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Design and Implementation of an Automatic Fish Feeding System Based on Internet of Things (IoT)

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ABSTRACT: Manual feeding of ornamental fish often encounters obstacles such as delays, inaccurate portions, and dependence on human presence, which can affect fish health and water quality. To overcome these problems, this study designed an automatic fish feeder system based on the Internet of Things (IoT) using a prototype method with Arduino as the main controller, RTC as the scheduler, an ultrasonic sensor to monitor feed availability, a DHT11 sensor to measure temperature and humidity around the aquarium, a servo motor as the feed dispenser actuator, and a relay as an additional switch. The test results showed that the system was able to feed automatically three times a day according to the schedule, accurately detect feed availability, but still faced limitations in displaying temperature and humidity conditions. This system proved to improve maintenance efficiency, reduce feed waste, and help maintain the health of ornamental fish.

Keywords: Ornamental Fish, Automatic Feeder, Arduino Uno, Internet of Things, RTC

I. INTRODUCTION

Freshwater fish farming is one of the efforts that can help improve the community's economy, especially amid the difficulty of employment and increasing living needs. To optimize cultivation results and simplify the process, technology development is needed in these activities. Feed plays a vital role in supporting the growth and reproduction of cultivated fish.

Digital technology advancements now offer solutions through automatic systems that are more efficient and effective [1].

However, in ornamental fish maintenance, several obstacles are still encountered. One of them is the difficulty in controlling fish feed in real-time, especially when the keeper cannot be present at the location. Similarly, controlling water quality is quite challenging. With the advancement of information technology, farmers can be assisted in remote control using the Internet of Things (IoT) [2].

By utilizing IoT technology, feeding systems and water quality monitoring can be done automatically and in real-time. Sensors integrated with microcontrollers and internet connectivity allow users to monitor water temperature and set feeding schedules efficiently from a distance through applications or dashboards. This not only improves operational efficiency but can also increase productivity and sustainability in fish farming businesses. Therefore, this study designs and builds an automatic fish feeding system equipped with IoT-based water quality monitoring features. This system is expected to be an appropriate technological solution for small to medium-scale fish farmers [3].

The technology to be applied is an automatic fish feeder that can schedule feeding automatically and monitor feed conditions through the Blynk application on smartphones. The electronic components used include ESP8266 as data processor, MG996R Servo Motor as feed valve actuator, SG90 Servo Motor as potentiometer driver, Potentiometer for blower control, Blower for feed spreading, HY-SRF05 Ultrasonic Sensor for feed condition monitoring, Power Supply for 12V input, Buzzer for notification alarm, and Blynk application on smartphone. The test results show that the device can function properly, feeding schedules and feed monitoring work normally according to commands set in the Blynk application [4].

Based on the background above, the author considers research on automatic fish feeding important. The author initiates research entitled "Design and Implementation of Automatic Fish Feed Based on Internet of Things (IoT)". Aquarium fish maintenance has become a popular hobby due to its calming beauty and easy accessibility at home. However, the most common problem faced by aquarium owners is inaccurate feeding time, daily busyness such as work, school, and other activities that cause many people to forget to feed on time with appropriate portions. This not only affects fish health but can also reduce water clarity due to excess feed residue or food decomposition.

In the current modern era, the development of automatic systems and the Internet of Things (IoT) can help these problems. One innovation that has emerged is the automatic fish feeding system. This system is designed to provide feed regularly and with precise portions, without relying on human labor. Using sensors and microcontrollers such as Arduino and ESP32, this system is developed to regulate feeding time and the amount of feed dispensed.

II. PROBLEM STATEMENT

The problems formulated in this research are:

1. How to create an automatic fish feeder based on the Internet of Things that can

provide feed on time and according to the correct portion?

