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Design and Control System Monitoring of Water Quality on Tilapia Cultivation Farm based Internet of Things (IoT) with NodeMCU

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KEYWORDS

System Monitoring, Cayene Application, NodeMCU, IoT Technology

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A B S T R A C T

Fish cultivation has a high potential to improve the welfare of the community. One of the important factors influencing the success of fish cultivation is the aspect of water quality in the pond which is illustrated by several physical parameters such as temperature, degree of acidity (pH) and turbidity of the water. The use of water for cultivation must always be maintained at turbidity level, the impact of turbid water causes disruption to the physical growth of the fish and even death. Due to the limitations of humans who cannot monitor ponds 24 hours, a system is created that can monitor and control water quality in real time. To get good water quality for cultivation, the authors make this system using a turbidity sensor to detect water turbidity, a pH sensor to detect the acidity of the water and a temperature sensor to detect the temperature of the water on the pond. While processing and control using a microcontroller, namely NodeMCU. Periodically the sensor will send the measurement results to the Cayenne application in real time which can be viewed via a smartphone / PC. The control system is also made with two modes, namely automatic and manual modes to fill and drain water on the pond. Based on the results of system testing, turbidity, pH and temperature sensors are very good in detecting any changes in pond water conditions. Cayenne application with IoT technology is able to provide action on the water pump in the process of draining and filling water in ponds with manual mode. NodeMCU is able to send data with a good internet connection.

INTRODUCTION

One of the most important factors influencing the success of fish cultivation is water quality. Water quality is defined as the suitability of water for fish survival and growth [1]. Some physical parameters that can be observed to describe water quality include the degree of water acidity (pH), temperature and turbidity of water [2]. When temperatures are low, fish do not want to eat and fish are susceptible to disease. However, if the temperature is high then the fish will stress in breathing and damage to the gills.

Turbid water also affects the growth of tilapia. Turbid water conditions make the fish competition with plankton to get oxygen and the fish's response to food will decrease because the fish's vision is blocked by turbid water. In addition, tilapia can grow well in waters with low or neutral alkalinity. In waters with low pH the growth has decreased but tilapia fish can still grow well [3].Tilapia that produces acid from this metabolic process can reduce the pH of water.

Ponds that are not replaced by water (drained) decrease in pH, an increase in acid production by tilapia that accumulates constantly in the pond and makes toxic substances from ammonia and nitrite in tilapia cultivation will be high. The importance of water quality has an impact on the success of fish farming and needs to be monitored continuously to get good quality fish. So, we need a water quality monitoring and control system that can reach parameters in real time to maintain the quality of tilapia.

IoT technology is suitable for use as monitoring and controlling water quality in tilapia ponds. Temperature, pH and turbidity sensors will send the measurement results to a smartphone / PC which will be displayed in the cayene application. Besides this system there are two modes, manual and automatic modes. Both of these modes function to fill and drain water on the pond. If the automatic mode is activated, it means that when the turbidity sensor detects turbid water conditions, the water pump will automatically activate.

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However, if manual mode is activated, farmers can freely fill and drain water on the pond. This device has purpose to facilitate farmers in monitoring and controlling water quality remotely in real time so that it is more efficient to drain and fill water in ponds.

RESEARCH METHOD

The working principal of controlling and monitoring water quality on ponds based IoT Technology with NodeMCU, need the block diagram as a guide to make this device. In the block diagram between one block and another block interconnected as shown in Figure 2.1

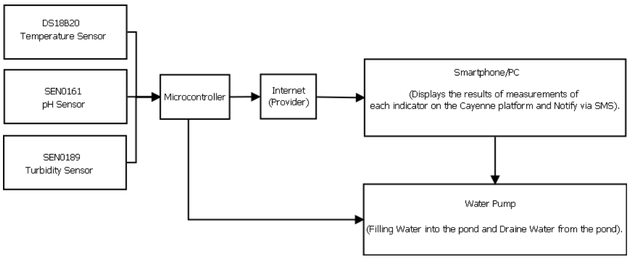

Figure 1. Block Diagram

The input block consists of 3 components. The first component is a temperature sensor to measure water temperature. The second component is a pH sensor to measure the acidity in a pond and the third component is a turbidity sensor to detect turbidity in the pond. Input is inserted into the processor which is the main control of this device is Microcontroller (NodeMCU). In Microcontroller, program run. Microcontroller will process reading input from sensors. The result of the input is from the voltage that goes into microcontroller. Provider in this block connects the block process with block output. IoT Technology on this system is at the provider.

