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# Smart Aquaponic Fish Tank using IoT

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**ABSTRACT-** Aquaponics is a sustainable farming method that combines aquaculture and hydroponics. However, traditional systems require constant manual monitoring of water quality parameters, which can be time-consuming and inefficient. This project introduces a Smart Aquaponic Fish Tank using IoT, integrating sensors, ESP32, ThingSpeak cloud, and Telegram alerts for real-time monitoring and automation. The system collects data from sensors and uploads it to the cloud, allowing users to access live readings remotely. Automated fish feeding, water circulation, and lighting control ensure an optimal environment for fish and plants. The system also features a real-time alert mechanism for over-safe parameters, enabling quick corrective actions. This IoT-based solution reduces manual effort, enhances system efficiency, and ensures sustainability by minimizing water and resource wastage. It can be applied in home-based farming, commercial aquaponics, urban farming, and educational research.

**KEYWORDS:** Farming, closed loop system, Telegram, ThingSpeak cloud, Smart Aquaponic Fish Tank.

## I. INTRODUCTION

Aquaponics is a closed-loop sustainable farming method that combines hydroponics (soilless plant cultivation) and aquaculture (fish farming). In this system, plants naturally filter and purify the water for fish, and fish waste supplies nutrients for plants. This self-sustaining method is an environmentally benign way to produce food because it uses less water and requires less artificial fertilisers.

The Intelligent Aquaponic Fish Aquarium By adding automation and real-time monitoring, the Internet of Things improves this conventional approach. It ensures the ideal conditions for fish and plant growth by using sensors to monitor vital parameters including pH, temperature, turbidity, and water level. Through a web interface or mobile app, users can remotely monitor and operate the device once an ESP32-WROOM microcontroller interprets the data and delivers it to a cloud platform.

In order to maintain stable conditions with little assistance from humans, the system also includes automated lighting management, water circulation, and fish feeding. The technology ensures that prompt action can be taken to avert problems by sending alerts via Telegram if any parameter surpasses predetermined limits.

## II. LITERATURE SURVEY

Y.B. Lin and H.-C. Tseng, An IoT-Based Mini Aquarium System FishTalk, 2019. Yi-Bing Lin and Hung-Chun Tseng created FishTalk, an IoT-based mini aquarium system that monitors fish tank conditions using an ESP8266 microcontroller, pH, temperature, and turbidity sensors[1]. M.M. M. Mahmoud, R. Darwish, and A.M. Bassiuny, Smart Aquaponics System Using IoT, 2024. The authors proposed an IoT-based smart aquaponics system using ESP32 microcontrollers and cloud-based monitoring, but emphasized the need for an edge computing model to reduce operational costs[2]. Noel Shaji, S. Sunil, T. Johanson, R. Joseph, and M. T. Joy, Automated Fish Feeder System Using Embedded Controller, 2024[3]. Noel Shaji's research on a smart fish feeding system utilizes embedded technology, Raspberry Pi, servo motor, and camera integration, suggesting low-power microcontrollers for cost-efficiency and energy-saving[4]. S. Jha, A. Batra, and A. K. Dewangan, Smart Water Quality Monitoring in Aquaponics, 2024. The study aimed to enhance aquaponics water quality management using IoT integration, replacing STM32 with ESP32 and introducing a user-friendly dashboard [5]. A. Jain, D. Sharma, and P. Kumari, IoT Based Real-Time Water Quality Monitoring System, 2023. The study proposes an IoT-based system for real-time monitoring of water quality parameters, incorporating automatic actuators and manual control features for improved flexibility and user control.

### III. METHODOLOGY

The Smart Aquaponic Fish Tank Using IoT automates aquaponic system management by integrating ESP32-WROOM, multiple sensors, Thingspeak cloud, and real-time alerts via Telegram. Sensors like turbidity, temperature, pH, and water level monitor water quality and environmental parameters, ensuring optimal conditions for fish and plants. The ESP32 microcontroller analyzes data and determines necessary actions to maintain a balanced aquatic ecosystem.

