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PROTOTIPE OF AN ARDUINO-BASED WATER QUALITY MONITORING EQUIPMENT FOR OPTIMIZATION OF BIOFLOC SYSTEMS

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Abstract. The disadvantage of this biofloc system cultivation is that it requires intense monitoring of water quality to maintain floc stability in the cultivation media. The solution to this problem is the creation of a prototype water quality monitoring tool in a biofloc system cultivation pond that is able to measure water quality consisting of DO, temperature, pH, and ammonia and is able to display measurement data into applications and is able to provide treatment suggestions. Create prototyping with a microcontroller system as well as designing applications and carrying out testing experiments on component units. The prototype accuracy test is carried out by comparing the results of water quality measurements with conventional tools. The results of the study explained the procedure for making a prototype of a tool consisting of the design of a water quality measuring device and the design of a viewer application of water quality measurement results. The accuracy of the tool components of the DO sensor is 98.5%, the temperature sensor is 99.89%, the pH sensor is 95.1%, and the ammonia sensor is 95.4%. This tool is able to take measurements well and is useful for the breeder.

INTRODUCTION

The more intensive the cultivation activities, the higher the concentration of nitrogen compounds, especially ammonia, so as to increase metabolites and reduce the content of dissolved oxygen in the water of the cultivation media which can cause a decrease in water quality (Apriyani, 2017). There are many farmers who feel that the biofloc system is too complicated because it requires continuous monitoring of water quality. Farmers are concerned about the potential failure of death in flocs due to the lack of control over the materials that make up the biofloc system (Akhmad, 2018).

Seeing the problem of inadequate monitoring of water quality in biofloc system cultivation ponds, although there are many advantages of biofloc system cultivation such as cost-effectiveness, shorter maintenance time, more efficient land and water resources (Fatimah, 2018). According to previous studies, there is no system that regulates the automation of water quality measurements in the cultivation ponds of the biofloc system. Therefore, the author has a solution in the form of creating a prototype of an application-based automatic water quality monitoring tool to build a more efficient, intensive, and inclusive biofloc ecosystem with the help of technology to advance the economy and welfare of the Indonesian people, especially for fish or shrimp farmers. The purpose of this study is to create a prototype of a water quality monitoring tool and find out the measurement results of the water quality monitoring tool prototype.

RESEARCH METHODOLOGY

Research Materials

The equipment used in this study is arduino project as a control tool that can be programmed to run prototypes, solar cell sets to capture energy from sunlight which will later be converted into electric power, LCD is used to display data in digital form, solder to assemble or disassemble electronic components that are usually embedded in PCB boards (*Printed Circuit Board*), PCB drill (*Printed Circuit Board*) is used to make small holes on the PCB (*Printed Circuit Board*), *the dissolved oxygen* meter sensor AZ-8403 is used to measure the dissolved oxygen content in the cultivation pond, the DS18B20 temperature sensor is used to measure the temperature in the cultivation pond, the MQ-137 sensor + NH3 Ammonia module is used to measure the ammonia content in the cultivation pond, and the pH electrode sensor + module 4502C is used for measuring pH in aquaculture ponds. The materials used are the tool case to protect prototype components, male to male cables to connect electronic components, female to female cables to connect between components that have male headers between sensors, tin as a material to connect between two components, namely electronic adhesive components and PCB boards, diodes as electric current rectifiers, crocodile circumcisors to channel electrical energy from the adapter power source to wearer, wire, acrylic to conduct electric current from one point to another in an electronic circuit or in an electrical network system, soldier's eye serves as a conductor or heat conductor which will later be used to bray lead when assembling electrical components, resistors are used to reduce current flow, adjust signal levels, to divide voltage, refracting active elements, and stopping transmission lines, and operational amplifiers or AMP OP to amplify both direct current (DC) and alternating current (AC) signals.

Research Methods

The method used in this study is to make a prototype automatic water quality measuring device in the cultivation pond of the biofloc system with a *single chip microcomputer* system or commonly known as a microcontroller as a data processor and the implementation of test experiments on each component. The water quality measuring device design system has several component units, including the DS18B20 Temperature sensor, pH Sensor Electrode + module 4502C, Sensor Dissolved Oxygen Meter AZ-8403, Sensor MQ-137 + Ammonia Module (NH3), Arduino Nano, Solar Panel, and LCD then assembled into a series of drivers with microcontrollers as the brain in making instruments for water quality measuring devices that will process the output signal into a besa a ran that can be read and displayed in an LCD, each component will take measurements when the sensor is dipped in a biofloc pool and will capture the measurement results.

