AUTOMATION OF FISH POND WATER CIRCULATION BY USING ARDUINO UNO- BASED CONTROL SYSTEM

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Abstract. Fresh water aquaculture is the most cultured fish by fishery farmers with its success is determined by several factors, one of which is the water quality in accordance with the levels required that oxygen content in water is greater than 3, 5 ppm and pH content of water in the pool range from 7.8 to 8.0.
Microcontroller technology development is very fast. Electronic devices have been requirement to meet in supporting daily life activities. Most fish ponds are now using manual tools using water pumps. This is less efficient and effective for fish ponds.
This research focuses to make automation of fish culture water pond circulation with pH control device. ATMega 328P integrated with Arduino and Analog sensor of pH meter is used as control device.
Keywords: fish farming, pH control, microcontroller, arduino

I.INTRODUCTION

The development of microcontroller-based technology is increasingly encountered with rapid technology development. Electro devices have been a requirement to be met. Currently most fish ponds use manual tools such as water pumps making it less efficient for an fish. Some consider this way is less practical due to its manual system Freshwater aquaculture is the most cultured fish by fishery farmers with its success is determined by several factors, one of which is the water quality in accordance with the levels required that oxygen content in water is greater than 3,5 ppm and pH content of water in the pool range from 7.8 to 8.0. pH concept was first introduced by a Denish chemist expert named SorenPederLauritz Sorensen in 1909. Thecertainmeaning of "p" on "pH" abbreviation is unknown. Some references hint that the p stands for *power* (rank), others refer to German word *Potenz* (which also means rank), and some refer to the word *potential*. Jens Norby's paper published in 2000 argue that p is a negative logarithm.[1]

In fisheries world, particularly aquaculture, pool entrepreneurs are still using the manual system to control water pH levels by the manual water pumps. This will slow down their performance as it is double work. With our creation of tool, fish entrepreneurs do not need to drain fish pool manually.

II.PROBLEM FORMULATION

Regarding the brief review of the background, problem of how to perform neutralization automation to control the moisture content automatically that owner of water pool does not have to intervene directly to drain and refill fish pond water.

III.RESEARCH PURPOSES

The purpose of this study are:

1. Creating automation system of fish pond water circulation by using Arduino to control fish pond water pH and can be implemented on all fish pond.
2. The system will be integrated with a water level sensor to monitor the volume of water in fish ponds.

IV.BENEFITS OF RESEARCH

The research benefits include:

1. Maximizing manual water circulation system in the pool
2. Facilitating the work of fish pond owner to measure the pH level of the water.
3. Keeping pH level of fish pond water in normal conditions.
4. Keeping the fish pond water volume according to the level needed.

V. THEORY BASIS AND HYPOTHESES

5.1.pH sensor

PH is the degree of acidity used to express the degree of acidity or alkalinity of solution. It is defined as cologarithm activity of dissolved hydrogen ions (H +). Hydrogen ion activity coefficients cannot be measured experimentally, thus, the value based on the calculation of theoretical pH scale is not absolute. It is relative to a set of standard

solutions whose pH is determined on the basis of international agreements [2].

Figure 1.pH Sensor [2]

5.2 *Relay*

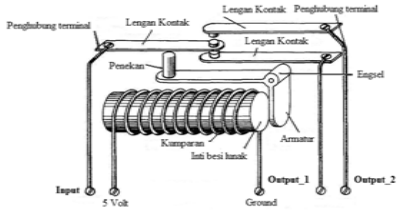

Figure 2 Relay

Relay is an electromagnetic switch component that can turn switch contacts in it at the time electrical signal is received. Relay was invented by Joseph Henry in 1835. Work system relay is as follows. Coil wire flown by electric current will cause electromagnetic fields and make soft iron core magnetized, as a result, *armature* will be attracted by the iron core (same magnetic poles), *armature* will move suppressor (suppressor has hinge for easy movement) to push the input contact arm connected with contact input which is connected with output contact arm_1 to output arm _2. Three types relay condition is as follows:

1. *Normally Open* (NO), a condition of zero current flow on open connection of coil wire 2. *Normally Closed* (NC), a condition zero current flowon close connection of coil wire

Change-Over is relay condition that has a pair of *normally open* and *normally closed* contact lever. Aswire coil electrified with electric current,*normally open* condition will be closed and *normally closed* condition will be opened or otherwise [3].

