IMPLEMENTATION OF FUZZY LOGIC TO CONTROL TEMPERATURE AND TURBIDITY IN CATFISH BREEDING PONDS

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Water quality is very influential on the success of baby catfish farming. Temperature and turbidity are parameters of water quality, therefore farmers have been maintaining the quality of pond water by changing pond water regularly. Much weakness arise from how to maintain water quality so far, some of which are the lack of mobility of farmers and the parameters of pond water content cannot be known. To overcome these problems, a management system of pond water can be made. With this management system, farmers can control pond water drainage based on data that is read by the sensor, to maintain pond water quality according to predetermined parameter values. In this study the microcontroller uses fuzzy logic with input values of temperature sensors and turbidity sensors, the output of this system is a solenoid valve which functions as a regulator of pool water drainage, and the amount of water volume that must be replaced can be known by installing a water flow sensor. With the application of fuzzy logic, it can maintain water quality with a temperature value fluctuation range of 2.5 °C and a turbidity fluctuation range of 14 NTU. With the system that has been created, farmers can manage pond water easily and can find out the value of pond water quality parameters.

Key words: Water quality, Temperature, Turbidity, Fuzzy logic

INTRODUCTION

Catfish seed farms are farms that produce catfish seeds which will be followed by the enlargement process by consumption catfish farmers, where the breeding starts from parent spawning, hatching eggs and rearing until the catfish seeds are 2 months old with a size of approximately 7 cm. Temperature and turbidity plays an important role in baby catfish growth. It also can affect the survive rate of baby catfish population because it defines the rate of water quality [1] [2]. Based on, temperature value for baby catfish farming needs to be maintained at 25 °C - 30 °C and turbidity need to be maintained under 50 NTU [3]. So, a good drainage system is needed to maintain water quality in the baby catfish pond. So far, the conventional method is to replace the pool water regularly. This method causes several weaknesses, including the lack of mobilization from farmers who must manually adjust the process of replacing pond water every day and waiting for the circulation process to take place, water replacement will be carried out continuously without knowing the parameters of pond water content such as temperature and turbidity which is very effect on the development of catfish seedlings.

To overcome the manual method in this research, an automatic control system is made with the installation of temperature and turbidity sensors that can read the condition of pool water, as well as an actuator in the form of a solenoid *valve* that functions as a substitute for pool water. The combination of sensors and actuators will work according to the fuzzy

logic embedded in the controller [4] [5]. The use of fuzzy logic in this system is expected to increase the stability of the system and be adaptive to changes in pond water parameters [6].

SYSTEM DESIGN

This section will explain the stages in the design ofthe system including the design of hardware and software systems in detail.

A. The Overall System Design

The figure below shows a system block diagram. Input from the system in the form of value temperature sensor andwater turbidity, the block diagram consists of several parts, namely the arduino board as a data processor, the processingof ADC values and fuzzy logic is carried out in the arduino board microcontroller. The output data from the Arduino board will control the solenoid valve opening and the work ofthe water pump. When the temperature and turbidity levels donot match, the solenoid will open the valve and replace the water in the pool. When the temperature and turbidity levels are in accordance with the set point, the solenoid valve will close and the water pump will turn off, then the readings of each sensor can be accessed through the android application.Below is a block diagram of the whole system.

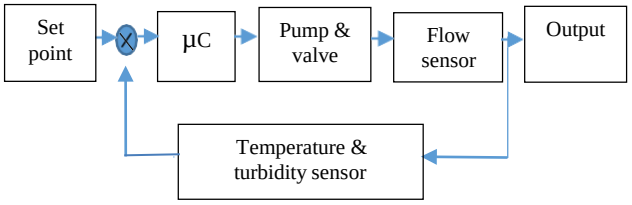

Figure 1. The whole block diagram.

