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Smart Monitoring System for Aquaculture Using IOT

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ABSTRACT
The main objective of this project is TO MONITOR THE AQUACULTURE by checking water quality, temperature, humidity in real time. To test water quality and temperature and humidity in real time, we placed pH and DHT11 sensors connected to Arduino. The results are displayed on a LCD after the system connected to the web server if any sudden changes occur we will upload it into the internet and followed by rapid buzzer alert. It improves aquaculture economy and Indian culture economy.

Keywords: Monitoring, Water quality, Low cost, IoT, Wireless transfer.

1. INTRODUCTION
Aquaculture plays a crucial role in global food production, contributing significantly to the economy, particularly in countries like India, where fisheries and aquaculture form an essential part of the agricultural sector. However, maintaining optimal water quality is critical for ensuring healthy aquatic life and improving productivity. Various environmental factors such as pH level, temperature, and humidity directly affect the growth and survival of aquatic organisms. Traditional monitoring methods often rely on manual testing, which is time-consuming and prone to inaccuracies.

To address these challenges, this paper presents a real-time monitoring system for aquaculture that leverages sensorbased technology and Internet of Things (IoT) integration. The proposed system utilizes pH and DHT11 sensors connected to an Arduino microcontroller to continuously monitor water quality parameters, including pH level, temperature, and humidity. The collected data is displayed on an LCD screen and transmitted to a web server for remote access. In the event of critical deviations from the predefined threshold values, an alert mechanism, including a buzzer notification, is triggered to prompt immediate corrective actions.

By implementing this automated monitoring system, aquaculture farmers can enhance productivity, reduce losses, and improve the overall economic viability of fish farming. This project not only contributes to sustainable aquaculture but also aligns with broader economic goals by strengthening India's aquaculture industry. The following sections of this paper discuss the system design, implementation, and potential benefits in greater detail.

2. LITERATURE REVIEW

Throughout the development of our project, we were able to review some projects, Journals, Articles and books which are related to the title of our project. We believe that all the reviewed materials have been a good asset for the overall design and development of the project we have chosen. In this section some of the related projects we have reviewed are discussed.

The integration of sensor-based monitoring systems in aquaculture has gained significant attention in recent years, driven by the need for improved water quality management and sustainable fish farming. Several studies have explored the application of Internet of Things (IoT) and embedded systems for real-time monitoring of aquatic environments.

In, researchers developed an IoT-based water quality monitoring system that utilized multiple sensors, including pH, dissolved oxygen, and temperature sensors. The system provided real-time data transmission via cloud platforms, enabling remote monitoring and decision-making. However, the study highlighted challenges in sensor calibration and data accuracy, which impact long-term reliability.

Another study implemented a wireless sensor network (WSN) for aquaculture monitoring, demonstrating improved efficiency in detecting water quality variations. The authors emphasized the importance of timely alerts in preventing fish mortality but noted limitations in power consumption and system scalability.

A similar approach was presented in, where an Arduinobased aquaculture monitoring system was developed using pH and temperature sensors. The system successfully transmitted data to a web-based dashboard for remote access. While effective, the study lacked an automated alert mechanism for immediate action in case of critical water parameter changes.

Recent advancements have also explored artificial intelligence (AI) integration for predictive analytics in aquaculture. Machine learning algorithms have been used to analyse historical sensor data and predict potential threats to aquatic life. However, such implementations require extensive datasets and computational resources, making them less feasible for small-scale farmers.

Based on these studies, this paper builds upon existing research by developing a real-time aquaculture monitoring system using pH and DHT11 sensors integrated with an Arduino microcontroller. The system enhances previous designs by incorporating an automated buzzer alert mechanism alongside web-based monitoring to ensure rapid response to environmental changes. This approach aims to improve efficiency, reduce fish mortality, and support sustainable aquaculture practices.

3. EXISTING METHOD

Currently, most aquaculture monitoring systems rely on manual methods or semi-automated systems that require frequent human intervention. Traditional monitoring involves collecting water samples and testing parameters such as pH, temperature, and dissolved oxygen using laboratory equipment. Some farms use standalone sensors with local displays, but these systems lack remote access capabilities and automated alert mechanisms. In certain
cases, water quality monitoring is performed periodically instead of continuously, leading to delayed responses to unfavourable conditions.

3.1 Problems in the Existing System

Manual Effort & Inefficiency: Traditional monitoring methods require significant labour and are prone to human error.

Lack of Real-time Monitoring: Most existing systems do not provide continuous monitoring, making it difficult to detect sudden changes in water quality.
Delayed Response: Since water parameters are not monitored in real time, critical changes may go unnoticed until it is too late, leading to fish mortality.
Limited Data Accessibility: Standalone sensor-based systems do not support remote monitoring, preventing aquaculture farmers from accessing real-time data.
No Automated Alerts: Existing methods lack an integrated alert mechanism to notify users instantly when abnormal conditions occur.

