



# AUTOMATION OF AERATORS AND FEED BASE MANAGEMENT SYSTEM IN AQUACULTURE PARWNS FARMING

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## ABSTRACT

*The Smart Aquaculture Management System is a cutting-edge, integrated solution that uses real-time water quality monitoring and automated feed management to maximise prawn farming. The system continuously measures important parameters like pH, temperature, dissolved oxygen, ammonia levels, and turbidity using a network of Internet of Things-based sensors. The Arduino Uno microcontroller is used to process this data, guaranteeing accurate monitoring and flexible feed management to avoid overfeeding, lower water pollution, and preserve ideal aquatic conditions. A motor driver regulates the automated aeration and feeding systems, guaranteeing steady oxygen levels and effective feeding schedules that promote better prawn health and faster growth. Through a specialised mobile application, remote monitoring and control are made possible by an ESP8266 Wi-Fi module that sends real-time data to the Thing Speak cloud platform. Decision-making and operational efficiency are improved for farmers by the actionable insights, warnings, and suggestions they receive.*

**Index Terms**—Smart Aquaculture, IoT-based Monitoring, Water Quality Management, Automated Feeding system, Prawns Farming, Real-Time Data Monitoring.

## I. INTRODUCTION

In order to meet the increasing demand for seafood worldwide, aquaculture has become an essential solution that has a major impact on rural development, economic growth, and food security. Prawn farming is particularly significant within the larger aquaculture industry because of its high market value and broad consumer demand. Prawn farming is still a difficult undertaking, though, since it necessitates exact control over environmental elements like feed management, aeration, and water quality. Conventional methods, which mainly depend on manual monitoring and intervention, frequently result in inefficiencies, subpar management of water quality, and higher operating expenses. Deteriorated water conditions, decreased dissolved oxygen (DO) concentrations, and elevated ammonia levels can result from overfeeding, insufficient aeration, and fluctuating water parameters. Prawn health, growth rates, and overall productivity are all negatively impacted by these factors. The use of automated and intelligent management systems is becoming more widely acknowledged as a workable way to address these issues. In order to maximise aquaculture operations, this project suggests a Smart Aquaculture



Management System that combines sensors, microcontrollers, cloud platforms, and Internet of Things (IoT) technology. The system seeks to maintain water quality, effectively control aeration, and guarantee exact control over feeding schedules. The suggested system greatly lowers feed waste, labour dependency, and operating costs while promoting sustainable farming practices by using automated decision-making processes based on real-time data. Specialised sensors that measure important water parameters like temperature, pH, dissolved oxygen (DO) levels, and ammonia concentration are among the system's main parts. An Arduino Uno microcontroller serves as the central processing unit and is directly interfaced with these sensors. To elicit the proper responses, the gathered data is processed in real-time. For example, a feeding system with a servo motor mechanism guarantees accurate feed dispensing in response to sensor feedback or a preset schedule. In order to maintain ideal oxygen levels and promote prawn health, a motor driver module is also used to control aerators. A Wi-Fi-enabled ESP8266 module sends data to cloud platforms like Thing Speak to enable remote monitoring and control. With the help of a specialised mobile application, farmers can now monitor real-time water quality data and get immediate alerts and useful insights. Farmers can remotely modify aeration levels, feeding schedules, and other parameters thanks to the system's intuitive interface, which guarantees proactive management. A buzzer module creates alerts in the event of significant water parameter deviations, triggering prompt remedial action to avoid prawn stress and death. This intelligent aquaculture management system offers advantages that go beyond improved operational effectiveness. The system considerably lowers the buildup of organic waste by avoiding overfeeding and reducing water contamination, preserving healthier aquatic environments. In addition to encouraging prudent resource use, this sustainable method lessens the negative environmental effects of prawn farming.