B. Pond Design

The baby catfish pond used is a tarpaulin pond and is placed outdoors and has dimensions of 3 x 1.5 x 0.7 meters in long, width and height respectively, with a seed density of 7000 fishes. In the water circulation system, there are pipes input and output, on the input pipe installed solenoid valve and a water flow sensor are sequentially. The function of the solenoid valve is to regulatethe opening and closing of the water entering the pool, whilethe function of the water flow sensor is to calculate the flowof water flowing into the pool so that the volume of water which is the output of fuzzy logic control can be known. Thedrainpipe height can be adjusted by rotating the L pipe connection so that the desired water level can be adjusted andis very useful in preventing overflow of pool water when it rains. The following is an overview of the pond used in this research.

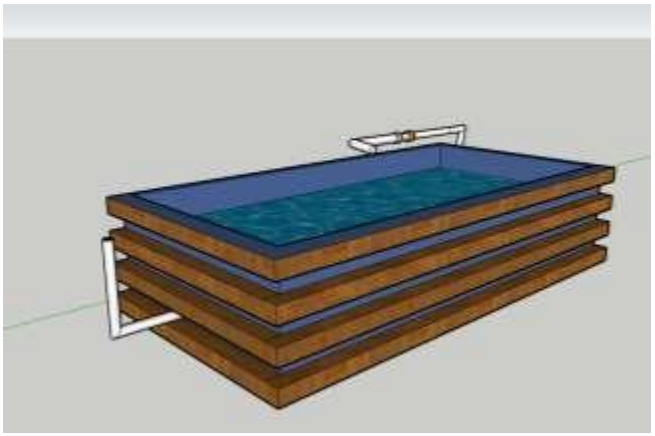

Figure 2. Pond design

C. Electronic Design

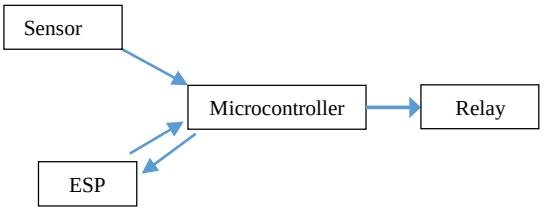

Figure 3. Electronic design

1) Microcontroller Circuit

The microcontroller circuit plays a major role in thecontrol of the system created, namely as a sensor reader and actuator controller and communicating with the ESP module.In this study, the Arduino pro mini microcontroller was used.In the system, the sensors used are turbidity sensors, temperature sensors, and water flow sensors. Then it takes 3 sensor ports, but there is a difference in the water flow sensor,namely the installation of an LED which functions as an indicator if the sensor is working, because the water flow sensor when working will send a pulse-shaped signal to the microcontroller, so that if an LED is installed, the LED will flash continuously when the sensor is working. There are 3 relays consisting of 2 relays whose common contacts are connected to a voltage of 220 volt as the controller of the water pump and aerator and 1 relay whose common contactsare connected to a voltage of 12 volt as the solenoid valve controller. All actuators are connected to normally open relaycontacts and each relay is connected to a microcontroller.

2) The Accuracy of DS18B20 sensor

The DS18B20 temperature sensor is an electronic component that can capture changes in environmental temperature and then convert them into electrical quantities. This sensor is a digital sensor that uses 1 wire to communicate with the microcontroller. Before being used, this sensor has passed the test by comparing the value read by the sensor and the value read by the thermometer. So, the average sensor error is 0.84%. This is the sensor test chart.