The output of water quality measuring data will enter the server, and the classification system of water quality measurement results will appear in the LCD in addition to that the *output* of water quality measurement results can be accessed through the application. The sensor construction also plays an important role in direct contact with the parameters to be measured, so that the sensor can measure without interference from the packaging sensor. The sensor construction is well made so that the sensor is not easily damaged and undisturbed.

The application was made to support this research in displaying data on the results of measuring the water quality of the aquaculture pond biofloc system carried out by the prototype water quality measuring device, this application is able to display the results of water quality measurements and treatment suggestions in the cultivation pond of the bifloc system.

RESULT AND DISCUSSION

Prototype design of Water Quality Monitoring

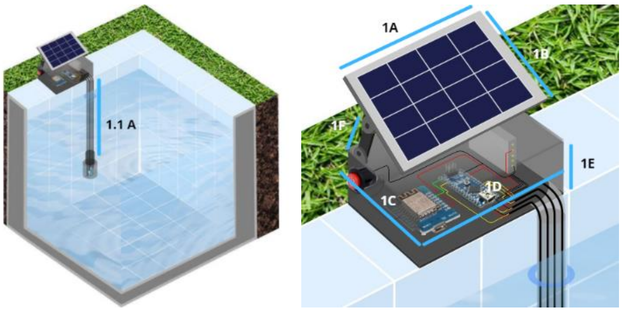

Figure 1. Prototype Detail Design Detail of Prototype

The prototype of the water quality monitoring tool for the cultivation pond of this biofloc system is made of *polycarbonate* material with a length of 40-50 cm (1D); with a tool width of 20-30 cm (1C); and height 5-8 cm (1E); At the top of the appliance there are solar panels with a length of 20 cm (1A); with a length of 15 cm (1B); Between the solar panel and the main frame there is a supporting leg that has a length of 3-4 cm (1F). On the front of the tool there is a sensor that will have a cable length of 100-120 cm. On the front of the tool there is a sensor that will have a cable length of 100-120 cm (1.1 A).

The water quality monitoring tool for the cultivation pond of the biofloc system is a technological innovation that is able to monitor various indicators of biofloc sustainability in one tool with the help *of the Internet of Things* (IoT), namely glucose levels (using a pH sensor where a good pH level represents the optimal level of good microorganisme decomposition due to the sufficient supply of glucose), nitrogen (muse nh sensor $_3$), temperature and *Dissolved Oxygen* (DO) are automatically and integrated with the application which will display the data of the results of the measurement of floc quality parameters. In addition, this monitoring tool uses renewable energy sources from solar panels so that it can save on cultivation operational costs, this monitoring tool has a system that can take actions quickly in certain locations or conditions, applications that can automatically respond to problems in the cultivation pond by providing suggestions on treatments that must be done by cultivators and there is a complete guide to the use of tools in the application to make it easier for cultivators to carrying out fish or shrimp farming biofloc system, by using this monitoring tool, monitoring in the sustainability of the floc will be maintained and can increase effectiveness in the cultivation of the biofloc system.Pemade a prototype water quality measuring device in the cultivation pond of this biofloc system there are several sensor components, namely DO, pH, temperature, and ammonia sensors which are then assembled with Arduino Nano and LCD into a series of drivers with a microcontroller as the brain in making instruments which will then process the output signal into a quantity that can be read and displayed on the LCD. Each sensor component will automatically work to take measurements if it is dyed into a cultivation pond and capture the results which are then sent to the server and the classification system of the water quality measuring results will appear in an LCD, besides that the data can also be displayed through an application that can be accessed on a computer or cellphone.

Prototyping of Water Quality Monitoring Tool

At the stage of making a viewer application, the results of the aquaculture water quality meter begin with the creation of a *source code* for the classification of water quality meters in the cultivation pond, which then the measurement result data will be classified based on the optimal value data group and non-optimal value data so that later the application is able to display measurement results based on classification and is able to provide treatment suggestions.

