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Fish Feeding System in Aquaponic Media Using Firebase and Internet of Things Based Codular

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Abstract—The aquaponics system is an agricultural method that integrates fish cultivation with plants in an interrelated system. Where fish are used as a source of nutrition for plants, and plants become natural filters to clean water. Feeding fish is very important because it is the main source of nutrition for fish and has a direct impact on fish health, plants, growth and production. Providing scheduled feed and appropriate doses is very important to maintain the health of fish and the aquaponic ecosystem. Use a 30 liter dryer for catfish and kale plants. Feeding is regulated by the number of servo revolutions, the RTC sensor regulates the feed schedule, the ultrasonic sensor measures water level, and the IR-FC51 sensor measures feed availability. Kodular and Firebase applications as real-time databases are used as tools to create a system interface that can be accessed by users for monitoring water levels and feed availability as well as controlling automatic schedules and feeding doses with the aim of ensuring regular feeding, good and healthy fish growth, reduces feed waste absorbed by plants. This system has additional manually operated facilities to control the water pump and feeding which the user can access in real time via smartphone.

Keywords—Aquaponics, Feeding, Automatic Systems, Internet of Things, Smartphones

I. INTRODUCTION

Aquaponics is an agricultural method that integrates fish cultivation with plants in an interrelated system. In an aquaponics system, fish are used as a source of nutrition for plants, and plants become natural filters that clean the water which will be used again for the fish. [1] Aquaponics can help overcome the problem of water and land scarcity which is increasing in several regions in the world. Dr. Rebecca L. Nelson, an agroecologist from Cornell University, stated that aquaponics can help reduce the use of chemical fertilizers and pesticides in agriculture, thereby producing healthier and environmentally friendly products. [2][3] Overall, experts agree that aquaponics has great potential as an agricultural alternative that is environmentally friendly, sustainable, and can increase food availability in urban areas where land and water are limited. In an aquaponic system, feeding fish is very important because it is the main source of nutrition for fish and has a direct impact on fish health, plant health, growth and production. [4] Providing timely and appropriate fish food in an aquaponic system is very important to maintain fish health and growth as well as the balance of the aquaponic ecosystem as a whole. Feeding fish in an aquaponic system is often problematic due to several factors, such as lack of time to feed fish, irregular feeding, and poor quality of feed. [5] Giving food on an irregular schedule can cause the fish's appetite to decrease due to changes in eating patterns where the fish should be fed at a certain time to be late or where the fish should have been fed and then fed again due to forgetting whether they have fed it or not. [6] Previously there was research in 2020 with tittle Design of Internet of Things (IoT) Based Fish Feeding Equipment. The overall system for this internet of things based fish feeding equipment has two options, namely manual operation and automatic operation. When using the manual option, users can operate it by pressing the ON and OFF buttons on the Blynk application. Meanwhile, for the automatic option, the user needs to set the on time and off time for the fish feeder according to their wishes. [7] Then research was conducted in 2022 with the title Design and Implementation of an IoT-Based Automatic Fish Feeding System. The hardware in this system is implemented using an Arduino Nano as the main control device. A servo motor is used to move the door or gap dividing the fish feeder, while the ESP8266 WiFi module is used to connect the hardware to the internet. In addition, there is an Android application developed to control the feeding schedule and the amount of feed given. [8][9] However, there are still several shortcomings in this research to be applied to aquaponic media, such as there is no food dose given, there is also no monitoring of water levels or control for turning on or off the water pump. Based on these problems, it is necessary to build a fish feeding system using aquaponic media that can provide scheduled fish food automatically based on a predetermined time, and can determine the availability of fish food, measure the water level. This system is also equipped with a manual system to control the water pump and feeding via the application. Based on the description above, research will be carried out with the title "FISH FEEDING SYSTEM IN AQUAPONIC MEDIA USING FIREBASE AND INTERNET OF THINGS BASED CODULAR". This system is expected to help fish farmers in providing regular feeding, good and healthy fish growth, and can reduce feed waste so as to increase the efficiency of feed use in aquaponic media. Apart from that, the remaining fish food absorbed by plants can be reduced so that plants grow healthier and more fertile.

