WATER LEVEL CONTROL SYSTEM OF TILAPIA PONDS USING ARDUINO-BASED ULTRASONIC DISTANCE SENSOR

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-Abstract-

Rapid technological developments have an impact on all aspects of the field of work so a lot of the application of science and technology that is designed to simplify the job. One is the content fill process and drain the water in the pond tilapia farm that aims to keep the water level to suit the needs of the fish. Water level control system of tilapia ponds designed to facilitate farmers in maintaining high water on the pond tilapia with control using the Personal Computer. The system is designed using the Arduino as a control center that will control the relay to turn on the tap electric and water engines. Proximity sensor that is used to monitor the water level is an ultrasonic distance sensor PING. PING will provide feedback on the value of Arduino that will determine the output of the system to be run by either the process of filling or draining the pond water. By using a water machine and 4 pieces of tap electric, drains can be designed that is able to fill the water and drain the water mechanically. Interface to the system would make it easier to use. There are two control modes that can be used, the AUTO mode to select the type of tilapia pond that will be used and MANUAL mode by pressing the ISI or KURAS to run the system.

Key Word : Control, Arduino, Tilapia, PING

INTRODUCTION

Background

Rapid technological developments lately impact on all aspects of the field of work, almost all of the work done by human labor has been done in order to research how the job can be done better controlled by using control techniques that apply the knowledge of electrical and mechanical concepts.

One of the jobs in Indonesia today are still using the traditional way, namely in the field of fish farming in the filling and draining water fish pond. We will make the filling water into the pond, the farmer should open the valve that connects into the pool and headed to the water machine located far apart and the engine usually located close to the water source. Then when the pool fills with water, the farmer should pay attention to the height of the pool water in accordance with the needs of the fish, so the farmers have to go back to the pool and estimate whether water-filled pond is enough or not, even some that use a wooden stick to determine the height of the pool water . Having adequate water, the farmer should back off the engine and back water valve closes.

Tilapia is a freshwater fish consumption by fish body shape is elongated and white-black. In tilapia fish farming, the water level must be considered in order to keep the condition of the fish and the water quality is good. Well when fish during spawning, fish spawning or during growth.

Problem Formulation

Based on the above background, it can be formulated-constraint problems exist:

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a. How to design a control system of filling and draining pool water that is able to work for 24 hours?

b. How to design a system that can fill and drain the pool water without the use of human labor?

c. By applying the concept of electromechanical, a case of what the water level can be used in a tilapia fish farm ponds?

Limitations

a. This system does not impose limits on the duration when filling or draining pool water.

b. The system is applied to one type of pool in a smaller scale (prototype).

c. Water used machine is the water machine type MRC -100N 350W.

d. Valve used is electric valve 220V AC 1/2 inch

e. The microcontroller used in this system is the Arduino MEGA 2560.

Destination

The purpose of the design of this system are:

a. The system can maintain water levels in the pond certain conditions.

b. Draining and filling the pool water can be controlled using a PC without using manpower to manually turn on the water machine, or also install pipes and unscrew the valve the water flow into the pond.

LITERATURE REVIEW

Previous studies

There are several studies that have been done previously associated with the design of this system as research conducted by Eko Syamsuddin, et al (2007) who designed a water thermostat and automatic filling water bath through a short message service-based microcontroller. Water sensor used is a resistive sensor that is placed at the lower limit and upper limit of the water bath. Output voltage of the sensor and a microcontroller in if the resulting output logic for the system.

Tegar Bakhti Prihantoro, et al (2010) designed a water level detector automatically on water reservoirs using ultrasonic sensors based microcontroller. Microcontroller used is ATMEGA8535 which controls automatic water machine using relay. Ultrasonic sensors will provide input to the microcontroller, and then turn on the water until the machine is full of water and the machine will stop automatically.

I Made Budhi Dwipayana (2010) created a simulation of the design water level PC-based control system. Detection of water level on the tool uses pulleys and float construction has been designed with a sensor optocoupler. The working principle is the same sensor as the principle of the mouse wheel work consisting of 2 and 1 infrared phototransistor. 2 pieces of the phototransistor will generate 2 pulses which have a phase difference as an input into the PC and processed using Delphi 7.0 software to determine the output of the system is started the water.