4. PROPOSED SOLUTION

To overcome the limitations of the existing system, we propose an IoT-based **Smart Monitoring System for Aquaculture** that enables real-time water quality monitoring and automated alerts. The system consists of multiple sensors, a microcontroller, cloud-based data storage, and an alert mechanism.

4.1 Features of the Proposed System

Real-time Monitoring: Continuously monitors water parameters such as pH, temperature, and humidity using pH and DHT11 sensors.
Automated Alerts: Triggers a buzzer and sends notifications to users when critical water conditions are detected.
Cloud-Based Data Storage: Uses IoT technology to store sensor data on a cloud platform for remote access.
LCD Display: Provides real-time readings on-site for local monitoring.
Remote Accessibility: Farmers can access real-time and historical data through a web-based dashboard or mobile application.
Energy Efficient: Uses low-power sensors and an optimized communication protocol to reduce power consumption.

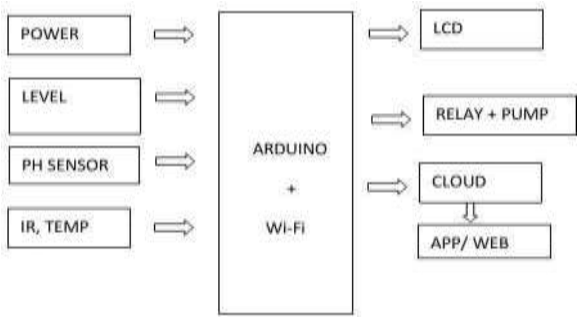


Fig.4.1.1: Block Diagram

5. HARDWARE COMPONENTS

5.1 Arduino UNO

This is an open-source Microcontroller ATmega328P with a total of 28 pins but 20 pins can only be programmable divided into 14 Digital pins and 6 Analog pins. We are using ARDUIO IDE for programming with USB Cable.

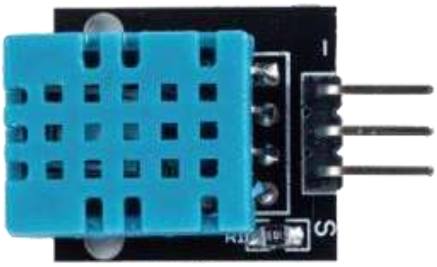
5.2 Ph sensor

A pH sensor is an essential tool for measuring the acidity or alkalinity of liquids and semi-solids. It plays a crucial role in various industries, including medicine, agriculture, food production, and environmental monitoring.

5.3 WIFI module

A Wi-Fi module is a small, integrated circuit that enables electronic devices to connect to a wireless network. It's essentially the heart of wireless communication within many modern gadgets
DHT11 is a basic, ultra-low-cost digital temperature and

5.3 DHT 11 sensor



humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and outputs a digital signal on the data pin.

5.4 ESP 32 Cam

The ESP32-CAM is a low-cost, Wi-Fi-enabled development board that integrates an ESP32 microcontroller with an OV2640 camera module. It supports image processing, video streaming, and AI applications, making it ideal for IoT and smart surveillance projects. With low power consumption and built-in SD card support, it is widely used for real-time monitoring and wireless image transmission.

5.5 16x2 LCD display

The 16x2 LCD display is a widely used alphanumeric display module that can show 16 characters per row across 2 rows. It operates using the Hitachi HD44780 controller and supports both 4-bit and 8-bit parallel communication with microcontrollers like Arduino. This display is ideal for embedded systems, providing a simple and efficient way to visualize sensor data and messages.

5.6 Buzzer

It generates sound by vibration of piezoelectric element by applying electricity. In our project we are using this as high alert indication for critical conditions.

5.7 Adapter

It's a 12V adapter used as a power supply which converts alternating current into direct current. We are connecting this from wall outlet.

6. SOFTWARE

6.1 Installation of ARDUINO

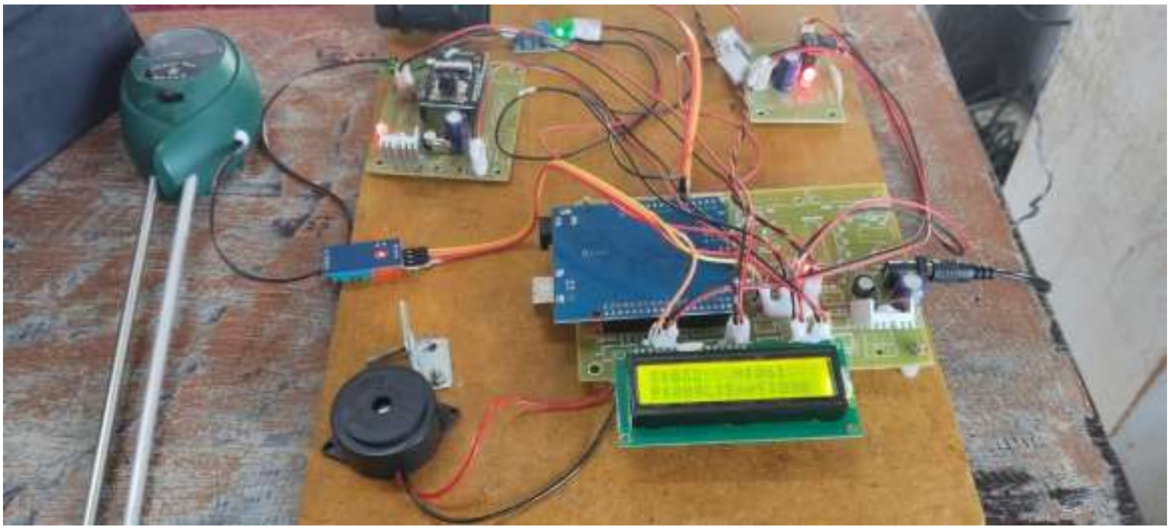
Step-1: Download And Extract Arduino IDE Software.

