Telemonitoring of Water Quality for Koi Fish Hatchery Using Mechanical Turbine Method Based on Microcontroller

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Abstract— **One way to meet the needs of fish seeds in the general public is to cultivate fish species. UPT BBI (Balai Benih Ikan) Tlogowaru, is one of the fish seed cultivation sites located on Tajinan Tlogowaru, Kedungkandang sub-district, Malang City. Fish seeds include koi fish seeds. In the pool using water from the river. To maintain the water of the koi fish hatchery, the condition of color turbidity is monitored as the level of turbidity of the water visible from above the waters of the koi fish hatchery, and a water flow sensor is processed by esp32. The water flows through the gravity pipe which will turn the turbine. With the rotation, the generator will produce power which is used to activate the telemonitoring device. The water then enters the filtration and will be channeled to the koi fish hatchery. The results of this study have an average pH value of 6.8 - 7.2 and a TDS of 257-282 ppm after water filtration with the turbine speed value being influenced by water flow and turbine rotation speed and the average power consumption generated for system performance of 8.265 w/h using a MiFi network with QoS parameters measured are delay and packet loss in the low category. And the use of the website makes it easier for users to monitor fish seed ponds**

Keywords— **Water Turbine, Crossflow, Water, pH, TDS, Electric Power, QoS.**

I. INTRODUCTION

UPT BBI (Balai Seed Ikan) Tlogowaru is one of the fish seed cultivation which is located on Jalan Tajinan Tlogowaru, Kedungkandang sub-district, Malang City. Koi fish seeds are cultivated in there. The fish hatchery uses water sources from the local residents' rivers. To maintain the water of the koi fish hatchery pond, monitoring the condition of color turbidity as the level of turbidity of the water that is visible from above the waters of the koi fish seed pond. Water is a medium for fish cultivation which is the main factor [1]. Therefore, this can affect the characteristics to provide a good life for fish farming[1][2].

In determining water quality in koi fish ponds, the main parameters include Power of Hydrogen (pH) [3], and Total Dissolved Solids (TDS) [4] to determine water according to koi fish hatchery standards. Waste disposed of in rivers will result in the emergence of biological pollutants [5] that can create pollution in koi fish seed pond water [2]. Therefore, the turbine mechanic [6] is designed to reduce pollutants carried by river water by providing filter media in the form of pumice stone, zeolite stone, biofoam, and ginger coral. With this, we need a system that can help make it easier to monitor water in fish seed ponds so that it can create better koi fish seed culture water. With a microcontroller that is ESP32 as the control center [7] for the overall system and the monitoring system uses a website and the main and supporting parameters are used using pH sensors and TDS sensors, water flow sensors[8], optocoupler sensors [9] and voltage-current sensors [10].

In this paper, a telemonitoring system for pond water quality for a koi fish farm was developed with several parameters, independent variables, using research time and water level [11]; bound variables, namely power, water flow from the river water pond to the turbine house, water flow from the turbine house to the koi fish pond, turbine rotation speed [12], pH sensor and TDS sensor [4][13] in the turbine housing, pH sensor and TDS sensor in the koi fish pond; and controlled variables, such as water turbine house [14] and koi fish pond[15].

II. METHOD

A. Research Flow Stages

The research flow was arranged systematically with the aim of regulating the relationship between sensor outputs in monitoring koi fish hatchery pond water. Before conducting the research, it is necessary to make observations with the UPT for koi fish farming to permit data collection at the location. The following for the research flow is shown in Fig. 1.

In Fig. 1, it can be explained as follows: (1) Conduct literature studies from reference journals regarding koi fish cultivation, water turbines, water filtration, and observe problems in the field and determine the object and parameters of the problem; (2) After finding the problem, the design of the system design that will be made is carried out. Starting from measuring the area of the pool that will be used to the design of the tool to be made; (3) Implementing tools, both in the form

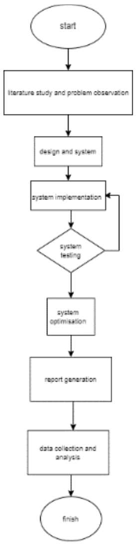

Figure 1. Research Flowchart

of hardware and software that are tailored to the designs that have been made and consulted; (4) Testing the system by seeing whether the system applied to the tool can be used or not. If yes, then system testing can be applied, and in accordance with the parameters to be tested (discharge, current, voltage, rotation (rpm), pH (dissolved solids particles). The testing process will be carried out by direct testing at the aquaculture sample location. If not, then repeat to the second stage, namely the design of the system design, with the aim of fixing and analyzing the failure of system testing; (5) Optimizing the system so that it can work by getting maximum results and minimizing the occurrence of errors; (6) Perform system work analysis. The results of the system work are analyzed in order to obtain data along with an explanation of the output data taken; and (7) Make reports and conclusions, make journals, and publish them in the journal of the D4 Digital Telecommunication Network study program.