Harlinda. L (2010) designed a water level control with visual basic programming, which use water sensors utilize the principles of transistor work as a switch that will turn on the LED and received by the microcontroller. The design of this sensor utilizing the properties of water as a conductor of electricity for the water sensor driver. For a tank, water sensors installed 6 units with different height levels ranging

from the lowest to the highest limit the water tank.

Basis Theory

Closed Loop Control Systems

Closed-loop control system is a control system in general which affect the work output signal of the system itself. So the closed-loop control system is composed of a control section itself, and also plant controlled sensors as feedback to be received by the control section. (Katsuhiko Ogata: 2002)

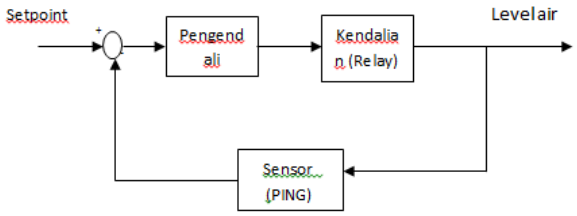

Image 2.1 Closed Loop Control System

Arduino

Arduino is a physical computing platform that is open source where Arduino has an input / output (I / O) that can be controlled using a simple programming language. Arduino can be connected to devices such as computers. The programming language used on the Arduino is the C programming language that has been simplified with features in the library so it is quite helpful in making the program.

There are two main parts to the Arduino, the hardware and software. Arduino hardware is an electronic board called the Arduino microcontroller while the software is used to enter a program that would be used to run the Arduino. The programming language used is the language C.

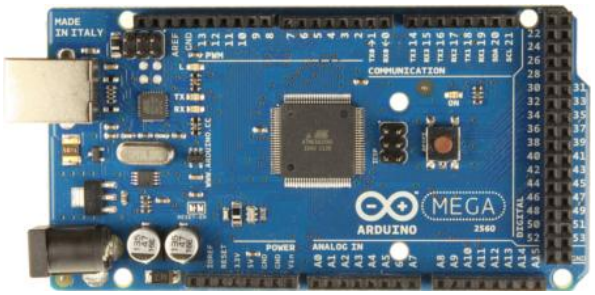

Image 2.2 Arduino MEGA 2560 Board

Sensor

The sensor is an electronic device or component that serves to convert a physical quantity into a digital signal which will be processed in an electric circuit as well as in a more complex system (Iwan Setiawan: 2009). In the design of this system, which is used as the feedback sensor to control bagin is PING ultrasonic distance sensor. Later PING serves to monitor the water level in the fish pond and sends the value to the control and processed to produce the required output.

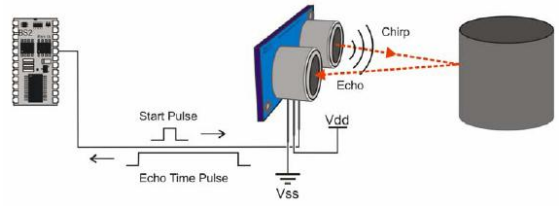

Image 2.4 The Working of the PING

Visual Basic

Visual Basic is a computer programming language. Programming languages are commands understood by the computer to perform certain tasks. Visual Basic programming language, which was developed by Microsoft since 1991, a development of its predecessor the programming language BASIC (Beginner's

All-purpose Symbolic Instruction Code) was developed in the 1950s. Visual Basic is one of the Development Tool is a tool for making a wide variety of computer programs, especially those that use the Windows operating system. Visual Basic is a computer programming language that supports object (Object Oriented Programming = OOP). (Krishna D. Octovhiana: 2003)

Tilapia

Based on research conducted by the National Development Planning Agency (2000), for raising tilapia we should pay attention to the pool to be used, because each fish has a way of life different. There are 4 types of pools needed to raise tilapia, which is an aircraft maintenance / spawning pool, pool maintenance seed / nursery ponds, and rearing ponds. Any use of the pool, the pool must pass through stages of preparation in which to prepare the pool, the water level must be maintained within a few days to get the pool water with a good mineral content required by tilapia.

