Water Quality Monitoring System with Parameter of pH, Temperature, Turbidity, and Salinity Based on Internet of Things

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Abstract – This research aims to monitor the quality of water used for aquariums. The physical parameters used are water pH, water temperature, water turbidity, and water salinity. Using a pH sensor, temperature sensor, turbidity sensor, and salinity conductivity sensor with Arduino as the controller. The prototype method used in this research, starting from the formulation, research, building stages to testing and evaluating the results of the research. The working process of the system is when the system is activated, the sensors will detect and capture the amount of value contained in the water, then the data from the sensor is sent to a database in the cloud using an ethernet shield that is connected to the media router as a liaison for the internet network then displayed on the website dashboard in the form of graphs and monitoring record tables in real time. The sensors function to detect water quality, where quality standards have been set in this system, namely temperature standards of 27-30°C, pH standards of 7.0-8.0, turbidity standards of 2.5-5 ntu, and salinity of 20-28 ppt. If the sensor detects non-compliance with water quality standards, the buzzer in this system will sound. From the results of system testing, sensors can detect water quality in real time within 5-10 seconds. Based on the research results, this water quality monitoring system is effective to help ensure the quality of the water in the aquarium so that it always meets the standards.

Keywords – Water Quality, Internet of Things, Ph, Temperature, Turbidity, Salinity

I. INTRODUCTION

Water is the main source of need for human survival. Clean water has a very important role in improving environmental health, and plays a role in improving standards or life quality [1]. In daily life, the use of water is used in various fields such as plantations, fisheries, industry, animal husbandry, and other fields. In this pandemic period, many people use water in the field of fisheries, one of which is by keeping ornamental fish in the aquarium to fill activities while at home. [2]. To keep fish in an aquarium, of course you have to pay attention to aspects of the feasibility of clean water, such as temperature, pH, turbidity, and water salinity. Standard of pH for clean water is 7.0-8.0, temperature 27-30°C, turbidity tolerance 2.5-5 ntu, and salinity 20-28 ppt [3]. Thus, to ensure that water quality is always in a standard state, a monitoring system is needed [4] by utilizing Internet of Things technology (IoT) so that water quality can be ensured always in accordance with the standard [5]. IoT can be interpreted as all objects that can communicate with other objects [6]. Therefore, in this study, a prototype of an IoT-based water quality monitoring system will be made [7] by using the temperature sensor model DS18B20 [8], pH sensor [9], salinity sensor [10], and turbidity sensor[11]. Then the controller used is ethernet shield and Arduino [12], as well as a buzzer as an alarm if the sensor detects a non-compliance with AI quality standards [13]. The data from the sensor is sent to the database and displayed on the website dashboard [13] in real time [14].

Research on water quality monitoring has been carried out by Muhammad Faisal, et al to monitor water turbidity using the TSD-10 sensor. From this research, it can be seen that the sensor sensitivity value from the results of the TSD-10 sensor characteristics is 2 mV/NTU and the average accuracy of the measurement has a value of 93.49%. The maximum relative error of measurement is 24.64% [15]. Monitoring of water turbidity was also carried out by Muhammad Kautsar, et al by examining the turbidity level of PDAM water. After conducting calibration trials with conventional water volume measurements by accommodating the volume of water within a certain period of time in a measuring cup and getting a fairly good accuracy result, namely 98.8% [16].

Research on water temperature monitoring conducted by Jamal Maulana Hudin, et al uses NodeMcu, DS18B20 temperature sensor, and the Cayenne application as an IoT platform. The monitoring system designed can provide information on water temperature conditions in real time. The control system will turn on automatically when the temperature is outside the normal range. In the application of the system if the pool temperature is below 25°C it will display a "Bahaya DINGIN" notification and if the pool temperature is above 30°C it will display a "Bahaya PANAS" notification [17]. Arif Indra Irawan, et al conducted research on the temperature of fish ponds with the aim of improving the performance of the DS18B20 temperature sensor. The results showed that the measurement accuracy can be improved by using the linear regression method. The linear regression method in experimental measurements at temperatures of ± 3°C to ± 50°C can increase accuracy by 0.42%, RMSE by 34.4%, and increase sensor response time by about 12% -30%. The use of a normal distributed measurement rate and linear regression in calibration can increase the response time by 12%-19% but reduce the level of accuracy when compared to the linear regression method alone. The use of the linear regression method and a normal distributed measurement rate can increase the accuracy of the actual pool temperature measurement, both in the afternoon and in the morning by 90%.[18].