2. How can this system regulate fish feed efficiently to reduce waste of ornamental fish feed?

III. SCOPE AND LIMITATIONS

This research has the following limitations:

1. Only for fish feed in aquariums
2. Only uses 1 Arduino
3. Only uses 1 RTC
4. Only uses 1 DHT11 sensor
5. Only uses 1 ultrasonic sensor
6. Only uses 1 relay

IV. RESEARCH OBJECTIVES

The objectives of this research are:

1. To design and develop an automatic fish feeding system based on Internet of Things (IoT) capable of providing feed automatically and in real-time
2. To regulate feeding automatically

V. RESEARCH BENEFITS

The benefits of this research are:

1. To provide an alternative and time-saving solution for fish feeding, especially aimed at aquarium owners or small-scale fish farmers who have time constraints

VI. RELATED WORK

Based on research conducted by Nur et al. [5] entitled ”Automatic Measured Feed System for Red Nile Tilapia Cultivation Based on IoT”, the background of this research is the development of an IoT-based system for red Nile tilapia cultivation with automatic feeding. The system monitors water quality using pH and temperature sensors, measures feed availability using a load cell sensor, and regulates time through an RTC controlled by Arduino. By applying fuzzy logic, feed portions can adjust to environmental conditions. Integration with the Blynk application allows users to obtain real-time information about water quality and feeding. The difference from previous research is the use of Arduino as a controller, while this research uses ESP8266 and does not apply fuzzy logic.

Fernanda and Wellem [6] conducted research entitled ”Design and Implementation of IoT-Based Automatic Fish Feeding System”. Fish are livestock commodities with high demand, encouraging people to cultivate them. Feed is an important factor in cultivation because it must be given regularly and according to needs. This research designs an automatic feeding system using Arduino Nano, servo motor, and ESP8266 WiFi module connected to an Android application for scheduling and feed portions. Test results on fish ponds with three schedules showed an average feed output of 24.04 grams per second, and the system proved capable of working according to specified times and portions.

Algifri Prayudha Diwiryo et al. [7] researched ”Development of Smart Fish Feeding Based on Internet of Things in Ornamental Fish Cultivation”. The system uses HC-SR04 sensor to detect feed amount, JSN-SR04T sensor to measure water level, ESP32-Cam for visual monitoring, and Solenoid Water Valve as water regulator connected to Android application via Firebase. Test results show the system can distribute feed on schedule with an average of 16.38 grams per second.

Kurniawan et al. [8] designed an automatic feeding system for Sangkuriang catfish (Clarias gariepinus) based on IoT in biofloc cultivation. The system uses ESP32 microcontroller as the main controller connected to a servo motor to regulate feed output, Real Time Clock (RTC) as scheduler, and LCD as display. The feeding schedule can be set through the Catfish Feeder IoT application on the Adafruit.io platform with feeding times at 06:00, 15:00, and 20:00 WIB.

Budi Suyitno et al. [9] designed an automatic fish feeder based on IoT using solar panels. The results show the automatic fish feeding system works well, with stable power supply circuits, ultrasonic sensors capable of measuring feed amounts, servos and electric motors functioning according to needs capable of throwing feed up to 7 meters, and IoT integration enabling remote monitoring and control through the Blynk platform.

Tikneon and Belutowe [10] researched automation and monitoring of dumbo catfish feeding based on IoT. This system uses ESP32 microcontroller with internet connectivity as the main controller, Real Time Clock (RTC) for scheduling, ultrasonic sensor for feed availability detection, and servo motor to dispense feed from the container. The Blynk application is used as a monitoring and remote control medium.

Mutaqien and Supriatna [11] designed a prototype monitoring system for fish feed feeding based on IoT. This research designs an automatic feeding system based on ESP32 with Blynk application, water level sensor, and HC-SR04 ultrasonic sensor using the Rational Unified Process (RUP) method.

Setiawan et al. [12] designed an IoT-based automatic fish feeding system (smart feeder). This research designs an automatic feeding system based on NodeMCU ESP8266 connected to Wi-Fi and controlled through a smartphone application made with App Inventor. The system is equipped with an infrared sensor to monitor feed stock in real-time, LCD 16x2 display, and automatic or manual mode features.

Marwondo et al. [13] designed IoT devices for feed control in Betta fish cultivation. The system is designed using Arduino Uno R3 SMD as microcontroller, DS18B20 sensor for temperature, pH sensor, and servo motor as feed dispenser controller, while Thingspeak is used as an online monitoring dashboard.

