Monitoring System and Automatic Drug Administration in Betta Fish Farming

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***Abstract*—This research focuses on a website based monitoring system for pH, temperature, turbidity, and water level in a betta fish pond, including the administration of pH and salt medication, as well as automatic water draining and refilling when the pond water becomes cloudy. The results show a high level of accuracy. pH measurements using five samples with values of 5.65, 6.36, 7.32, 8.21, and 9.47 achieved an accuracy of 99.48 percent. Ultrasonic distance measurements using five samples with distances of 5 centimeter, 6 centimeter, 7 centimeter, 8 centimeter, and 9 centimeter achieved an accuracy of 100 percent. Temperature measurements using five samples with values of 25 degree Celsius, 26.42 degree Celsius, 27.90 degree Celsius, 28.50 degree Celsius, and 29.30 degree Celsius achieved an accuracy of 99.47 percent. Water level measurements using five samples with heights of 1.5 centimeter, 2 centimeter, 2.5 centimeter, 3 centimeter, and 3.5 centimeter achieved an accuracy of 100 percent. In addition, the developed website successfully displays real time data from each sensor reading and allows users to set threshold limits for each sensor parameter.**

***Keywords*— ESP32 Microcontroller, Water Level, Water pH, Water Quality Monitoring, Website.**

I. INTRODUCTION

Indonesia is a country with vast waters and a diversity of aquatic biota [1]. One of the aquatic biota that is widely cultivated by the people of Indonesia is hickey [2]. Hickey fish are used as a business field to earn income. This type of fish is in great demand and is often used as an ornamental fish collection [3].

There are several things that need to be considered in the cultivation of hickey fish, including water pH, temperature, turbidity, feed, and administration of drugs/vitamins to hickey fish. These parameters are important things that must be considered when cultivating betta fish [4]. This is because each fish has different characteristics regarding the conditions of pH, temperature, turbidity, feed and the type of medicine used. Water quality in hickey cultivation must be considered in order to obtain a quality harvest [5]. Water quality is said to be normal when it is at a temperature of 25-30°, Ph 6-8 and turbidity below 900 NTU [6].

The type of food given to Betta fish tends to be natural such as mosquito larvae, bloodworms, silk worms, and other small animals [7]. The drugs/vitamins given to the hickey also vary according to the needs of the hickey itself, such as Ascorbic Acid, Elbayou, Praziquantel, Acriflavine, Methylene Blue, and so on [8].

A common problem in betta fish farming is the difficulty of manually monitoring and regulating these parameters, especially in terms of drug/vitamin administration [9]. A common problem in betta fish farming is the difficulty of manually monitoring and regulating these parameters, especially in terms of drug/vitamin administration [10].In the context of hickey farming, the application of IoT technology can help farmers by providing an automated monitoring and control system to maintain water quality and fish health. This technology enables automatic and accurate monitoring of important parameters such as temperature, pH, turbidity, and water level, as well as the administration of drugs/vitamins according to water conditions.

Previous research has shown various approaches to monitoring and managing a betta fish aquarium. Asep Rachmat Pratama identified the ideal pond water level for betta fish as about 10 cm with a volume of 10 liters and an aquarium size of 40 cm x 25 cm x 17 cm, and determined good water quality with a pH between 6-8, a temperature of 25-30°C, and a maximum turbidity of 900 NTU [11]. Fauziah supports these findings in his research on water turbidity [12]. Wahyu showed that Light Dependent Resistor (LDR) sensors are not optimal for turbidity detection because they can be affected by scale. As an alternative, they used a turbidity sensor with a more accurate infrared system [13]. Alfin Aditya Sani designed a web-based monitoring system for water turbidity and temperature of a betta fish aquarium that can be accessed remotely. However, this system does not include automatic action to overcome turbid water, so this research adds an automatic water discharge and replenishment system using ultrasonic sensors, pumps, and solenoid valves [14]. Riki developed an Arduino-based automatic water purification system that changes water automatically, and this research adds a feature for adding salt after changing water, which was not included in previous research [15]. Rifky Ridho Prabowo et al (2020) developed an automatic feeding system with Wemos and IoT, and this study replaces the feeding action with automatic drug administration to maintain water pH using a

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servo motor that drips liquid medicine [16]. Finally, FirmanBurhani created an IoT-based monitoring system with the Blynk platform, which has limited features and problems in updating the application. This research uses a website with a Firebase database for better data management and ease of system updates [17].