II. METHODOLOGY

The research procedure was carried out in the process of making Fish Feeding Equipment in an Internet of Things (IoT) Based Aquaponics System. The research flow used can be seen in the following image

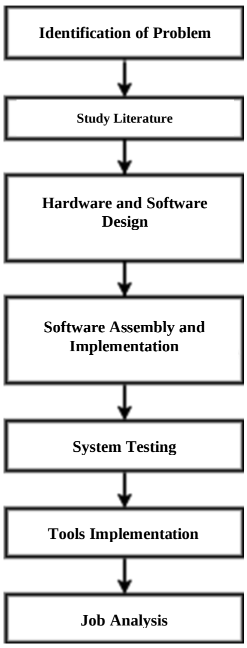

Figure 1. Research Flow

Before creating a Fish Feeding System in Aquaponic Media Using Firebase and Kodular Based on the Internet of Things, there are several tools that must be prepared. The list of equipment used in this research can be seen in the table

Material name	Function
Esp 32	As a microcontroller or command processor that will be executed
Sensor Ultrasonic	Used to measure water height.
RTC	Works as an automatic scheduler
LCD	Function to display time
Sensor IR	Serves as a measure of feed availability
Motor Servo	Functions as a driver to open or close the feed valve
Relay	Functions as a switch to turn on or turn off the water pump
Water pump	Serves to drain water from the fish pond to the plants
Firebase	as a server where sensor data is stored
Kodular	Place to make applications

The system design assembly process aims to facilitate system creation. The system design assembly concept can be described in the form of a block diagram which provides a general overview of how the system to be created works in Figure 2 below

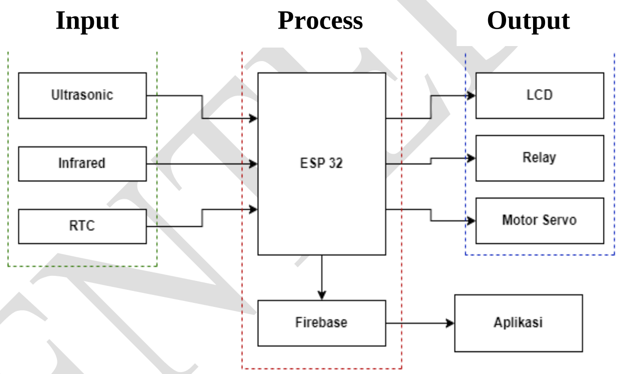

Figure 2. System Blok Diagram

Below is a series of ESP 32 and Ultrasonic sensors, which function to measure water level. The ultrasonic sensor will detect the percentage of water level in the pool. Then it will be processed by ESP 32 to the server which will be sent to the application.

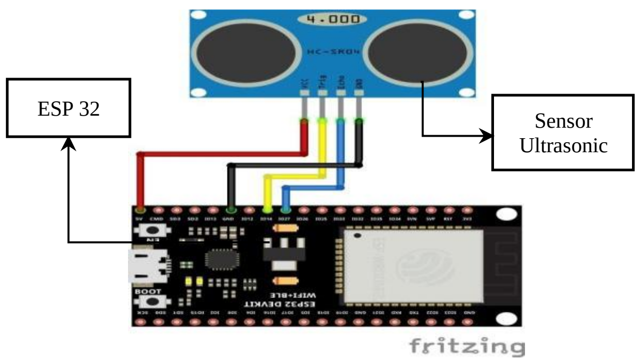

Figure 3 Ultrasonic Sensor Circuit

Below is a series of ESP 32 and IR sensors, which function to detect feed availability. The IR sensor will detect if the infrared signal is blocked by an object, namely fish food, then the sensor will send a signal in the form of 1, otherwise the sensor will send a signal in the form of 0 based on the indicators, namely AVAILABLE (above 200 grams to 700 grams), LITTLE (Below 200 grams to 50 grams) , and EMPTY (Under 50 grams).

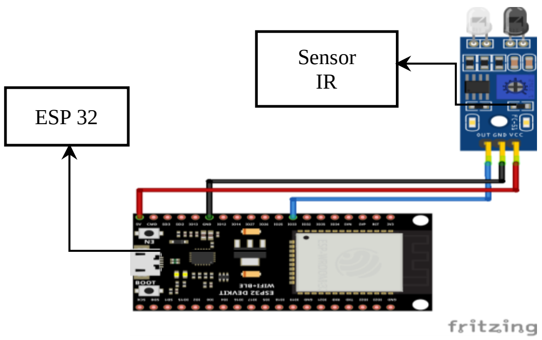

Figure 4 IR Sensor Circuit

Below is the ESP 32 circuit and servo motor, which functions to open the feed valve according to a predetermined schedule. The servo motor will rotate 180º opening and closing 15 times.