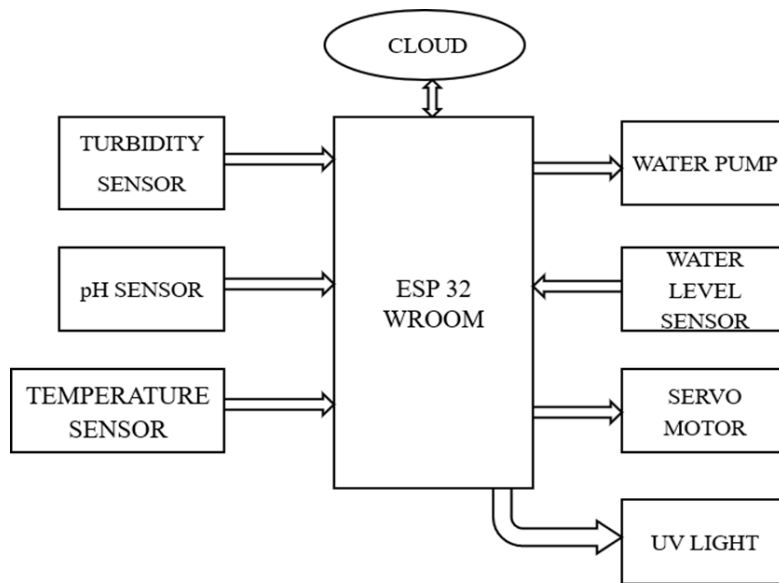


Figure 1 Block Diagram

The Thingspeak aquaponic system uses sensor data to monitor water levels and alert users when they exceed safe limits. It includes an automated water circulation mechanism, a water heater, LED grow lights, and a smart feeding system. The closed-loop system provides nutrient-rich water, filters and purifies the tank, and uses LED grow lights for artificial illumination. The system integrates IoT, cloud computing, and real-time monitoring, reducing manual intervention and improving sustainability. It's adaptable for home and commercial applications.

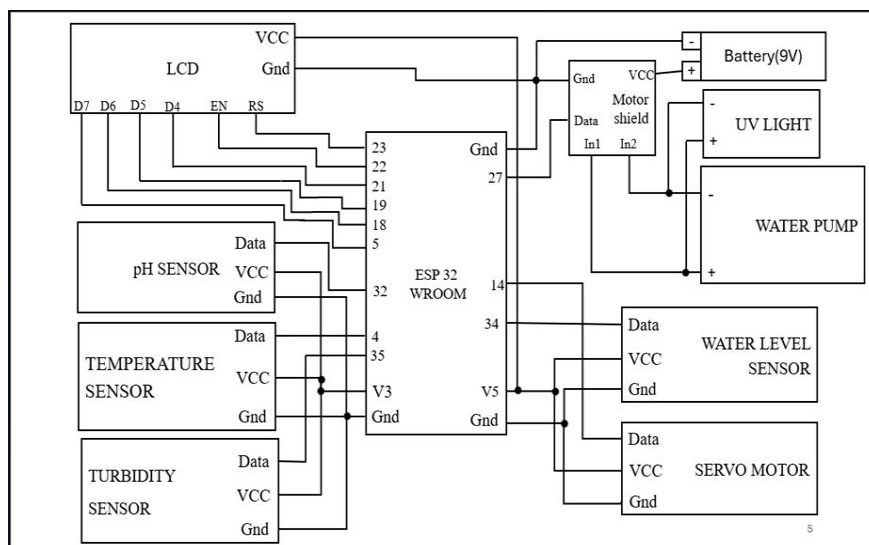


Figure 2 Circuit Diagram



The ESP32-WROOM microcontroller is used to automate and monitor an aquaponics system. The system uses digital pins for real-time data display, pH, temperature, and turbidity sensors for analog or digital inputs. Digital pins 34 and 14 are linked to a servo motor for automatic feeding and water level sensor. The system is powered by an external 9V battery and a motor shield for high-power parts like the submersible water pump and UV lamp. The wiring ensures stable operation, enabling effective data collection, actuator control, and real-time feedback, resulting in an intelligent and self-regulating aquaponic system.