5.3 Water Pumps

Figure 3 Pump

Water pump work is basically very simple, it sucks water from lower area and pushes it to higher ground or water body. Each pump is equipped with automatic equipment that would enable it to ease operation and does not require any activity of switching on and switching off the pump with automatic sensor that works based on the pressure contained in pipes or drains at the output of the pump.

At engine water pump, there is suction and exhaust channels. The automated tool or sensor uses pressure sensor or Pressure Switch and installed on the tube at the pump output channels. When the pump is turned on or connected to the mains, the pump will rotate that the inside of the vacuum pump occurs due to the difference in pressure, so that the water contained in the soil will be sucked upwards.

When the engine is off, the rotor also rotates together with the propeller. Vane movement is limited by ring and drain the water from the suction hole or a large hole or a small press, and all the water faucets in the house is closed. The pump output channel will arise considerable pressure. When the pressure generated exceeds the existing press set on the sensor, the sensor will work and the water pump will be witched off instantly, water pump will live longer if a water tap is open as the water pressure has dropped.

The existing system on the machine pump valve is a volume control and idle-up system.

- Volume control valve is required by the water pump for higher rotor rotation.The volume of fluid produced by rotor ishigher. Too big power is detrimental to the stability of driving as the driver cannot feel the wheel contact with the road surface and this is very dangerous. This is the function of volume control valve. Thus, the pump needs water pressure drop as engine requires contact or friction with other devices to make pumping process run well.
- idle-up system or increase idle rotation serves to drive the pump. Rotor and propeller can continue to spin when idle rotation is increased with this system.

When we forget to turn off the water pump , the water pump engine will not be burnt.This is due to continuous work, and again we do not need to install or remove the plug from the engine water pump as everything works automatically. In short, pump produces water pressure. The

pressure pushes the suction valves, and on suction channels, the sucks isbigger, thepressure arising from water drops down opening the gas valve. [3]

5.4 *Water Level*

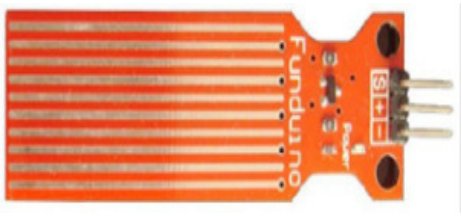

Figure 4 Water Level

Water Level Sensor is a device used to provide a signal to the alarm / automation panel as the water level has reached a certain level. Sensor will provides dry contact signal (NO / NC) to the panel. The detector is useful to provide alerts or to drive other automation devices. Water sensor is equipped with a built-in buzzer that produces sounds whentriggered. Water height sensor is normally used to calculate the height of the water in rivers, lakes, or water tank. This sensor is very easy to make for the simpletools and low risk.

5.5 Arduino Uno

Figure 5 Arduino Uno

Arduino Uno is one of complete, small sized microcontroller development board and support the use of breadboard. Arduino Uno is created with a base of ATmega328 microcontroller (for Arduino Uno version 3.x) or ATmega 168 (for Arduino version 2.x). Arduino Uno has nearly the the same functionasArduinoDuemilanove, yet in a different package. Arduino Uno does not include Barrel Jack-typed DCplug, and connected to a computer using a USB Mini-B port. Arduino Uno is designed and manufactured by Gravitechcompany. Below are the specifications Arduino Uno [3].

5.5.1 Programming

Arduino Uno can be programmed with the Arduino software (Download Arduino software). Select "ArduinoDiecimila, Duemilanove, or Nano w / ATmega168" or "ArduinoDuemilanove or Nano w / ATmega328" via Tools menu> Board (adjust to the type of microcontroller that you have).

ATmega168 and ATmega328 on Arduino Nano has been packagedpreburnedwith bootloader that allows you to upload new code without using external hardware programmer. This is because the communication that occurs uses the original STK500 protocol. You can also pass through (bypass) bootloader and microcontroller program through pin header ICSP (In-Circuit Serial Programming) by using Arduino ISP or similar [3]

5.6 Pond definition

Swimming is an area created to accommodate a certain amount of water that can be used for the gathering fish or other aquatic animals. Based on the technical sense, pool is an artificial water with limited area and deliberately made by human to be easily manageable in terms of water setting, the type of farming animal and production targets (Arsyad, 2006).

