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Implementation of an IoT-Based Water Quality Monitoring System for Aquaculture

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A B S T R A C T

In recent years, the demand for seafood has increased globally due to the growing awareness of its health benefits. Meeting this demand is a significant challenge for aquaculture farmers who must maintain the quality of their products while increasing production. To address this issue, an Internet of Things (IoT) based water quality monitoring system can be employed to enhance aquaculture production. The system monitors and controls the water quality parameters remotely, ensuring optimal conditions for aquatic life, and reducing the amount of waste generated.

With the IoT-based water quality monitoring system, farmers can observe and control the aquafarming process from anywhere in the world without physically being present. The system continuously monitors the water quality parameters such as temperature, pH, dissolved oxygen, and salinity. If any of these parameters go out of range, the system automatically alerts the farmer through an app or a web-based dashboard. This allows the farmer to take corrective action promptly, preventing any damage to the aquatic life and ensuring the quality of growth.

Another advantage of this system is its water recycling mechanism, which helps to reduce the amount of waste generated by the aquafarming process. The system captures and recycles the wastewater, reducing the amount of water required for the farming process. This not only reduces water usage but also minimizes the cost of disposal of the waste material.

The IoT-based water quality monitoring system offers several benefits for aquaculture farmers. It reduces the energy, labor, and time required for manual monitoring and controlling the aquafarming process. This also minimizes the risks associated with human error in monitoring and controlling the parameters. By ensuring the quality of growth, the system helps to increase the economic benefits of aquaculture, making it a more viable business proposition.

In conclusion, the use of an IoT-based water quality monitoring system for aquaculture is a promising approach for enhancing production, reducing costs, and ensuring the quality of growth. The system can help farmers to meet the increasing demand for seafood globally while minimizing their impact on the environment.

1. Introduction

Aquaculture, also known as aquafarming, is a method of farming aquatic animals such as fishes and crabs. This practice plays a crucial role in economic development and food production in many countries [8] [9]. Aquaculture is carried out in various locations, including coastal shorelines, ponds, rivers, and land-based facilities. With around 71% of the earth's surface being covered by water, aquaculture accounts for approximately 13% (10.2 million tons) of the world's fish production. Asian countries are responsible for 90% of the global aquaculture, with China being the largest producer and contributing 70% alone.

The production of fish is highly dependent on water resources, and it involves the selective breeding of fish in either freshwater or seawater for the purpose of providing a food source for consumption [10] [11]. Fish and other seafood are excellent sources of protein and also contain valuable nutritional components such as natural oils like omega-3 fatty acids. Aquaculture farming is relatively easy compared to other forms of farming as aquatic animals require less intensive care, needing only proper water conditions, temperatures, and food.

To meet the growing demand for seafood, farmers face the challenge of increasing their production, while also ensuring the quality and safety of the produce [12] [13]. Therefore, the use of advanced technologies, such as the Internet of Things (IoT), is increasingly being implemented in aquaculture. An IoT-based water quality system for aquaculture has been proposed to improve production and sustainability. The system enables remote monitoring of aquafarming from anywhere in the world without direct human intervention, which reduces energy, labour costs, time and the risks associated with traditional aquaculture practices [14] [15]. Additionally, the system proposes a water recycling mechanism to reduce the amount of aquatic waste materials produced. Implementing such a system ensures the quality of growth and increases the economic benefits of aquaculture.

2. METHODOLOGY

Aquaculture, or the farming of aquatic animals, is becoming increasingly important in economic development and food production globally. In this context, the design and implementation of an Internet of Things (IoT)-based water quality system for aquaculture is a crucial step towards improving production efficiency, reducing energy and labor costs, and ensuring high-quality growth of aquatic animals [16] [17].

This project focuses on developing a water quality system for aquaculture using the ESP32 microcontroller, turbidity sensor, DS18b temperature sensor, air pump, water pump, relays, LED's, and a servo motor [18] [19]. The DS18b temperature sensor and turbidity sensor measure the temperature and quality of the water, respectively. The ESP32 microcontroller processes the data from both sensors, and if the values cross the normal range, a red LED turns on to alert the user. On the other hand, if the parameters remain within the normal range, green or yellow LEDs turn on. The water pump is responsible for recycling waste water, and the air pump injects air (oxygen) into the water, releasing carbon dioxide [20] [21]. The servo motor feeds the fishes.