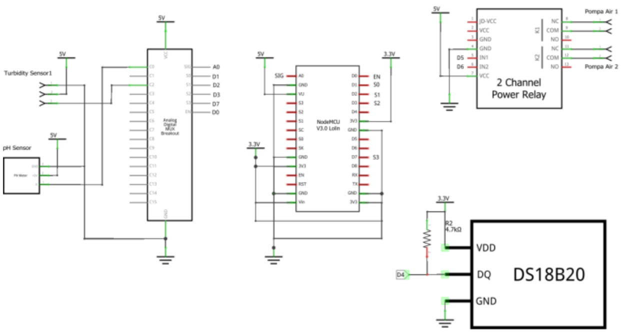

Figure 2. The whole circuit of the device

After the input is processed on microcontroller, there will be output from process in the form of SMS, display measurement of each sensor on cayenne application and water pump. Output SMS will appear when the temperature and pH of the water on pond exceeds the standard limit. In the block output, there is Smartphone/PC. Smartphone/PC in this device is used to display the results of measurement of the sensors and can also be used to activate the water pump on the pond when manual mode is activated. Latest, after the microcontroller processes the input from the turbidity sensor and it is detected that the pond water is turbid; the water pump can automatically fill and drain the water on the pond.

SOFTWARE DESIGN

Software design explains the program that used to operating the system. Tis section consist of flowchart and the explanantion how the program works.

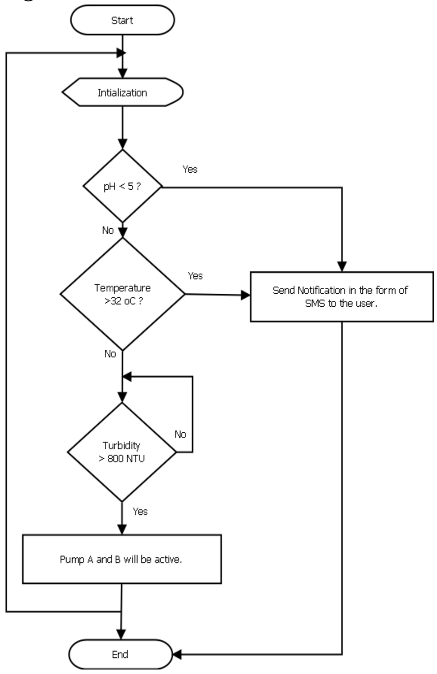

Figure 3. Flowchart Program

Description to the program flowchart shown in Figure 3 is when the device is activated, the program will start. After that initialize the program, and read the pH sensor. If the pH sensor is detected pH of water < 5, a notification will be sent to the farmer's mobile number. Then the program continues to temperature sensor, if the temperature sensor is detected temperature of water > 32^{0}C, a notification also will be sent to the farmer's mobile phone. And then if the turbidity sensor detected turbid of water > 800 NTU, the water pump will be active. The process has been completed, and will repeat from the beginning accordance with the input received from each sensor (as determined).

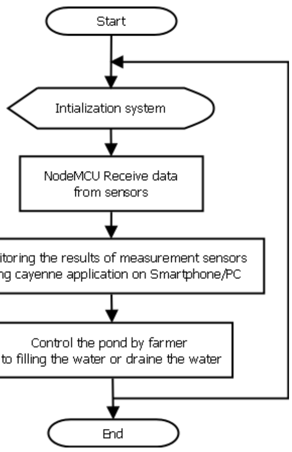

Figure 4. Flowchart of Water Quality Monitoring and Control System with cayenne application

Water quality monitoring and control also starts with initialization. Then, NodeMCU receives the input signal from each sensor. NodeMCU which is already connected to an

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internet connection will send the results of each water quality parameter measurement to the cayenne application. At this time there is monitoring through the cayenne application on smartphone / PC and farmer condition control by farmer. The farmer can activate automatic or manual mode for water filling or drainage.

RESULTS AND ANALYSIS

In this section, result and analysis is done on hardware and software. In the following test was tested on the device and each program. The component parts were tested in the circuit:

TURBIDITY SENSOR

Sampling of water turbidity can be seen from the magnitude of the output voltage of the turbidity sensor. Testing turbidity sensors, the authors tested 3 levels of turbidity of water, clean water from ground wells that are generally used for household needs such as bathing or washing dishes. Medium level turbid water uses tea solution mixed with coffee and high level turbid water uses water that has been mixed with soil.