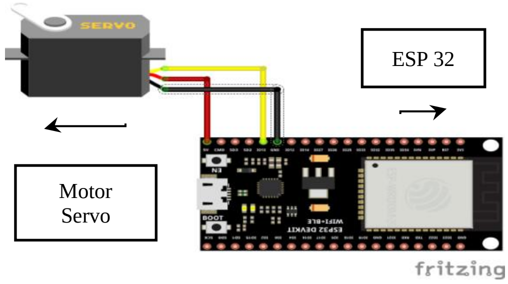

Figure 5 Servo Motor Circuit

Below is a series of LCD and RTC, which function to display time, feed conditions and water level.

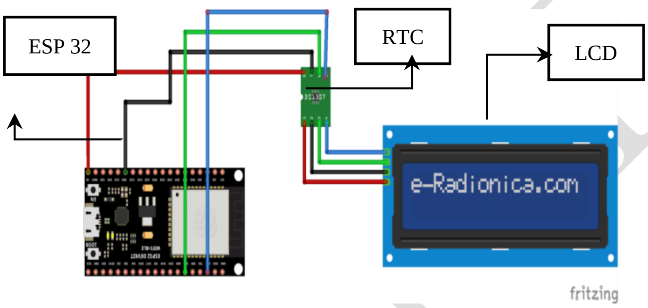

Figure 6 LCD and RTC Circuit

Below is the ESP 32, Relay and water pump circuit. Which functions as a switch that turns on or off the water pump. The relay will turn on or off when the button on the application is pressed.

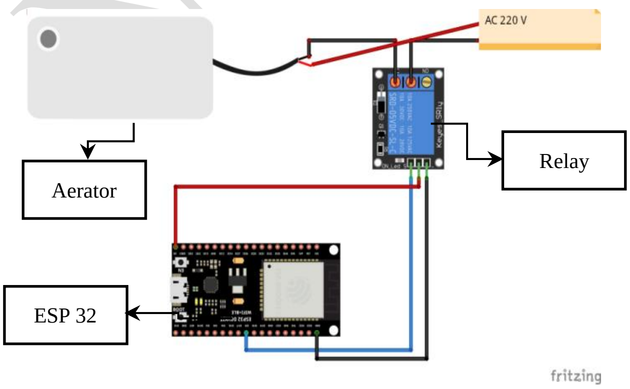

Figure 7 Aerator Circuit

The software design assembly is a design for how sensor data will be read by the microcontroller which will be sent to the Firebase real-time database and then processed using Rest API to be displayed by the application. A clearer picture of software design can be seen in Figure 8 below

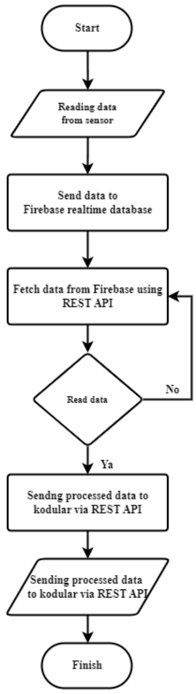

Figure 8 Software Flowchart

The assembly of the feeding automation system design is an illustration of how logical feeding automation works in the system. The flowchart of the feeding automation system can be seen in figure 9 below

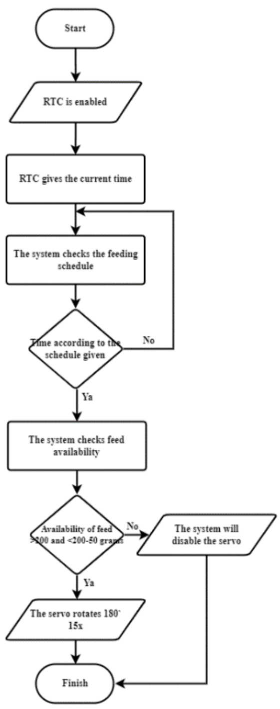

Figure 9 flowchart of the Feeding Automation System

It is necessary to create a design plan that can provide assistance and convenience for researchers in carrying out the manufacture of tools. The following (figure 10) is an illustration of the mechanical system design drawing that will be produced:

