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Smart IoT Based Fish Tank Monitoring System

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***Abstract*—In the realm of aquaculture, maintaining optimal fish health and tank conditions is paramount for maximizing productivity and ensuring fish welfare. Traditional monitoring methods, often reliant on manual observations and periodic water quality testing, prove to be time-consuming, labor- intensive, and susceptible to human error. To address these limitations, this research presents the development of an IoT- based fish tank monitoring system utilizing ESP32 and Arduino microcontroller. This research delves into the design, implementation, and evaluation of an IoT-based fish tank monitoring system that continuously gathers and analyzes data on critical water parameters and environmental factors. The proposed system demonstrates remarkable efficacy in detecting anomalies, identifying potential health issues, and enabling proactive interventions to optimize fish care and prevent problems before they escalate. Moreover, the system boasts a user-friendly interface for remote monitoring and data visualization, empowering aquaculturists to make informed decisions and enhance fish well-being.**

***Keywords*— Aquaculture, Fish health monitoring, IoT-based system, ESP32 and Arduino microcontrollers, Real-time data analysis, Anomaly detection, User-friendly interface**

I. INTRODUCTION

In the realm of animal husbandry, maintaining optimal growth and productivity is paramount for maximizing yield and ensuring the well-being of livestock. Conventional feeding methods, often reliant on fixed schedules and estimated feed quantities, can lead to overfeeding, underfeeding, or inconsistent nutrient delivery. These inefficiencies hinder growth, increase labor costs, and contribute to environmental concerns. To address these challenges, this research delves into the development of an IoT-powered precision feeding system, harnessing the power of IoT technologies to revolutionize animal husbandry practices.

The proposed system integrates an ESP32 microcontroller, an environmental sensor, and a servo motor to establish a data- driven feeding mechanism. The temperature sensor continuously monitors the relevant environmental parameters, such as temperature or humidity, which are crucial factors influencing animal metabolism and appetite. Real-time environmental readings serve as input for the ESP32 microcontroller, which utilizes a pre-programmed algorithm to calculate the optimal feed quantity. This algorithm considers the prevailing environmental conditions, animal species, and growth stage to ensure precise feed delivery tailored to the specific needs of the livestock population.

The servo motor, acting as the system's actuating mechanism, precisely controls the release of feed from a designated dispenser. The servo motor's position is dynamically adjusted based on the calculated feed quantity, ensuring that the animals receive the exact amount of feed required for optimal growth and nutrient utilization. This precise and controlled feeding approach eliminates the risk of overfeeding or underfeeding, promoting efficient nutrient uptake and maximizing growth potential.

In conclusion, the IoT-powered smart fish tank monitoring developed in this research represents a paradigm shift in aquaculture practices. The system's ability to continuously monitor water temperature, calculate optimal feed quantities, and precisely control feed delivery offers a groundbreaking solution for optimizing fish growth, enhancing productivity, and improving overall aquaculture management. By harnessing the power of IoT technologies, this system paves the way for a more sustainable, efficient, and data-driven approach to aquaculture, contributing to global food security and addressing the challenges of feeding a growing population.

II. LITERATURE REVIEW

In this section, the relevant literature is reviewed. It describes various techniques used in the work.

A. Smart Aquarium Based Microcontroller

Researchers Budi Prijo Sembodo et al. developed a smart aquarium system with an Arduino-based feeding system that controls a servo motor to automatically deliver fish feed.The system also features an automated drainage and water filling system based on water turbidity, and an automated lighting system based on light intensity.

B. Smart system for maintaining aquascape environment using internet of things-based light and temperature controller

Researchers Daniel Patricko Hutabarat et al. developed a smart system based on an internet of things (IoT) application for a plant aquarium.The system controls light intensity and temperature using sensors and actuators, and allows users to monitor and control the system remotely via a smartphone app.

C. Smart Aquarium Design Using Raspberry Pi and Android Based

Researchers Khairunisa et al. designed a smart aquarium device using a Raspberry Pi and Android to automate fish feeding and control aquarium lighting.The system employs a servo motor to operate the fish feeding valve and a relay to control the aquarium lights.