Table 2.1 Water height pool Tilapia

	Level Air	
	Minimum	Maksimum
Spawning pool	40 cm	60 cm
Separating pool	30 cm	50 cm
Growth pool	75 cm	100 cm
harvest	7 cm	12 cm
Preparation growth pool	5 cm	10 cm

RESEARCH METHODOLOGY

System Overview

On water level control system of tilapia pond is built using several components, such as PING ultrasonic distance sensor is used to determine the height of the water, which is used to electrically tap unscrew the valve, the relay is used to turn on and turn off the water motors and an Arduino as a control center this system.

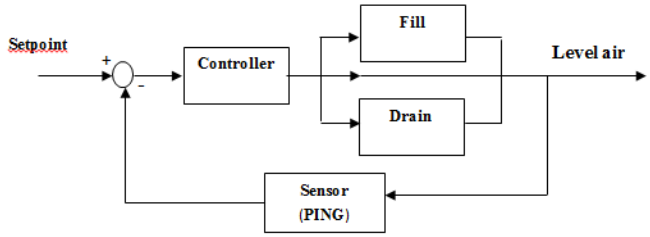

Image 3.1 Altitude Control System Block Diagram Water Pond

Part of the controller will receive input from the sensor, the sensor values will be compared with a set point that we created earlier. The comparisons that determine whether the output of the system will make the filling water into the pond or whether the system should do the drainage pond. Then the two processes lead to changes in the water level in the pond and the sensor will send a signal to the controller values that will make the process of returning.

The filling and draining system the pool water

At the time of filling and draining the pool water, this system will work drain the water from the source to the pool and from the pool to drain. In this system is designed so that the process can be controlled via the PC enough to unscrew the valves that connect all pools. Valves used are electrically tap that has been designed to be

controlled by the Arduino using the relay as a switch. Electric valve works for a 220Vac supply, the valve will open if given voltage 220VAC and will be closed if there is no voltage. Then the pipes are connected to a water machine water machine which works based on a series of relays which are also controlled by the Arduino.

Image 3.2 Electric Valve

Power Supply

To run this system of power needed for the system to work. Power needed to supply include:

- Arduino : 12V DC
- Relays : 12V DC
- Water Machine : 220V AC
- Taps Electric : 220V AC

To supply Arduino and relay, use a power supply that is available in the market with the output voltage of 24V DC, then to the power supply voltage of 12V DC required LM7812 regulator circuit so that the output of the power supply can be used.

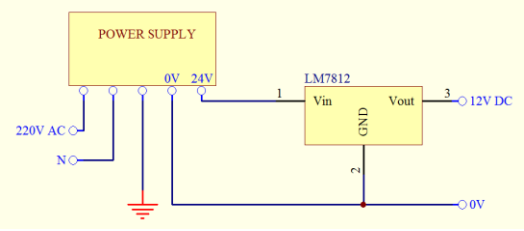

Image 3.3 Regulator 12V DC Circuit

Driver of water machine and Electrical valve

Driver circuit which is used to activate the electric engine and the tap water consists of 1 piece relay and 1 piece transistor NPN 9013. Transistor will be in saturation state when it receives voltage from Arduino port is active at the transistor base. With so transistor will function as a switch that will turn on the relay machine tap water and electric.

