeeding and associated waste, thereby conserving resources and preserving water quality. Similarly, real-time water quality monitoring and responsive pumping actions prevent harmful fluctuations, promoting fish health and reducing disease risk.This system is both scalable and energy-efficient. Its modular design allows for the addition of extra sensors, such as pH or dissolved oxygen probes, enabling comprehensive environmental surveillance. Future enhancements could include AI-driven analytics, machine learning-based behavioral prediction, SMS or mobile alerts, and integration with wireless sensor networks for broader data coverage.In summary, the Smart Aquaculture System represents a robust and adaptable solution for sustainable fish farming. It merges IoT, automation, and data-driven insights to improve operational efficiency, environmental control, and yield outcomes. By addressing the limitations of traditional practices and empowering farmers with accessible technology, this project contributes meaningfully to the evolution of modern aquaculture and sustainable food production.

2. LITERATURE SURVEY

Aquaculture, the controlled farming of aquatic species, plays a crucial role in global food production. Ensuring optimal water quality, proper nutrition, efficient breeding, and protection from diseases and predators are fundamental aspects of successful aquaculture practices [1]. The industry has experienced significant growth, with aquaculture production increasing at an annual rate of at least three percent between 2011 and 2019 [2]. This expansion is largely driven by the rising global population and the depletion of wild aquatic resources. However, numerous challenges persist in aquaculture, such as resource inefficiency, environmental concerns, and disease management, which must be addressed to ensure sustainable production [3].

One of the most pressing challenges is maximizing yield while optimizing resource utilization. This issue can be mitigated through precision aquaculture, which incorporates advanced technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT) to enhance efficiency, sustainability, and environmental conservation [4, 5]. Unlike traditional aquaculture, which relies on manual experience and observation, precision aquaculture leverages data-driven approaches to improve decision-making and automate key processes [6].

A subset of precision aquaculture, smart aquaculture, also known as intelligent aquaculture or digital aquaculture, integrates modern technologies such as sensors, computer vision, and AI to enhance productivity and sustainability [7, 8]. These technologies allow for real-time monitoring and automated decision-making, reducing labor costs and increasing operational efficiency [9]. Among these innovations, IoT plays a critical role by enabling seamless communication between various sensors and devices within aquaculture systems.

3. PROPOSED METHODOLOGY

The proposed system enhances the automation and monitoring of the fish farm using an advanced ESP-32 microcontroller, which is powered by a regulated power supply. This system integrates various sensors and actuators to ensure optimal fish farm management.

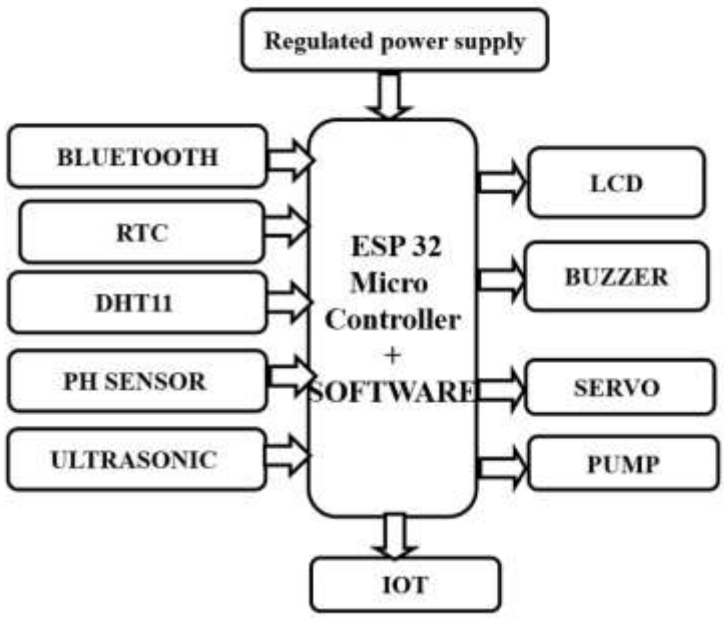

Fig. 2: Proposed Block diagram.

Temperature and humidity sensors provide real-time environmental data, while a turbidity sensor monitors water quality. A real-time clock (RTC) maintains accurate scheduling for operations, and

Bluetooth connectivity allows for wireless communication. IoT technology is incorporated for remote access and control, enabling farmers to monitor and manage the system from anywhere. The system includes an LCD display for real-time data visualization, a feed motor for automated fish feeding, and inlet and outlet water pumps to regulate water circulation efficiently. This advanced setup ensures improved environmental conditions, reduces manual labor, enhances fish growth, and optimizes resource usage, leading to better productivity and cost efficiency in fish farming.

4. RESULTS AND DISCUSSION

The Figure depicts a prototype of an IoT-based real-time aquaculture monitoring and control system mounted on a wooden board, designed to observe and regulate environmental parameters such as temperature, humidity, and gas presence in aquatic environments. At the core is the ESP32 microcontroller, which gathers data from sensors like the DHT11 (for temperature and humidity) and the MQ gas sensor (for detecting gases like ammonia or CO_2), and displays the results on a 16x2 LCD screen.