D. IoT Based Automatic Aquarium Monitoring System for Freshwater Fish

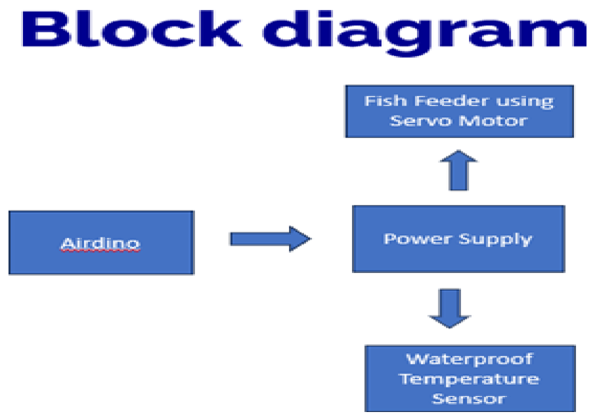
Researchers Mohammad Fahmi Suhaimi et al. developed an IoT-based automatic aquarium monitoring system for freshwater fish. The system monitors and controls various water parameters, including temperature, pH, turbidity, and water level, and sends notifications to users when problems are detected.

E. Aquarium Monitoring System Based on Internet of Things

Researchers Wen-Tsai Sung et al. developed an IoT-based remote monitoring system for aquarium environments. The system collects data on temperature, illuminance, water level, and fish activity, and displays the data in real-time on a cloud platform

III. METHODOLOGY

The illustration depicts a schematic representation of the smart aquarium system, comprising a harmonious integration of hardware components and software modules



A. Temperature Sensor

In the context of a fish aquarium, where meticulous control of water conditions is imperative, a thermistor-based temperature sensor emerges as a pivotal instrument. This sophisticated sensor leverages the principles of inverse time characteristics. In essence, as the water temperature undergoes variations, the thermistor exhibits a corresponding alteration in resistance, inversely correlated with the extent of temperature fluctuation. To elucidate further, an elevation in water temperature prompts a reduction in thermistor resistance. This nuanced responsiveness serves as a discerning indicator, facilitating the real-time detection of temperature shifts. Consequently, aquarists are promptly apprised of any deviations, empowering them to expeditiously recalibrate environmental parameters and ensure an optimal habitat for the aquatic denizens.

The proposed system uses a temperature sensor DS182B0. We used an Arduino DS18B20, the waterproof temperature sensor shown in fig. Operates within ±0.5°C, -10°C to +100°C.

B. Servo Motor

A servo motor is governed by the signals it receives at its control pin, employing Pulse Width Modulation (PWM) as its operational principle. The servo's structural composition includes a DC motor, variable resistors, and a gear mechanism, culminating in a mechanism that exhibits controlled motion. This motion can span either 180 or 360 degrees, contingent upon specific adjustments. Significantly, when subjected to a high pulse signal, the servo motor manifests a heightened responsiveness, instigating a nuanced to-and-fro oscillation in its motion. This intricate interplay between electronic input signals and the mechanical components affords the servo motor the capability to precisely position itself, offering a refined and adaptable range of angular displacements in its operation.

C. Arduino IDE

The Arduino Integrated Development Environment (IDE) represents an open-source software solution tailored for the composition and compilation of code intended for Arduino modules. Serving as the officially sanctioned software for Arduino applications, its core function is to simplify the intricacies of code compilation, rendering it accessible even to individuals with limited prior technical knowledge. Compatible with prominent operating systems like MAC, Windows, and Linux, the Arduino IDE operates seamlessly on the Java Platform, featuring integrated functions pivotal for debugging, code editing, and the holistic compilation process. Arduino modules, spanning models like Uno, Mega, Leonardo, and Micro, each house microcontrollers that execute the coded instructions. This intuitive, user-friendly environment caters not only to beginners but also serves as a foundational tool for those entering the intersection of programming and electronics.

IV.CONCLUSION

The genesis of this project stemmed from the visionary idea of developing an automated system dedicated to the comprehensive care of fish, specifically streamlining operations such as temperature maintenance. Employing cutting-edge IoT technology, the system demonstrates proficiency in monitoring, visualizing data, and providing manual control over essential variables through internet connectivity. The project successfully achieves the overarching objective of automating critical aspects of fish care. A distinctive feature lies in the ingenious mechanical design implemented for the fish feeding system, utilizing a servo motor. While alternative designs exist, often marked by complexity, this project stands out for its commitment to simplicity, efficiency, and cost-effectiveness. Its paramount goal is the practical application of advanced skills to effectively address management challenges, particularly in the creation of an ideal and conducive environment for aquarium fish, underscoring the importance of both inventive solutions and pragmatic problem-solving approaches.

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