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Iot Based Smart Monitoring And Management System For Fish Farming

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Abstract **-** Fish farming is one of the fastest growing manufacturing businesses in many parts of the world as the demand for fish and processed fish feed is increasing day by day. Fish farming is also known as aquaculture, breeding, rearing, collecting fish and many other organisms. It is also defined as a breeding species that thrives in an aquatic environment under controlled conditions. In India the fish farms are still controlled and managed in the traditional way where the fish feeding and management of water is still handled manually. This paper deals with the design and implementation of an internet of things (IoT) based system for real-time monitoring, control and management of fish farming. This proposed system design will remotely monitor the pH level, turbidity and temperature of water. Sensors are installed in this system to receive data. This IoT based system also consist of controlled feeding system and an aerator for management of water.

INTRODUCTION

The fish farming of aquatic organisms, has become a critical industry worldwide to meet the growing demand for seafood, contribute to food security, and stimulate economic growth. Fish farming refers to the commercial production of fish in an enclosure or, when located in a body of freshwater or marine water, in an area that is penned off from the surrounding water by cages or open nets in other words these are artificial ponds and tanks created for growing fish.

Fish farming is an ancient practice, dating back to about 2500 BC in China, when carp were raised in ponds and in artificial lakes created by receding floodwaters. Some of the motivations for fish farming in ancient China are shared with fish farm owners and operators in 2008. These include maximizing the food available from the resource; reducing the energy needed to search for, gather, and transport the food; making food production more predictable and less likely to be influenced by weather, predators, or other factors; and ensuring that the quality of the resource remains acceptable over time. Over time, aquaculture practices spread to other parts of the world and diversified to include various aquatic organisms and environments.

However, maintaining optimal water quality in fish farm systems is essential to ensure the health and productivity of aquatic organisms. Fish are common aquatic organisms, and for their survival, water serves as the medium to perform vital bodily functions such as respiration, feeding, growth, waste elimination, and reproduction. Thus, monitoring and regulating various physicochemical parameters become crucial to create an environment conducive to fish welfare by observing the waters parameters physical and chemical variables such as: pH level of water, temperature and turbidity level in water is some of the main conditions to be checked often in the tank. The traditional method of doing so is by collecting water samples weekly and sending them for testing in other words each and every task of water management including feeding of fish is handled manually which consumes a lot of time.

Fish is a rich source of vitamins, minerals, protein, nutrients and micronutrients. It is a big challenge for farmer to full fill market demand with healthy sea food. Fish farming is a tool to fill gap between of sea food supply and demand. Use of controlled environment production of aquaculture has been increased to a significant level but losses huge due to manual equipment and management failure. Farmers need real time

and accurate information to monitor and maximize production potential.

The model proposed in this work will assist the fish farmers in monitoring fish ponds using IoT. The Internet of Things (IOT) is an upcoming innovation for all the smart gadgets to connect people remotely. Integrating sensor and internet technology in combination with a user-friendly interaction interface smartphone application, desktop application, and web services to provide real-time monitoring of fish ponds

In farming system, various sensor nodes are used for checking the water parameter. The wireless sensors networks (WSN) composed of a large number of sensor nodes deployed in a monitoring region to collect, transmit and process information. Currently the aquaculture has become highly challenging due to emerging problems in farming regions. The main purpose of the project is to observe the farming system remotely by using different Sensor for the water parameter. By using the proposed system, we will increase the productivity of the fish, reduce the cost, minimize loss and increase the survival of aquatic life. There are vast opportunities to improve the fish farming. Water quality is a key to success and also has direct impact on production of fish yield, among all farms of aquaculture for all species most important parameters are Temperature, PH, turbidity. Water quality is an important factor for aquaculture and drinking water treatment plants and other related industries because polluted water not only claim losses of aquatic products but also face significant human health threats. Further we have also used a aerator which helps to maintain the oxygen dissolved in the water and temperature of water and a feeding system which are controlled through smartphone application.

