Prototype Smart Fish Farm in Koi Fish Farming

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***Abstract*— Koi fish is one type of ornamental fish that is much loved because it has a beautiful shape, color, and pattern. Quality koi fish can be formed with a good maintenance pattern and do not rule out environmental factors and feed, especially when koi fish are still seed-sized and maintained in aquariums when feeding and controlling the state of water temperature should be done regularly. This research aims to create an intelligent fish farm system in the form of feeding and monitoring water temperature based on the internet of things that can be controlled through a smartphone in the Blynk application as an automation system that can increase efficiency in koi fish cultivation. In this prototype, the feeding process uses the HX711 Load Cell module, RTC DS3231 sensor, and DS18B20 sensor for water temperature monitoring controlled using Atmega 2560 Arduino microcontroller with connection access using ESP8266 WiFi module, which is then delivered to Blynk application. Feeding is carried out based on the time and weight of the feed that has been determined. In the temperature control system, if the temperature is less than 25°C, then the lamp will turn on, and if the temperature is more than 27°C, then the fan will turn on, and if the temperature ranges from 25-27°C, then the fan and lights are off. The result of this study is that it can monitor the feeding process and the temperature of aquarium water in koi fish cultivation automatically.**

Keywords—water temperature, feeder, blink application, smart fish farm

I. INTRODUCTION

Quality koi fish can be formed from the excellent quality brood, superior seeds, and not putting aside environmental factors and feed. At the time, koi fish are still seed-sized, maintained in the aquarium should be considered feeding time, and control the state of water temperature regularly. If there is a sudden busyness or other activities with an extended period, it is often an obstacle to feeding and controlling the state of water temperature in the aquarium. Therefore, to facilitate users in fish breeding, there needs to be an intelligent fish farm system [1].

smart fish farm is a system that makes it very easy for humans to control and supervise the object of cultivation, both when in the cultivation land and when not in the cultivation land [2]. From the above process, a fundamental process is monitoring the water temperature and feeding koi fish automatically in the aquarium because this process is the main bridge to help fish growth..

II. RESEARCH METHODOLOGY

In this research, the steps are taken to obtain the intended results in Prototype smart fish farm in Koi fish farming that made in the form of a flowchart as shown in Fig 1.

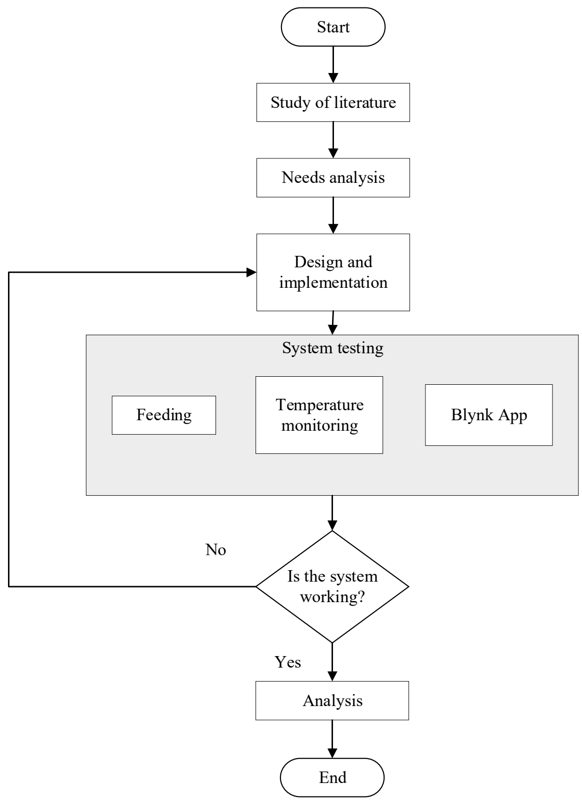

Fig. 1. Flow Chart Research Method

Can be seen on Figure 1, literature review, identification of problem, and analysis needs which has been done in this research. The last, the problem will be found and it must be solved by this system, to be analysed.

III. DESIGN AND IMPLEMENTATION

A. Design and Implementation of Hardware

The design of hardware (hardware) in this system consists of 2 parts, namely part 1 (feeding) and part 2 (temperature monitoring) [3].

- Feeding

This design using HX711 and RTC DS3231 Load Cell modules. The HX711 Load Cell module use as a fish feed scale, which then feeds inputs using the DS3231 RTC sensor.