There are three types of aquaculture systems: traditional / extensive, the pond used is made from ground. Semi-intensive pond is one whose part of the pond (bund wall) is made of a wall while the base is made of ground pond. Intensive pond is one whose the entire section consists of a wall.

Based on the technical sense (Susanto, 1992), pondis an artificial waters with limited area and deliberately made by man to be easily manageable in terms of water setting, the type of farming animal and production targets. In addition to medium of live fish it also functions as as a natural food source for fish, which means that pool must have potential to be able to grow food naturally [5].

5.7 Definition of Fish

Fish are members of Poikilotherm vertebrates (cold-blooded) that live in water and breathe with gills. Fish is the most diverse vertebrate groups with the number of over 27,000 around the world. Taxonomically, fish are a paraphyletic group whose exact relationships are much debated, fish are usually divided into:

- Jawless fish (Agnatha class, 75 species including lampreys and hagfish),
- Elasmobranchii (Chondrichthyes class, 800 species including sharks and rays)
- Bony fish (class Osteichthyes)

Fish come in different sizes, ranging from whale shark measuring up to 14 meters to stout infant fish of only 7 mm (approximately 1/4 inch). There are several aquatic animals frequently regarded as "fish", such as whales, squid and dugongs, which is not classified as a fish. Fish are generally consumed immediately. Processing effort still has not been done much except for dried / salted fish. Fish can be processed into various products such as dried fish, shredded fish, fish crackers, salted fish, kemplang, fish balls and fish blood meal as fertilizer for crops and fish feed [6].

5.8 Definition of Fish According to the Fisheries Act (Act 45 of 2009)

Under the Law 45 of 2009. Fish can be defined in general as animals that live in water, invertebrates, poikilothermic,

moving by using fin, breathing with gills, and has a lateral line (linealateralis) as organ of balance. However, referring to law 31 of 2004 on fisheries as amended by law 45 of 2009, the definition of fish is different and wide-ranging. According to Article 1 of Law 45 of 2009, fish are all kinds of organisms that all or part of their life cycle is in the water environment.

In explanation part, it is described that below are included as type of fish:
a.finnedfish (Pisces);
b. shrimp, crab, and the like (crustacea);
c. shell, oysters, squid, octopus, snails, and the like (molluscs);
d. jellyfish and the like (Coelenterata);
e. sea cucumber, sea urchins, and the like (echinoderms);
f.frogand the like (amphibia);
g. crocodile, turtles, tortoises, lizards, water snakes, and alike (reptiles);
h. whale, dolphins, dolphins, dugongs, and the like (mammalian);
i. seaweed and other herbs that lives in water (algae); and
j. other waters biota
From the description we can conclude taht fins and gills are not the only animalsbelonged to fish, but all aquatic biota whose all or part of cycle of life isin the aquatic environment, including coral, crocodiles, turtles, tortoises etc.

The use and definition of the word "fish" in the fishery laws is actually less accurate for society or academia. It might be more appropriate to use the word aquatic species or "biota / aquatic organisms ". However, laws and explanation of fisheries is expected to clarify the scope of work of the Ministry of Maritime Affairs and Fisheries, which was previously ownedby the department of agriculture and forestry. Thus, there is no difference in comprehension when doing work in the field, especially in law enforcement and supervision. [6]

VI RESEARCH METHODOLOGY

6.1 Framework

The first step in initiating this study is to gather data needed. These data can be obtained in the field. Once the data is collected, the data is further processed by using direct method by going into the field.

6.2 Data Collection Methods

A study aims to produce data useful to provide an adequate understanding of the object of research and problems faced. Therefore, data obtained from the study should be reliable, relevant, and can provide insight into actual condition. Data collection was conducted by library research. Library research method is carried out by collecting data from literature as well as books of reference and data that have a relationship with the problems examined.

