



An IoT- Based Automatic Fish Feeder

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Abstract. Fish owners and small-scale aquaculture systems often face difficulties in maintaining regular feeding schedules due to busy routines or absence from home. Irregular feeding can affect fish health, growth, and water quality. This project presents an IoT-based Automatic Fish Feeder for smart and remote fish feeding, a web-based system that allows users to control feeding operations through a Wi-Fi connected interface. The system is developed using an ESP32-CAM microcontroller integrated with a servo motor attached to a food container to dispense a controlled amount of fish feed. When a feeding command is given through the web interface, the servo motor rotates and releases a measured quantity of food into the tank. The ESP32-CAM module also provides a live camera view, enabling users to monitor the feeding process and confirm that feeding has occurred successfully. The system operates through wireless connectivity without requiring complex additional hardware, making it suitable for home aquariums and small-scale fish farming setups. By enabling timely feeding and remote monitoring, the system improves fish care while reducing manual effort. This approach supports Sustainable Development Goal 2 (Zero Hunger), Sustainable Development Goal 9 (Industry, Innovation and Infrastructure), and Sustainable Development Goal 12 (Responsible Consumption and Production) by promoting efficient and responsible feed management in aquaculture systems.

Keywords — Automatic Fish Feeder, Internet of Things (IoT), Smart Aquaculture Systems, Web- Based Control, Remote Fish Feeding, Wi-Fi Enabled Monitoring, ESP32-CAM Microcontroller, Servo Motor Control, Real-Time Fish Tank Monitoring, Sustainable Aquaculture.

I. Introduction

Fish keeping in home aquariums and small aquaculture systems has become increasingly popular in recent years. However, feeding fish regularly can be challenging when owners are busy, traveling, or unable to monitor the aquarium continuously. Manual feeding often leads to problems such as missed feeding times or overfeeding, which can negatively affect fish health, growth, and water quality. These challenges highlight the need for an automated and reliable feeding solution that reduces manual effort and ensures proper feeding management. Traditional data cleaning methods often require extensive manual effort and domain expertise to identify and correct such issues. Researchers typically perform preprocessing tasks such as removing duplicate records,



handling missing values, and standardizing response formats before conducting analysis. These manual processes are time-consuming and may introduce human errors, particularly when working with large-scale datasets.

Traditional fish feeding methods mainly depend on human involvement, where the owner must feed the fish at specific times every day. Inconsistent feeding schedules or incorrect feed quantities can cause stress to fish and may also lead to water pollution due to excess food remaining in the tank. Therefore, implementing a smart feeding system that can automate the feeding process and control the feed quantity is important for maintaining a healthy aquarium environment. With the development of Internet of Things (IoT) technologies, it has become possible to control and monitor devices remotely through wireless connectivity. Microcontrollers such as the ESP32 enable devices to connect to Wi-Fi networks and interact with users through web-based interfaces. These technologies provide an effective way to design smart systems that can automate daily tasks and improve efficiency.

This project proposes an Automatic Fish Feeder system that uses an ESP32 microcontroller and a servo motor to dispense fish food automatically. The system allows users to control feeding through a Wi-Fi connection using a mobile phone or laptop. When a feeding command is given, the servo motor rotates and releases fish food from the container. In addition, the system adjusts the quantity of food based on the number of fish entered by the user, helping to avoid overfeeding and reduce food wastage. The proposed system aims to provide a simple, low-cost, and efficient solution for automated fish feeding suitable for home aquariums and small learning projects.

II. Related Works

A. Fuzzy Logic Based Fish Feeding System

Indrawati et al. proposed an automatic fish feeding system that uses fuzzy logic combined with IoT-based water quality monitoring. The system analyzes sensor data to determine appropriate feeding times and quantities, improving feeding efficiency and maintaining better water quality. Their study shows that fuzzy logic can adapt feeding decisions based on environmental conditions. However, the system design is more complex than fixed-schedule feeders and requires careful calibration of multiple sensors. In addition, the system depends on continuous power supply and internet connectivity, which may limit its use in remote aquaculture areas

B. IoT-Based Automated Fish Feeder

Researchers from the J. D. College of Engineering & Management (2024) developed an automated fish feeder using IoT technology. The system uses sensors and algorithms to optimize feeding schedules and adjust feed quantity for different fish species. Their study shows that IoT-based feeding systems can reduce overfeeding and improve feed efficiency. However, the system mainly focuses on scheduling and optimization and does not include real-time visual monitoring of the feeding process.

C. IoT-Based Aquaculture Monitoring System

Anonymous authors (2024) presented an automated fish feeding system integrated with aquaculture monitoring using IoT technology. The system allows farmers to monitor



environmental parameters and manage feeding operations more effectively. The research highlights how IoT can improve aquaculture management and reduce manual effort.