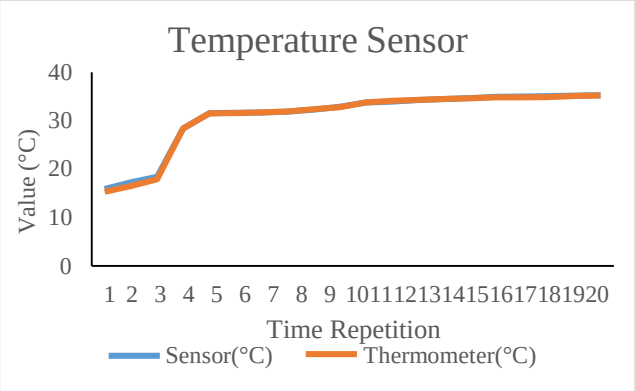

Figure 4. Output temperature graph

3) The Accuracy of Turbidity sensor

Turbidity sensor as a tool used to measure the level of turbidity of water. The turbidity meter sensor is built using the nephelometer method, the nephelometer method is a method that utilizes the intensity of light scattered by the sample in the water. Because the price of the turbidity meter is expensive, we calibrate the sensor with the help of the Kediri regional health laboratory (LABKESDA), the results of testing the turbidity sensor carried out on 15 samples obtained linear regression results between the sensor and the LABKESDA test data, namely y = -0.3234x + 245.22, x is the turbidity value in NTU (Nephelometric Turbidity Unit) units and y is the ADC sensor value. So, it can be concluded that the equation results obtained can be used as a formula for reading the turbidity value of the pool water.

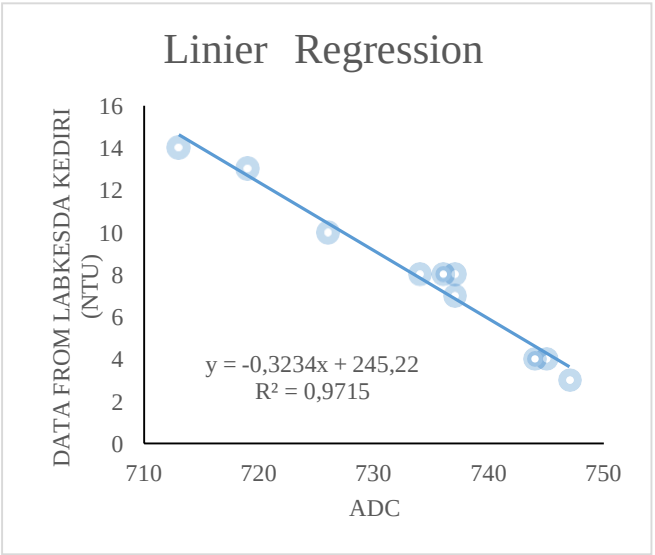

Figure 5. Linier regression graph of turbidity sensor

4) The Accuracy of Water Flow Sensor

Flow sensor is a measuring instrument that used to measure the flow rate or the amount of a moving fluid flowing in a pipe to measure flow in the form of flow velocity, flow capacity and volume. Before being used, the sensor haspassed the test, the results carried out on 6 samples obtained an average error of 2.78%. So, it can be concluded that the results of the sensor data can be said to be quite good becausethe error generated is quite small.

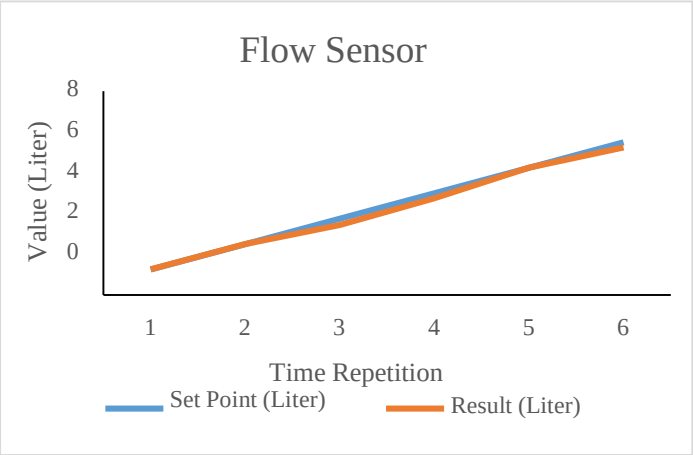

Figure 6. Output flow sensor graph

D. Fuzzy Logic Design

1) Input Variable

At this stage, there will be 2 variables fuzzy that will bemodeled into a fuzzy set using Matlab [7], the first is temperature pool water. Consists of 3 fuzzy sets (Cold, Medium, Warm). Here is a picture as a membership function of the pool water temperature expressed in units of °C.