B. Block Diagram

The design carried out for the study is shown in the block diagram in Fig. 2.

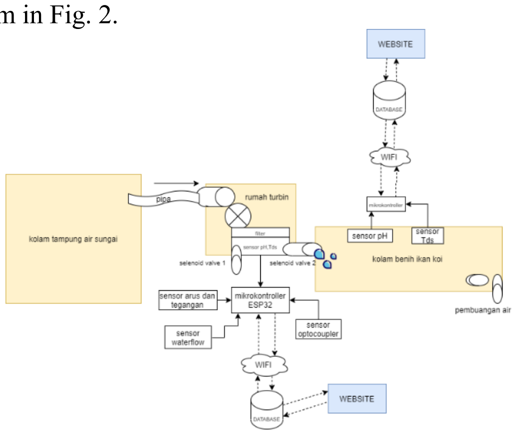

Figure 2. System Block

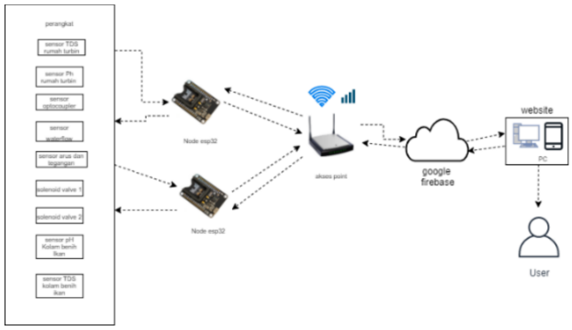

Figure 3. Telemonitoring Device Block Diagram System

Fig. 3 explains that the device performs sensoring and the device data is sent to the ESP32 so that the information data can be transmitted to the user through the website. The sensor device is programmed to adjust its function which is then connected to the ESP32 microcontroller, where the ESP32 is connected to the internet/WIFI network. The network is obtained from the access point. Then the data will be stored and recorded in the cloud database. This study uses firebase which the database is stored and processed by the web server and displayed on a website that displays the information data to the user.

C. Working Procedure and Parameter

Fig. 4 describes the system workflow mechanism when monitoring is connected to the internet/WIFI network so that it can appear on the website for monitoring koi fish seed pond water. If the connection is connected, the device reads and can provide information data that is sent to the website.

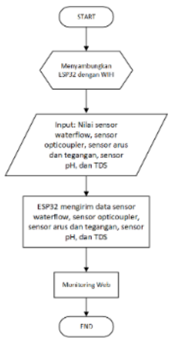

Figure 4. Monitoring mechanism system flowchart

Input devices include water sensors¬flow, optocoupler sensors, current and voltage sensors, TDS sensors, and water pH sensors. In the TDS and Ph sensor device readings of water before the water enters the koi fish pond, and water processing through artificial water filtration. As can be shown in Fig. 5 From the input of the pH sensor and TDS sensor connected to the internet, the device starts the sensor reading and then is processed by the website for sensor monitoring. Furthermore, if the incoming water is in accordance with the pH and TDS parameters, then the solenoid valve 2 ON and solenoid 1 OFF drains water into the fish seed pond. Meanwhile, if the parameters do not match, the solenoid valve 1 ON and solenoid 2 OFF and water will flow to the drain.

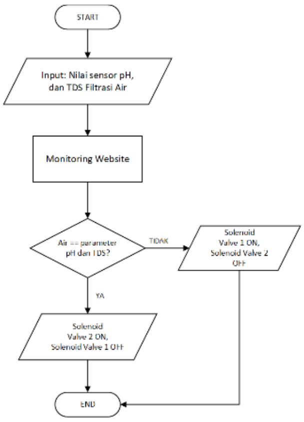

Figure 5. Flowchart Monitoring Water flow mechanism Pool

The parameters used in this study are as follows: (a) Independent variables: research time and water level; (b) Bound variables: Power (watts), water flow from the river water pond to the turbine house (liters/minute), water flow from the turbine house to the koi fish pond (liters/minute), turbine rotation speed (rpm), pH sensor and TDS sensor in the turbine housing (ppm), pH sensor and TDS sensor in the koi fish pond (ppm). Controlled variables: water turbine house and koi fish pond.

III. RESULTS AND DISCUSSION

A. Hardware Implementation

Hardware circuit on the turbine is placed near the location of the koi fish seed pond. The implementation of the hardware circuit consists of a seed pond device box, solar charger controller as a voltage source, INA219 sensor, pH sensor, TDS sensor, solenoid valve, optocoupler sensor, water-flow sensor, and ESP32 device box, pH module, and TDS. The hardware circuit is shown in Fig. 6.