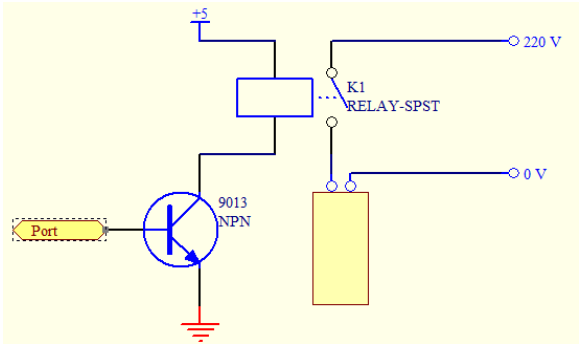

Image 3.4 Driver Circuit Water Machine and Electrical Valve

Draft Waterways

The design of the pipes connected to the water from the engine to the water source and also to discharge into the pond which is determined by the direction of water flow valves. For example, when going for a fill the pond of water, which will open the valve is the B valve , so if you want to drain the pool of water that had opened the valve is A valve. After the machine is turned on the water, the water will flow to the place that we want

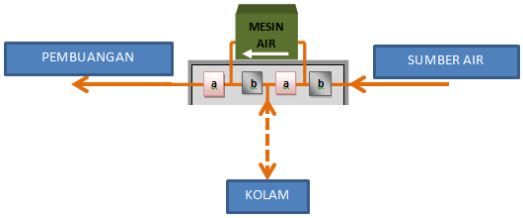

Image 3.5 The Design Scheme Waterways Pool

Monitoring System of highest the pool water

The system is designed to monitor the condition of the pool water level. This system serves to provide data on a set point that will determine the output of the filling system and drainage. In the design of this system, which serves as a monitor is PING proximity sensor which is designed with a float as the object of observation. PING will send the value of the distance through port 7 on the Arduino, then the value will be in the process to determine the output of the system.

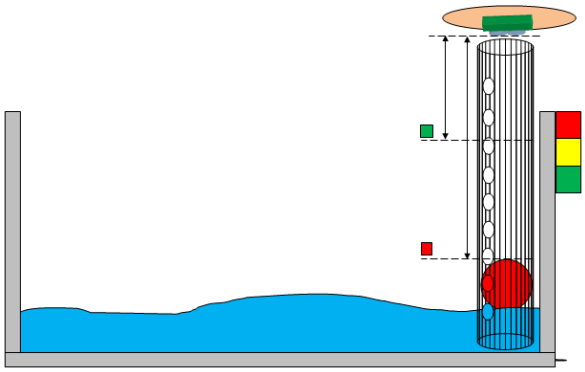

Image 3.6 Water Elevation Monitoring Scheme Design Pool

Interface Controller

In the design of this system, an interface is needed to facilitate the running of the system with a more attractive appearance on the computer screen as a monitoring and control system works. Manufacturing interface for the water level control system is an application using Visual Basic 6. Controller interface is divided into two tabs, the tab Auto and Manual.

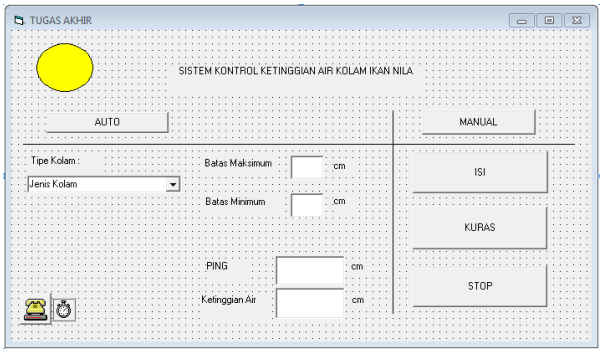

Image 3.7 Interface Control System Altitude Tilapia's Pond

On the AUTO tab, the system will run as a kind of pool we choose. Once the type of pool is selected, the display will go out the maximum and minimum bounds description of the pool and the pool water level Actual conditions. The system will start to work after pressing the OK button. Pond water level will adjust automatically according to the type of pool you choose.

The system can also be used with manual on MANUAL tab, given the freedom to the user to either fill the water to the pond without limitation, as well as for the total depletion of the pool. The "ISI" to start the filling process water pond, the "KURAS" to the process of draining the pool water and the "STOP" to stop the ongoing process and display the water level display indicates the actual condition of the water level in the pond.

TESTING AND RESULTS

Testing The Circuit of Power Supply

Power supply used is a commercially available power supply with output voltage is 24V DC. while the required voltage is 12V DC, then use the circuit with 1 piece LM7812 regulator to get the voltage to be 12V DC supply to the Arduino.