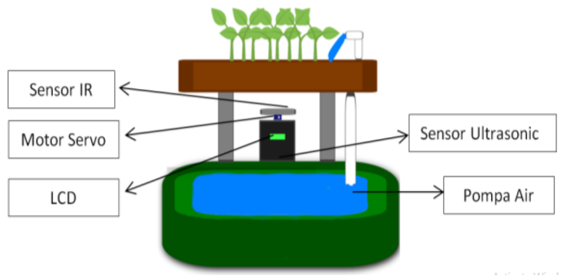

Figure 10 mechanical design

III. RESULT AND DISCUSSIONS

Testing begins by ensuring that each component used is in good condition (can work well), then checking that each path connected to the component used is connected to the internet, where the circuit is adjusted to the schematic drawing. Tests carried out include testing ESP32, relays, servo motors, ultrasonic sensors, IR sensors, RTC, LCD, and modular applications as well as testing the entire system.

Figure 11 testing on the kodular application

Ultrasonic sensor testing was carried out to detect the distance to the water in the fish tank. This test is carried out in real time at the height of the pool at that time. Calculation of the ultrasonic sensor by means of calibration becomes a percentage result. Fish tank surface height = 25 cm (from the bottom of the fish tank to the ultrasonic sensor)
Maximum water height in the fish tank = 20 cm (from the bottom of the tank to the water pipe)
Safe limit water height in a fish tank = 17 cm (from the bottom of the tank to the bottom of the water pipe)
25cm = 100% (empty water from the bottom of the tank to the ultrasonic sensor)
20 cm = 100% (water filled from the top of the tank to the maximum water level)
25-20 = 5 cm (distance of water from the sensor when the water is filled to the maximum)

$$= (\frac{5}{25}) \text{ x } 100 = 0{,}2 \text{ x } 100 = 20\%.$$

So the maximum water distance with the ultrasonic sensor location is 100% - 20% = 80%.

The distance obtained from the height of the fish pond water during testing was 17 on the LCD while the application showed a percentage of 68%. The calculation to get the percentage results was based on calculations as follows:
Number of percent = (Value you want to find / Total value) x 100%
Here, we want to find what percentage of 17 is of the value 25.
Total percent = $(\frac{17}{25})$ x 100%
= 0,68 x 100%
= 68%
The test results will be displayed in table 1

Table 1 Testing the Response of the Ultrasonic Sensor

Test	Water Conditions	Sensor Ultrasonic	Results	Information
1	Maximum water distance (20 cm)	Life	80%	Successfully detected water availability in the tank as much as 80%
2	Safe water distance (17 cm)	Life	68%	Successfully detected water availability in the tank as much as 68%
3	Empty water distance (0 cm)	Life	0%	Successfully detected water availability in tank as much as 0%

IR sensor testing is carried out to detect the availability of fish food. This test is carried out when the feed condition is AVAILABLE if the feed is above 200 grams to 700 grams, LITTLE if the feed is below 200 grams to 50 grams and EMPTY if the feed is below 50 grams. The test results will be displayed in table 2

Table 2 Testing the Response of the IR Sensor

Test	Condition	Sensor IR	Results	Information
1	Feed above 200 grams to 700 grams	IR 1 (Blocked) IR 2 (Blocked)	Detected successfully	Feed AVAILABLE
2	Feed under 200 grams to 50 grams	IR 1 (Unobstructed) IR 2 (Blocked)	Detected successfully	Feed A LITTLE
3	Feed under 50 grams	IR 1 (Unobstructed) IR 2 (Unobstructe	Detected successfully	EMPTY Feed

d)

IR Sensor testing is carried out by placing an IR sensor (A) at a height of 200 grams and an IR sensor (B) at a height of 50 grams in the feed container after weighing. If the feed availability is above 200 grams, the IR (A) and IR (B) sensors will be blocked by an object, namely fish food, and will show the feed status with the AVAILABLE indicator. If the feed availability is below 200 grams, the IR (A) sensor will not be blocked by an object, namely fish food while in IR (B) it is still blocked by an object and will show the feed status with a LITTLE indicator, then if the feed availability is below 50 grams then the IR (A) and IR (B) sensors will be blocked by an object, namely fish food and will show the status feed with EMPTY indicator.