However, the system was mainly tested on small-scale setups, and challenges such as scalability, hardware durability in outdoor ponds, and maintenance requirements remain concerns for real-world implementation.

D. NodeMCU-Based Fish Feeding and Monitoring System

Sobri et al. (2024) proposed an automatic fish feeding and monitoring system using the NodeMCU ESP8266 microcontroller. The system integrates multiple sensors and actuators to automate feeding and monitor tank conditions through IoT connectivity. Their research demonstrates that microcontroller-based systems can effectively automate aquaculture operations. However, integrating multiple sensors and actuators on a single microcontroller board requires good technical expertise for proper installation and maintenance.

E Wireless Microcontroller-Based Fish Feeding System

Another study published in the International Journal for Research in Applied Science and Engineering Technology (2023) introduced an automated fish feeder using a microcontroller with wireless communication capabilities. The system allows users to monitor environmental conditions, schedule feeding times, and adjust feed quantities through a mobile application. While this approach improves convenience and remote access, it mainly focuses on monitoring and scheduling and does not provide real-time visual confirmation of the feeding process.

III. Proposed Methodology

The proposed system is an Automatic Fish Feeder developed using an ESP32 microcontroller and a servo motor connected to a food container. The feeding process is controlled through a Wi-Fi connection using a mobile phone or laptop. The user enters the number of fish in the system through the interface. Based on this input, the ESP32 controls the rotation angle of the servo motor to release the appropriate quantity of fish food. Different fish counts result in different food portions, ensuring accurate and controlled feeding. This portion-based feeding method helps prevent overfeeding and reduces food wastage in the aquarium. By maintaining proper feeding levels, the system also helps in maintaining better water quality and healthier fish growth. The overall design is simple, low-cost, and suitable for home aquariums and small learning projects.

IV. System Architecture

A. Overall Architectural Design

The proposed IoT-Based Automatic Fish Feeder system follows a modular and layered architecture to ensure efficient operation, scalability, and real-time control. The architecture integrates user interaction, wireless communication, embedded processing, and hardware actuation to automate the fish feeding process. Each layer is designed to per-

form a specific function while maintaining seamless communication with other components through Wi-Fi-based protocols. The use of an ESP32-CAM microcontroller enables both control and monitoring functionalities, making the system compact and cost-effective. The modular design allows easy expansion, such as integrating sensors or cloud-based analytics in future enhancements

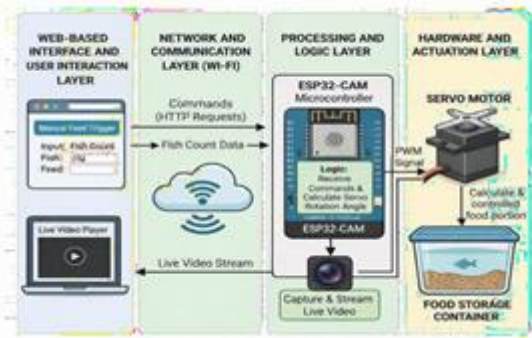


Figure 1: High-level architecture Diagram

A. User Interaction and Control Layer

At the user interaction layer, the system provides a web-based interface accessible through smartphones or computers. Users can manually trigger feeding operations and input parameters such as the number of fish. The interface is designed to be simple and intuitive, ensuring ease of use even for non-technical users. Additionally, the interface supports real-time monitoring by displaying live video streaming of the feeding process. This layer acts as the primary control point for initiating system operations.

B. Network and Communication Layer

The communication layer is responsible for enabling data exchange between the user interface and the embedded system. It utilizes Wi-Fi connectivity supported by the ESP32-CAM module and employs HTTP protocols for transmitting commands and receiving responses. User inputs, such as feeding requests and fish count data, are sent to the microcontroller, while live video streams and system status updates are transmitted back to the user. This layer ensures reliable, real-time communication, which is essential for IoT-based applications.

C. Processing and Control Layer

The processing layer acts as the core intelligence of the system and is implemented using the ESP32-CAM microcontroller. Upon receiving input commands, the system processes the data to determine the appropriate quantity of food required. Based on predefined logic, the controller calculates the servo motor rotation angle corresponding to the required food portion. Additionally, the ESP32-CAM manages camera operations for capturing and streaming live video. This layer ensures accurate decision-making and coordinated system functionality.

D. Actuation and Feeding Mechanism Layer

This layer is responsible for executing the feeding operation. It consists of a servo motor connected to a food storage container. The ESP32-CAM sends Pulse Width Modulation

(PWM) signals to control the rotation of the servo motor. Based on the calculated angle, the motor dispenses a controlled quantity of fish feed into the tank. This mechanism ensures precise feeding, thereby preventing overfeeding and maintaining water quality

E. Monitoring and Feedback Layer

The monitoring layer provides real-time feedback to the user through the integrated camera in the ESP32-CAM module. It captures live video of the feeding process and streams it to the user interface via Wi-Fi. This visual confirmation enhances system reliability and allows users to verify that feeding has occurred as expected. The feedback mechanism forms a closed-loop system, improving transparency and user confidence.