This research aims to develop an automatic drug delivery device using an ESP32 microcontroller as a control center made using the C programming language using the Arduino IDE [18]. Equipped with a DS18B20 sensor to measure water temperature [19], water level sensor to determine the level of drug availability [20], pH sensor to measure water quality [21], turbidity sensor for turbidity, and ultrasonic sensor to measure water level [22], this tool will also have output components such as LCD to display information, buzzer as an indicator, and website as a user interface for real-time data monitoring. This research will be conducted at Sumde Betta Fish Farm, Tulungagung Regency.

II. METHOD

In the design of the monitoring system and automatic drug administration in the Sumde Betta case study betta fish pond, shown in the following block diagram in Fig. 1.

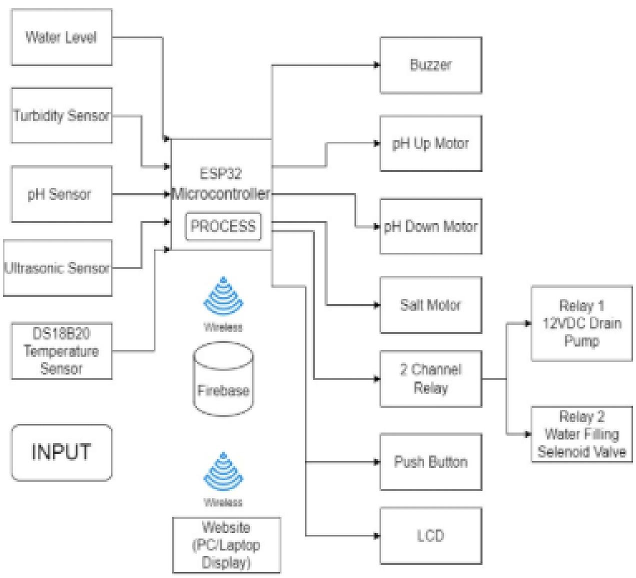

Figure 1. Diagram block system

Fig. 1 shows the systematic work of the tool, with inputs of water level sensor, turbidity sensor, pH sensor, ultrasonic sensor, DS18B20 temperature sensor, and push button, and using the ESP32 microcontroller. Then for the output in the form of 3 servo motors, 2channel relays, and 16x2 LCD. Where when the pH sensor detects acidic and alkaline water conditions, it will give pH Up and pH Down drugs, when the turbidity sensor detects water conditions in a cloudy state, it will turn on relay 1 (pump) to drain, and when the ultrasonic sensor detects water at the lowest point of the pool, it will turn on relay 2 (solenoid valve) to fill the water. All reading data from the sensors will be displayed on the LCD screen and the push button is used to change the menu on the LCD.

A. *Hardware System Design*

Fig. 2 shows a flowchart of the device system process where the pH, temperature, turbidity, ultrasonic, and water level sensors will read the environmental conditions of the pool water and medicine. When the pH value is outside the specified pH value, the servo will work to provide medicine, both pH Up and pH Down drugs. When the turbidity value exceeds the specified turbidity value, relay 1 will be on to turn on the pump, after the ultrasonic sensor detects the minimum pool water level relay 1 off and relay 2 on to open the solenoid valve, while the water level will read the amount of medicine, when the medicine is at the lowest point of the water level, the buzzer will be On as an indicator that the medicine runs out. All sensor reading data will be stored in the Firebase database.