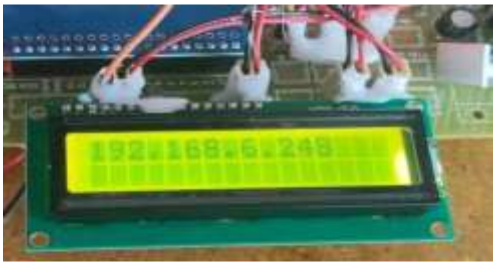
Step-2: Launch Arduino IDE, Open the Arduino IDE from the desktop icon click next to install then click on icon to open the software.

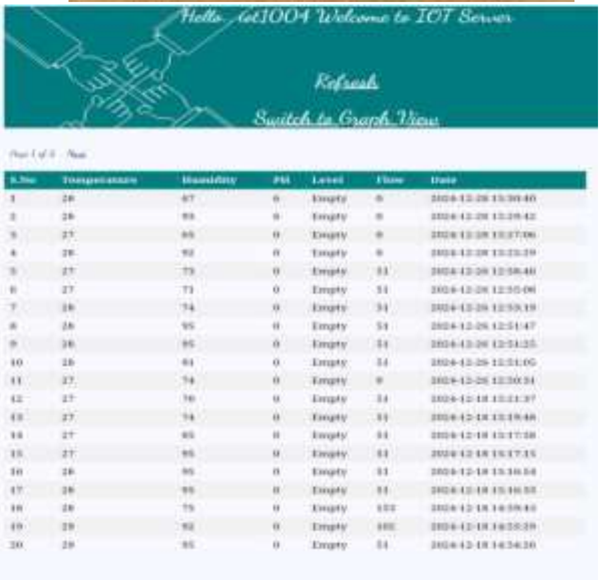
6.2 ARDUINO Code Dumping

Step-1: Open your first project.

Step-2: Select your Arduino board then, Go to Tools > Arduino nano Boards > Boards Manager.







Step-3: Select your Arduino board Processor then, Go to Tools > Processor > ATmega328P.
Step-4: Edit Code on Editor Window then, Click on File tab and then open preferences.
Step-5: Compile code.
Step-6: Upload Code into Arduino Board.

7. ADVANTAGES

By This work represents the design and implementation of aquaculture monitoring system.
This will help to increase the aquaculture production to a significant level.
Further there is no need for manual testing, reduction of losses saves and also prevention of critical condition.

8. EXPERIMENTAL RESULTS

The proposed IoT-based aquaculture monitoring system was successfully tested in a controlled water tank setup. Real-time readings of pH, temperature, and humidity were accurately captured and displayed on the LCD. Alerts were effectively triggered through the buzzer and data was uploaded to the cloud when thresholds were crossed. The system demonstrated high responsiveness and reliability in monitoring water quality conditions.

9. FUTURE SCOPE

The **future scope** of this project includes various enhancements and expansions to improve the efficiency and usability of the system:

Integration of AI and Machine Learning: Predictive analysis can be implemented to forecast water quality trends and detect potential risks in advance.

Addition of Advanced Sensors: Future implementations can include dissolved oxygen, turbidity, and ammonia sensors for a more comprehensive water quality assessment.

Mobile Application Development: A dedicated mobile app can be developed to provide real-time notifications and remote-control features.

Automated Water Quality Adjustment: Integration with automatic water treatment systems, such as aerators and pH balancers, can help maintain optimal conditions without human intervention.

Solar-Powered System: Enhancing the system with renewable energy sources like solar power can make it more sustainable and suitable for remote aquaculture farms.

10. CONCLUSION

This paper presents an IoT-based smart monitoring system for aquaculture that enables real-time tracking of water quality parameters. By integrating pH and DHT11 sensors with Arduino and cloud-based data visualization, the system ensures enhanced aquaculture management. Future work will focus on incorporating additional sensors such as dissolved oxygen and turbidity sensors for more comprehensive monitoring.

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