The significance of this proposed plan is that it provides Real-time Monitoring which Ensures continuous supervision of critical parameters like pH, temperature, turbidity of water and Automation that Reduces human effort by automating aeration, feeding, and water circulation processes

1. LITERATURE REVIEW

Conventional procedures of checking water quality required manual inspecting and investigation in research facilities, which were both time-consuming and incapable to supply real-time comes about. In any case, the presentation of IoT innovation has come about in a more rearranged and computerized prepare. IoT frameworks utilize a run of sensors to screen basic water quality components like temperature, pH and turbidity in genuine time. These sensors are associated to gadgets such as the Arduino Uno to screen measures within the sea-going environment. Whereas prior inquire about has looked into different observing models, IoT stands out for its capacity to screen online and communicate in genuine time. IoT-based frameworks give broad checking capabilities by joining temperature, pH, water level, turbidity, and movement location sensors [1].

Several studies have explored the application of IoT in fish farming, integrating sensors, cloud computing, and wireless networks to enhance monitoring and control.

Sharma et al. (2020) developed an IoT-based real-time water quality monitoring system using pH, temperature, and dissolved oxygen sensors. Their study emphasized the role of cloud storage and mobile applications for remote monitoring [2].

Rathore & Sharma (2019) designed an IoT-based system using Raspberry Pi and Arduino to monitor water parameters. Their results showed improved efficiency in detecting water quality variations compared to traditional methods [3].

Gutiérrez et al. (2018) implemented a smart aquaculture system with machine learning algorithms to predict fish health based on sensor data. The study demonstrated how AI integration with IoT enhances decision-making in fish farming [4].

An innovative approach was introduced in a study added to IEEE Xplore in November 2023, which presents a **robotic system** powered by the **Internet of Farming Things (IoFT).** This floating, solar-powered system autonomously monitors water quality and dispenses food based on fish behavior, thus achieving greater automation in freshwater aquaculture. The robot relies on a Real-Time Operating System (RTOS) for accurate control, demonstrating a practical application of embedded systems and smart technologies in aquaculture (2023, IEEE Conference July 06–08) [5].

Shete, Bongale and Dharrao (2024) also contributed to this domain with a paper on **real-time IoT-enabled water quality monitoring**. Their system emphasizes the collection and analysis of data from key water parameters to support timely and effective decision-making. While details are limited, the emphasis on responsiveness and reliability in water monitoring aligns with broader trends in smart aquaculture technologies [6].

Focusing on a species-specific application, a 2024 study titled *"Smart Aquaculture: IoT-Enabled Monitoring and Management of Water Quality for Mahseer Fish Farming"* utilizes an **ESP32 Development Board** and multiple sensors, including those for ammonia and water temperature. The system employs the **Blynk IoT platform** for remote monitoring and visualization, highlighting the role of user-friendly interfaces and wireless communication in promoting sustainable and efficient aquaculture practices [7].

Lastly, the work by Abdallah et al. (2023) presents a comprehensive **IoT-based monitoring and management system** that employs **fuzzy logic controllers** to automate water quality and environmental management. Their system, which includes various sensors embedded in each tank, underscores the importance of adaptive control strategies to support fish growth and maximize productivity [8].

2. PROPOSED METHODOLOGY

The proposed system is made for fishermen to monitor the quality of water for a healthy environment for fish to live in. This work designs and implements a unique aquaculture monitoring and management system based on IoT. Both Wi-Fi and Internet are combined in this system for convenience. Healthy water is essential for aquatic animals. Water quality is decided by some factors like pH level, Turbidity, temperature etc. Some sensors have been integrated with the proposed system to collect the values of some parameters from the water and for management a fan is integrated for aeration which controls the temperature and oxygen level in the water as well. This system collects data from several locations throughout the tank by making use of three individual sensors. This integration makes it possible to collect comprehensive samples from the tanks center as well as its sides, which improves the accuracy of water quality analysis as a whole. The proposed water quality monitoring system senses the data pH, Turbidity, and, TDS data of the tank and transfers data to the cloud can be assessed by the BLYNK app similarly a controlled food dispenser helps controlling the amount of food dispensed for particular time through the app. This work finds a way to give better result with low cost than other available systems. Aqua farmers can avoid time consuming manual testing now. This will help the aqua farmers to produce a greater number of fishes which will help to fulfil the demand for fish. Though we have created a system to control a demo aeration system, more actuators such as fish feeder etc. will be integrated to this system.