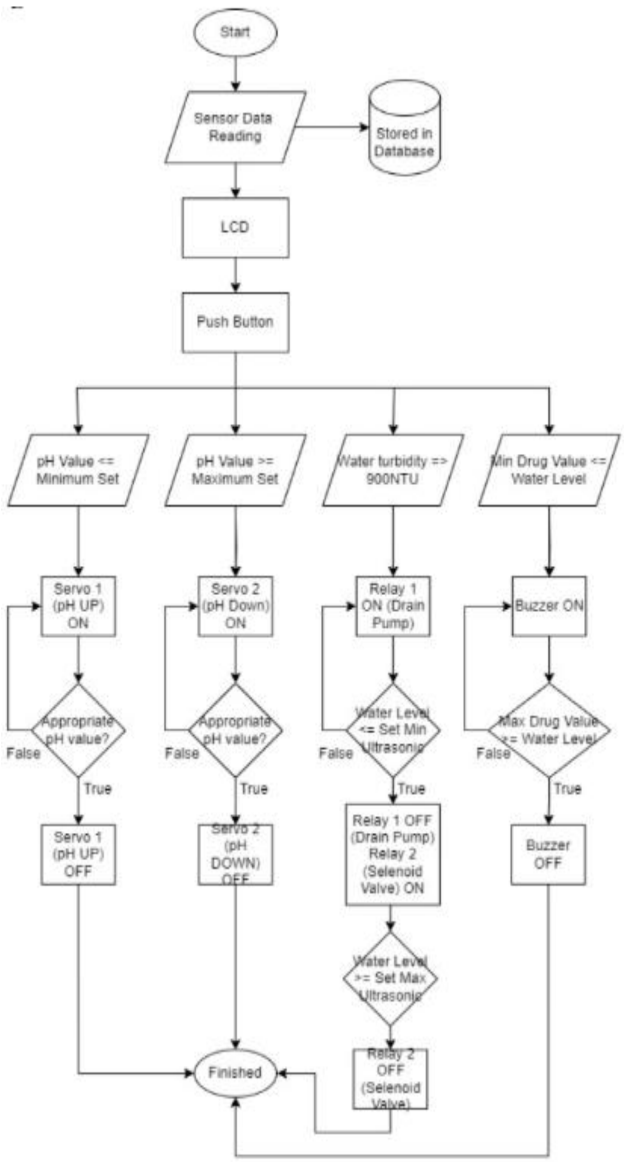

Figure 2. Flowchart device

B. Hardware System Design

The process of this pond monitoring website can be seen in Fig. 3, starting with the user logging in at the website URL and entering the email and password that has been entered in the MySQL database, if the user forgets the password there is a password forget feature, if you get a new password, the user can log in and enter the Dashboard page, where all data from the sensor readings displayed will be stored in the Firebase database, in the Dashboard page there are several menus including, Edit limits, when the user changes the value of the sensor variable the data will be stored in the Firebase database and also displayed on the dashboard page, Profile, if the user changes the website account password, the password will be automatically stored in the MySQL database, Logout, when the user wants to log out, the page will return to the login page.

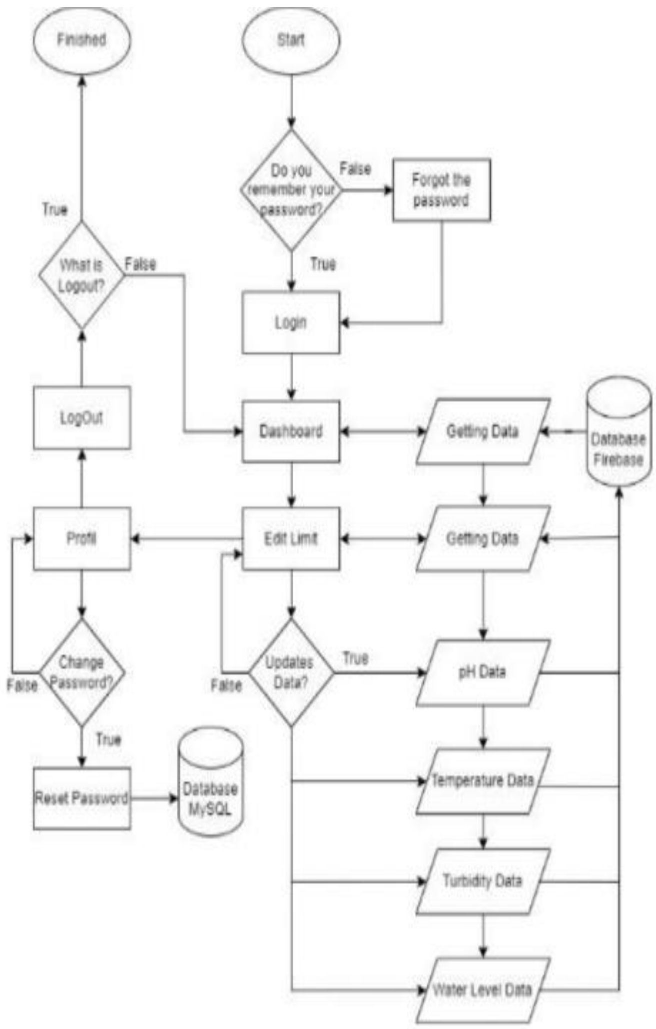

Figure 3. Flowchart website

C. Hardware System Design

The system flow process starts with connecting the microcontroller to WiFi, then the data from the sensor-sensor readings will be displayed on the LCD. The user logs in to the website by entering Email and Passsword, then will enter the monitoring website page where the sensor reading data from the microcontroller is sent to the website and displayed, the displayed data will be stored in the firebase database. For more details on this process can be seen in Fig. 4.