Saputra and Fadlillah [14] designed a temperature and pH monitoring system for aquascapes based on IoT. The system uses NodeMCU ESP8266 for WiFi connectivity, RTC module as time recorder, DS18B20 temperature sensor, relay, and information display through LCD and Thinger.io dashboard.

VII. THEORETICAL BACKGROUND

Ornamental fish have strong appeal to fish enthusiasts, so market demand continues to increase over time. In ornamental fish maintenance, one very important aspect is providing feed precisely and regularly. Manual feeding is often considered less effective because if the aquarium owner is active outside the home or traveling, the feeding schedule can be missed, potentially disrupting fish health. To overcome this problem, a device utilizing Internet of Things (IoT) technology was developed [15]. This research aims to develop an Arduino-based automatic fish feeder, utilizing RTC (Real Time Clock) module for scheduling and servo motor as the feed mechanism driver. Prototype testing on ornamental fish showed satisfactory results, where the device could accurately distribute feed according to the set schedule, and the servo motor worked optimally in controlling feed distribution. The RTC module proved effective in maintaining time accuracy, keeping fish eating patterns regular [16].

A. Arduino Uno

Figure 1: Arduino Uno Microcontroller

Arduino Uno is one of the most widely used microcontroller boards in electronics and automation, especially by students, researchers, and embedded system developers. This board uses the ATmega328P microcontroller, a chip manufactured by Atmel which is now under Microchip Technology. Its popularity is driven by its open-source nature, ease of programming, and support from a vast hardware and software ecosystem. Arduino Uno can be easily run through Arduino IDE, programming software based on C/C++ language with a simple interface. In its use, Arduino Uno acts as the control center for various automation projects, for educational, research, and real-world applications such as agriculture, robotics, and smart home systems [17].

B. Ultrasonic Sensor

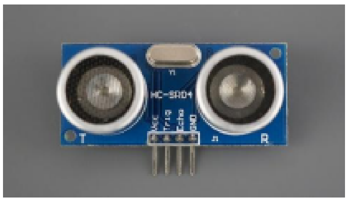

Figure 2: Ultrasonic Sensor HC-SR04

The ultrasonic sensor is a device that works based on sound wave reflection, capable of detecting the presence of an object at a certain frequency. This sensor generally operates in the frequency range of approximately 40 kHz to 400 kHz. The ultrasonic sensor consists of two main parts: a transmitter unit and a receiver unit. The structure of these two units is quite simple, consisting of a piezoelectric crystal mounted on an anchor mechanism and connected to a vibrating diaphragm. When alternating voltage is applied to the metal plate, this voltage produces ultrasonic waves with operating frequencies between 40 kHz to 400 kHz, which are then reflected by objects and received back by the sensor for detection [18].

C. Relay

Figure 3: Relay Module

The relay module is an electronic component that functions as a switch controlled by electric current. This device allows low-voltage control systems to operate higher voltage loads, especially in AC circuits. Additionally, the relay also acts as an interface separating the control circuit from the load, providing safety and flexibility in using various electrical power sources in electronic and automation systems [19].

D. DHT11 Sensor

Figure 4: DHT11 Temperature and Humidity Sensor

The DHT11 sensor is a sensor module used to detect temperature and humidity by producing a voltage signal output that can be further processed by a microcontroller. Generally, this sensor is equipped with calibration features so that temperature and humidity readings are quite accurate. The calibration data is stored in OTP (One Time Programmable) program memory known as calibration coefficients [20].

E. Servo Motor

Figure 5: Servo Motor

The servo motor is a motor with a closed feedback system capable of precisely controlling shaft position. The main components of this motor consist of a motor, gears, potentiometer, and control circuit. The shaft rotation angle is determined by the pulse width received at the signal pin, for example, a 1.5 ms pulse will place the shaft in the middle position. The larger or smaller the pulse width, the shaft will move clockwise or counterclockwise. Generally, servo motors only move at certain angles and do not rotate continuously like DC motors or stepper motors [20].

F. Real Time Clock (RTC)

Figure 6: RTC (Real Time Clock) DS3231 Module

RTC (Real Time Clock) functions to regulate time according to a predetermined schedule and control devices to determine fish feed portions through servo motor rotation. Meanwhile, the microcontroller is a mini computer system where most components are packaged in a single IC chip (Integrated Circuit), often referred to as a single-chip microcomputer [20].