2.1 HARDWARE COMPONENTS

I. ESP32

fig.1. esp32 microcontroller

ESP32 is a family of low-cost, energy-efficient microcontrollers that integrate both Wi-Fi and Bluetooth capabilities. These chips feature a variety of processing options, including the Tensilica Xtensa LX6 microprocessor available in both dual-core and single-core variants, the Xtensa LX7 dual-core processor, or a single-core RISC-V microprocessor. In addition, the ESP32 incorporates components essential for wireless data communication such as built-in antenna switches, an RF balun, power amplifiers, low-noise receivers, filters, and power-management modules.

II. pH Sensor

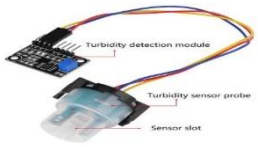
fig.2. pH sensor

A pH sensor is an electronic device that measures the level of acidity or alkalinity (pH) in a liquid or solution. The sensor contains a glass electrode that is sensitive to changes in pH. The electrode is made up of a thin membrane that is coated with a special solution containing a reference electrode, which is usually made of silver/silver chloride. When the pH sensor is submerged in a liquid, the hydrogen ions in the liquid interact with the reference electrode, creating an electric charge. This charge is then measured by the sensor and converted into a pH value, which is displayed on a screen or outputted to a data logger**.**

III. Temperature Sensor

Fig.3. DS18B20(Temperature sensor)

DS18B20 Water Proof Temperature Sensor Probe is a 1-Meter-Long Waterproof, sealed and pre-wired digital temperature sensor probe based on DS18B20 sensor. It is very handy for when you need to measure something far away, or in wet conditions. Because they are digital, you don't get any signal degradation even over long distance**.**



IV. Turbidity Sensor

fig.4. turbidity sensor

A turbidity sensor is an analytical sensor that measures turbidity. They are highly useful and effective instruments to identify the clarity and particle content in a solution, like water. Turbidity sensors are used to reduce waste, improve yields, and analyze water quality in a wide range of industries. Turbidity sensors measure the amount of light that is scattered by suspended solids in a liquid, such as water. When the concentration of total suspended solids (TSS) and total dissolved solids (TDS) in a liquid increase, the turbidity also increases. Turbidity sensors are used to measure the cloudiness or haziness (turbidity) of a liquid, usually to determine water quality**.**

Relay

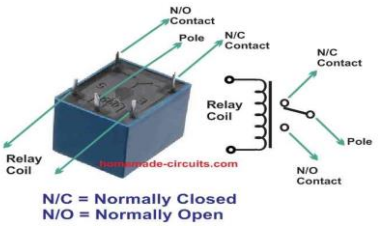


fig.5. relay

A relay is an electrically operated switch and like any other switch, it that can be turned on or off, letting the current go through or not. It can be controlled with low voltages, like the 3.3V provided by the ESP32 GPIOs and allows us to control high voltages like 12V, 24V or mains voltage. The relay uses the current supply for opening or closing switch contacts. Usually, this can be done through a coil to magnetize the switch contacts & drags them jointly once activated. A spring drives them separately once the coil is not strengthened. By using this system, there are mainly two benefits, the first one is, the required current for activating the relay is less as compared to the current used by relay contacts for switching. The other benefit is, both the contacts & the coil are isolated galvanically, which means there is no electrical connection among them.

fig.6. Aerator

V. Aeration fan

Aeration fan enhances the oxygen requirement for fish growth, and it is crucially important in the intensive tank stocked with high densities. Dissolved oxygen concentrations have been linked to the water quality of the tank, Fish Growth and Survival, Reproduction, Feed utilization and microorganisms. Aeration function is to increase the area of contact between air and water so that oxygen can enter into the water surface. Various materials require aeration due to the changing environmental conditions. aeration fans are utilized in processes or systems either to supply air or to remove unwanted compounds in waste-water treatments in other words it also works as a filter. aeration fans also provide moisture and temperature control in tank.