This servo motor test is carried out to find out that the servo motor can work properly. The servo motor is used as a food pusher so that it can release fish food into the fish tank. The angle position is 0 degrees, the servo motor will rotate 180 degrees and rotate 15 times to release the feed. This servo motor works using a time schedule, a predetermined schedule of 3 times, namely morning time at 8 am, afternoon time at 12 o'clock, and evening time at 5 o'clock for rotating the feed container. The test results will be displayed in table 3

Table 3 Testing the Response of the Servo Motor

Test	Servo condition	Results	Information
Morning time (08.00)	Spin 180° (15x rounds)	Removing feed	Running well (putting out 5 grams of feed)
Noon (12.00)	Spin 180° (15x rounds)	Removing feed	Running well (putting out 5 grams of feed)
Afternoon time (17.00)	Spin 180° (15x rounds)	Removing feed	Running well (putting out 5 grams of feed)

The test on the relay is aimed at ensuring that the relay can run according to commands, that is, it can control the state of the water pump via buttons on the smartphone application. Testing is carried out by pressing the button on the application to turn the water pump off and on. The results obtained in this test will be displayed in table 4

Table 4 Testing the Response of the Relay

Test	Condition	Results	information
1	The relay button is pressed on the application	Air pump ON	Goes well (water flows in the pipe)
2	The relay button is pressed again in the application	Water pump OFF	Goes well (water does not flow in the pipe)

Testing on the relay is carried out by placing the relay in the fish pond to channel water from the pond to the plants. If the button on the application is pressed, the relay will turn on and will drain water from the pond to the plants, and if the button on the application is pressed again, the relay will turn off and will stop flowing water from the pond to the plants.

From the test results of the entire system, it can be seen that automatic feeding is according to schedule using RTC (Real Time Clock) and Servo Motor. It is found that RTC provides real time and the servo motor rotates and feed can be released according to schedule. Real time water level using an ultrasonic sensor found that the sensor detected 17 cm on the LCD and 68% on the application and detected water in the fish tank as much as 17 cm on the LCD and 68% on the application. Feed availability using an IR sensor can be read by the sensor with the feed status available, little and empty with explanations namely: AVAILABLE when the feed contains above 200 grams to 700 grams, LITTLE when the feed contains below 200 grams to 50 grams, and EMPTY when the feed contains below 50 grams. Water pump relay By using the relay, it is found that when you press the application button, the water pump relay is ON, the water will flow into the fish tank and when you press the application button again, the water pump relay is OFF, so the water will not flow into the fish tank.

IV. CONCLUSION

Based on the system performance testing and analysis that has been carried out, the conclusions obtained are as follows:

The system has been created using an ultrasonic sensor to measure water level, an infrared sensor to measure feed availability, an RTC for automatic system scheduling time, a servo to dispense feed, and a relay to control the water pump.

The system can provide feed automatically based on 3 schedules (morning, afternoon, evening) that have been set in the application by feeding 15x servo rotation with a total of 5 grams of feed coming out per schedule.

The system interface was created using KODULAR with the real-time FIREBASE database as a medium for storing data. The facilities provided in the application as a medium for conveying information to users consist of feed availability indicators (AVAILABLE, LITTLE, EMPTY), water level indicators (percentage), feed dosage regulator, automatic schedule controller, feed quantity indicator per schedule, and is equipped with two Additional facilities are a button to provide feed and a button to turn off/on the water pump which can be used if an error occurs in the system such as damage to the automatic feeder and if you want to turn off the water pump temporarily.

This fish feeding system using aquaponic media can make it easier to feed fish automatically and can monitor it in real time via an application on a smartphone.

This system still has weaknesses, so it is hoped that it can become a reference for development in further research, namely as follows:

1) This system only relies on the number of servo revolutions given so that the feed that comes out must be weighed first if you want to change the dosage in the application so that the dosage can be adjusted (in gram).

2) This system only provides notifications for schedule changes, changes in feed dosage, feed has been provided, and feed is empty. So notification is required if damage occurs to the sensor

3) This system only relies on electricity, so additional power is needed as a backup in the event of a power failure

LIMITATIONS AND STUDY FORWARD

The scope or study plan of this paper must use artificial intelligence and use more than one type of sensor.

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