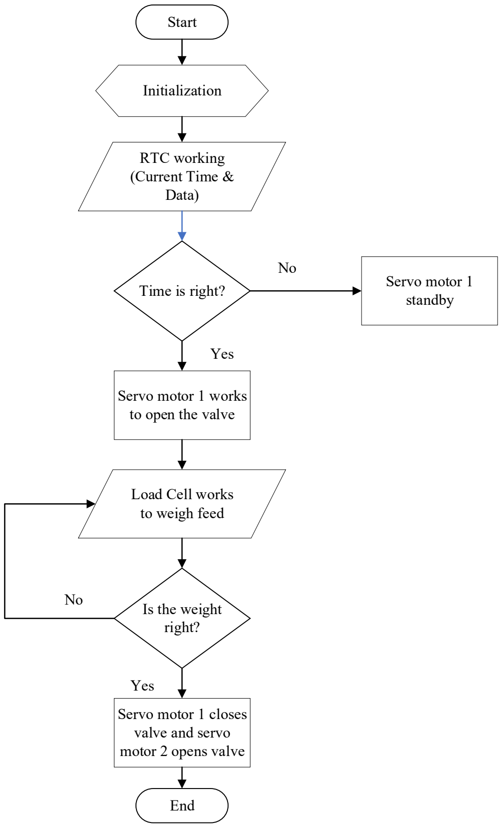

Fig. 2. Flow chart of feeding

The diagram in Figure 2 designed for the feeding system merges between the Module and sensors to the microcontroller Arduino Atmega 2560. Arduino will do initialization, then rtc module DS3231 acts as input time for fish feed eradication [4]. So when the time show of the specified hour, then automatically servo motor in the feed reservoir will be open.

In feeding fish, the HX711 Load Cell sensor will first weigh the weight of fish feed that falls when the servo1 motor is opened in the feed reservoir. So if the HX711 Load Cell scale has reached the specified weight, then the servo 2 motor will drop fish feed into the aquarium. While the servo motor 1 in the feed reservoir will close and the 2nd servo motor used to drop the feed will return to the original position angle.

- temperature monitoring

System design uses relays and DS18B20 temperature sensors. The relay module serves as a mechanical switch that turns the fan on and off, and incandescent lights alternately match the temperature requirements ordered by Arduino [5].

Arduino will perform the process of measuring water temperature through the reading of the DS18B20 sensor. Arduino is the brain's control system in the process of reading sensor data that exists during the device is used. Then the relay is used to control the input and output of the system, namely, relay 1 one as a heater (lamp) relay 2 as a coolant (fan).

That to maintain the parameters of water temperature in koi fish aquaculture aquariums. For flow chart of how the temperature monitoring system works can see in Figure 3

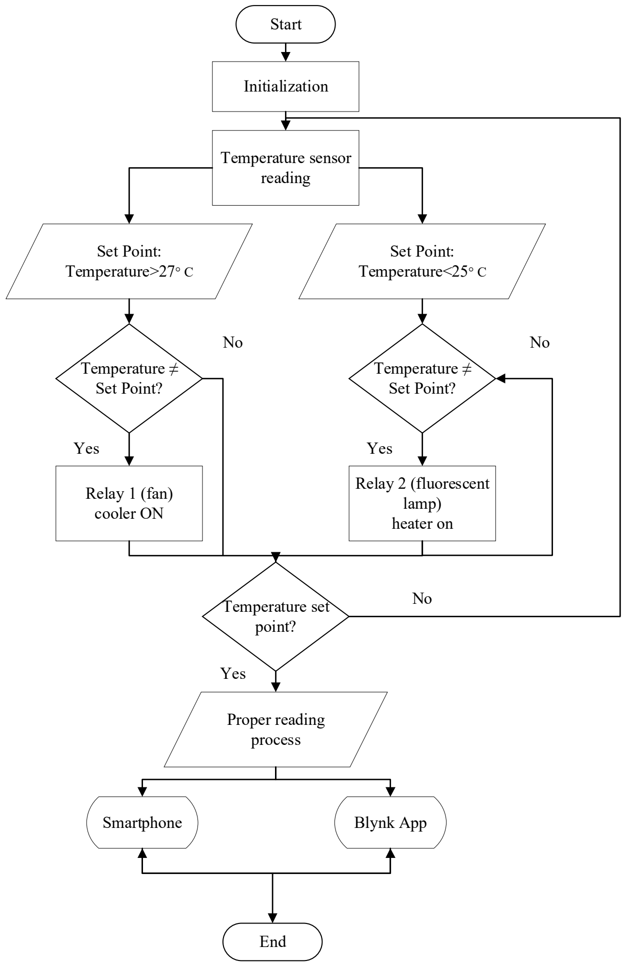

Fig. 3. Flow Chart of temperature monitoring system

B. *Design and Implementation of Sofware*

After assembling the hardware then the software used is ready to be combined with the hardware. Software described earlier in the software design then implemented on hardware, such as uploading source code in Arduino IDE and opening Blynk Application to display monitoring system in Figure 4.