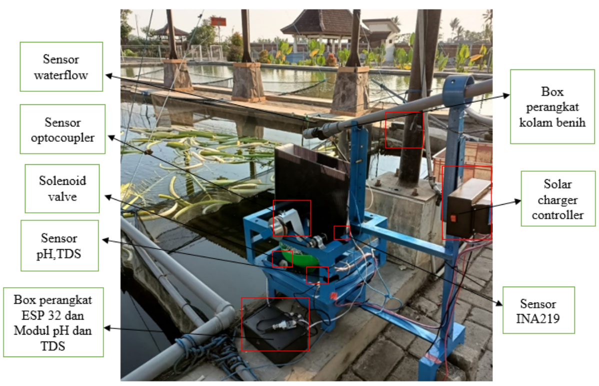

Figure 6 design results on turbine housing hardware

B. Software Implementation

The following are some display images on the web server, shown in Fig. 7, 8, and 9 are part of the web display.

Figure 7 Website initial view

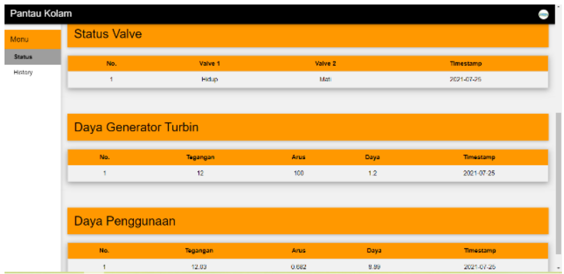

Figure 8 Homepage

The display in Fig. 7 and 8 is a status menu to find out the current state/condition in the pool which contains the following: Turbine state: monitoring turbine housing system; Fish pond status: monitoring system in koi fish ponds; Solenoid valve status: monitoring solenoid valve on turbine; Turbine generator power: monitoring power generated in the generator; Power usage monitoring power usage on today.

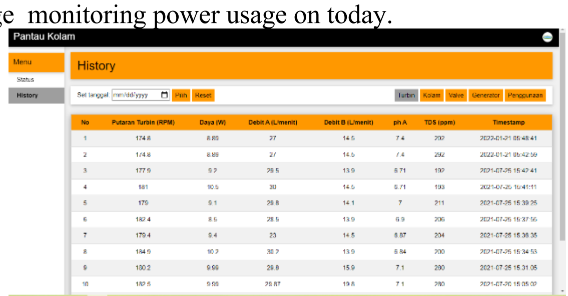

Figure 9 Pages on the Turbine History menu

In Fig. 9 shows the display on the history menu (notes) contains a datalog display, making it easier for users to see the condition of the previous system or as a record of user monitoring tools and systems. If you want to see the history of the fish pond, power usage, or generator power, the user can select the button function on the website. This will display the desired datalog.

C. Testing Water Turbine Rotation Speed Against Water Discharge and Power Generated

In this test, it is shown that the rotational speed of the water turbine is produced, where the rotational speed of the resulting turbine has a dependent variable on the water discharge and the power generated (power on the DC generator). This test is carried out for a period of one hour each with 3 research days, carried out on 24-26 July 2021 at 08.00-15.00 WIB. Tests carried out on Saturday, July 24, 2021 resulted in a comparison of the rotational speed of the water turbine with the water flow and power generated. The higher the value of the water discharge, the higher the speed of the water turbine produced.

The higher the value of the turbine speed, the higher the value of the power generated from the rotation of the generator shows a relatively stable comparison, but at 10.00 there was an increase in water flow, causing the other two parameters to also increase. This shows that the discharge and power speed are directly proportional, where if the water discharge is high then the water turbine rotation speed and power increase. there was a decrease in the water flow, causing the other two parameters to also decrease. This shows that the discharge, speed, and power are directly proportional, where if the water discharge is low, the rotational speed of the water turbine and the power produced is low. A graph with a relatively stable comparison, but at 12.00 to 13.00 WIB there was a decrease in water flow, causing the other two parameters to also decrease. This shows that if the water discharge is low, the rotational speed of the water turbine and the power produced is low. And if the water discharge is high, the rotation speed of the water turbine and the power generated is high.