Yuri Rahmanto, et al monitored the pH of aquaponic water by using the Arduino Uno microcontroller. The result of the research is that by looking at the results of the water pH sensor readings, farmers can determine that the water is in good condition or not for mustard plants. The results of the water pH sensor readings have a difference that is not so far from the pH meter, which is 5.5 to 6.5 [19]. Dista Yoel Tadeus, et al also conducted research on the turbidity and pH of the water, with the object of the research being a freshwater aquarium by utilizing Internet of Things technology. Monitoring data is used to activate the actuator in the form of a water filter. The filter will be active if the water turbidity level has exceeded the specified turbidity limit. The turbidity test of the aquarium water shows that when the turbidity reaches 3000 ntu at 14.12 the pump is active and the filter works until the turbidity is at a value of 498 ntu at 17.00 and the pump turns off automatically. The pH value and water turbidity were successfully displayed in the Blynk application on the cellphone. The test results conclude that the monitoring system developed has been successfully implemented [20].

Dynar A. Wibisono, et al conducted a study with the aim of designing a monitoring system based on the internet of things and an automatic control system using a salinity sensor to monitor salt levels, a DS18B20 temperature sensor to monitor temperature, and a pH sensor SEN0161 to monitor water pH. The sensor data is processed by the Arduino Nano microcontroller and the Wi-Fi-based Wemos D1 mini board from the ESP8266 family, sending data to the firebase realtime database, then the user will monitor the salt content, temperature and pH content on the web. Tests are carried out by validating and reading sensors as well as sending and recording data on the web and controlling actuators to maintain water quality. the system is able to increase the temperature by 1°C in 1.25 minutes with an error value of ±1°C, the system is able to increase the salinity content by 2 ppt in 2 minutes with an error value of ±1 ppt, pH control can also be done by increasing the pH value by 1 which has an error of±0.7. The results show that sensor data can be sent in real time on the website at a speed of 484.75 ms using the HSDPA network and 75 ms using the LTE network [21].

II. RESEARCH METHODOLOGY

A. Prototype Method

In making this research, the researcher divides into 4 stages, namely formulation stage, research stage, building stage, testing stage and evaluation stage.

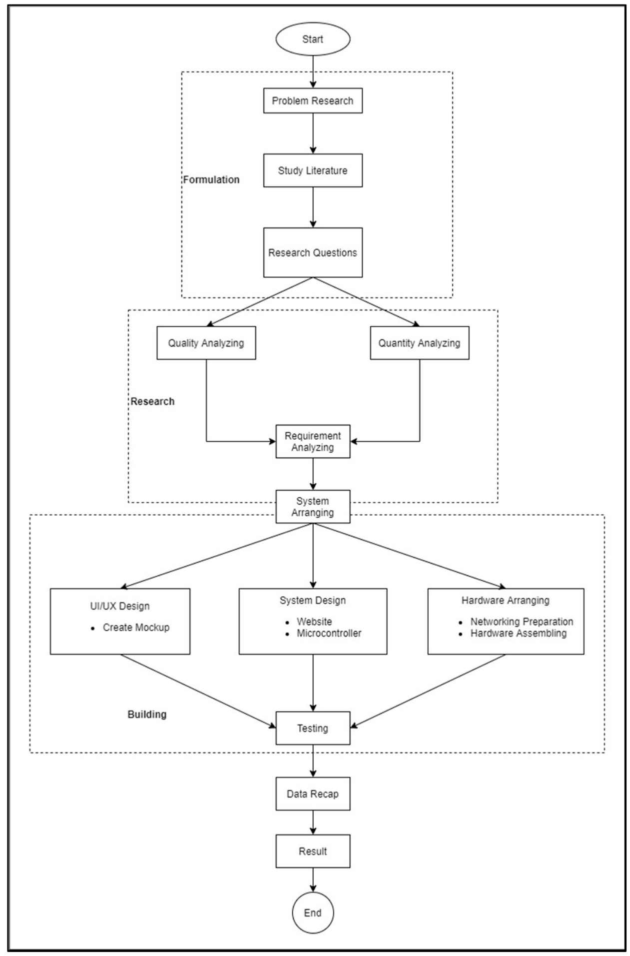


Figure. 1 Prototype Method

The following is an explanation of the methodological stages in Figure. 1.