Fig. 4. Enter auth token and SSID

Following input Auth Token that has been sent 2rototy Blynk, then open the software Arduino IDE, then input the SSID and wifi password to be used. After finishing the setting then press the play button on the project, as shown in Figure 5.

Fig. 5. Project display

IV. Testing and Analysis

A. Feeding System Testing

Testing the fish feeding system was conducted by testing the HX711 Load Cell module, RTC DS3231 sensor, and servo motor. This test aims to find out the feeding time and weight of feed following the time and weight that has been set. The modules and sensors connected to Arduino Atmega 2560 according to pins that have been determined before, then see how the performance of the sensors and modules [6].

1) HX711 Load Cell Module Testing

The HX711 Load Cell module used in this study aims to determine the weight of feed the fish by weighing ten times the weight of the feed. HX711 Load Cell Module test and test results are contained in Figure 6.

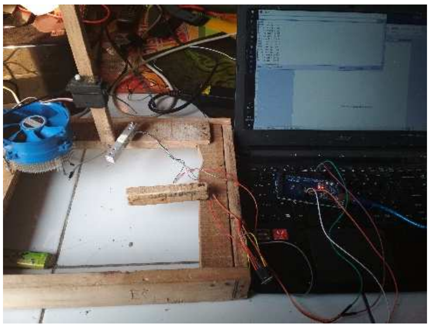

Fig. 6. Modul load cell HX711 testing

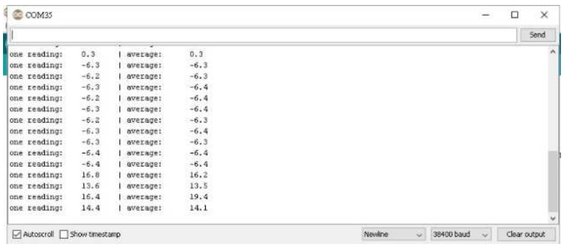

Fig. 7. Result of modul load cell HX711 testing

Based on Figures 6 and 7, the tests that have been done on the HX711 Load Cell module are working correctly and can be used. The HX711 Load Cell Module readings showed the weight of the feed, so that in this study, the HX711 Load Cell module can be used as a tool to weigh the weight of the fish feed.

2) Sensor RTC DS3231 Testing

In this test, RTC DS3231 sensor aims to move servo motors installed in fish feed reservoirs in real-time from the specified time. In the testing of the rtc sensor, DS3231 is in the early stages of time adjustment so that the time on the RTC is the exact time. The test and results of the RTC DS3231 sensor are in Figure 8.

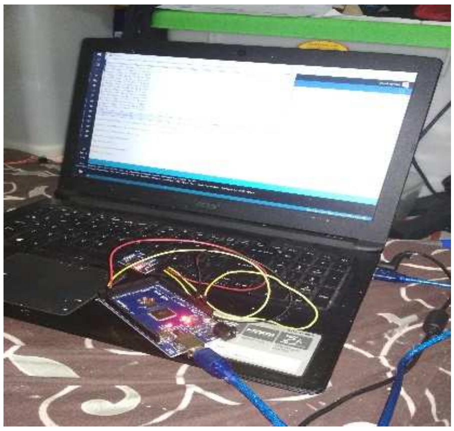

Fig. 8. Sensor RTC DS3231 testing

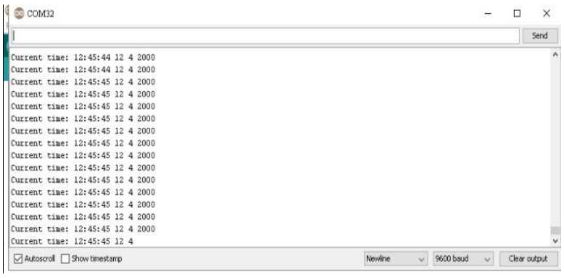

Fig. 9. Result of sensor RTC DS3231 testing

According to the predetermined time, the time description contains hours, minutes, seconds, months, dates, and years in real-time. Thus, the tests conducted on the RTX DS3231 sensor have been functioning correctly [7].