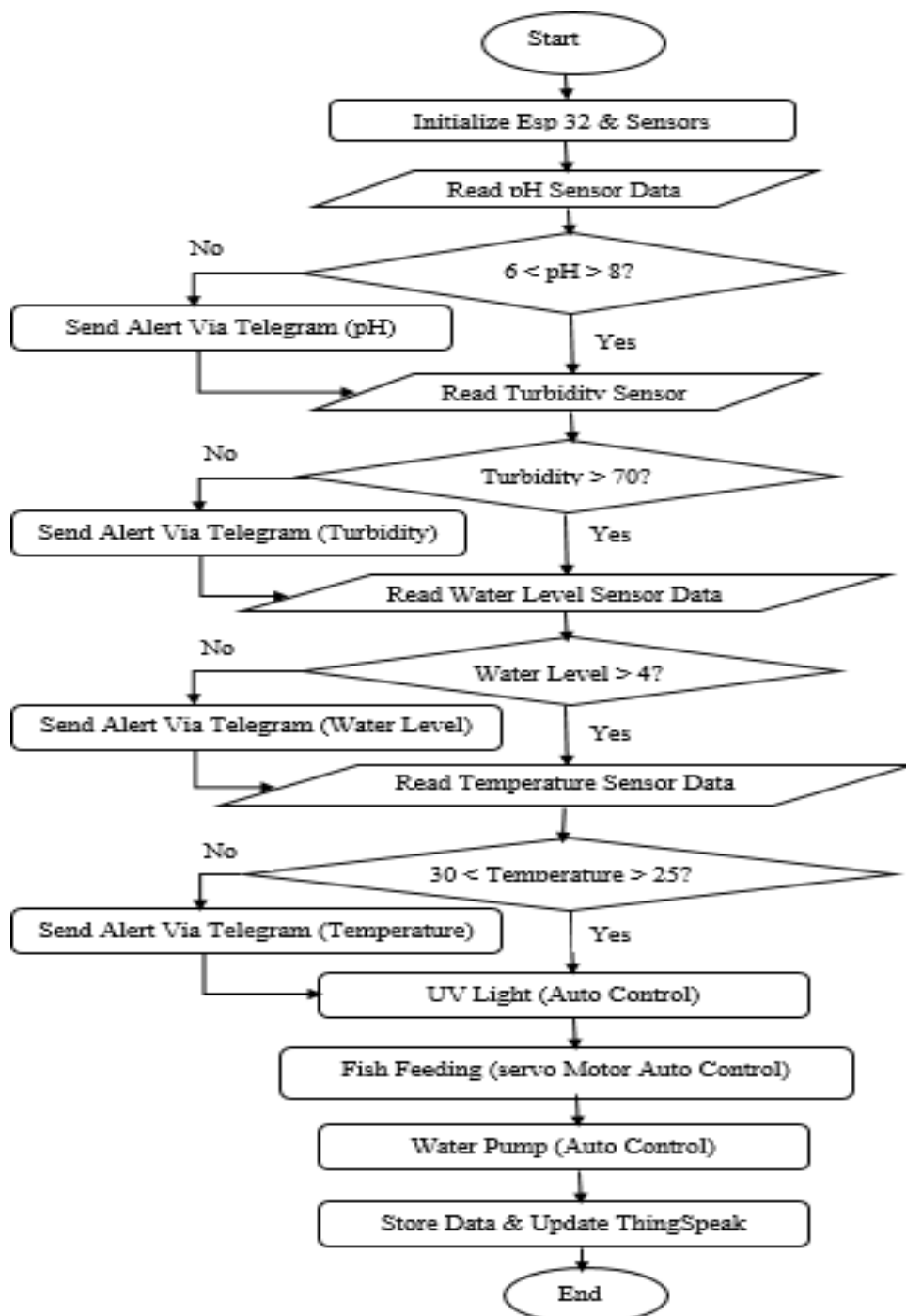


Figure 3 Flow Chart

This flow chart explains the step-by-step operation of the Smart Aquaponics System uses ESP32-WROOM to monitor and automate environmental parameters in a fish and plant co-culture system shown in figure 3. The system initializes the microcontroller and sensors, collecting data from pH, turbidity, water level, and UV light. Automatic fish feeding is handled by a servo motor, and the system controls the submersible water pump. All collected data and system actions are stored and updated in the ThingSpeak cloud, providing users with access to environmental records and system logs.