Tabel 1. Water Turbidity and Output Voltage

Level	Pengujian Tegangan (Volt)					Rata-Rata (Volt)	NTU
	1	2	3	4	5		
Level 1 (Clean Water)	3,46	3,48	3,50	3,45	3,48	3,47	649,25
Level 2 (Turbid Water)	2,48	2,45	2,48	2,43	2,46	2,46	1899,25
Level 3 (Very Turbid)	1,90	1,89	1,90	2,20	1,89	1,95	2586,75

Figure 1: Sample for water turbidity

When the output voltage is lower it indicates that the water has increased turbidity. The above test results will be used as a reference parameter in determining the level of turbidity of water:

Table 2. Water Conditions based on the results of testing voltage

No	Voltage (Volt)	Water Conditions
1	> 3	Clean Water
2	> 1 dan > 2	Turbid Water
3	< 2	Very Turbid

pH SENSOR

Testing the pH sensor with three sample values found that the sensor reads the pH value of the more alkaline water. Then the voltage measured on the multimeter gets lower. This can be interpreted if the pH of acidic water has an electrical conductivity that is stronger than water that has an alkaline pH.

Testing is also carried out on the pH sensor, as shown in table 3 below:

Table 3. Test Results of pH sensor with pH meter

pH Tested	pH Meter Value	pH Sensor Value	Error	%Error	Output Voltage (mV)
4,00	4,1	4,90	0,8	19,51	3,40
6,86	7,0	6,47	0,53	7,57	2,88
9,18	9,4	7,57	1,83	19,46	1,94

The optimizer of fish cultivation is usually the pH of the water in the pH range 6-8 in the voltage range 2.5 - 2 mV. It means that fish cultivation cannot be optimal in waters that have acidic pH and will be more optimal if the water tends to be alkaline.

TEMPERATURE SENSOR

In addition to testing on the turbidity and pH sensor, testing is also on the temperature sensor by comparing the DS18B20 temperature sensor with a mercury thermometer.

Table 4. Sensor DS18B20 Temperature test results with mercury thermometer

No	Sensor DS18B20 (^oC)	Mercury Thermometer (^oC)	Error	%Error
1	45,50	46,50	1	2,1
2	37,25	37,40	0,15	0,4
3	26,62	26,80	0,18	0,7
4	24,50	25,00	0,5	2,0
5	22,44	23,00	0,56	2,4
6	21,19	21,90	0,71	3,2
7	19,88	20,00	0,12	0,6
Average error and % error			0,46	1,63%

The temperature sensor and mercury thermometer are placed in the glass then the temperature measurement process will begin. Temperature observation with the DS18B20 sensor will be shown on the cayenne platform. . The test results on the DS18B20 temperature sensor with a mercury thermometer have an average measurement error of 0.46^0C and not above 2% that means the accuracy of sensor measurements when compared to mercury thermometers is not too different. So it can be used for the measurement of water temperatures in monitoring water quality in the pond tilapia fish farming. The sensor will also calculate the error rate. The calculation of the error value can be described as follows:

$$Error = |\,The\ true\ Value - Measured\ Value|$$

$$\%\ error = \left|\frac{The\ true\ Value - Measured\ Value}{The\ true\ Value}\right| x100\%$$

WATER PUMP

Testing of water pumps and providers used when testing to find out the response of the water pump are running well. Providers used in this trial use three types of providers. Here are the test results.

Table 5. Testing in manual mode based provider

Provider	Situation	Speed	Water Pump	SMS
3 (Three)	Sunny	Fast	ON (3 Sec) OFF (4 Sec)	1 Sec
	Gloomy	Slow	ON (20 Sec) OFF (13 Sec)	1 Sec
Simpati (Telkomsel)	Sunny	Fast	ON (3 Sec) OFF (1 Sec)	1 Sec
	Rainy	Fast	ON (8 Sec) OFF (4 Sec)	1Sec
IM3 (Inodsat)	Sunny	Slow	ON (22 Sec) OFF (30 Sec)	1 Sec
	Gloomy	Slow	ON (120 Sec) OFF (150 Sec)	1 Sec

Table 6. Testing in automatic mode based provider

Provider	Situation	Speed	Water Pump	SMS
3 (Three)	Sunny	Fast	ON/OFF 1 Sec	1 Sec
	Gloomy	Fast	ON/OFF 1Sec	1 Sec
Simpati (Telkomsel)	Sunny	Fast	ON/OFF 1 Sec	1 Sec
	Rainy	Fast	ON/OFF 1 Sec	1Sec
IM3 (Inodsat)	Sunny	Fast	ON/OFF 1 Sec	1 Sec
	Gloomy	Fast	ON/OFF 1 Sec	1 Sec

The results of testing with several providers for manual and automatic mode were tested in the writer's home area in Depok during different weather conditions. It can be concluded that the automatic mode is more efficient for filling and draining water when the turbidity sensor has detected that the pond is in a turbid condition. Weather conditions and the location of the area also affect the stability of the signal from each provider. However, manual mode with IoT technology can also be used efficiently if the pond will be thoroughly cleaned such as brushing the pond bottom. So, the water pump does not fill and throw water together. Manual mode can also be used when a farmer wants to fill water on a pond in summer or drain water on a pond during the rainy season.