VI. Food Despenser

The feeding of fish and shrimp is done by hand in most farms and there are advantages in doing so. IoT based automatic fish feeder with a mobile application is a system that aims to automate the process of feeding fish in a fish tank. Automatic feeders are particularly appropriate to intensive systems and the feeding of nursery fry tanks which require frequent, small doses of feed. For this system we have connected a motor to an endless screw mechanism that transfers the feed from the hopper to the outlet. The amount of feed released

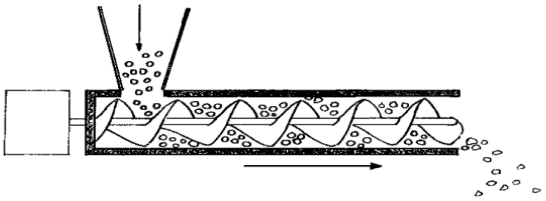


fig.7. automatic feeder

depends on the number of revolutions of the motor drive screw, which is controlled by the mobile application as is the periodicity of feeding. In this system the motor attached to the screw is controlled through the relay which is controlled via the mobile application.

3.BLOCK DIAGRAM

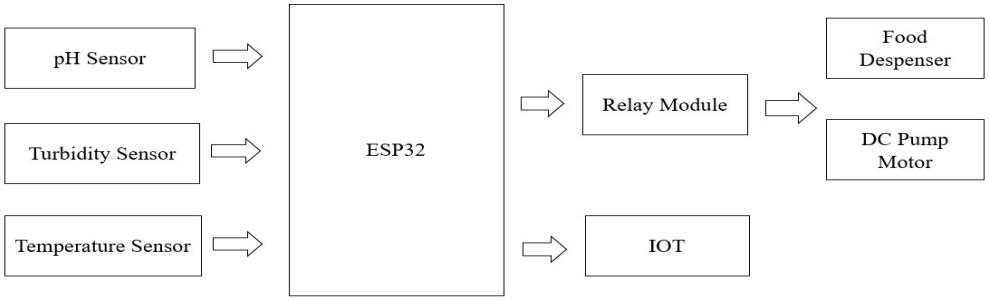
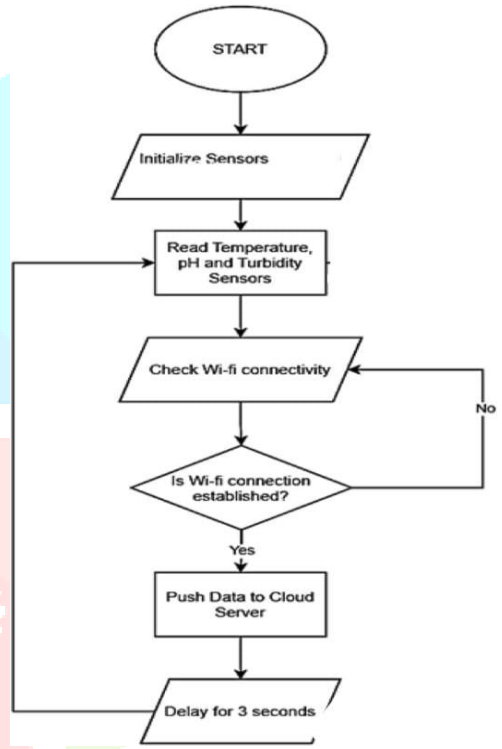


Fig.8.block diagram

4.FLOW CHART



5.RESULT

The system continuously monitored critical water parameters including temperature, pH level, dissolved oxygen (DO), and water level using appropriate sensors. The collected data was transmitted in real-time to a cloud platform using Wi-Fi/GSM connectivity, and visualized via a mobile application/web dashboard