#### **IV. RESULT & DISCUSSION**

##### **A. Sensor Monitoring Module**

1. pH Sensor (SEN0161): The Smart Aquaponic Fish Tank system measures water's pH level in real-time, maintaining a range of 6.0-8.0. It sends alerts via Telegram if pH falls outside the threshold. To ensure accuracy, lime was added to the water, gradually increasing pH.
2. Temperature Sensor (DS18B20): The Smart Aquaponic Fish Tank uses a temperature sensor that accurately monitors water temperature between 25°C and 32°C, alerting users when it exceeds safe levels. The sensor's accuracy was tested by exposing it to different temperatures, confirming its reliability and responsiveness to temperature changes.
3. Turbidity Sensor (SEN0189): The Smart Aquaponic Fish Tank's turbidity sensor accurately monitors water clarity by detecting suspended particle concentrations. It reports high turbidity conditions when clarity drops below 50%. The sensor's effectiveness in monitoring water cleanliness was tested by adding soap to simulate real-world conditions.
4. Water Level Sensor: The Smart Aquaponic Fish Tank's water level sensor detects low levels and sends alerts, preventing damage to the pump and aquatic life. Tests confirmed the sensor's reliability in monitoring water levels and triggering alerts when the water drops below the required threshold.

##### **B. Control and Automation Module**

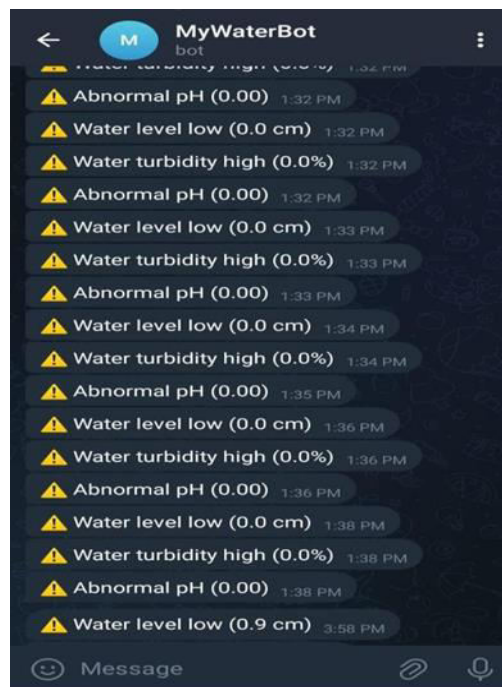
1. ESP32-WROOM Microcontroller: The system collects and processes data from all sensors, transmits it to the ThingSpeak cloud, and manages decision-making logic for alerts and actuators.
2. Servo Motor (MG996R): The fish feeding mechanism operates at scheduled intervals, ensures proper and consistent feeding, and can be remotely triggered for manual feeding.
3. Submersible Water Pump: The device efficiently circulates water between the fish tank and plant bed, automatically operating based on water level and timer settings.
4. LED Grow Lights: The device is designed to provide artificial light for plant photosynthesis, which is controlled by ambient light and timer settings.

##### **C. Cloud Monitoring & Alert Module**

1. ThingSpeak Cloud: The system provides real-time visualization of sensor data through interactive graphs, stores historical data for analysis and trend identification, and allows remote access via smartphones or browsers.
2. Telegram Alert System: The system sends immediate notifications when sensor values exceed safe limits, including low water level, high turbidity, unsafe pH, and high temperature.



Figure (a) Thingspeak colud graphs



(b) Telegram alert message

The smart aquaponics system uses an ESP32-WROOM microcontroller for real-time monitoring of environmental parameters, including pH, temperature, turbidity, and water levels. It provides timely alerts via Telegram, and features automated components like a fish feeder, pump, and LED grow lights. ThingSpeak data visualization allows for remote monitoring and analysis.

## V. CONCLUSION

The Smart Aquaponic System is a sustainable farming approach that combines aquaculture and hydroponics using advanced IoT technology. It uses sensors, ESP32, cloud platforms, and Telegram alerts to monitor critical parameters like pH, temperature, turbidity, and water levels, ensuring optimal conditions for fish and plants. The system uses 90% less water than traditional farming methods and is ideal for urban areas, commercial farming, home-based agriculture, and educational research. Despite initial costs and technical challenges, long-term benefits like sustainability, automation, and cost savings make it a valuable solution for smart agriculture. This project aims to promote eco-friendly food production, address water scarcity, and address urban food demand. With continued advancements in IoT, AI, and automation, these systems will play a crucial role in reshaping modern farming techniques.

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