## **II. LITERATURE REVIEW**

An Arduino-based IoT-enabled Smart Aquaculture Management System ensures Real-time water quality monitoring, automated feeding, and aeration control [1]. Using sensors to measure pH, dissolved oxygen, ammonia, and temperature, IoT technology automates aquaculture water quality monitoring. Remote monitoring is made possible by cloud-based systems, which decrease manual labour and increase productivity. Accurate data for preserving ideal water conditions and raising the productivity of prawn farming is ensured by sensor calibration [2]. To improve farm management, an Internet of Things (IoT)-based smart aquaculture system combines cloud connectivity, automated feeding and aeration, and microcontrollers. In addition to lowering resource waste and manual intervention, real-time communication enhances prawn growth, feed efficiency, and water quality [3]. Using predictive models, AI and IoT in aquaculture maximise water quality, aeration, and feeding. With case studies demonstrating higher yields and decreased disease risks, real-time data analysis improves sustainability, efficiency, and cost effectiveness [4]. Pollutants brought in by agricultural expansion have a detrimental effect on the water quality used for prawn farming. Automated systems for continuous monitoring make it easier to identify variations in dissolved oxygen, nitrate, and ammonia levels, guaranteeing prompt remedial action and promoting sustainable aquaculture [5] This study offers insights for increasing aquaculture efficiency by demonstrating how IoT automation in aquaponics optimises aeration, nutrient dosing, and water quality [6]. In order to maintain ideal conditions, lower contamination, and improve sustainability through real-time monitoring and control, this study highlights the function of automated sensor systems in aquaponics water quality management [7]. This study explores AI and sensor-based techniques for diagnosing shrimp health, emphasizing early disease detection



through behavior analysis and water quality monitoring. Automated health monitoring improves farm efficiency and sustainability while reducing manual inspections [8]. This study demonstrates how feed efficiency, growth, and survival rates are improved by auto-feeder technologies in prawn farming. Farmers find automated feeding to be a profitable option because it minimises waste, avoids water pollution, and lowers labour and feed expenses. [9]. IoT-based real-time monitoring in aquaculture improves prawn yields, lowers errors, and boosts efficiency by allowing remote access through smartphone apps to track water parameters like temperature, pH, dissolved oxygen, and ammonia.

### **III. PROBLEM DESCRIPTION**

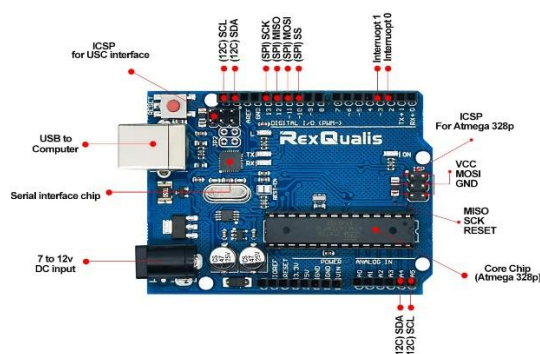
Maintaining water quality, effectively managing feed, and guaranteeing ideal growing conditions are challenges in prawn farming. Shrimp health and farm productivity are adversely affected by manual monitoring and feeding, which frequently results in irregular water parameters, overfeeding, and water pollution. Furthermore, large-scale farming is inefficient and expensive due to the substantial time and labour requirements of traditional methods.

An Internet of Things (IoT)-based smart aquaculture system is suggested as a solution to these problems in order to monitor water quality in real time and manage feed automatically. Sensors will keep an eye on vital variables like temperature, dissolved oxygen (DO), and pH, delivering precise data for prompt analysis. In order to ensure ideal water conditions and minimise feed waste, automated feeders and aerators will modify operations in response to sensor feedback. Through a mobile application, farmers can access real-time data and receive alerts, facilitating remote management and prompt interventions. This integrated system promotes sustainable prawn farming methods, reduces environmental impact, and increases farm efficiency.

### **IV. ARCHITECTURE**

#### *A. Arduino Uno*

The Arduino Uno is a popular microcontroller board that is essential to embedded systems and prototyping. It runs at a clock speed of 16 MHz and is powered by the ATmega328P microcontroller, offering dependable performance for a range of applications. Sensors, actuators, and other peripherals can be connected in a variety of ways thanks to the Arduino Uno's 14 digital input/output pins, which include 6 PWM outputs and 6 analogue inputs. In addition, it has a DC power jack for an external power source and a USB Type-B port for programming and serial communication. Using communication protocols like I2C, SPI, and UART, the Arduino Uno facilitates simple integration with external devices. During development, a built-in reset button guarantees speedy debugging and troubleshooting. Improved functionality is made possible by the board's compatibility with multiple expansion modules and shields. The Arduino IDE also offers an easy-to-use environment for uploading and coding programs. The open-source nature of the Arduino Uno promotes experimentation, which makes it perfect for rapid prototyping, education, and a variety of embedded applications.