Based on results of measurements that have been performed on the output of the regulator, the test results obtained as follows.

Table 4.1 Regulator circuit Testing Results

Parameter	Measurement Results
Input Voltage	24V DC
Output Voltage	12.2V DC

Arduino testing

Arduino that will be used should be checked first on his pins, both the pin to be used as input or output.

Testing Digital Output

In this research, the digital output pins are used there are 3 pin. There are two testing conditions on Arduino digital output, which is the condition of LOW and HIGH.

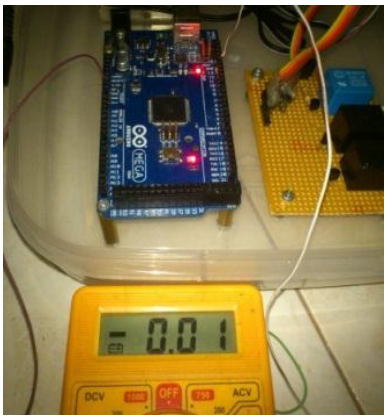

Image 4.1 Arduino Digital Output Pin Testing At LOW Conditions

Based on results of measurements that have been performed on the third pin in the LOW condition, the value obtained following results

Table 4.2 Testing results of Pin Digital Output LOW Conditions

Digital Pin	Voltage Measurement(VDC)	Condition
11	-0.01	LOW
12	-0.01	LOW
13	-0.01	LOW

Image 4.2 Arduino Digital Output Pin Testing At HIGH Conditions

Based on results of measurements that have been performed on the third pin in the HIGH condition, the value obtained following results

Table 4.3 Testing results of Pin Digital Output HIGH Conditions

Digital Pin	Voltage Measurement (VDC)	Condition
11	4.77	HIGH
12	4.77	HIGH
13	4.77	HIGH

Testing the Analog Input

To perform the test on the analog input, the ADC can use already available on the Arduino. Pin used is pin A0. On the A0 pin and the voltage will be processed into the Arduino as an analog signal, and then converted into a digital signal using the ADC and the results are displayed on the monitor.

Based on the results of the testing that has been done on the analog input pin, the result of the display on the serial monitor as follows.

Table 4.4 Analog Input Test Result

Tegangan *Input*	**Display On Monitor**
5V	500
3.3V	343
0V	0

Serial Connection Testing with Visual Basic

To perform the test using the program input receiver in visual basic. Then the readings are acceptable in the show at the following layouts.

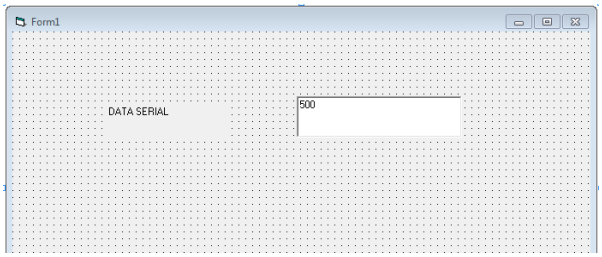

Image 4.3 Layout Testing Serial Monitor Connection With Visual Basic

Based on the testing that has been done with the Arduino to send data from Visual Basic through a serial connection, obtained the following results.

Table 4.5 Testing results for visual basic serial connection

Input Voltage (Volt)	Display On Visual Basic
5	500
3.33	343
0	0

Relay Control circuit testing

Relay works when conditions transistor 9013 serves as a switch when in a state of saturation with the receiving voltage from Arduino pin. LOW when pin in conditions where the transistor back in a normal state so that the relay is inactive. But when conditions changed to HIGH, the transistor will be in saturation so that the relay will be active.

Image 4.4 In the Active and Off Relay testing circuit

Based on the tests performed on the circuit using a relay with a multimeter, showed the following results.