G. Jumper Cables

Figure 7: Jumper Cables

Jumper cables are types of cables used to connect electric current between one electronic device and another. These cables have two types of connectors: male for inserting and female for receiving. Their use is very practical because they do not require soldering, so if installation errors occur, the cables can be easily removed and reattached. Additionally, jumper cables are available in various lengths, making it easier to create electronic circuit prototypes [20].

H. Arduino IDE

Figure 8: Arduino IDE Software

Arduino IDE is software used to design and manage programs on Arduino microcontrollers. Through this application, users can write, edit, and upload program instructions directly to the Arduino Uno board. The programming language commonly used in Arduino IDE is C or its derivatives, making it easier to create and operate various electronics projects [21].

VIII. METHOD

A. Research Method

The prototype method is an approach in system development by creating a prototype or initial model that functions to provide a real picture of the display, workflow, and main functions of the system before being fully built. The stages include identifying basic user needs, creating a simple prototype, direct testing by users, and evaluation and improvement based on feedback until the prototype meets requirements. After approval, the system is fully developed according to final specifications. This approach has several advantages, such as facilitating communication between developers and users, providing early visualization, being more flexible to changes, and reducing error risk. However, this method also has disadvantages, such as taking longer if requirements change frequently, being less suitable for very complex projects, and sometimes users focusing more on appearance than technical aspects. Therefore, the prototype method is very suitable for projects requiring early visualization, adaptability to changes, and supporting continuous system development processes.

B. Research Flow

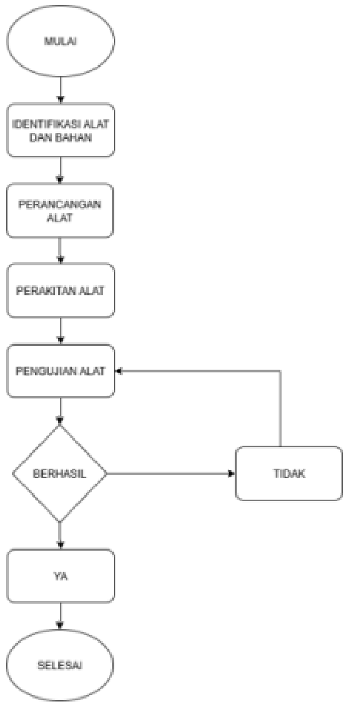

Figure 9: Research Flow Diagram

The research flow begins with the problem identification stage, analyzing obstacles in fish maintenance related to inefficient manual feeding so an automatic system is needed. Next, system design is carried out by selecting hardware components such as Arduino Uno as microcontroller, ultrasonic sensor to detect feed height, relay as automatic switch, servo motor to move the feed container, RTC as scheduler, and DHT11 sensor to monitor temperature and humidity. At this stage, circuit diagrams, workflows, and program algorithms are also created. The next stage is implementation, assembling all components according to the design and programming the Arduino so the system can work according to logic, such as opening the feed container at specific times, reading feed levels with sensors, and displaying necessary data. After that, testing is conducted to ensure feeding accuracy, RTC time accuracy, sensor accuracy, and servo performance. If obstacles are found such as inappropriate feed portions or suboptimal servo movement, repairs are made until the system works stably. With this flow, the automatic feeding system can function according to the objectives and support maintenance efficiency.

C. Identification of Tools and Materials

Table 1: Identification of Tools and Materials

NO	HARDWARE	FUNCTION
1	Arduino Uno	Functions to control various hardware data through programming
2	DHT11	Measures temperature and humidity around the aquarium
3	Ultrasonic Sensor	Detects feed height or volume inside the container
4	Relay	Functions as an electronic switch that connects or disconnects electric current
5	RTC	Regulates feeding time based on programmed schedule
6	Servo Motor	Functions as actuator that moves the feed container opening/closing mechanism
7	Jumper Cables	Functions to connect circuits on the Arduino board to electronic devices

Table 1 shows the main hardware devices used in designing the IoT automatic fish feeder. Arduino functions as the control center to manage sensors and regulate actuator work. The DHT11 sensor is used to measure temperature and humidity around the aquarium, while the Ultrasonic Sensor detects feed container height or feed volume. RTC ensures the feeding schedule according to time, while the Relay serves as an electronic switch to control additional devices. The Servo Motor becomes the actuator to open and close the feed container. All these components are interconnected with the help of jumper cables, forming an integrated system to support automatic fish feeding.