The servo motor is a rotary actuator designed with a closed-loop feedback control system. This study servo motor was used as a system controller to regulate the opening and closing of fish feed from predetermined angles or degrees. Servo motor test in Figure 10, and the test results are in the table I

Fig. 10. Motor servo testing

TABLE I. RESULT OF MOTOR SERVO TESTING

Condition	Angle Degree	Information
Feeding ON	60^0	Servo Open
Feeding OFF	0^0	Servo Close
Feed Weight >=1,4 gram	100^0	Servo Open
Feed has been given	10^0	Servo Close

B. Temperature Monotoring System Testing

They tested the aquarium's water temperature monitoring system using the DS18B20 sensor shown in the Blynk application. To find out the accuracy of the temperature reading, and the value of the DS18B20 temperature sensor reading is compared to the reading value of the aquarium water temperature thermometer sensor. The data was taken at an aquarium containing 50 liters of fresh water (50 liters) and conducted ten tests during the day and night.

1) Relay and Temperature Sensor DS18B20 Testing

The test was conducted to find out how the relay responds when given voltage, then see if the fan, lamp, and DS18B20 Sensor can work well to adjust the predetermined temperature. DS18B20 relays and sensors are assembled as in Figure 11.

Fig. 11. Relay and temperature sensor DS18B20 testing

Relay testing is done by connecting the relay with Arduino Atmega 2560 according to the pin. In this study, relays are used to control fans, incandescent lamps, and DS18B20 sensors [8]. The relay control system used in this study can be seen in Table II.

TABLE II. CONTROL SYSTEM

Temperature (^{0}C) 27^0		Control System	
Initial Termperature	***Final Temperature***	***Relay 1 Cooler (Fan)***	***Relay 2 Heater (fluorescentlamp)***
30^0 C	27^0 C	ON	OFF
22^0 C	25^0 C	OFF	ON

The temperature setpoint value required for the koi fish appetite is 25-27°C—the best temperature for a long and heavy growth of koi fish at 27°C. So when the sensor reads the temperature of 22°C, then the heating device (lamp) will work until the temperature corresponds to the setpoint value (25°C). If the sensor reads a temperature of 30°C, then the cooling device (fan) will work until the sensor reading value corresponds to the setpoint value (27°C).

2) Testing of DS18B20 Sensor and Water Temperature Thermometer.

Testing of the DS18B20 sensor and water temperature thermometer was conducted to compare or match the temperature and difference of the DS18B20 sensor and the water temperature thermometer. The results of the comparison test on the sensor can be seen in Table III.

TABLE III. DS18B20 TEMPERATURE SENSOR TESTING

Testing	Temperature measurement (^{0}C)		Deviation (^{0}C)
	Thermometer	***Sensor DS18B20***	
1	27,3	27,06	0,24
2	25,2	24,31	0,89
3	26,7	26,09	0,61
4	27,5	27,17	0,33
5	30,3	30,11	0,19
6	27,6	26,78	0,82
7	27,5	27,02	0,48
8	34,3	34,16	0,14
9	36,8	36,10	0,7
10	35,8	35,31	0,49
Average	**29,9**	**29,41**	**0,48**

Based on the data in Table III, the difference in readings of this temperature sensor is relatively small. If average, the difference is only about 0.48°C. This test proves that the temperature sensor works well. The output produced by the DS18B20 temperature sensor is a digital signal, binary numbers 0 and 1, indicating the value of a given temperature. The temperature value changes converted into binary numbers and converted back to decimal numbers received by the Arduino Atmega 2560 microcontroller. Proof of temperature measurement results is presented in Figure 15.

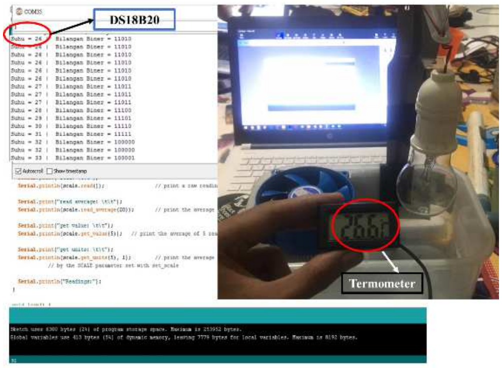

Fig. 12. Proof of measuring result

Testing on Figure 12 was conducted on 29-6-2019 at 15:24. As seen in Figure 12, the output of the DS18B20 temperature sensor shows a temperature of 26°C, and the water temperature thermometer gauge shows a temperature of 26.6°C. If average, the difference is 0.6 °C.

3) Temperature monitoring testing

In this test, the aquarium water temperature lowering and raising is done, aiming to know the temperature change and know the time it takes to lower and raise the temperature. Testing was conducted daily using a prototype aquarium measuring 30x25×40 cm filled with 50 liters of fresh water on August 4, 2019. The test results are in Table IV.