Table 4.6 Relay Circuit Testing Results

Relay	Digital Pin	Condition	Relay Status
Relay of Filling valve	13	HIGH	On
		LOW	Off
Relay of Draining valve	12	HIGH	On
		LOW	Off
Relay of Machine	11	HIGH	On
		LOW	Off

Table 4.7 Electric Valve Testing Results

Electric Valve	**Source Voltage**	**Condition**
Valve 1	188V AC	Open Valve
	0V	Close Valve
Valve 2	188V AC	Open Valve
	0V	Close Valve
Valve 3	188V AC	Open Valve
	0V	Close Valve
Valve 4	188V AC	Open Valve
	0V	Close Valve

Testing Electric Valve

In this research, electric valve is the main device that determines the direction of water flow. So that damage or problems that occur in electrical tap will greatly affect the overall system so that the system can't fill or drain the pond water. To ensure electrical tap to work well, tested at the tap water that has flowed to the supply voltage is 220V AC.

Image 4.5 Testing the Electric Valve

Based on tests performed on an electric valve with giving a supply voltages 188V AC, Showed the following results

PING testing Proximity Sensor

Proximity sensor PING testing done by using tools such as a ruler and the object to be detected.

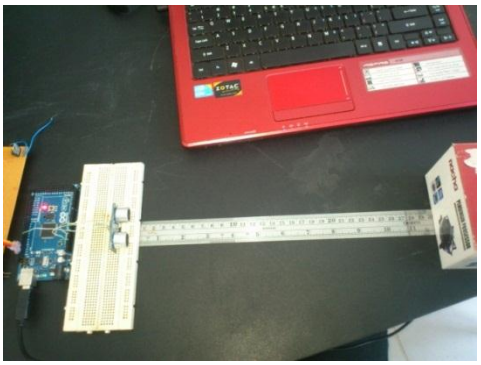

Image 4.6 Distance Measurement Using PING

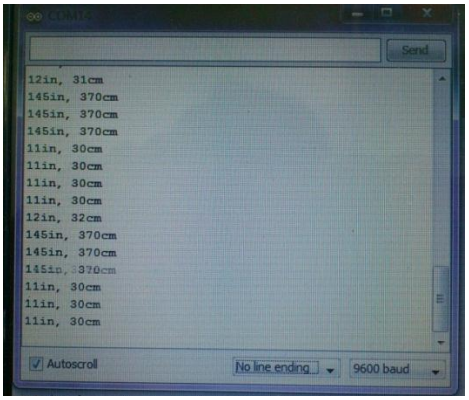

Image 4.7 Results Rating Distance Decision On Serial Monitor

Based on tests performed by using PING as distance sensors, measurement results obtained distances displayed on the serial monitor as follows.

Table 4.8 PING Distance Sensor Testing Results

The Real Distance (cm)	In the Serial Monitor display distance
30	30
20	20
10	10
5	5

Through the Interface Control System Testing

Control via the interface which has been designed using Visual Basic form input value fish pond water levels and also display the actual water level was detected using the proximity sensor PING

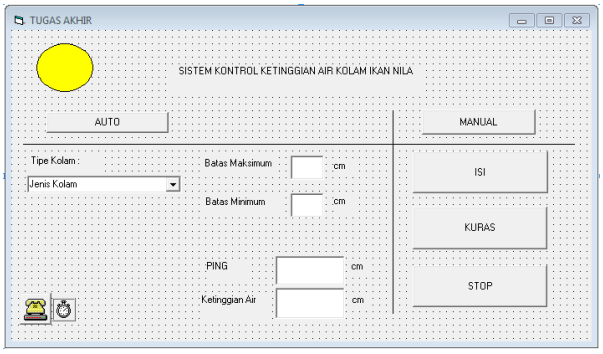

Image 4.8 Interface Controller System

At the interface consists of two tabs, controlling tab which is lacking automatic and manual control tab. At AUTO tab there is a column type of an option to be used. There are 5 types of pools to choose from with different water levels vary, the spawning pool, nursery, enlargement, harvesting and pools that are currently in preparation before use. When one type of pools have been it will show the value of the water level in the pond field maximum and minimum limit on the interface. Then the system will automatically direct to condition the water level of the pond have been kind. Display height of the water column is the actual data of high-water pond using PING taken every 1 sec.