Cayene Application

In the android application the author creates a project on the cayenne.mydevices.com platform.

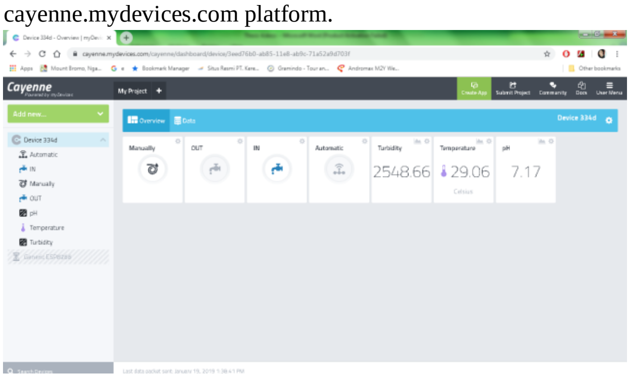

Figure 5. Manual Mode and Visualization when the pump is active to fill fish pond water

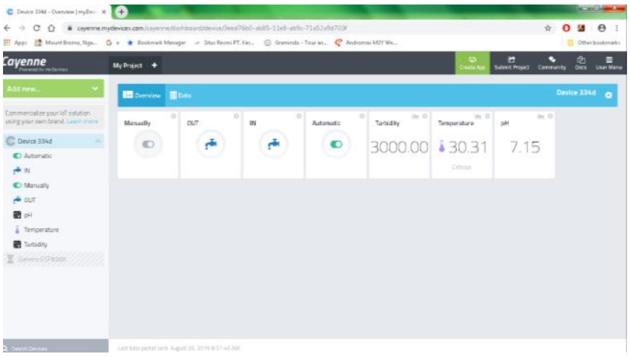

Figure 6. Automatic Mode and Visualization of active pumps to fill fish pond water

Visualization of the dashboard display in the cayenne application will show whether the pump control process is successful or not. The next process is to do automatic mode testing where turbidity sensors, pH and temperature will detect water conditions and then the data will be displayed visually on the Cayenne dashboard on an Android smartphone/PC. In addition, in this design, the authors add triggers to give notice of water temperature and pH conditions in aquaculture ponds. If the DS18B20 sensor detects water temperature> 32oC, cayenne will send an SMS notification to the mobile number specified in the settings. Meanwhile, if the pH sensor detects water pH <5 (acid), cayenne will also send a notification in the form of an SMS. Display shown as notification via SMS can be seen in Figure 7.

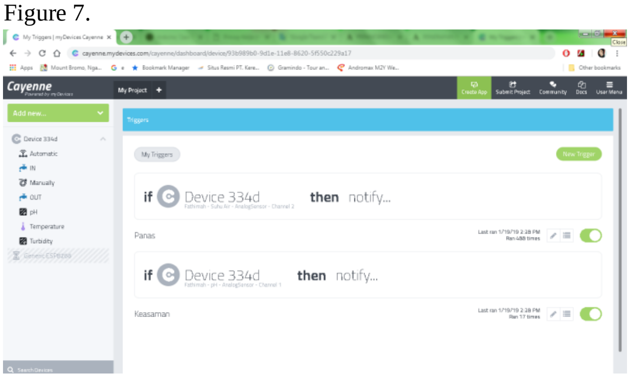

Figure 7. Trigger for notifications SMS

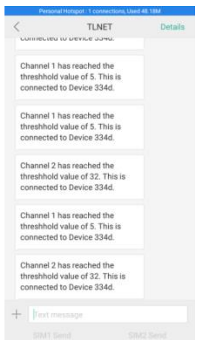

Figure 8. Display Notification in the form of SMS on Android Application

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CONCLUSIONS

In conclusion, this system is designed to facilitate monitoring of water quality in tilapia cultivation using a pH sensor, turbidity sensor and temperature sensor as water quality parameters and provide a display of sensor results while controlling. The sensor will send the measurement results to NodeMCU and display in the cayene application. Farmers can receive information about pond conditions in real time through the cayenne application and information on temperature, pH via SMS. In this prototype, the system can replace turbid water into clean water on the prototype for 2 minutes by adding 6500cc of clean water.

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REFERENCES

[1] Ahmad, R. 2004. *Kimia Lingkungan*. Yogyakarta: PT ANDI

[2] Minggawati, Saptono. 2012. *Parameter Kualitas Air untuk Budidaya Ikan Patin (Pangasius pangasius) di Karamba Sungai Kahayan*. Palangka Raya. Jurnal Ilmu Hewani Tropika Vol. 1, No.1, Juni 2012.

[3] https://digital-meter-indonesia.com/faktor-kualitas-air-budidaya-ikan-nila/ (accessed on August 27,2019)

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