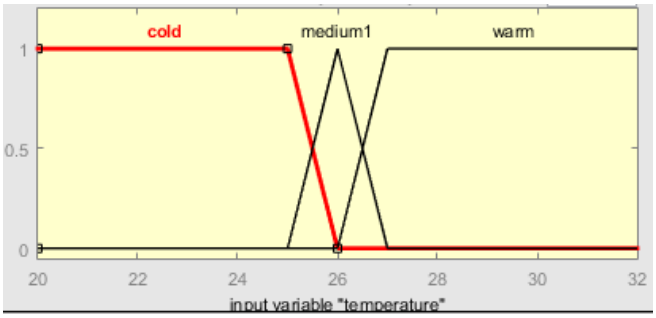

Figure 7. Membership function of temperature

The second is the turbidity of the pool water. Consists of 3fuzzy sets (Clean, Medium, Turbid), this is the picture as a membership function of the turbidity of pool water expressedby NTU (Nephelometric Turbidity Unit).

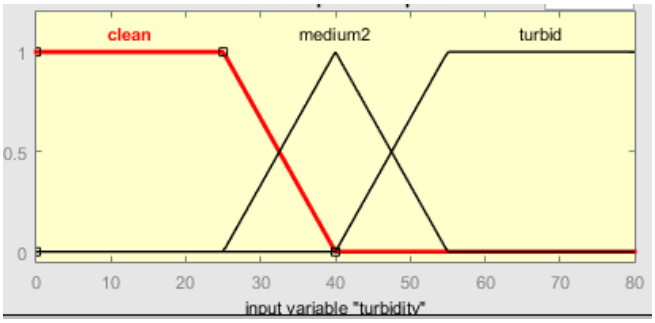

Figure 8. Membership function of turbidity

2) Output Variable

In this research, the output used is the volume of pool waterthat must be replaced. In the system that will be made, the volume of water can be calculated by installing water flow sensors. Pool water volume consists of 4 fuzzy sets (Very Low, Low, Medium, High). The following is a membershipfunction using Matlab.

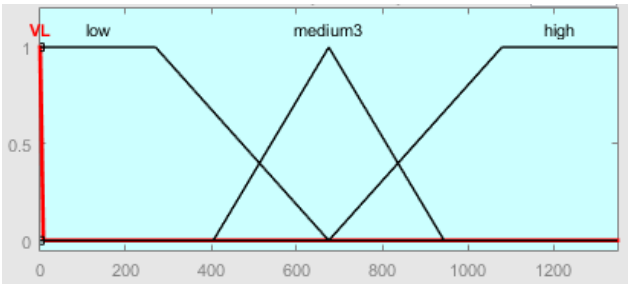

Figure 9. Membership function of volume

3) Rules

The rule created is used to determine the output value based on the input value entered the fuzzy logic controller system, the following rules have been created using software Matlab.

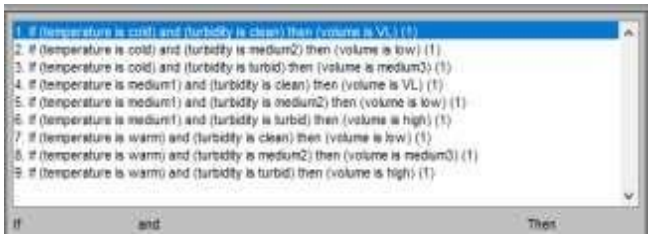

Figure 10. Rules

DISCUSSION

The following is data obtained from observations made on pond water using three different control methods, namely manual control commonly used by farmers (regular pool water replacement, three times a day), then digital control (If-Else), and the last is the fuzzy control that has been made in this study. So that it can be seen the effectiveness of the control method in maintaining the quality of pond water. Thevalue of the pond water quality parameters will be presentedin the graph below.