D. System Design

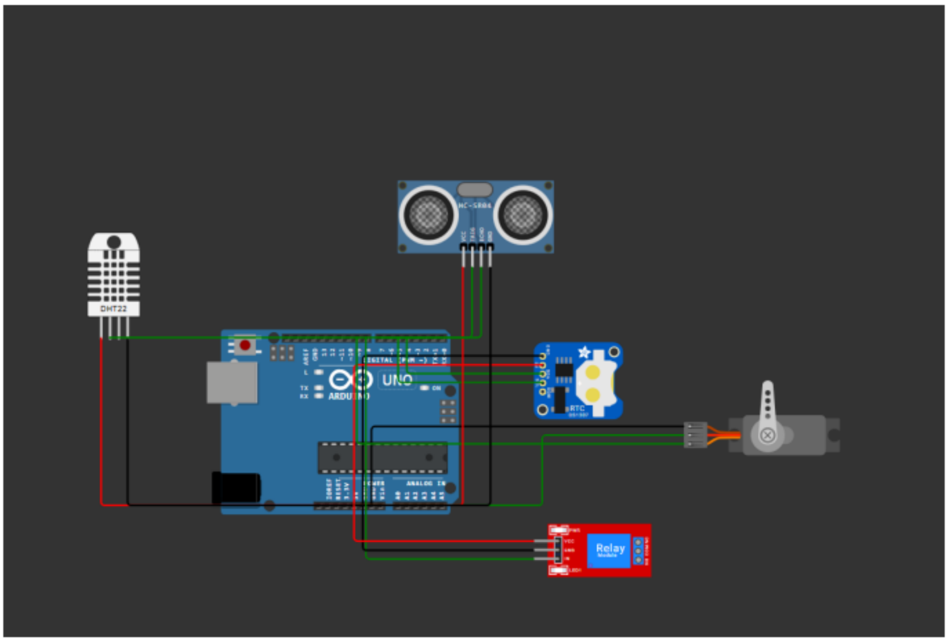

Figure 10: System Block Diagram

Figure 10 shows the system diagram. Arduino works by utilizing several main components, where Arduino Uno acts as the control center to regulate the entire system. RTC (Real Time Clock) is used to determine the automatic feeding schedule according to the programmed time, while the servo motor functions to open and close the feed container so feed can come out on time. For monitoring conditions, the ultrasonic sensor detects feed height in the container to determine if feed is running low, and the DHT sensor measures environmental temperature and humidity to ensure feed remains in good condition. Additionally, the relay can function as an automatic switch to control additional devices such as water pumps or aerators if needed, making the overall system smarter and more efficient.

E. Hardware Assembly

8.5.1 Connecting RTC to Arduino Uno

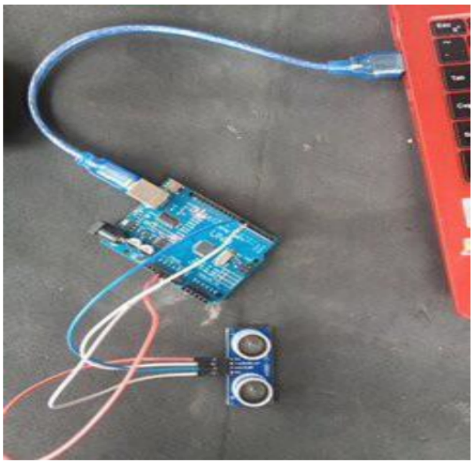

Figure 11: Connecting RTC to Arduino Uno

Connecting RTC to Arduino Uno uses I2C (Inter-Integrated Circuit) communication using four main pins: VCC to 5V, GND to GND, SDA to pin A4, and SCL to pin A5. Through this connection, Arduino can read and set real-time time, while the backup battery on the RTC module keeps time data stored even when Arduino is not powered.