**Fig. 1. Arduino Uno.**

With its strong open-source ecosystem, the Arduino Uno is perfect for a variety of uses beyond basic prototyping. From wireless communication and data logging to motor control and sensor integration, it supports a number of libraries and shields that expand its functionality. Developers can easily execute complex projects thanks to its compatibility with a wide range of sensors, actuators, and modules. Additionally, the Arduino IDE offers a straightforward yet effective programming interface for the Arduino Uno that facilitates both novice and expert programming tasks. Its large community offers a wealth of resources, tutorials, and libraries for efficient project development, and it can be programmed using the C/C++ language. It is also appropriate for real-time data processing because it allows serial communication with external devices.

#### *B. DO Sensor*

An important tool for monitoring water quality in aquaculture, environmental research, and wastewater treatment is a dissolved oxygen (DO) sensor, which measures the amount of oxygen dissolved in water. It usually uses optical or electrochemical sensing technology to provide precise and trustworthy measurements of oxygen levels. The sensor is made up of a probe that is immersed in water, where it finds oxygen molecules and transforms the information into values that can be read. In order to maintain ideal conditions for aquatic life, a dissolved oxygen (DO) sensor is an essential tool for measuring the amount of oxygen dissolved in water. Applications like aquaculture, water treatment facilities, and environmental monitoring depend heavily on it. To provide precise and trustworthy oxygen level readings, DO sensors employ optical technology or electrochemical techniques like galvanic or polarographic sensors.

**Fig. 2. DO Sensor.**

#### *C. Ammonia Sensor*

Aquaculture, wastewater treatment, and environmental monitoring all frequently use ammonia sensors, which are

crucial instruments for detecting and measuring the amount of ammonia ( $\text{NH}_3$ ) in water or air. It usually uses semiconductor-based, optical, or electrochemical technology to provide precise and instantaneous ammonia level readings. The sensor is made up of a probe that finds ammonia ions and transforms the information into values that can be read. Aquaculture, wastewater treatment, and environmental monitoring all depend heavily on ammonia sensors, which are vital instruments for identifying and quantifying ammonia ( $\text{NH}_3$ ) concentrations in water or air. Since high ammonia concentrations can be toxic to aquatic life, precise and timely monitoring is crucial to preserving water quality and averting dangerous situations.

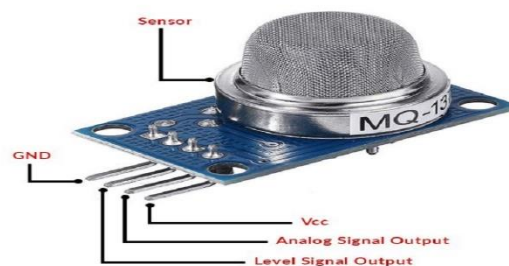


Fig. 3. Ammonia Sensor.

## V. PROPOSED SOLUTION

Using an Arduino Uno microcontroller, the suggested system provides an intelligent aquaculture management solution. To continuously monitor the water quality in real-time, it integrates a number of sensors, such as ammonia, dissolved oxygen (DO), water flow, temperature, pH, and infrared sensors. Sensor data is gathered by the Arduino Uno and shown on a 16x2 LCD screen for real-time monitoring. In order to support healthier aquatic life, the system makes sure that the water conditions stay within ideal ranges. The motor driver is in charge of managing external equipment like fans and water pumps in order to maintain appropriate water quality. The Arduino controls the motor driver to modify the surroundings and maintain stable conditions when sensors identify departures from the intended thresholds. There is less chance of overfeeding or underfeeding because the servo motor automates the feeding mechanism, releasing feed at preset intervals according to programmed schedules. The block diagram of the proposed model is shown in Fig .4