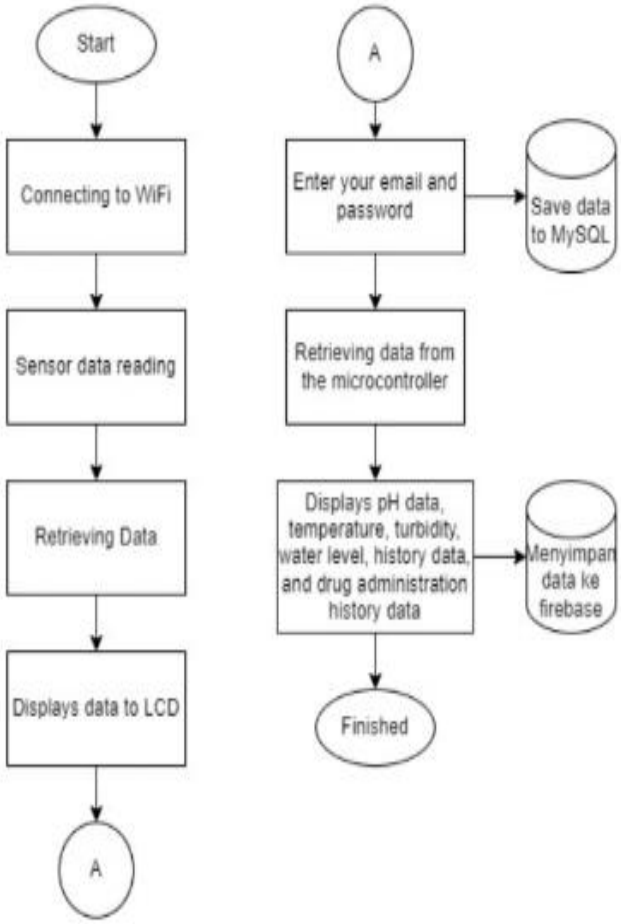

Figure 4. Flowchart System of IoT

III. RESULTS AND DISCUSSION

The results of the research obtained are the manufacture of a tool for giving medicine to automatic fish and monitoring using an ESP32 microcontroller, while for monitoring a website media interface is used. The monitoring website can monitor in real time the reading results of sensors including pH, temperature, ultrasonic, water level, turbidity sensors, equipped with data records when the system is giving medicine. The creation and results obtained will be useful for these partners.

A. Hardware

In Fig. 5 is the result of the hardware design of a betta fish pond with a size of 56.2 cm long x 39.4 cm wide x 34.5 cm high, where in the design there are several component parts including: 12V 20 A power supply, 3 servo motors, DS18B20 temperature sensor, turbidity sensor, and a black box containing ESP32, 2 channel relay, LM2596 step down, pH sensor module, 16x2 LCD, and 2 push buttons.

Figure 5. Hardware

B. Hardware

To access the web page enter the URL first, can be seen in Figure 6.

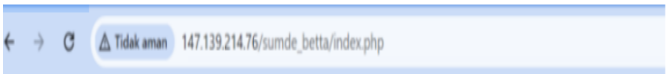

Figure 6. URL to access website

After successful access, the website display on the first page will show the login page, as shown at Fig. 7, to be able to enter the main page of the website application.

Figure 7. Login pages

After successful login, it will continue on the monitoring Dashboard page in Fig. 8, on the dashboard page there are several menu options including Edit Limit, Profile, and Help. On the Dashboard page, the reading results from each sensor are displayed, including the pH sensor, temperature sensor, turbidity sensor, and ultrasonic sensor for monitoring the pool water level, as well as the water level sensor for monitoring the condition of the drug supply pH Up, pH Down, and liquid salt. In addition, the dashboard page also displays drug administration history data. Click Edit Limit to make changes to the minimum and maximum sensor variable values. Then if you want to change the maximum and minimum values of the variables contained in each sensor, select the Edit Limit menu. The standard for the minimum and maximum limits of the pH sensor is 6-8, for temperature 25°C-30°C, turbidity 150NTU-800NTU, and for water level 8cm-15cm.