Prototype Trial of Water Quality Monitoring Tool

Tool prototype trials are carried out to determine the level of accuracy of the prototype that has been made. In this trial, 30 trials were carried out time of study data collection was carried out in 3 sessions, namely in the morning, afternoon, and evening and measurements were taken once every 20 minutes in each session. The trial system carried out is to compare the level of accuracy of the tool prototype compared to conventional tools.

Table 1. Measurement Using Prototype Water Quality Monitoring Tool

No	DO (ppm) (Optimum Value >3)			Temperature (Celsius) (Optimum value 27-32)			Ammonia (mg/l) (Optimum Value 0.01-0.99)			pH (Optimum Value 6-8)		
	Morning	**Noon**	**Night**	**Morning**	**Noon**	**Night**	**Morning**	**Noon**	**Night**	**Morning**	**Noon**	**Night**
1	4,54	4,84	4,35	29	31	29	0,11	0,13	0,17	6,8	7,4	7,2
2	4,67	4,01	4,67	27	30	26	0,14	0,14	0,19	7,3	7,4	7,1
3	4,71	3,98	5,01	26	31	28	0,13	0,11	0,18	7,2	7,3	7,0
4	4,45	4,76	5,06	28	29	29	0,14	0,14	0,18	6,9	7,1	7,2
5	4,67	4,89	4,58	29	30	27	0,14	0,14	0,19	7,0	7,3	7,3
6	4,55	4,26	4,78	27	30	28	0,13	0,14	0,19	7,1	7,2	7,1
7	4,70	4,89	4,26	29	28	29	0,12	0,12	0,18	7,2	7,3	7,2
8	4,54	4,76	4,81	27	29	28	0,15	0,12	0,17	7,0	7,3	7,0
9	4,44	3,25	4,66	26	30	27	0,11	0,12	0,18	7,2	7,5	6,9
10	4,56	4,59	4,33	28	28	29	0,11	0,13	0,19	7,3	7,1	7,0

Comparison with Conventional Tools

Table 2. Measurement Using Conventional Tools

No	DO (ppm) (Optimum Value >3)			Temperature (Celsius) (Optimum value 27-32)			Ammonia (mg/l) (Optimum Value 0.01-0.99)			pH (Optimum Value 6-8)		
	Morning	**Noon**	**Night**	**Morning**	**Noon**	**Night**	**Morning**	**Noon**	**Night**	**Morning**	**Noon**	**Night**
1	4,59	4,94	4,37	29	31	29	0,16	0,18	0,23	7,8	7,2	7,3
2	4,72	4,41	4,68	27	30	26	0,19	0,19	0,24	7,8	7,6	7,4
3	4,77	3,72	5,05	26	31	28	0,18	0,17	0,22	7,9	7,8	7,6
4	4,50	3,76	5,04	28	29	29	0,19	0,19	0,24	7,6	7,5	7,4
5	4,69	3,89	4,55	29	30	27	0,20	0,16	0,22	7,0	7,4	7,3
6	4,76	4,56	4,73	26	30	28	0,23	0,19	0,23	7,5	7,6	7,3
7	4,78	4,66	4,27	29	28	29	0,22	0,17	0,26	7,8	7,6	7,2
8	4,59	4,87	4,86	27	29	28	0,25	0,17	0,28	7,9	7,8	7,5
9	4,53	3,95	4,67	26	30	26	0,18	0,18	0,28	6,2	7,5	6,5
10	4,76	4,89	4,28	28	28	29	0,16	0,19	0,29	7,8	7,3	7,4

Error Value and Error Percentage of Monitoring Tool Prototype

Table 3. DO (*Dissolved Oxygen*) Test Result Data

No	DO Measurement by Conventional Tools	MEASUREMENT OF DO by sensor	Error Difference	% Error
1	4,54	4,59	0,05	1,1
2	4,67	4,72	0,05	1
3	4,71	4,77	0,06	1,2
4	4,45	4,50	0,05	1,1
5	4,67	4,69	0,02	0,4
6	4,55	4,76	0,21	4,6
7	4,70	4,78	0,08	1,7
8	4,54	4,59	0,05	1,1
9	4,44	4,53	0,09	2
10	4,56	4,76	0,2	4,3
		Average error		**1,85**

Based on the tests that have been carried out, it can be seen that the AZ-8403 DO sensor can work well as a measurementof dissolved oxygen protection using conventional tools. This can be seen from the accuracy of the AZ-8403 DO sensor of 98.15%.