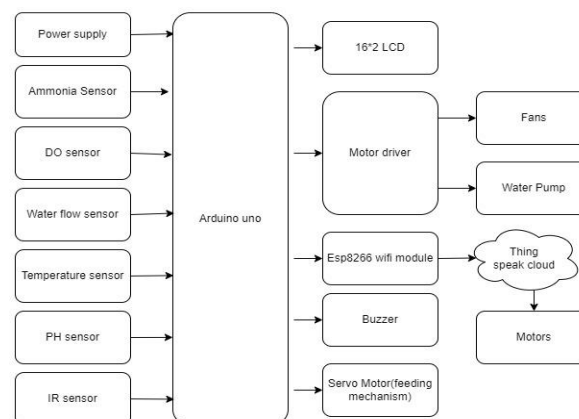
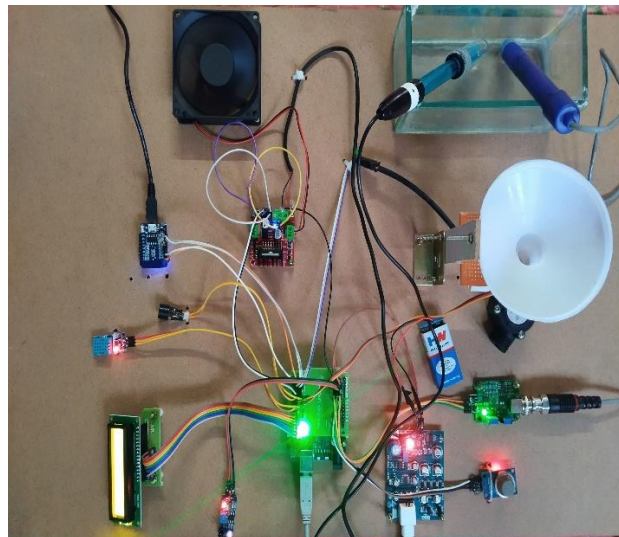


Fig. 4. Block Diagram of proposed model.

## VI. IMPLEMENTATION

### A. Hardware

The hardware configuration is an Internet of Things (IoT)-based automated prawn farming aeration and feeding system. In order to automate the feeding process and monitor and maintain ideal water quality, it combines a number of sensors, controllers, and actuators. Water parameters are continuously measured by submerged pH and dissolved oxygen (DO) sensors in a glass water container. An Arduino Uno microcontroller receives the data from these sensors and processes it. A water flow sensor is also employed to keep an eye on the system's water circulation. A servo motor and a white funnel are used in the feeding mechanism, which dispenses feed in response to sensor feedback or a preset schedule. Remote monitoring is made possible by an ESP8266 Wi-Fi module, which enables IoT-based data transmission to cloud platforms like Thing Speak. Temperature, pH, and dissolved oxygen levels can all be seen in real time on the 16x2 LCD display that is included.



**Fig. 5. Hardware Setup.**

Proper oxygen distribution is ensured by a motor driver module that regulates the operation of fans and aerators. A buzzer is installed to increase safety by sounding an alert whenever water quality parameters diverge from acceptable ranges. Power modules and networked wiring guarantee smooth operation, facilitating effective automation and real-time monitoring in aquaculture management.