8.5.2 Connecting Ultrasonic Sensor to Arduino Uno

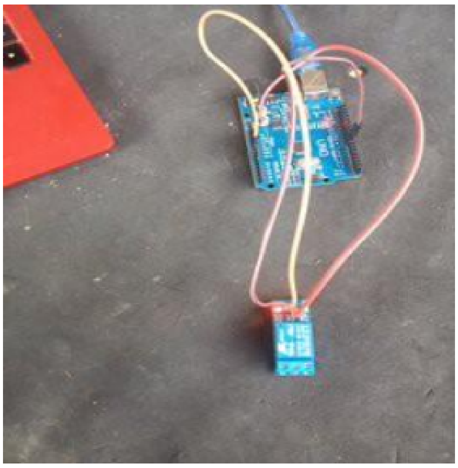

Figure 12: Connecting Ultrasonic Sensor to Arduino Uno

Connecting the HC-SR04 ultrasonic sensor to Arduino Uno uses four main pins: VCC, GND, Trig, and Echo. The VCC pin is connected to Arduino 5V, GND to Arduino GND, then the Trig pin is connected to digital pin 4, and the Echo pin to digital pin 5. With this connection, Arduino sends pulses through the Trig pin and receives reflections through the Echo pin to calculate distance or object height, for example to detect remaining feed in the container.

8.5.3 Connecting Relay to Arduino Uno

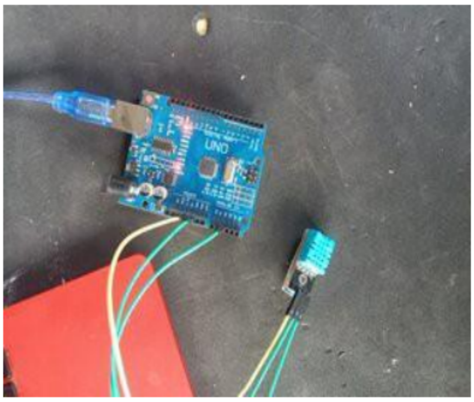

Figure 13: Connecting Relay to Arduino Uno

Connecting the Relay to Arduino Uno uses three main pins: VCC, GND, and IN. The relay VCC pin is connected to Arduino 5V to provide power supply, the relay GND pin is connected to Arduino GND as the negative path, while the relay IN pin is connected to Arduino digital pin 5 to receive control signals. With this connection, Arduino sends HIGH or LOW logic to the IN pin so the relay can work as an automatic switch connecting or disconnecting current to external electrical devices such as water pumps, lights, or aerators.

8.5.4 Connecting DHT11 to Arduino Uno

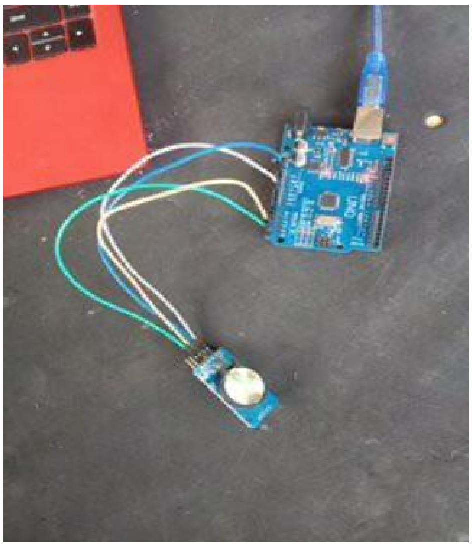

Figure 14: Connecting DHT11 to Arduino Uno

The DHT11 sensor in the automatic fish feeder functions to measure temperature and humidity around the aquarium or pond. Data from this sensor is sent through the data pin connected to pin 2 of Arduino Uno, so the microcontroller can process this information to monitor environmental conditions and ensure fish receive feed in suitable conditions.

8.5.5 Connecting Servo Motor to Arduino

Connecting Arduino Uno to the servo motor is quite simple. The red cable from the servo is connected to the 5V pin on Arduino Uno as a power source, while the brown or black cable is connected to the Arduino GND pin for the ground path. Meanwhile, the orange or yellow cable from the servo is connected to digital pin 9 on Arduino Uno as the signal path. With this connection, Arduino can send PWM signals through pin 9 to adjust the servo motor rotation angle according to program commands.