In the manual control tab, users are given the freedom to run the system. Consists of three buttons, namely the "ISI", "KURAS" and the "STOP". When the button is pressed ISI, the system will continue to fill water into the pool so if the button is pressed KURAS system will drain the pond. STOP button to stop the functioning of the system that is running. To find out how the height of the pool water, the height of the column of water available that show the actual height of tilapia pond water. PING column is the distance between the sensor with a float in the pool.

Image 4.9 Filling System Water Pool Is On When Press the ISI Button

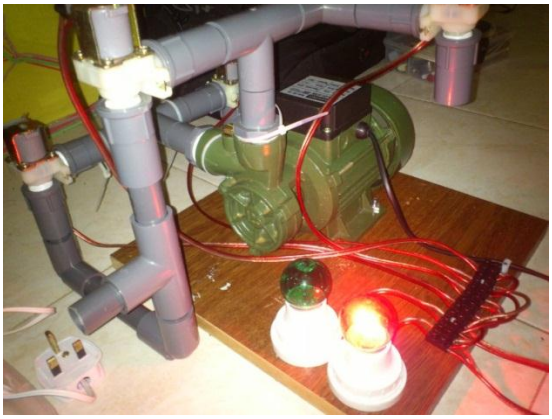

Image 4.10 Draining System Water Pool Is On When Press the KURAS Button

ANALYSIS AND DISCUSSION

Water level control system of tilapia pond work using the PING ultrasonic distance sensor measures the distance from the PING function to float. Pond water height values obtained by the distance to the bottom of the pool by a PING minus PING distance to the buoy. Values obtained water level will be displayed on the Visual Basic software via serial monitor. There are 5 types of pools, the spawning ponds with a high range of 40 to 60 cm, with a range of nursery ponds of 30 to 50 cm, an enlargement of the range of 70 to 100 cm, harvesting pond with a range of 7 to 12 cm and the height of the water in the pool is in preparations ranged from 5 to 10 cm.

Control system is done through the interface that consists of two tabs control, the tab control automatically which in this tab users can simply select the type of pool that will be used. PING determine the value of the process to be run. If PING is greater than the maximum limit of the pool, then the system will perform as well if PING depletion is smaller than the minimum threshold, the system will make the filling water into the pool. Control can also be done manually. Interface available on the manual tab consists of three buttons, the button "ISI", "KURAS", and the "STOP". These buttons function as the name implies.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the obtained results, it can be concluded that:

1. By utilizing Arduino as a controller involving sensor to monitor the distance the object and value feedback on the giver as well as the controller using the relay as a switch that will turn on the tap electric and water engines. It can produce a system that can work for 24 hours because the sensor will detect the changes that occur at the level of the pool water and the system will continue to keep the pond water conditions remain normal.

2. By using a water machine and 4 pieces of tap electrical, plumbing systems can be created that is able to make the filling and draining of water is mechanically without the need for human labor to change the direction of water flow.

3. Control of tilapia pond water level can be designed using Arduino, a proximity sensor that is used is PING sensor with an accurate distance readings as well as an easy usage, so the pond water level control system to function properly.

4. Reading of the value of fish pond water level is displayed on the interface are designed using Visual Basic software can do the reading with a better and more stable without any values that misses the true value.

5. Pond water level control can also be done in two ways, namely automatic and manual control. Such control can be done with the involvement of two different types of programs, namely programming via Arduino that is connected to all the devices used and visual programming that will facilitate users to perform controlled via the interface.

Suggestion

This study still has deficiencies that need to be repaired again and developed better. Therefore, suggestions for further research are:

1. Expected water level control system of a fish pond is not only able to control the water ponds for tilapia. So the system has a database of every kind of fish farm ponds and this tool can be used by all the existing fish farmers.
2. Use a serial cable in the future will be less visible, given the rapid communication technologies of our times. Thus control via mobile will be more helpful to look more attractive and more distance control.

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