6.3 Systems Development Method

System floating methods to control pH uses *System Development Life Cycle (SDLC)* that can be described in several stages, they are [7]:

a. **Determining Information needs,** this stage puts anything decisive and determineinformation to the users involved. The device used to specify information is to determine the sample and examine the raw data and interview.
b. **Analyzing Information Needs, particular** tools and techniques help determiningneeds. The device use is data flow diagrams to draw up a list of inputs, processes and outputs in the form of a structured chart. It isr developed into data dictionary which contains a whole list of items of data used in the system.
c. **Designing Information Systems recommended,** using the information gathered earlier to achieve logical design of information systems, designing procedures of data entry thatthe data entered into the information system is completely accurate and to use techniques and the design of *a* particular *layer* to ensure enter the effectiveness of information systems.
d. **Developing and Documenting Programs,** at this stage, initial software is developed. It needs some structured techniques for designing and documenting software including plans and pseudocode.
e. **System Trial,** prior to using, information must be tested to find out the problems before the system is implemented. This phase is performed routinely during the update is run.
f. **Implementing and Evaluating System,** this stage involves training for users to control the system. This evaluation is intended for discussion actually done at each stage, the main criteria to meet iswhether the designated user actually uses the system.
g. **Identifying Problems, Opportunities and Interest,** activity in this phase includes interviews with user management, concludes the knowledge gained, estimate the project scope, and documenting results. The output of this stage is a flexible report contains definitions, problems and summary purposes.

VII DISCUSSION

7.1. Manufacturing water pH control circulation tool

The device made consists of two modules, namely water pH sensor module which connect with arduino and sensors module that reading the pH of pond water.

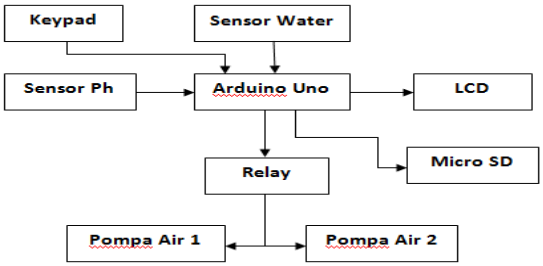

Figure 5. Technology Architecture of pond water Circulation

PH sensor system and Water Level Sensor will send data to arduino if the fish pond water ph is<7 or pH> 8.5, arduino will transmit data to water pump to drain or fill the water up to normal level as desired.

7.5.3 *Model process*

The process model of the system to be created uses model applied using UML *(Unified Modeling Language).* Diagrams of UML applied to the system is explained as follow:

Use Case Diagram

In the *use case diagram*, the processes to be performed by users in the ph control using arduino is explained

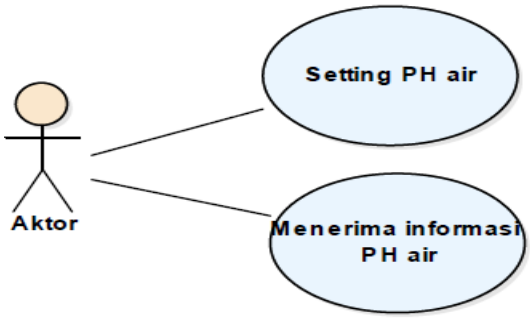

Figure 3 Use Case Diagram System

7.5.4 Formulation

Below is data processing ofph level of water in the water circulation system with ph control. Data processing is used to determine pH level of the water the fish pond. In the previous study, grade or content limit of the water content both normal or dangerous is shown in table 1.

Table 1 Levels of water ph

Category	Ph levels of water
Acid	1-6
Normal	6.5 to 8.5
alkali	8-14

Table 1 describes the ph level of the water status categories:

1. When water content is less than neutral 7, acid level in the pond is less good.
2. Neutral value in the pool ranged from 6.5 to 8.5.
3. When water level exceeds neutral level of 7, the base level is unfavorable.