IX. RESULT AND DISCUSSION

A. System Design

System design is an important initial stage in building an IoT-based automatic fish feeder, which includes determining component requirements such as Arduino Uno as the main controller, ultrasonic sensor to detect feed amount, DHT11 sensor to monitor temperature and humidity, RTC for scheduling, servo motor as feed container actuator, and relay as automatic switch. At this stage, a block diagram is also prepared to illustrate the system workflow, from sensor input to actuator output. Hardware is designed to connect and work synchronously, while software is programmed using Arduino IDE to set work logic, such as servo movement based on schedule and system response to certain conditions. With careful design, the system can work automatically, on schedule, and integrated with IoT to facilitate remote monitoring.

B. Implementation

Table 2: Tools and Materials Used

NO	TOOLS AND MATERIALS	FUNCTION
1	Arduino Uno	As the brain of the system that controls all components through programming
2	DHT11	To measure temperature and humidity around the aquarium
3	Servo Motor	Actuator used to open and close the feed container
4	RTC (Real Time Clock)	Sets and maintains real-time time so the system can provide feed on time
5	Ultrasonic Sensor	Used to determine remaining feed
6	Relay	Functions as an electronic switch to control current or other devices with larger power
7	Jumper Cables	As connectors between components and Arduino

C. System Diagram

The automatic fish feeding system works by integrating several components controlled by Arduino Uno. RTC (Real Time Clock) provides accurate time sent to Arduino so Arduino can provide feed according to the programmed schedule. When feeding time is reached, Arduino sends a signal to the servo motor to open and close the feed container so feed comes out as determined.

The ultrasonic sensor is used to measure feed height in the container. If the sensor detects too far, it indicates the feed is running low or even empty. This information is then processed by Arduino so the relay triggers an alarm for the aquarium owner to immediately refill the feed container. DHT11 is used to measure temperature around the area; this data can be used to assess fish habitat conditions.

The relay functions as an automatic switch controlled by Arduino to connect and disconnect additional current such as alarms. With the relay, the system is safer because Arduino only connects low voltage. Arduino Uno becomes the control center by processing input from RTC, ultrasonic, and DHT11, then producing outputs such as servo movement or relay activity. This system enables automatic feeding, feed stock monitoring, and fish environmental condition surveillance.

D. Assembly Results

Table 3: Assembly Results

Component Name	Function	Success/Failure
Arduino Uno	As microcontroller to manage all sensors	Successful
Ultrasonic Sensor	As feed amount measurer in container	Works well, can measure feed amount accurately
Servo Motor	As feed container opener/closer	Works very well, can open and close container with precise amount
DHT11	To check temperature and humidity around aquarium	Not working well, cannot detect temperature in aquarium area
RTC (Real Time Clock)	As time indicator for Arduino, triggers servo to open/close container according to schedule	Works according to function, provides feed 3 times a day at the right time
Relay	As additional switch	Successful

E. Testing Results

9.5.1 RTC Testing

The RTC testing results show that the RTC works well as a feeding scheduler. The RTC can provide feed accurately and stably, with a very small difference compared to the actual clock. Additionally, thanks to the backup battery, the RTC retains and continues time even when the Arduino is turned off or the main power source is disconnected. The RTC testing results show it works well because it provides feed at the right time.

9.5.2 Ultrasonic Sensor Testing

It can be concluded that the ultrasonic sensor successfully detects feed accurately. The values obtained correspond to the actual condition of the container. The measurement distance for feed amount when the container is full reads 5-7 cm, when feed reaches 10-12 cm it reads half full, and when it reaches 15-20 cm the feed reads almost empty or empty. Although there are slight fluctuations, the sensor remains reliable by adding data filtering methods.

9.5.3 DHT11 Testing

Based on the testing, it can be concluded that the DHT11 sensor cannot function properly as it is unable to measure humidity and temperature around the aquarium.