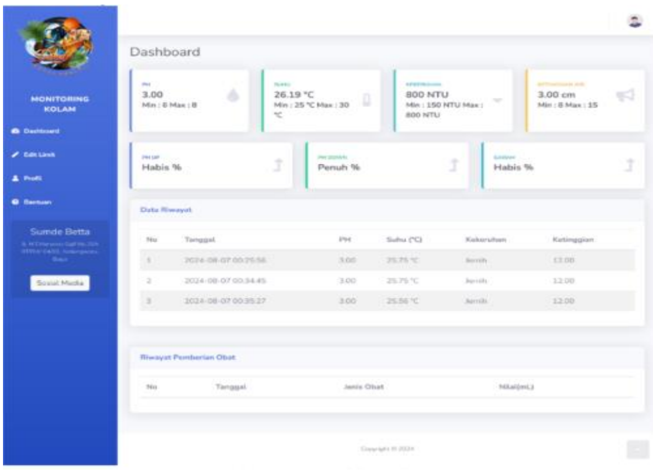

Figure 8. Dashboard pages

If you want to change the password for the account, select the *Profile* menu, click to change password, and enter the desired new password. Then click *Reset Password*; the password will automatically change, as shown at Fig. 9 and Fig. 10.

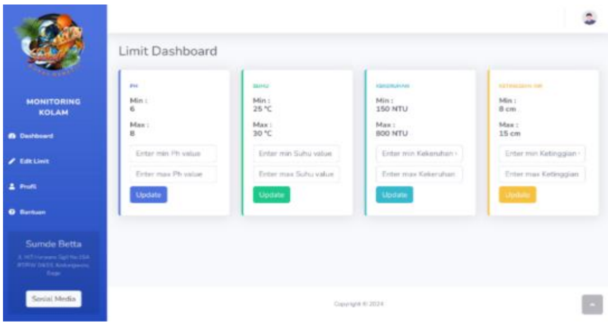

Figure 9. Edit dashboard pages

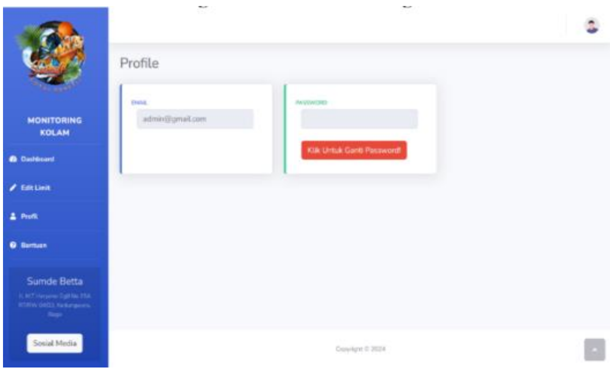

Figure 10. Profil account pages

C. Testing and Discussion

This test is carried out to get the accuracy value of each sensor and also find out whether the system that has been designed can work well in this study.

1) pH Sensor Testing

To ensure that the pH sensor can provide precise and reliable readings according to the actual pH value of the solution under test, as shown at Table 1.

TABLE I
ACCURACY OF PH SENSOR

No	pH Meter	pH Sensor	Error (%)	Accuracy Value (%)
1	5,65	5,69	0,70	99,30
2	6,31	6,36	0,79	99,21
3	7,29	7,32	0,41	99,59
4	8,18	8,21	0,36	99,64
5	9,44	9,47	0,31	99,69
Average Error (%)			0,51	99,48

The graph of the pH sensor accuracy test can be seen in Fig. 11.