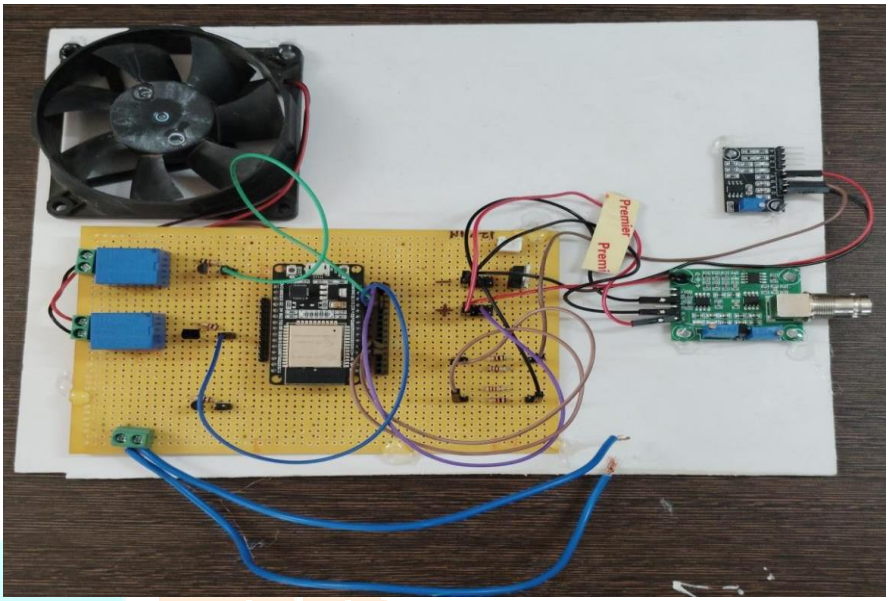


fig.10.implementation on PCB board

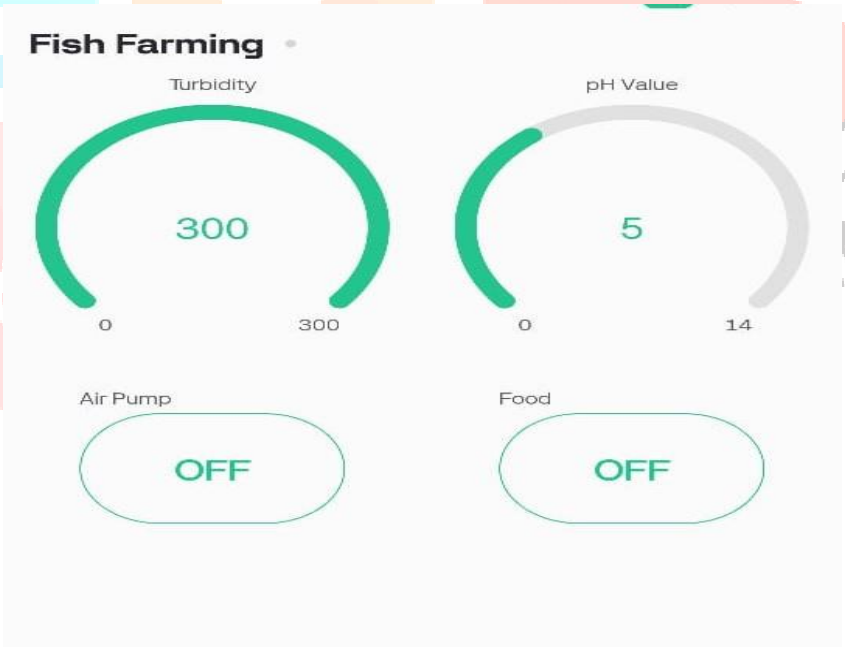


fig.11.mobile application

6.CONCLUSION

In fish farming, several key parameters significantly impact fish health, growth, and overall production. These include water quality parameters like temperature, dissolved oxygen, pH, alkalinity, and ammonia levels, turbidity as well as physical factors like water depth and sunlight. Additionally, factors such as feed quality, stocking density, and disease management are crucial for successful fish farming, thus it must be monitored and preserved to protect the complex web of life that depends on it. We have developed an effective Internet of Things (IoT)–based wireless water quality monitoring system that makes use of Arduino (ESP32) microcontrollers. The turbidity, Temperature and pH may all be measured in real-time by using this device, which was developed specifically for tanks. Different sensors are integrated in this system that makes it possible to collect comprehensive samples from inside the tank, which considerably improves the accuracy of the study. The BLYNK app's ability to send data to the cloud in real time enables the system to promote timely evaluations and decisions by allowing for the transmission of data. We have also integrated the aerator and automatic feeder in this system that are controlled through the mobile application. unlike the traditional method used in fish farming in which all the parameter that are required to maintain water quality and fish feeding is done manually in IoT based smart monitoring and management system for fish farming IoT systems continuously track crucial water parameters like temperature, pH and turbidity. Automated systems can also control water flow, aeration, and feeding, minimizing manual interventions and potential errors.

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