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FISH FEEDING AUTOMATION WITH ESP32 AND KODULAR APPLICATION VIA RABBITMQ AND MQTTX

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Abstract

In this study, we developed an automatic fish feeder connected to an IoT network using an ESP32 microcontroller, ESP32 is used to control the time and amount of fish feed based on a programmed schedule. Our system also uses the MQTT communication protocol for data transfer and remote device control, and RabbitMQ as a message broker to facilitate message exchange between devices and user applications. Our testing method involves setting up an Eras ESP32 device to connect a feed sensor and a servo motor that controls the feed mechanism. We implemented the control logic using the Arduino IDE programming language and connected the ESP32 to RabbitMQ using MQTTX as a link to the MQTT broker. Testing was carried out by simulating feeding conditions in a model aquarium and monitoring equipment performance and energy efficiency. The test results showed that the developed automatic fish feeder can effectively deliver food according to a specified schedule with minimal potential for error. The integration of RabbitMQ allows the system to perform reliable message processing and ensure consistent data delivery between the ESP32 device and the control application. The significance of this research is to expand the application of IoT technology in the context of pet care, improve the efficiency of resource utilization, and facilitate pet care users to care for fish automatically.

Keywords: *ESP32, RabbitMQ, MQTTX, Fish Feeder, Automatic, IoT.*

INTRODUCTION

Indonesia, which is rich in culture, is also known for its extensive fish farming sector, supported by abundant water areas as a maritime country. Fish farming is an affordable profession in various regions, aided by the construction of ponds and the vastness of the waters. Modern technology has brought significant innovations to fish farmers (Himawan & Yanu F., 2018). The development of electronic technology has produced high-precision tools that operate automatically, increasing the efficiency and effectiveness of human work. Fish farming, as part of this sector, has long been the backbone of the Indonesian fisheries industry (Sutiani & Bachtiar, 2020). Feed plays an important role in fish farming. To support farmers, this study developed an automated system that provides feed at the right time and in the right amount (Muharram & Endah Sudarmilah, 2022). However, inefficient feeding can increase production costs (Muharram & Endah Sudarmilah, 2022). Therefore, a tool that can automatically regulate the time and amount of feed is urgently needed. ESP32, a popular IoT platform, offers extensive capabilities to control sensors and actuators via the internet (Arsy, 2023). Regular and timely fish feeding is the key to successful fish farming. However, feeding is often done manually, causing potential errors and inefficiencies (Arsy, 2023). IoT technology, such as ESP32, has introduced an interesting automated solution to address this problem. This study aims to develop an automated fish feeding tool using ESP32 and the Kodular application via RabbitMQ and MQTTX (Santoso & Sitohang, 2024). This system is expected to improve the effectiveness and efficiency of fish farming, reduce manual workload, and support better productivity.

METHODOLOGY

This research was conducted in several main phases, including system design, hardware and software implementation, and testing and evaluation. Here is an explanation of each step:

1. System design

This step includes the overall design of the automatic fish feeder which includes the following components:

a. ESP32: Mikrokontroler bertindak sebagai pengontrol otak dari sistem yang akan mengendalikan motor untuk membersihkan makanan dari pengumpanan ikan berdasarkan perintah yang diterima melalui jaringan Wi-Fi.
b. RabbitMQ: Acts as a message broker that will manage communication between ESP32 devices and applications controlled by the MQTT protocol.
c. MQTTX: Used as an MQTT client to configure and monitor the system in real time.
d. Kodular: Used to create visual applications that allow users to build Android applications without requiring extensive programming knowledge.
e. Pin Header: Used to connect electronic devices to PCB boards.
f. Data Cable: Used to transfer data between devices.
g. Powerbank: Digunakan untuk sumber daya cadangan untuk mengisi baterai perangkat lunak.
h. Servo SG 90: Used to move small bottles to provide fish food.
i. PCB board: Used to assemble components in an electronic circuit.
j. Jumper Cable: Used to connect two points of a component in an electronic circuit.

Design Sub-stage

a. System design diagram: Create a diagram showing how all components will be connected.

b. Software design: Develop software for the ESP32 that will operate to control the motors based on MQTT messages received from RabbitMQ.