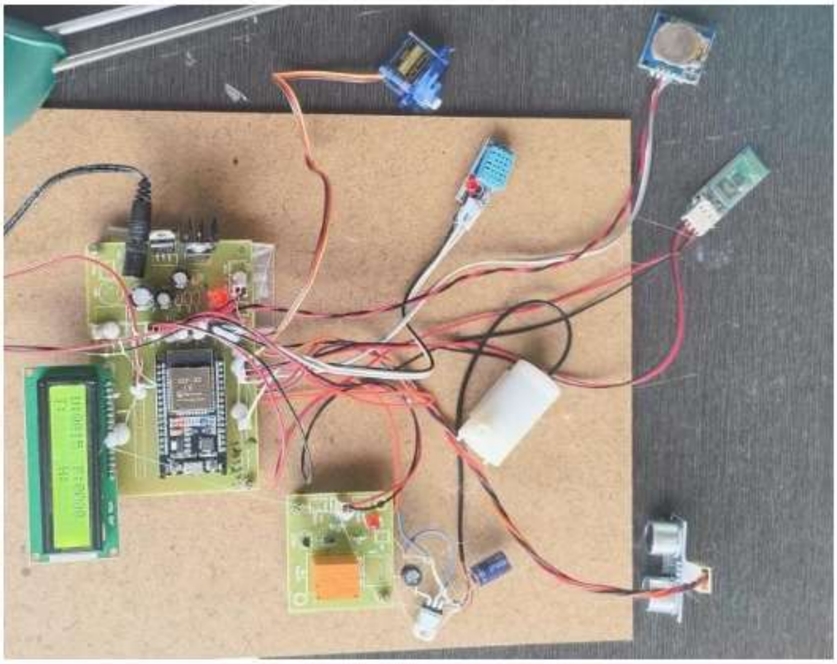

Fig. 3: Prototype Setup of an IoT-Based Real-Time Water Quality Monitoring and Control System.

A Bluetooth module (HC-05) facilitates wireless data transmission to a smartphone or other devices. The system also features a relay module to control actuators like a DC water pump (used for circulating or draining water) and a servo motor (for valve control), enabling automated responses based on sensor thresholds. Power is supplied via a regulated source using a barrel jack and voltage regulator (7805 IC), while various capacitors, resistors, and jumper wires interconnect the components, ensuring signal integrity and stable operation.

The Figure showcases a close-up view of a 16x2 LCD display integrated into an IoT-based aquaculture monitoring system, presenting real-time environmental sensor readings. The LCD is actively displaying four parameters: U (Unknown/Custom Unit) = 0016**,** P (Possibly pH or Pressure) = 0010**,** T (Temperature) = 0032°C**,** and H (Humidity) = 0049%**.** These values are obtained from various sensors like the DHT11 for temperature and humidity, and potentially MQ or analog sensors for other parameters.

Fig. 4: Real-Time Sensor Data Display on 16x2 LCD in IoT-Based Aquaculture Monitoring System.

The LCD is wired to the microcontroller (likely ESP32), which receives and processes data from connected sensors before outputting the values to this display module. This live feedback mechanism is critical in smart aquaculture or environmental systems, where users need to monitor water or air conditions in real time for immediate decision-making or automatic control. The clear formatting on the LCD ensures ease of interpretation, supporting efficient system operation and real-time monitoring.

5. CONCLUSION

The project successfully implements an automated fish farming system using an ESP32 microcontroller. Various sensors monitor environmental parameters such as temperature, humidity, and water turbidity, ensuring optimal conditions for fish growth. The system automates feeding and water management through a feed motor and water pumps, reducing manual labor. Real-time monitoring is achieved via an LCD display, Bluetooth, and IoT integration for remote access. The RTC module ensures accurate scheduling of feeding and water changes. The Bluetooth module enhances local connectivity, allowing users to control the system wirelessly. IoT connectivity enables remote monitoring and control, improving system efficiency. The regulated power supply ensures stable operation of all components. Automated control enhances productivity and reduces human intervention. The system provides a cost-effective and efficient solution for modern fish farming.

REFERENCES

[1] Y.C. Shang, Aquaculture economics: basic concepts and methods of analysis, Westview Press, London, 1981, 153.

[2] FAO, FAO Yearbook, Fishery and Aquaculture Statistics 2019/FAO annuaire. Statistiques des pˆeches et de l'aquaculture 2019/FAO anuario. Estadísticas de pesca y acuicultura 2019, 2021. Rome/Roma.

[3] C. Wang, et al., Intelligent fish farm—the future of aquaculture, Aquacult. Int. 29 (6) (2021) 2681–2711.

[4] F. Antonucci, C. Costa, Precision aquaculture: a short review on engineering innovations, Aquacult. Int. 28 (1) (2020) 41–57.

[5] F. O'Donncha, J. Grant, Precision aquaculture, IEEE Internet of Things Mag. 2 (4) (2019) 26–30. [6] M. Føre, et al., Precision fish farming: a new framework to improve production in aquaculture, Biosyst. Eng. 173 (2018) 176–193.

[6] L. Yang, et al., Computer vision models in intelligent aquaculture with emphasis on fish detection and behavior analysis: a review, Arch. Comput. Meth. Eng. 28 (4) (2021) 2785–2816. H. Rastegari et al. Smart Agricultural Technology 4 (2023) 100187 10

[7] S. Zhao, et al., Application of machine learning in intelligent fish aquaculture: A review, Aquaculture 540 (2021), 736724.
[8] Z. Hu, et al., A method overview in smart aquaculture, Environ. Monit. Assess. 192 (8) (2020) 1–25.
[9] F. Xia, et al., Internet of things, Int. J. Commun. Syst. 25 (9) (2012) 1101.