9.5.4 Complete System Testing

Based on the design and testing results conducted, the automatic fish feeding system consisting of Arduino, ultrasonic sensor, servo, DHT11, relay, and RTC was successfully implemented with satisfactory results. The RTC module can maintain time so that feeding can be carried out according to the predetermined schedule. The servo motor works very well opening and closing the feed container so fish receive feed according to the determined time. The ultrasonic sensor can detect feed in the container so feed amount conditions can be monitored, while the DHT11 provides humidity and temperature information about the aquarium that can affect fish health. The relay remains available in this testing as a controller for additional devices, making the system flexible for further development. Overall, the system functions well and can help fish keepers provide regular, efficient feeding without depending on the aquarium owner's presence at all times.

Table 4: Testing Success Results

NO STATUS	DAY	DATE	MORNING	AFTERNOON	EVENING
1 Successful	Tuesday	Sept 09	07:01	12:01	17:01
2 Successful	Wednesday	Sept 10	07:01	12:01	17:01
3 Successful	Thursday	Sept 11	07:01	12:01	17:01
4 Successful	Friday	Sept 12	07:01	12:01	17:01
5 Successful	Saturday	Sept 13	07:01	12:01	17:01
6 Successful	Sunday	Sept 14	07:01	12:01	17:01
7 Successful	Monday	Sept 15	07:01	12:01	17:01
8 Successful	Tuesday	Sept 16	07:01	12:01	17:01

Based on the test results in Table 4, the automatic fish feeding system works according to the predetermined program. The RTC module is used to set the feeding schedule at 07:00, 12:00, and 17:00. The servo motor functions as the actuator to open the feed container so that feed can come out at the specified time. The ultrasonic sensor successfully detects the distance or feed level in the container, so the system can provide information about remaining feed conditions.

F. Discussion

The automatic fish feeding system that has been designed and implemented shows good performance in helping aquarium owners provide feed regularly. Based on testing conducted over eight days, the system successfully provided feed three times a day according to the schedule set through the RTC module.

The main success of this system lies in the use of RTC as an accurate timekeeper. The RTC DS3231 module used has good accuracy with a very small time difference compared to the actual clock. This is important because feeding time accuracy is one of the critical factors in fish maintenance. The servo motor also responded well to commands from Arduino to open and close the feed container, allowing feed to come out according to the specified portion.

The ultrasonic sensor proved capable of detecting feed levels in the container with good accuracy. The distance measurement results correspond to the actual feed volume conditions: 5-7 cm for full condition, 10-12 cm for half full, and 15-20 cm for almost empty or empty. This information is very useful for aquarium owners to know when to refill the feed container.

However, this research still has several weaknesses. The DHT11 sensor did not function optimally in measuring temperature and humidity around the aquarium. This is likely due to interference from the aquarium environment or less stable electrical interference. Another limitation is that the system has not been fully integrated with IoT connectivity for remote monitoring, as it still uses Arduino Uno which does not have built-in WiFi modules.

Compared to previous research by Fernanda & Wellem [6] which used Arduino Nano with ESP8266 for WiFi connectivity, and by Tikneon & Belutowe [10] which used ESP32 with the Blynk application, the system developed in this research is still limited to local control without internet connectivity. Nevertheless, the basic system for automatic feeding has been functioning well and can be a foundation for further development.

X. CONCLUSION

A. Conclusion

This research successfully designed and tested an Arduino-based automatic fish feeding system capable of working according to schedule and responding to environmental conditions well. This tool can provide feed regularly without requiring manual intervention, thus facilitating fish maintenance. The system also proved accurate in reading supporting parameters such as time, temperature, and feed height.

For further development, the use of modern microcontrollers such as ESP32 with built-in Wi-Fi features is highly recommended, as it will enable remote monitoring and control directly through IoT applications. With this improvement, the system is expected to become more efficient, practical, and provide added convenience in the form of automatic notifications and more flexible real-time settings.

B. Suggestions

The automatic fish feeding system has been successfully designed according to expected functions, but further development can be done by replacing the microcontroller with an ESP32 equipped with Wi-Fi connectivity. With this capability, feeding can be monitored and controlled remotely via the internet by creating a website or using third-party applications such as Blynk, as well as enabling automatic alerts when feed stock is running low or aquarium environmental conditions are unsuitable. Additionally, using ESP32 makes the device simpler, more energy-efficient, and capable of working in real-time with more complete features.

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