2. Hardware implementation

This step includes assembling all hardware components according to the schematic design that has been made. The main components used are:

a. Mikrokontroler
b. Servo motor or stepper motor to control the power supply mechanism
c. Power supply for ESP32 motors and servos
d. Power supply box with motorcycle drive control release mechanism.

3. Software Implementation

This step involves developing and testing software on several key components:

a. Code on ESP32: Write code that will be run on ESP32 to receive commands via MQTT, which engine returns status to RabbitMQ broker.
b. RabbitMQ Configuration: Configure the RabbitMQ message broker to receive and forward messages between the ESP32 and MQTTX.
c. MQTTX Usage: Using MQTTX to send commands to the ESP32 and monitor system status in real time.

4. System Testing

Testing is carried out in several stages to ensure the system is operating as it should:

a. Functional Testing: Ensuring each component functions correctly individually, as motors move according to commands from the ESP32.
b. Integration testing: Testing the entire system to ensure that all components can communicate and function correctly with each other.
c. Environmental testing: Test the system in a real fish farming environment to ensure that the system can provide fish food effectively and efficiently under real-world conditions.

5. Data Evaluation and Analysis

Data obtained during testing is collected and analyzed to evaluate system performance. Some of the metrics measured include:

a. Power accuracy and timeliness: How quickly and accurately the system delivers power according to a specified schedule.
b. Power consumption: Measures the amount of power the system uses during operation.
c. System constraints and resilience: Constraints relate to the long-term operation of the system without failure.

6. Preparation of documents and reports

The final stage includes recording the entire research process, experimental results, data analysis, and conclusions and suggestions for further development. This document is prepared as a detailed and comprehensive scientific review.

This research method is expected to provide clear guidance in developing efficient automatic fish feeding equipment that can be adapted to various fish farming needs.

RESULTS AND DISCUSSION

Based on the design that has been made, this project produces an automatic fish feeding device shown in Figure 1.

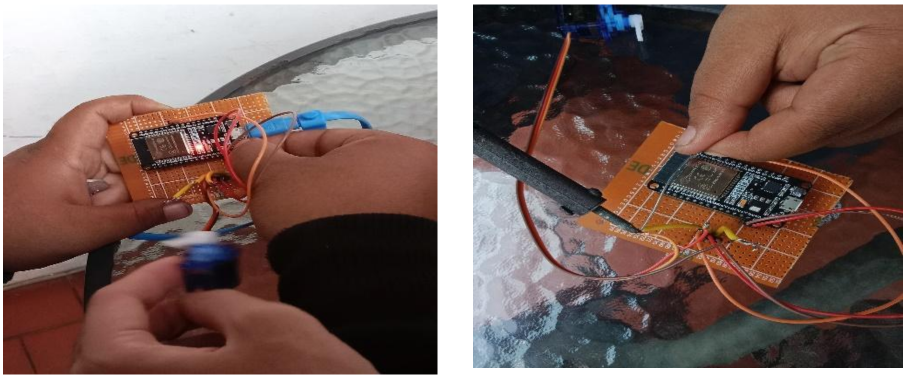

Figure 1. Circuit

This component is assembled into a fish feeding automation tool with ESP32 and Kodular Application via RABBITMQ and MQTTX. This tool can be managed via the Kodular Application. The tool has a feature to schedule fish feeding automation. This circuit is then installed above the aquarium so that users can efficiently control fish feeding in the aquarium.

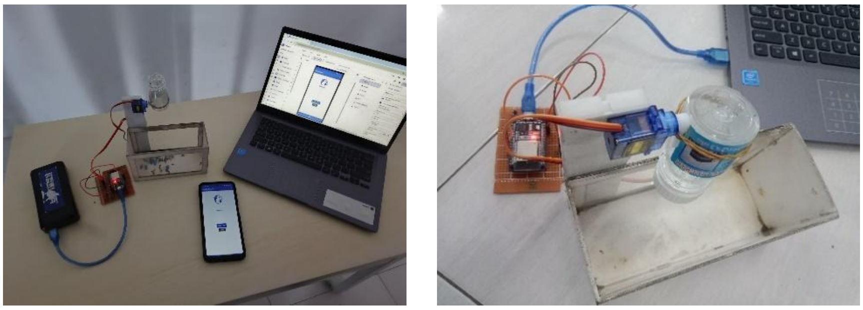

Figure 2. Component Circuit Results

This circuit works by automatically feeding fish based on commands from MQTTX controlled by the Kodular application. When we run the Feed Fish command, Servo Sg90 reads the Feed Fish schedule. If the time read by Servo Sg90 is the same as the schedule specified in the Arduino application, NodeMCU will run the ESP32 instructions, then Servo Sg90 moves the small bottle to provide fish food.