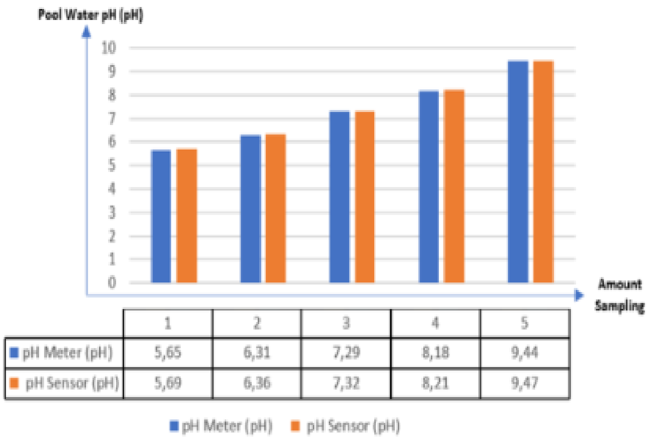

Figure 11. Accuracy curve of ph sensor

Accuracy testing on the pH sensor indicates that the sensor produces slightly higher pH values of water compared to the pH meter measuring instrument, with an average error of 0.51%. This suggests that the pH readings obtained from the sensor tend to be marginally higher than the actual values measured by the pH meter. Despite this small discrepancy, the difference is minimal and falls well within acceptable measurement limits. The low error percentage demonstrates that the pH sensor is capable of providing consistent and reliable measurements, reflecting good performance in practical applications. Overall, the test results confirm a high level of sensor accuracy, achieving an average accuracy value of 99.48%, which indicates that the sensor can be confidently used for monitoring water quality in the system.

2) Ultrasonic Sensor Testing

This test is carried out to ensure the ultrasonic sensor functions properly when reading the pool water level, as shown at Table 2.

TABLE II
ACCURACY OF PH SENSOR

No	Ruler (cm)	Ultrasoic Sensor (cm)	Error (%)	Accuracy Value (%)
1	5	5	0	100
2	6	6	0	100
3	7	7	0	100
4	8	8	0	100
5	9	9	0	100
Average Error (%)			0	100

The graph of the ultrasonic sensor accuracy test can be seen in Fig. 12.

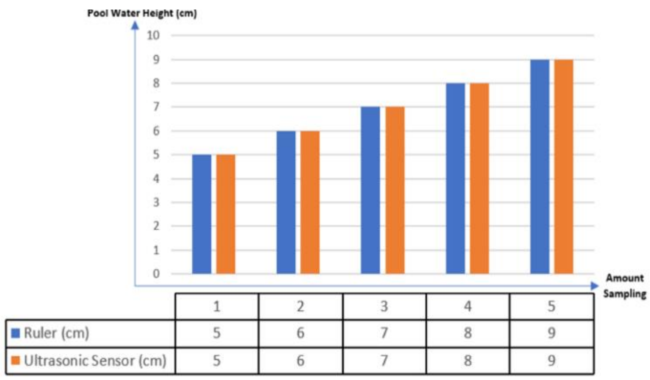

Figure 12. Accuracy curve of ultrasonic sensor

The accuracy test conducted on the ultrasonic sensor demonstrates that the distance measurements in centimeters obtained from the sensor perfectly match the readings from the reference ruler measuring instrument, with an average error of 0%. This indicates that the ultrasonic sensor is capable of measuring distances with complete precision, showing no deviation from the actual values measured manually. The zero percent error reflects the reliability and consistency of the sensor in practical use. Based on these results, it can be concluded that the ultrasonic sensor exhibits an excellent level of accuracy, achieving a perfect accuracy value of 100%, making it highly suitable for precise water level monitoring in the system.

3) DS18B20 Water Sensor Testing

This test ensures the DS18B20 temperature sensor works properly, as shown at Table 3.

TABLE III
ACCURACY OF DS18B20 WATER SENSOR

No	Thermometer (°C)	DS18B20 Sensor (°C)	Error (%)	Accuracy Value (%)
1	25,4	25,60	0,78	99,22
2	26,3	26,42	0,45	99,55
3	27,8	27,90	0,35	99,65
4	28,4	28,50	0,35	99,65
5	29,1	29,30	0,68	99,32
Average Error (%)			0,52	99,47

The graph of the pH sensor accuracy test can be seen in Fig. 13.