1. Formulation, which is the management stage of the research strategy to be carried out, consisting of:
   a. Problem research, we look for the problem of what object will be researched, especially in the IT field.
   b. Study Literature, after the object of the problem is found, the researcher examines previous studies related to the object to be studied.
   c. Research Question, we describe questions related to the object of research.
2. Research, is the stage to find the criteria to be researched.
   a. Quality analysis, aims to determine the standard quality of the object of research to be carried out.
   b. Quantity analysis, aims to determine the number of needs of the object of research to be carried out.
   c. Requirement analysis, after the two criteria have been determined, a needs analysis will be carried out by the author to conduct research.
3. Building, is the execution stage of implementing the research to be carried out, starting from system design which is divided into 3 designs, including:
   a. UI/UX design, is a process to provide an initial view for users in the form of making mockups so that they can be easily used as they should be.
   b. System design or program design, is the process of

e-ISSN: 2614-8404
p-ISSN:2776-3234

programming software in the system, namely the web system and programming on the microcontroller.

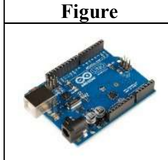
c. Hardware Arranging, is a hardware design process in the form of internet network configuration and a series of microcontroller tools.

4. Trial and Evaluation, is the final stage of research to test and evaluate research that has been designed in the previous stage which consists of:
   a. Trial, is a system testing process from research that has been previously designed.
   b. Data recap, conducting the process of collecting data on the evaluation results of the research object trial.

B. Hardware Requirement

The hardware devices needed in making a prototype water quality monitoring system are as follows:

Table 1. Hardware Requirement

Figure	Name	Qty	Used For
	Arduino IDE	1 pc	As a microcontroller
	Temperature Sensor model DS18B20	1 pc	Water temperature sensor with units of degrees Celsius
	pH Sensor	1 pc	Water PH level detection sensor
	Turbidity Sensor	1 pc	Water turbidity detection sensor with units of NTU
	Salinity Sensor	1 pc	Water salinity detection sensor with units of part per million ppt
	Buzzer	1 pc	As a notification in the form of a "beep" sound when the sensor detects non-standard water quality
	Ethernet Shield	1 pc	Additional port for connecting with router
	Project Board	1 pc	The place to assemble and combine sendor with arduino
	Mikrotik RB951UI	1 pc	Sebagai pengaturan dan jaringan IP arduino
	USB Arduino Cable	1 pc	As a liaison Arduino with laptop
	Jumper Cable	1 set	As a liaison sensor with arudini
	UTP/LAN Cable	1 pc	As a liaison Arduino with mikrotik

C. Flowchart System

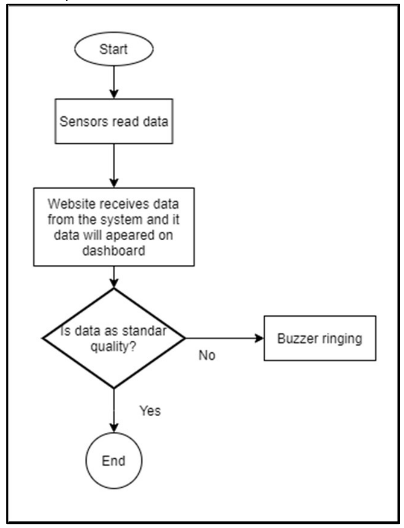


Figure. 2 Flowchart System

The following is an explanation of the flowchart in the figure. 2:

1. The sensors detect the water quality data in the aquarium.
2. 2. The system sends sensor data to the web server and displays it.
3. If the sensor detects a water quality discrepancy, the buzzer sounds.

D. Diagram System

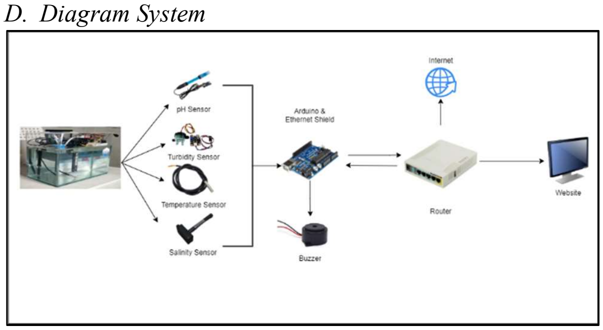


Figure. 3 Diagram System

Figures. 3 can be explained as follows.