The Internet of Things (IoT) enables access and control of electronic devices over the Internet, either through human interaction with the device or between the devices themselves. In this context, IoT can be used to automate fish feeding at predetermined times, allowing fish owners to go away for long periods of time without worrying about the fish being underfed (Marbun & Puspasari, 2023). This IoT-based fish feeding system is designed to reduce the need for manual feeding by automatically delivering food (Pranata & Candra, 2023). This study utilized several components, including the ESP-32 microcontroller manufactured by Espressif Systems, a company based in Shanghai, China. This microcontroller has the ability to connect to Wi-Fi, which is then used to connect the components to the Internet (Kusumah & Pradana, 2019).

The test results show that the designed device is capable of providing food automatically according to a predetermined schedule, with the amount of food adjusted to the number of fish seeds. Control is carried out using the Sg90 servo integrated with the Kodular application. This application has a simple interface with buttons for feeding fish and closing the feeding. When the button to feed is pressed, the servo will automatically open the feed container, and the button to close will return the servo to its original position (Matondang & Yanie, 2022). The servo motor used in this study is an electric motor with a closed loop system, which is used to control the speed, acceleration, and position of the motor with high precision, and plays a role in removing fish feed from the container. Further testing emphasizes the feed distribution mechanism to ensure that the amount of feed dispensed is sufficient or not, which is regulated by the rotation of the servo motor (Sulistyo, 2022). The Kodular platform is used to develop a mobile application interface that functions to display and interact with data generated by the system. The implementation process includes setting up and connecting the ESP32 with the Kodular software (Yazid, Kusumawati, & Febriliana, 2023). Kodular also supports mini-memory and dBase functions, which allow storing and loading data as needed (Muyasir & Musfikar, 2022). In this study, Android was used as a remote feed monitoring tool through the Kodular application, which also allows manual feeding by pressing a button on the feeder. The Kodular application is able to automatically regulate feed distribution using an Internet connection, so that fish growth can be optimized. The programming language used is Arduino, which was developed during this study to create a smart feeding system that can be monitored remotely (Djuandi, 2011; Florestiyanto, Prasetyo, & Handigar, 2019).

CONCLUSION

The main conclusions from this research on developing and testing an automatic fish feeding device using ESP32, RabbitMQ and MQTTX are:

1. System effectiveness and efficiency:
   - The developed system is able to provide feed to fish automatically and on time according to the regulatory schedule. This reduces dependence on manual feeding, which is often erratic and labor-intensive.
   - Using ESP32 as the main microcontroller, this system can be implemented at a relatively low cost while still providing good and reliable performance.
2. MQTT communication reliability:
   - Using RabbitMQ as a message broker for the MQTT protocol enables stable and efficient communication between ESP32 devices and control applications. The MQTT protocol is proven to be lightweight and efficient in processing messages with low latency and minimal bandwidth consumption.
   - MQTT as an MQTT client provides a user-friendly interface, allowing users to easily configure and monitor the system in real time.
3. System Testing and Performance:
   - The test results show that the system performs smoothly under real-world conditions, delivering food to the fish accurately and precisely based on the parameters specified via MQTTX.
   - The system also demonstrated high reliability, with little disruption or downtime during the extended testing period.
4. Benefits of fish farming:
   - This automatic fish feeder can improve the operational efficiency of fish farming, enable better feed management and reduce excessive feed waste.
   - By providing more regular and scheduled feeding, fish growth can be more optimal, which can ultimately increase production and profits for fish farmers.
5. Potential for further development:
   - This system can be further developed by adding other sensors, such as water quality sensors or fish presence sensors, to increase its autonomy and control of fish farming.
   - Integrating with other IoT platforms and using more sophisticated data analytics can help make better and more efficient decisions in fish farming operations.

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