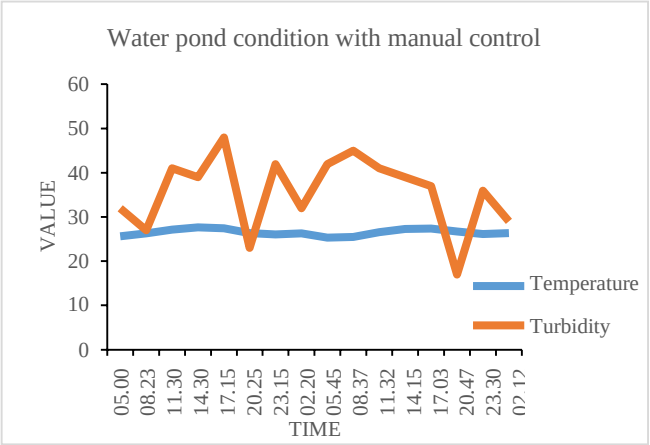

Figure 11. Manual Control

In the manual control data of measurement as seen in the Fig.11, the average pool water temperature value of 26.49 °C and an average turbidity value of 35.63NTU. Meanwhile, based on the results displayed on the water quality parameter graph with manual control, fluctuations in the pool water temperature value have a minimum value of 25.31 °C and a maximum value of 27.62 °C, while fluctuations in theturbidity value of pool water have a

minimum value of 17 NTU and maximum of 48 NTU.

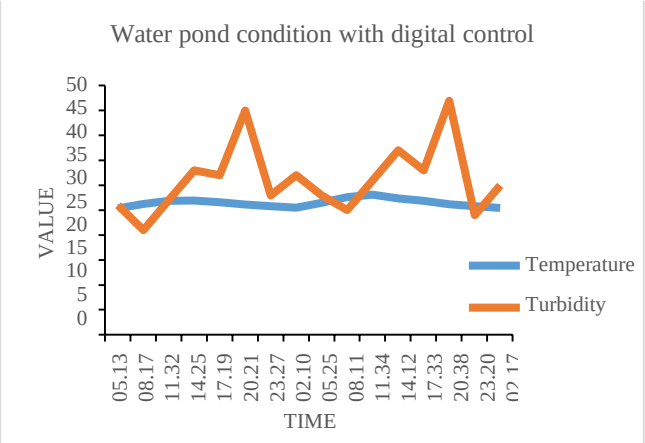

Figure 12. Digital Control

Based on the data obtained in the digital control Fig. 12 has an average pool water temperature value of 26.45 °C and an average turbidity value of 31.18 NTU. Meanwhile, based on the results displayed on the water quality parameter graph with digital control, fluctuations in the pool water temperature value have a minimum value of 25.37 °C and a maximum value of 28.12 °C, while fluctuations in the turbidity value of pool water have a minimum value of 21 NTU and maximum of 47 NTU.

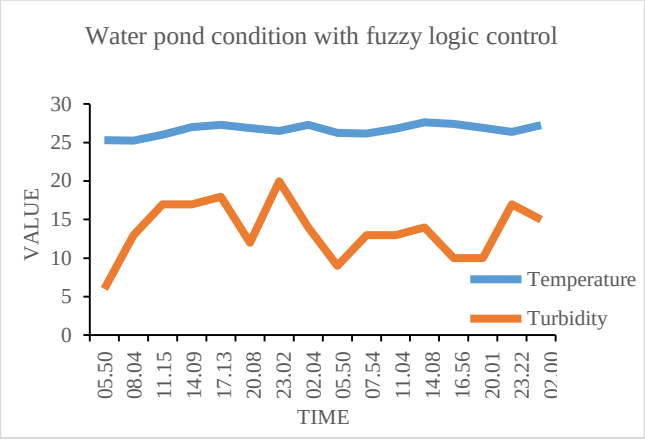

Figure 13. Fuzzy Logic

By using fuzzy logic control, the measurements data of temperature and turbidity are shown in Fig. 13. The pool water has an average temperature value of 26.65 °C and an average turbidity value of 13.62 NTU. Meanwhile, based on the results displayed on the water quality parameter graph with fuzzy logic control, fluctuations in the pool water temperature value have a minimum value of 25.25 °C and a maximum value of 27.62 °C, while fluctuations in the turbidity value of pool water has a minimum value of 6 NTU and maximum of 20 NTU.

CONCLUSION

Fluctuations in temperature values produced by manual control, digital control and fuzzy logic control do not show significant differences, namely in the range of 2.5°C. However, in terms of turbidity value parameters, fuzzy logic control has the best performance with a fluctuation range of 14 NTU, while digital control is 26 NTU, and manual control is 31 NTU.

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