TABLE IV. TESTING OF RISING AND DECREASING WATER TEMPERATURES DURING THE DAY

Testing (Hours)	Initial Temp (^0C)	Final Temp (^0C)	Duration (minutes)	Lamp	Fan
06:00	24,1	25	01:03	ON	OFF
07:04	24,3	25	01:00	ON	OFF
08:00	24,2	25	01:00	ON	OFF
09:01	26,8	26	00:05	OFF	OFF
10:01	25,1	26	00:14	ON	OFF
11:30	28,3	27	01:29	OFF	ON
12:05	28,4	27	01:10	OFF	ON
13:00	27,6	27	01:20	OFF	OFF
14:00	25,4	26	00:10	ON	OFF
15:30	24,2	25	01:40	ON	OFF

The second test is conducted at night time; the test to determine the temperature change at night temperature and know the time it takes to lower and raise the temperature. The test results can be seen in Table V.

TABLE V. TESTING OF RISING AND DECREASING WATER TEMPERATURES DURING THE NIGHT

Testing (Hours)	Initial Temp (^0C)	Final Temp (^0C)	Duration (minutes)	Lamp	Fan
18:00	26,8	26	00:03	OFF	OFF
19:09	26.2	27	00:15	ON	OFF
20:00	25.2	26	00:13	ON	OFF
21:30	24.2	25	01:29	ON	OFF
22:19	26.6	27	02:00	ON	OFF
23:10	24.4	25	01:10	ON	OFF
00:06	23.8	26	02:19	ON	OFF
01:20	21.1	25	02:14	ON	OFF
02:00	20.2	25	02:40	ON	OFF
03:30	22.1	25	02:11	ON	OFF

In the traditional koi fish cultivation process, there is less attention to temperature so that when extreme temperatures occur, the growth of koi fish is not good, because in principle koi fish require temperatures between 25^0 Celcius to 27^o Celcius.

C. *Feeding Testing*

Feeding tests given to koi fish are conducted with 3 times testing based on time, namely at 07.00, 12.00, and 17.00. Koi fish feeding testing using the method of feeding calculation as follows.

1) *Calculation of Feeding*

The daily feed needs of koi fish seeds range from 1-5% of the biomass weight. So that the feeding process is evenly distributed and get an estimate of biomass weight, the calculation is obtained as follows:

Calculating the average weight of koi fish in this study, the authors took 5 fish used as samples. The 5 fishes were then weighed and weighed. The result of summing the weight of the fish is then divided by 5 to get the average weight of koi fish. The total weight of 5 koi fish weighed 50 grams. The average weight is 50: 5 = 10 grams. The average weight of the koi fish is then multiplied by the population of koi fish in the aquarium to obtain an estimate of the weight of biomass. The average weight of koi fish is 10 grams, and the population of koi fish in the aquarium14 heads, the estimated weight of biomass is 10 × 14 = 140 grams. So in this study, the amount of koi fish feed given per day based on biomass weight is 1% × 140 grams = 1.4 grams. This feed is given 3 times a day.

The following are the results of feeding tests in the form of notifications on the Blynk application when the feeding process has been completed at a predetermined time, which can be seen in Figures 13, 14, and 15.

Fig. 13. Feeding At 07:00

Fig. 14. Feeding At 12:00

Fig. 15. Feeding At 17:00

Based on the predetermined setpoint, fish feeding time is given a day 3 days, namely at 07:00, 12:00, and 17:00. Fish feed weight is given as much as 1.4 grams weighed using the HX711 Load Cell module. The setpoint of 1.4 grams was obtained because the total number of fish was 14 and the average fish weight was 10 grams and the feed that had to be given was 1% of the fish's own weight.

V. CONCLUSION

Based on the analysis and testing results, it is concluded that Feeding automatically and in real-time is successfully done every 07:00, 12:00, and 17:00. The design of the temperature setting system was successfully carried out with a setting of 3 conditions, namely the temperature of <25°C lamp ON and Temperature >27°C Fan ON.

This study was conducted on a koi fish aquarium measuring 30x25x40 cm with DC fan size and 12 x 12 cm, 5 watt lamp, HX711 Load Cell Module, RTC DS3231 sensor, DS18B20 temperature sensor, ESP8266 WiFi module, and Arduino Atmega 2560 can function correctly.

This tool can function well with the average value of the measurement difference between the temperature sensor DS18B20 with a water temperature thermometer of 0.48°C. Furthermore, the average time it takes to lower the temperature per one °C during the day is 1 minute 3, and the average time it takes to raise the temperature during the day is 1 minute. The average time it takes to raise the temperature per one°C at night is 2 minutes 1 second, while the average time required for a dropper at one °C at night is 20 seconds.

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