Table 4. Temperature Testing Result Data

No	Temperature Measurement by Conventional Tools	Temperature measurement by sensor	Error Difference	% Error
1	29	29	0	0
2	27	27	0	0
3	26	26	0	0
4	28	28	0	0
5	29	29	0	0
6	26	26,3	0,3	1,1
7	29	29	0	0
8	27	27	0	0
9	26	26	0	0
10	28	28	0	0
		Average error		**0,11**

Based on the tests that have been carried out, it can be seen that the DS18B20 temperature sensor can work well as a temperature measurement using conventional tools. This can be seen from the accuracy of the temperature sensor of 99.89%.

Table 5. pH Test Result Data

No	pH Measurement by Conventional Tools	pH measurement by sensors	Error Difference	% Error
1	7,8	7,7	0,1	1,2
2	7,8	7,6	0,2	2,56
3	7,9	7,7	0,2	8,6
4	7,6	7,9	0,3	8,6
5	7,0	7	0	0
6	7,5	7,3	0,2	8,6
7	7,8	7,7	0,1	1,2
8	7,9	8	0,1	1,2
9	6,2	6	0,2	8,6
10	7,8	7,6	0,2	8,6
		Average error		**4,9**

Based on the tests that have been carried out, it can be seen that the pH of the electorde sensor + module 4502C can work well as a pH measurement using conventional tools. This can be seen from the accuracy of the pH sensor of 95.1%.

Table 6. Ammonia Testing Result Data

No	Ammonia Measurement by Conventional Tools	Measurement of Ammonia by sensors	Error Difference	% Error
1	0,16	0,11	0,01	6,25
2	0,19	0,14	0	0
3	0,18	0,13	0,01	5,5
4	0,19	0,14	0,01	5,2
5	0,20	0,14	0,01	5
6	0,23	0,13	0,1	4,3
7	0,22	0,12	0,02	9
8	0,25	0,15	0	0
9	0,18	0,11	0,01	5,5
10	0,16	0,11	0,01	6,2
		Average error		**4,6**

Based on the tests that have been carried out, it can be seen that the MQ-137 sensor + Ammonia Module can work well as a measurement of ammonia using conventional tools. This can be seen from the accuracy of the ammonia sensor of 95.4%.

Advantages and Benefits for Users

Figure 2. Prototype of Water Quality Monitoring Tool

In the condition of the biofloc system cultivation pond if there is no continuous monitoring of water quality, so that the increase in H_2S is one of the causes of floc death and the emergence of various diseases that can cause mass death in the biota cultivated, both fish and shrimp, this can certainly cause farmers to suffer losses.

The prototype of this water quality monitoring tool is an innovation of a sensory tool measuring water quality in the cultivation pond of the biofloc system so that the flocs contained in the pond remain alive. The existence of this tool can help farmers in monitoring water quality in detecting water quality if it is not optimal so that farmers can immediately provide *treatment* so that water quality can be optimal again, so that cultivators do not lose money due to the death of cultivated biota.

CONCLUSION

The procedure forcreating a prototype tool that can measure automatic water quality in the cultivation pond of the biofloc system begins with the design of a water quality measuring device, there are several sensor components, namely DO, pH, temperature, and ammonia sensors which are then assembled with Arduino Nano and LCD into a series of drivers with a microcontroller as the brain in making the instrument which then will process the output signal into a quantity that can be read and displayed on the LCD. Each sensor component will automatically work to take measurements if it is dyed into a cultivation pond and capture the results which are then sent to the server and the classification system of the water quality measuring results will appear in an LCD, besides that the data can also be displayed through an application that can be accessed on a computer or cellphone.The results of water quality measurements using automatic water quality measuring devices in the cultivation pond of the biofloc system , namely this tool has a good level of accuracy and has been tested comparatively with conventional tools. The accuracy rate of the DO sensor is 98.5%, the temperature sensor is 99.89%, the pH sensor is 95.1%, and the ammonia sensor is 95.4%. Each component in this tool is able to work properly according to its respective functions.

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