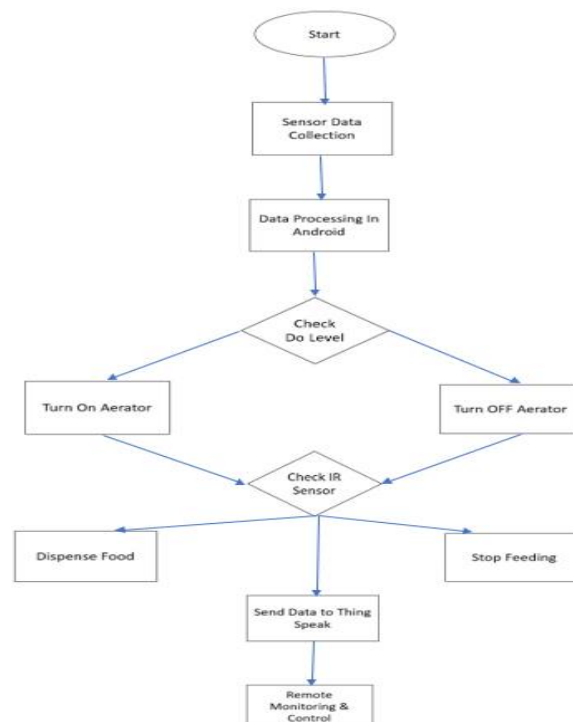
### B. Software

The Arduino Uno microcontroller is programmed and controlled by the Smart Aquaculture Management System using the Arduino Integrated Development Environment (IDE). The Arduino IDE makes sensor data collection, real-time analysis, and automated decision-making easier with its intuitive interface and simplified C/C++ language. The smooth integration of sensors, motors, and communication devices is guaranteed by its compatibility with a large number of libraries and modules. Algorithms written in the Arduino IDE are used to process sensor data, which includes variables like temperature, dissolved oxygen (DO), pH, and ammonia levels. To effectively control aerators and feeding mechanisms, control commands are transmitted to the motor driver. In order to maintain steady water quality and avoid environmental imbalances, the software is made to initiate quick reactions based on threshold values. The system makes use of the ESP8266 Wi-Fi module, which connects to the Thing Speak cloud platform for remote data transmission and monitoring. Farmers can use web or mobile

applications to monitor water quality thanks to real-time data that is recorded and displayed on dashboards. In order to ensure prompt intervention, the platform also generates alerts when sensor values surpass pre-established limits. Furthermore, the Arduino IDE's Serial Monitor feature facilitates real-time testing and debugging by providing information on sensor data and system performance. The adaptability of the software facilitates simple updates and changes to improve system performance. The Arduino IDE's open-source status allows for additional development, such as the addition of predictive algorithms for better decision-making

## VI. OPERATIONAL FLOW AND INTEGRATION

The Smart Aquaculture Management System's operational procedure optimises prawn farming through the use of sensor data, real-time processing, and automated control mechanisms. The system starts by initialising its various sensors, including temperature, pH, ammonia, and dissolved oxygen (DO) sensors. Data on water quality is continuously gathered by these sensors and sent to the microcontroller for additional processing. To ascertain whether remedial measures are required, the data is transmitted to an Android-based processing unit, where algorithms evaluate it in real-time. Verifying that the DO level stays within ideal ranges is one of the crucial decision points. The aerator is turned on to restore oxygen balance if the DO level is low. In contrast, the aerator is turned off to save energy if the DO level is high or normal. Additionally, an infrared (IR) sensor is used by the system to track feeding activity. In order to prevent waste, unnecessary feeding is avoided. If feeding is necessary, the dispenser is activated to release the proper amount of feed



**Fig. 8. Operational flow.**

Following the execution of actions, a Wi-Fi module transfers the data to the Thing Speak cloud platform, enabling real-time monitoring, data storage, and visualisation. Farmers can remotely monitor water quality parameters, modify system settings, and get immediate alerts in the event of anomalies by using the connected mobile application. Prawn growth and operational efficiency are enhanced by this automated, data-driven method, which

also drastically reduces manual intervention, minimises resource waste, and guarantees a healthier aquatic environment. If feeding is necessary, the dispenser is activated to release the proper amount of feed. Following the execution of actions, a Wi-Fi module transfers the data to the Thing Speak cloud platform, enabling real-time monitoring, data storage, and visualisation.



The image shows a typical lab report from SKAL (Sri Kalyan Aquaculture Lab). The report includes a header with the lab's name and contact information. Below this, there is a section for 'WATER ANALYSIS' which contains a table with various parameters and their corresponding values. The parameters listed include pH, Salinity, Total Ammonia, Dissolved Oxygen, Total Hardness, Calcium, Magnesium, Potassium, Sodium, Ammonia, Nitrite, Nitrate, Total Dissolved Solids, and Temperature. The report also includes a section for 'USEFUL PLANKTON' and 'HARMFUL PLANKTON' with corresponding counts and a 'Microbiology' section for 'Total Count of Viable Bacteria'.