D. Testing the results of Water Filtration in the Turbine

This test is a test of the water content of the filtration results in the turbine[4]. This test is carried out every 1 hour period, data collection is carried out on the graphic values of water pH and TDS from the turbine filtration system on Saturday, July 24, 2021, from 08.00 to 15.00 relatively stable with the resulting pH value range of 6.7ph - 7.1ph and the resulting TDS value range of 198.82 ppm. – 115 ppm. the water pH and TDS from the turbine filtration system on Sunday, July 25, 2021, which is relatively stable with a pH value range of 6.86ph - 7.05ph and the resulting TDS value range of 200.41 ppm - 213.9 ppm. the graphic value of water pH and TDS from the turbine filtration system on Monday, July 26, 2021, is relatively stable with the resulting pH value range being 6.85ph - 7.13ph and the resulting tds value range of 200.42 ppm - 218.2. ppm.

E. Koi Fish Seed Pond Water Quality Test Results

In testing the water quality of fish seed ponds, the period of time is every one hour, data. Water pH and TDS are reference parameter values to determine the water quality of koi fish seed ponds. The average pH of the water in a day on Saturday was 6.96 and the TDS in the koi fish pond was 258.89 ppm. shows the average pH of the water in a day condition is 6.94 and the TDS in the koi fish pond is 259.47ppm, Then for value shows the water quality on the value of water pH and TDS koi fish pond on Monday. Water pH and TDS are reference parameter values to determine the water quality of koi fish seed ponds. The average pH of the water in a day's conditions was 6.93 and the TDS in the koi fish pond was 265 ppm.

F. QoS (Quality of Service) Testing

QoS parameters measured include delay and packet loss. The following are the results of the QoS test.

1) Delay Test

The purpose of testing the delay in this system is to find out how long the data is sent on the website. The time used for this test is 3 days of data collection. The results of the delay test using Wireshark are shown in Fig. 10.

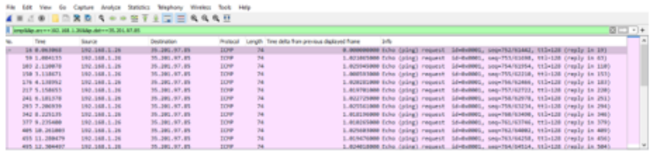

Figure 10 Wireshark

The table for calculating the delay from the test results above is shown in Table I.

TABLE 1
DELAY CALCULATION TABLE

No	Delay		
	Saturday	Sunday	Monday
1	0,0000000	0,0000000	0,0000000
2	1,0141580	1,0210650	1,0071770
3	1,0158100	1,0259450	1,0189120
4	1,0140990	1,0085930	1,0086880
5	1,0203840	1,0202810	1,02222560
6	1,024230	1,0197010	1,0091120
7	1,021892	1,02227250	1,0221590
8	1,0191520	1,0255610	1,0094600
9	1,0257250	1,0181960	1,0065870
10	1,0280240	1,0102650	1,0230920
11	7,0750020	1,0256030	1,0262940
12	1,0141910	1,0194760	1,0240940
13	1,0196320	1,0240180	1,0214550
14	1,0182250	1,0093570	1,0275110
15	1,0159380	1,0209830	1,0068180
16	1,0205450	1,0066770	1,0223390
17	1,0131990	1,0199380	1,0326440
18	1,0178060	1,0078380	1,0201290
19	1,03227740	1,0268810	1,0216440
20	1,0183940	1,0192510	1,0099550
Average	1,2714321	0,9676177	0,9670166

In Table I, the average result of the calculation of delay on Saturday is 1.2714321, Sunday is 0.9676177, and Monday is 0.9670166. The smaller the delay, the better the quality of sending the resulting data so that there is no delay in the information received.

2) Packet Loss Test

The time used for this test is 3 days of data collection. The results of the packet loss test using wireshark are shown in Fig. 11, 12, and 13.

Figure 11 Packet loss test (Saturday)

Figure 12 Packet loss test (Sunday)

Measurement	Captured	Displayed	Marked
Packets	3465	74 (2.1%)	—

Figure 13 Packet Loss Test (Monday)

IV. CONCLUSION

The telemonitoring system for pond water quality for koi fish hatchery with a mechanical turbine rotation method based on an ESP32 microcontroller is in accordance with the design made and the system can work well. The results of the sensor device reading data have an average sensor device error value of 0-0.5% accuracy level. Telemonitoring of water quality on the website has an average pH value of 6.8 - 7.2 and the resulting TDS value of 257-282 ppm water after water filtration with a turbine speed value that is influenced by water flow and turbine rotation speed and the average power consumption generated for the telemonitoring system performance for 3 days of testing is 8.265 W/h. Testing the network quality of the water quality telemonitoring system in koi fish hatchery ponds using a MiFi network with QoS parameters measured by delay and packet loss of 1.068688 and 1.86% respectively in the low category so that data transmission is in the good and very good category a small delay in information from the website. And the use of the website makes it easier for users to monitor koi fish seed ponds.

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