F. Scalability and System Reliability

The layered architecture ensures scalability and reliability of the system. The use of Wi-Fi communication and modular design allows the system to be extended with additional features such as automated scheduling, sensor-based feeding (e.g., water quality or fish activity), and cloud data storage. The system is designed to operate efficiently with minimal latency, ensuring timely feeding operations. Furthermore, the use of low-cost components makes the system economically viable for both small-scale and large scale aquarium setups.



Figure 2: Data Flow Diagram Level 0

The data flow design of the proposed IoT-Based Automatic Fish Feeder system describes the systematic movement of data from user interaction to the execution of feeding and feedback generation. The system is designed to ensure real-time communication, controlled feeding, and continuous monitoring through an efficient flow of information between components. The integration of wireless communication, embedded processing, and hardware actuation enables a seamless and automated feeding mechanism.

The process begins when the user interacts with the system through a web-based interface using a smartphone or computer. The user initiates the feeding operation by entering parameters such as the number of fish or by triggering a manual feed command. This input represents the primary data entering the system and serves as the basis for all subsequent operations. The user interface ensures that the input is simple, accessible, and easy to provide, even for non-technical users.



Once the input is provided, the data is transmitted to the Automatic Fish Feeding System through the network communication layer using Wi-Fi and HTTP protocols. This layer ensures reliable and real-time data transfer between the user interface and the embedded system. The transmitted data includes feeding commands and fish count information, which are essential for determining the appropriate quantity of food. The communication process is designed to minimize latency and ensure prompt system response.

Upon receiving the input, the processing unit, which is implemented using the ESP32-CAM microcontroller, interprets the command and executes the necessary logic. The system calculates the required quantity of fish food based on predefined conditions or proportional logic linked to the number of fish. It then determines the corresponding servo motor rotation angle needed to dispense the calculated food portion accurately. This stage represents the core intelligence of the system, where user input is transformed into actionable control signals.

After processing, the control signals are forwarded to the actuation mechanism. The ESP32-CAM generates Pulse Width Modulation (PWM) signals to drive the servo motor. Based on these signals, the servo motor rotates to a specific angle, allowing a controlled amount of fish feed to be released from the storage container into the aquarium. This ensures precise feeding, reduces food wastage, and helps maintain optimal water quality within the tank.

Simultaneously, the system generates output data in the form of feeding status and alerts. The ESP32-CAM's integrated camera captures the feeding process and streams live video back to the user interface via the network. This visual feedback provides confirmation that the feeding operation has been successfully executed. Additionally, system responses such as feeding completion status or error notifications are communicated to the user, enhancing reliability and transparency.

Overall, the Level 0 data flow illustrates a continuous and well-coordinated interaction between the user, system, and output components. The structured flow of data—from user input to processing, actuation, and feedback—ensures efficient system performance and real-time responsiveness. This design not only automates the feeding process but also provides monitoring capabilities, making the system intelligent, user-friendly, and suitable for modern IoT-based aquarium management.

V. Implementation Details

A. System Development and Architecture

The proposed IoT-Based Automatic Fish Feeder system is implemented as a real-time embedded system integrated with a web-based control interface. The architecture follows a modular approach, where each functional unit such as user interaction, data processing, control logic, and actuation operates independently while remaining interconnected through Wi-Fi communication. The ESP32-CAM microcontroller acts as the central processing unit, enabling both control and monitoring functionalities. This modular design ensures efficient system performance, ease of maintenance, and the ability to extend the system with additional features such as automated scheduling and sensor integration in future enhancements.



B. User Input and Data Acquisition Module

The implementation begins with the user input module, where the user provides the fish count or triggers the feeding operation through a web-based interface. This input is transmitted to the system as “Fish Count Data.” The system first validates the received data to ensure correctness and avoid invalid or extreme values that may affect feeding accuracy. Once validated, the input is forwarded to the next stage for further processing. This module ensures that only reliable and meaningful data enters the system, forming the foundation for accurate feeding control.

C. Quantity Calculation Module

In this stage, the system processes the validated fish count data to determine the appropriate quantity of food required. The ESP32-CAM executes predefined logic or proportional calculations to estimate the food portion based on the number of fish. The calculated value is temporarily stored as “Fish Count Data” and used as a reference for generating control signals. This module plays a critical role in preventing overfeeding and underfeeding by ensuring that the food quantity is optimized according to user input.