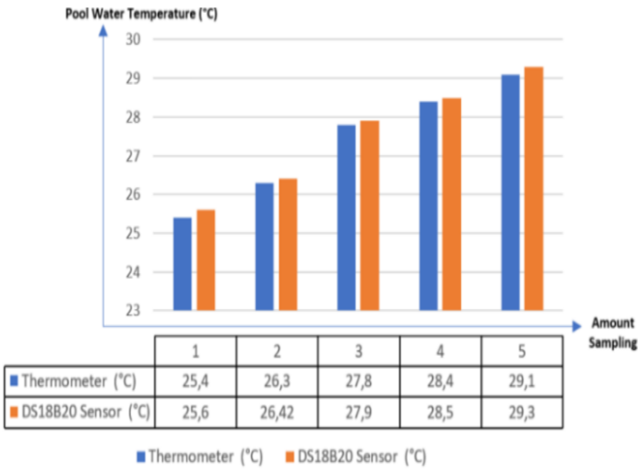

Figure 13. Accuracy curve of DS18B20 sensor

From the tests conducted on the DS18B20 Temperature Sensor, it was observed that the sensor produces slightly higher water temperature readings compared to the measurements obtained from the reference thermometer, with an average error of 0.52%. This indicates that the temperature values recorded by the DS18B20 sensor tend to be marginally higher than the actual temperatures measured by the thermometer. Despite this minor discrepancy, the error is very small and within acceptable limits, demonstrating that the sensor provides consistent and reliable readings. Based on these results, the DS18B20 sensor can be considered to have a good level of accuracy, achieving an overall accuracy value of 99.47%, making it suitable for precise water temperature monitoring in the system.

4) Water Level Sensor Testing

This test is carried out to verify that the water level sensor functions correctly for monitoring the levels of pH Up, pH Down, and liquid salt, as shown at Table 4. The purpose of this testing is to ensure that the sensor can accurately detect and report the liquid levels in each container, providing reliable data for the automated system. By comparing the sensor readings with the actual measurements obtained using a reference ruler, the performance and precision of the water level sensor can be evaluated, confirming its suitability for maintaining proper chemical levels in the system.

TABLE IV
ACCURACY OF WATER LEVEL SENSOR

No	Thermometer (°C)	Water Level Sensor (°C)	Error (%)	Accuracy Value (%)
1	1,5	1,5	0	100
2	2	2	0	100
3	2,5	2,5	0	100
4	3	3	0	100
5	3,5	3,5	0	100
Average Error (%)			0	100

Accuracy testing on the water level sensor demonstrates that the sensor's measurements in centimeters perfectly match the readings obtained from the reference ruler, with an average error of 0%. This indicates that the water level sensor can measure liquid heights with complete precision, providing values that are identical to those obtained manually. The zero percent error highlights the sensor's reliability and consistency in practical applications. Based on these results, it can be concluded that the water level sensor exhibits an excellent level of accuracy, achieving a perfect accuracy value of 100%, making it highly suitable for precise monitoring of chemical levels such as pH Up, pH Down, and liquid salt in the system.

5) Integration System Testing

To ensure the results of data readings from the sensor displayed on the LCD are in accordance with those displayed on the pool monitoring web page. The results of integration testing between the water level sensor and the pool monitoring website can be seen in Fig. 14.

Figure 14. Integration testing on water level sensor

Furthermore, integration testing of the turbidity sensor with the website is presented, as shown at Fig. 15. This test ensures that the turbidity sensor readings displayed on the website accurately correspond to the real-time measurements taken by the sensor, confirming the correct transmission and display of data within the system.

Figure 15. Integration testing on turbidity sensor

System integration testing on the pH sensor is shown at Fig. 16. The purpose of this test is to verify that the pH readings captured by the sensor are correctly transmitted and displayed on the monitoring website, maintaining consistency between the physical measurement and the digital interface.

Figure 16. Integration Testing on pH Sensor

Integration testing for the ultrasonic sensor is shown at Fig. 17. This test confirms that the water level measurements detected by the ultrasonic sensor are accurately reflected on the website dashboard, ensuring reliable monitoring of pool water levels in real time.

Figure 17. Integration Testing on Ultrasonic Sensor

Finally, system integration testing for the DS18B20 water temperature sensor is shown at Fig. 18. This test ensures that the temperature readings from the DS18B20 sensor are correctly displayed on the website, demonstrating proper synchronization between the sensor data and the monitoring interface.

Figure 18. Integration Testing on DS18B20 Sensor

IV. CONCLUSION

Results show that The automatic drug delivery system in the betta fish pond uses three main sensors, to perform drug administration actions using a pH sensor to read the condition of the pond water with a minimum pH limit of 6 and a maximum of 8, to perform draining and filling water using a turbidity sensor with a maximum turbidity limit of 900 NTU, and an ultrasonic sensor with a minimum pool water level of 5 cm and a maximum of 15 cm. The evaluation shows the average value of each sensor including, pH sensor has an accuracy level of 99.48%, ultrasonic sensor 100%, temperature sensor 99.47%, and water level sensor 100%. The test results of the fish pond monitoring system can be concluded that the designed tool has been successfully integrated using a website, which can be used to monitor the condition of the pond water in real time.

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