1. In the aquarium, sensors are installed to detect water quality, namely temperature, pH, turbidity, and salt

e-ISSN: 2614-8404
p-ISSN:2776-3234

levels. Its function is to ensure that water quality is always in accordance with standards.
2. Arduino and ethernet shield as microcontrollers that control sensors and servers that receive data from Arduino, then store and send it to the web server.
3. Buzzer sounds when the sensor detects water quality that is not up to standard

III. Results And Discussion

The results of the development of a water quality monitoring system are able to provide convenience in detecting water quality according to standards. In addition, it can also open up public insight regarding water detection in accordance with standards carried out by using automated technology. In this study, the system developed is based on Arduino which uses temperature, pH, salinity, turbidity sensors to detect water conditions using the method used, namely prototyping. The following are the results of water quality monitoring in this study.

A. Dashboard Website Monitoring Water Quality

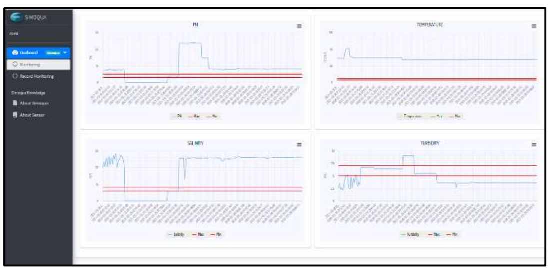


Figure. 4 Dashboard Website

Displays data graphs from sensor records that have been stored by the water quality monitoring system database. Consisting of graphs of pH, temperature, salinity, and turbidity, this website is very user friendly, so it can be set according to the needs of the type of water to be monitored. In this system, temperature standard of 27-30°C, pH standard of 7.0-8.0, turbidity standard of 2.5-5 ntu, and salinity of 20-28 ppt.

B. Graph of pH Monitoring

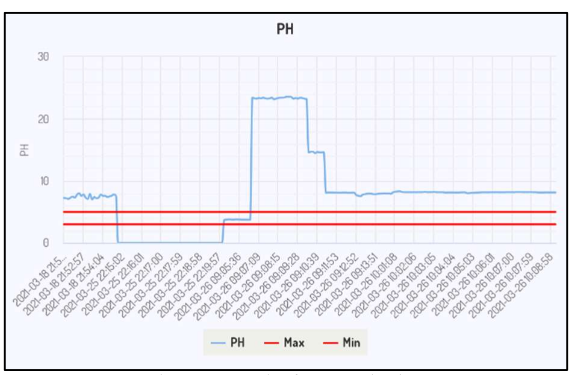


Figure. 5 Graph of pH Monitoring

On the graph of the pH data, the two red lines are the standard water pH parameters. The line below is the minimum value and the line above is the maximum value. Graphs display data in real time. Graphics can also be displayed full screen or can be downloaded with the formats that are available.

C. Graph of Temperature Monitoring

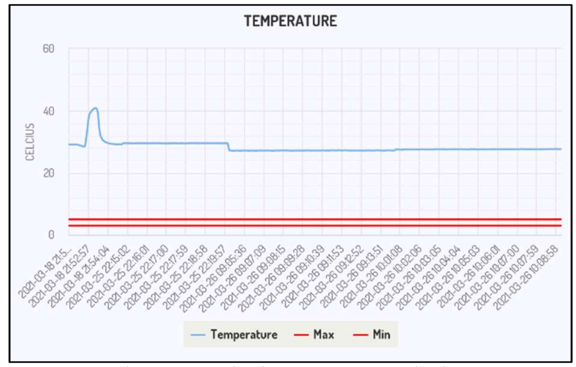


Figure. 6 Graph of Temperature Monitoring

In the temperature data graph, the two red lines are the standard water temperature parameters. The line below is the minimum value and the line above is the maximum value. Graphs display data in real time. Graphics can also be displayed full screen or can be downloaded with the formats that are available.