Fig. 9. Typical Lab report of water quality

## VII. RESULTS

### A. Real Time Monitoring

The project's outcomes demonstrate a real-time monitoring system that tracks several sensor parameters, as seen in the images that were supplied. Temperature (T), humidity (H), ammonia levels (A), dissolved oxygen (D), pH level (P), water flow (F), and IR sensor status (IR) are among the parameters for which the LCD display shows real-time data. The system provides real-time feedback on environmental conditions and water quality by continuously gathering data from the sensors and updating the values. Data collection and display are made easier by the use of a microcontroller-based platform, most likely an Arduino. This kind of real-time monitoring is essential for applications in environmental monitoring, wastewater treatment, and aquaculture because it guarantees prompt identification of anomalous conditions. The built-in infrared sensor aids in object presence monitoring, potentially controlling automated feeding or identifying unauthorised intrusions. Negative DO values may also indicate problems with sensor calibration or simulation data. The system's usability for large-scale deployments is improved by its ability to send data to cloud platforms for remote monitoring and analysis.



Fig. 10. Display of Ammonia, Humidity, Temperature on LCD.



Fig. 10. Display of Water Flow, IR, PH, DO on LCD

### B. Sensor Data Analysis

Data from sensors that track temperature, humidity, ammonia levels, dissolved oxygen, pH levels, and water flow are displayed in the Thing Speak charts. While humidity shows a sudden drop followed by a gradual rise, temperature shows slight fluctuations, indicating changes in the environment. A rise in ammonia levels could be a sign of contamination or breakdown. Data on dissolved oxygen shows initial instability with a peak and a subsequent decline, indicating alterations in the quality of the water. After a notable decline, which indicates increased acidity, pH levels rise, indicating a return to alkalinity. A sharp increase in water flow is followed by stabilisation, indicating a constant rate. These findings offer important new information for automation and environmental management.

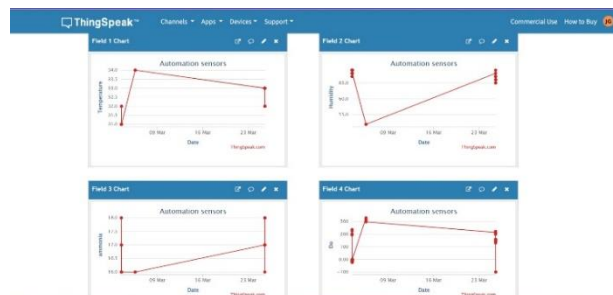


Fig. 11. Real-time Temperature, Humidity, DO, and Ammonia Monitoring

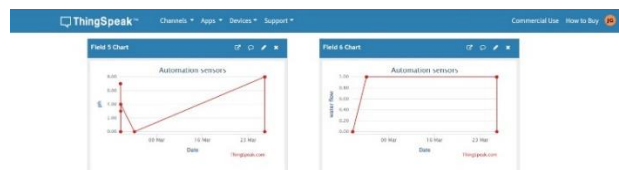


Fig. 12. Real-time PH, Water Flow Monitoring

## VIII. CONCLUSION

Aquaculture operations have been greatly enhanced by the use of IoT for feed management and aerator automation. The system minimises feed waste, minimises manual labour, and ensures optimal water quality management by combining sensors, Arduino-based control, and cloud connectivity. Remote access and real-time monitoring enable farmers to make well-informed decisions, leading to more productive and healthier prawns. The long-term benefits, such as cost savings, increased sustainability, and increased yield, make it a worthwhile solution for contemporary aquaculture, notwithstanding the initial setup and calibration difficulties. Its efficiency and scalability may be further improved in the future by integrating renewable energy sources and AI-driven



analytics.

## **IX. FUTURE SCOPE**

The integration of AI and ML algorithms for predictive analysis is part of the project's future scope, which will allow for proactive management and early identification of water quality problems. Using edge computing to improve the system can guarantee quicker data processing and instantaneous decision-making. Additionally, the system is expandable to add more sensors, which makes it suitable for a range of aquaculture settings. The system's sustainability can be improved by utilising renewable energy solutions, such as solar power. A more sophisticated mobile application with predictive alerts, interactive dashboards, and remote control features might be the next step. Additionally, implementing blockchain technology can improve accountability and traceability in aquaculture operations by offering transparent and safe data management.

## **DECLARATION**

We would especially like to thank Miss Sandhya Associate Professor of Internet of Things, for her unwavering support, knowledgeable advice, and helpful criticism, all of which greatly influenced the direction of our project. Our growth and learning have been greatly aided by her inspiration and insights. Finally, we would like to express our gratitude to every team member for their commitment, cooperation, and steadfast support, all of which helped us to successfully complete our project.

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