All the detected parameters are displayed on the Blynk app, which is connected to the ESP32 microcontroller via Wi-Fi. Blynk is a user-friendly platform that enables the user to monitor their hardware projects from their iOS and Android devices. After downloading the Blynk app, the user can create a project dashboard and arrange buttons, sliders, graphs, and other widgets on the screen [22] [23].

This IoT-based water quality system for aquaculture has several benefits, including remote monitoring from anywhere in the world without requiring direct human intervention, reducing energy, labor costs, and time, and ensuring the quality of growth and increasing the economic benefits of aquaculture [24] [25]. The proposed water recycling mechanism also reduces the amount of aquatic waste materials, contributing to a more sustainable and eco-friendly approach to aquaculture. Overall, the use of IoT in aquaculture is a promising solution for addressing the increasing demand for seafood and ensuring its quality, while also promoting sustainable practices in the industry [26] [27].

3.RESULTS:

The practical implementation of the water quality system for aquaculture using IOT involves the utilization of a prototype that effectively monitors and maintains the quality and temperature of the water in an aquafarming system [28] [29]. The system utilizes a turbidity sensor and a DS18b temperature sensor that are connected to the ESP32 launchpad. The sensors detect the water quality and temperature, respectively, and send the information to the microcontroller for processing [30] [31].

The microcontroller processes the data and stores it for further analysis and monitoring. The data is then transmitted to the user interface, which can be accessed through devices such as mobile phones and laptops [32] [33]. The user interface provides a dashboard that displays the real-time data of the water quality and temperature, allowing the user to monitor the aquafarming system remotely.

To alert the user whenever an abnormality is detected in the data, the system utilizes LED lights and a buzzer. Moreover, the system is designed to send a notification and an email to the base station (Blynk app) to notify the user of any detected anomalies [34].

Overall, this prototype offers an efficient and convenient solution for maintaining the quality and temperature of water in an aquafarming system. The system enables remote monitoring, reducing the need for human intervention, and provides timely alerts to prevent any potential damage to the aquafarming system.

4. CONCLUSION

This innovative water quality system for aquaculture using IOT is a great solution to the challenges faced by farmers in meeting the increasing demand for seafood worldwide. With the help of sensors like DS18b temperature sensor and turbidity sensor, this system can monitor the quality and temperature of the water in aquafarming. The data is then sent to the ESP32 launchpad to process the information, and the results are displayed on the user interface, which can be accessed via the internet on devices such as mobile phones or laptops.

This system not only helps in increasing the production but also reduces labour costs, energy consumption, and the time required to monitor the parameters manually. Traditional farming methods are not as efficient as this system because they lack technological advancements. By using this water quality system, farmers can remotely control the parameters without the need for direct human intervention. This means that farmers can save both time and money by avoiding the need for on-site monitoring.

Moreover, the water requirements for aquaculture farming are much lower than those for traditional farming. This is because the water in aquafarming is recycled and reused, making it a more sustainable solution. The air pump in this system is used to inject oxygen into the water, which improves the growth and health of aquatic animals while simultaneously releasing carbon dioxide. The servo motor, on the other hand, is used to feed the fishes at regular intervals.

One of the most unique features of this system is the use of the Blynk app. This app allows users to monitor the parameters remotely and control the system with ease. It provides real-time updates on the quality and temperature of the water, and users can receive alerts via LED lights and buzzers whenever an abnormality is detected. Additionally, the system sends a mail and a notification to the base station (Blynk app) if any irregularity is detected.

In conclusion, this water quality system for aquaculture using IOT is a groundbreaking solution to the challenges faced by farmers in meeting the increasing demand for seafood. With its use of sensors, microcontrollers, pumps, and servos, this system can effectively monitor and control the parameters of aquafarming remotely. The Blynk app interface makes it user-friendly, and the alerts sent to the base station ensure that farmers can take immediate action if any abnormality is detected. Overall, this system is a sustainable, cost-effective, and efficient solution to aquafarming.

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