D. Graph of Salinity Monitoring

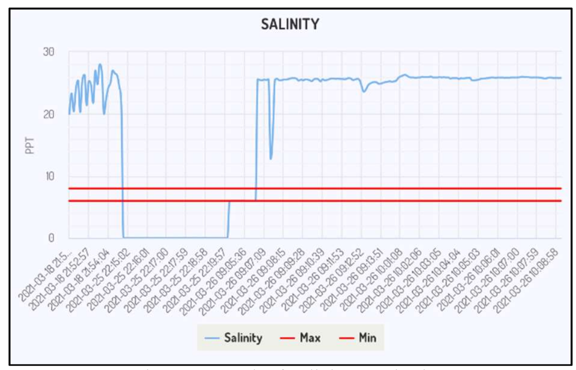


Figure. 7 Graph of Salinity Monitoring

On the salinity data graph, the two red lines are the standard water salinity parameters. The line below is the minimum value, and the line above is the maximum value. Graphs display data in real time. Graphics can also be displayed full screen or can be downloaded with the formats that are available.

E. Graph of Turbidity Monitoring

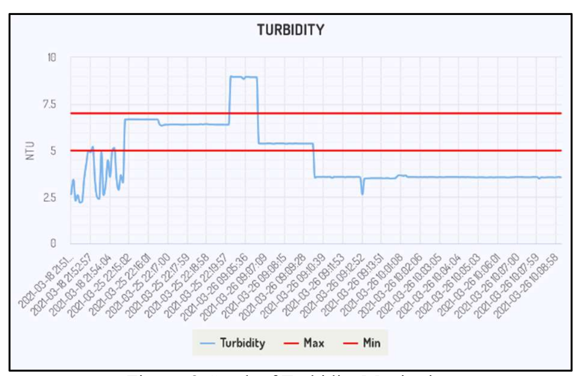


Figure. 8 Graph of Turbidity Monitoring

In the turbidity data graph, the two red lines are the standard parameters for water turbidity. The line below is the minimum value, and the line above is the maximum value. Graphs display data in real time. Graphics can also be displayed full screen or can be downloaded with the formats that are available.

F. Data Record Monitoring

This Monitoring Record contains recorded data from the sensors of the water quality system. There are data on pH, temperature, turbidity, salinity, and the date and time the data was recorded. Monitoring data can also be downloaded, and this is one of the advantages of the water quality system data report, namely that the report data attributes can be adjusted according to needs. The following is the data from the monitoring conducted on March 18, 2021.

Table 2. Monitoring Record

Temperature	pH	Turbidity	Salinity	Date & Time
29,12	7,25	2,65	20	2021-03-18 21:51:57
29,12	7,2	3,43	23,32	2021-03-18 21:52:03
29,12	7,1	2,3	20,4	2021-03-18 21:52:10
29,12	7,3	2,6	24	2021-03-18 21:52:17
29,06	7,45	2,2	25,4	2021-03-18 21:52:23
28,81	7,3	2,25	20,3	2021-03-18 21:52:30
28,62	7,77	3,48	25,4	2021-03-18 21:52:37
28,5	8	4,29	26,3	2021-03-18 21:52:43
32,31	7,6	5	21,4	2021-03-18 21:52:50
38,06	7,8	4,9	25,3	2021-03-18 21:52:57
39,69	7,3	5,2	24,7	2021-03-18 21:53:03
40,44	7,1	3,39	21,78	2021-03-18 21:53:10
40,88	7,9	2,5	27	2021-03-18 21:53:17
39,94	7	2,4	24,79	2021-03-18 21:53:23
33,25	7,4	4,9	28	2021-03-18 21:53:37
31,06	7,2	2,6	26,78	2021-03-18 21:53:44
30,25	7,3	3,2	20	2021-03-18 21:53:51
29,81	7,8	4,48	22,49	2021-03-18 21:53:57
29,56	7,6	3,59	24,23	2021-03-18 21:54:04
29,37	7,6	4,98	25	2021-03-18 21:54:11

G. Experimental Result

Figure. 9 Experimental Result

The prototype of the water quality monitoring system consists of a series of described hardware that is connected to a website-based system that is useful for displaying monitoring results.

IV. CONCLUSION

Based on the results of the research that has been done, it can be concluded that a water quality monitoring system based on the Internet of Things using a temperature sensor, pH sensor, turbidity sensor, and salinity sensor can monitor water in terms of temperature, pH, turbidity, and salt content whose data is displayed. on the website dashboard in real time every 5-10 seconds. The buzzer gives an audible warning when one of the sensors detects a water quality discrepancy. This can help ensure water quality is always up to standard.

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