D. Servo Control and Feeding Module

The calculated food quantity is passed to the servo control module, where the system generates control signals for actuation. The ESP32-CAM produces PWM (Pulse Width Modulation) signals to control the servo motor. Based on the received signal, the servo motor rotates to a specific angle, enabling the controlled release of fish feed from the storage container. The system also generates outputs such as feeding logs or error messages, which are communicated back to the user. This module represents the physical execution layer where digital commands are converted into mechanical actions.

E. Detailed Actuation Process

The Level 2 data flow diagram provides a deeper insight into the internal operations of the servo control and food dispensing process.

1. Servo Angle Calculation

The desired food quantity is converted into a corresponding servo rotation angle. This mapping is based on predefined calibration values that determine how much food is dispensed per unit rotation. Accurate calculation at this stage ensures precise feeding control.

2. Servo Rotation Mechanism

The calculated servo angle is translated into PWM control signals, which are sent to the servo motor. The motor rotates according to the received signal, initiating the mechanical movement required for dispensing food. This stage bridges the gap between software logic and hardware execution.

3. Food Dispensing Process

As the servo motor rotates, the mechanical mechanism attached to the food container releases the calculated amount of fish feed into the aquarium. This process ensures controlled dispensing and minimizes food wastage. The output of this stage is the actual delivery of food into the fish tank

F. Output Generation and Feedback

After the feeding operation is completed, the system generates output in the form of feeding status, logs, or error notifications. These outputs are sent back to the user interface, allowing the user to confirm successful feeding or identify any issues. This feedback mechanism improves system transparency and reliability

G. Overall Implementation Flow

The implementation integrates user input, data validation, processing, and hardware actuation into a unified system. The Level1 data flow illustrates the high-level process from receiving user input to executing feeding, while the Level 2 diagram provides a detailed view of the internal actuation mechanism. The structured flow ensures efficient operation, real-time responsiveness, and accurate feeding control.



Figure 3: Data Flow Diagram Level 1

Overall, the implementation of the IoT-Based Automatic Fish Feeder system demonstrates a well- organized integration of software and hardware components. The seamless data flow from user input to servo-controlled feeding ensures precision and reliability. By combining embedded processing, wireless communication, and controlled actuation, the system provides an efficient and automated solution for aquarium management. The modular and scalable design further enables future enhancements, making the system adaptable for advanced IoT applications.

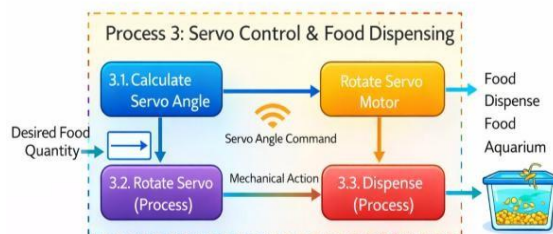


Figure 4: Data Flow Diagram Level 2



VI. Output

The output interface of the proposed IoT-Based Automatic Fish Feeder system provides real-time feedback and monitoring of the feeding process. It displays the feeding status by processing user inputs such as fish count and executing controlled food dispensing through the servo motor. The system ensures that the appropriate quantity of feed is delivered and confirms the operation through live video streaming, allowing users to visually verify the feeding activity. Additionally, the interface presents status updates such as feeding completion, execution success, or error alerts in case of communication or hardware issues, thereby improving system transparency and reliability.



Figure 5: Output image

Furthermore, the output interface acts as a centralized platform for monitoring and control by enabling users to observe aquarium conditions through continuous live video streaming. It also maintains records of feeding activities, including time, input parameters, and execution status, which can be used for future reference and optimization. By providing both real-time updates and historical insights, the system enhances automation, reduces manual effort, and supports efficient aquarium management, ensuring consistent and accurate feeding operations.

VII. Conclusion And Future Enhancement

The proposed IoT-Based Automatic Fish Feeder System demonstrates how embedded systems and IoT technologies can be effectively utilized to automate routine aquarium management tasks. By integrating a web-based interface, wireless communication, and microcontroller-based control using ESP32, the system enables accurate and controlled feeding along with real-time monitoring. The approach reduces manual effort, minimizes food wastage, and helps maintain better water quality by preventing overfeeding. The inclusion of live video streaming and status notifications further enhances user confidence and ensures reliable operation. Overall, the system provides a simple, cost-effective, and efficient solution for smart aquarium management. While the current system successfully achieves automated feeding and real-time monitoring, there is signif-



icant scope for future enhancements. The system can be extended by incorporating sensor-based automation, such as water quality monitoring (pH, temperature, turbidity) and fish activity feeding detection for intelligent feeding. Additional features like scheduled feeding, mobile application support, cloud-based data storage, and analytics can further improve usability and scalability. Integration with AI-based models for adaptive feeding and behavior analysis can make the system more intelligent and responsive. These advancements will help transform the system into a fully autonomous and smart aquarium management platform.

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