7.5.5 process Model

The system series describes the system hardware workflow of water pH sensor system when receiving signal and then received by arduino to control the water pump. The entire circuit water circulation system to control ph as shown in Figure 5 and automation system flowcharts pool water circulation is shown in Figure 4

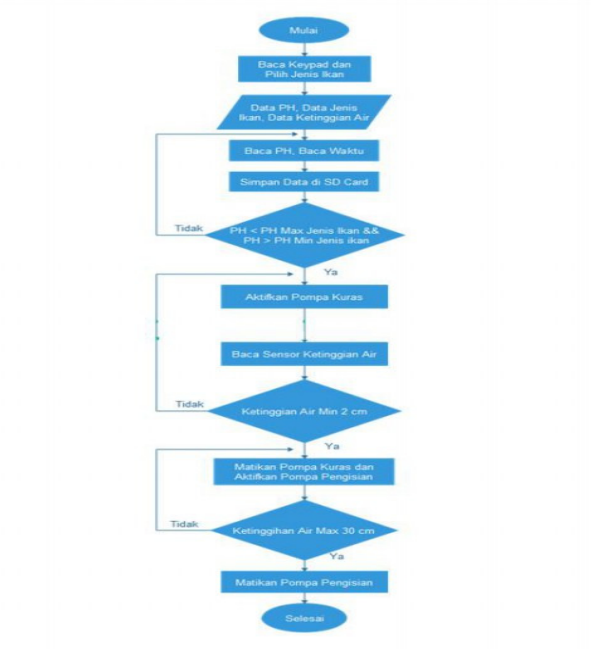

Figure 4 Flowchart of Fish Pond Water Circulation System

Figure 4 illustrates water circulation systemworkflow with automatic pH control by using arduino. The system will read the keypad to select the type of fish. pH sensor will then sends data to LCD and then pH sensor will transmit data to the arduino after receiving data from the pH sensor.

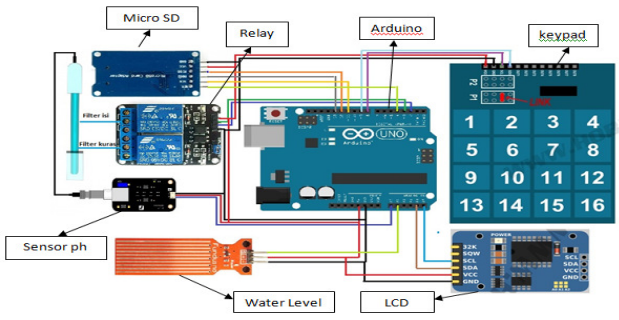

Figure 5 circuit Overall water ph sensor control system

In Figure 4, the hardpart of overall circuit of water circulation system with ph control by using arduinoare:

- arduino
- uno,

- ph sensor,
- keypad,
- LCD,
- RTC (real time clok),
- water level height sensor.

$$\text{Recall} = \frac{TP}{TP+FN}$$

VIII RESULTS

The focus of this section discusses the implementation of water circulation system design with ph control.
The trial results of water circulation system with ph control by using arduinois logged in the form of a .txt file that displays data date, time and ph levels. The data in this txt file is the result conveyed through communication tools to android device. From the existing data in the image it can be concluded that water content data dated 01.16.2017, at 22:34:18, ph levels by 0.00 to 6.87 is dirty water and to 7:14 to 7.67 is normal ph level of normal water and water content of 8:15 to 15:36 is dirty water pH levels, as seen in Figure 6.

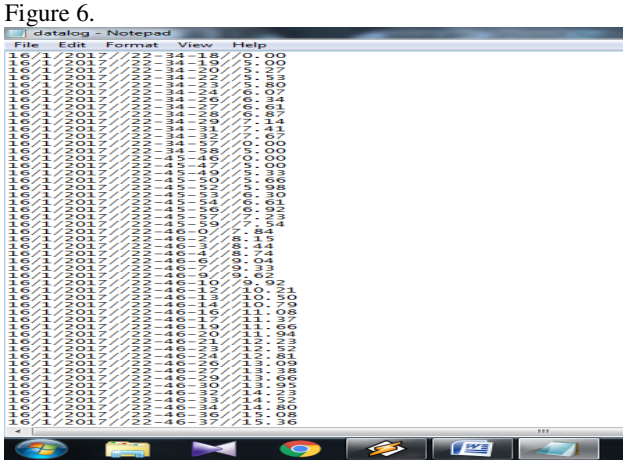

Figure 6 the contents of the log file txt trial results

1. Precision and Recall

Common measure used to measure the quality of data is a combination *of precision* and *recall. Precision* is the ratio of the amount of relevant information from which system with all the information is picked by both relevant and non-relevant system.*Recall* is the ratio of the amount of relevant information obtained throughout the system with relevant information contained in the collection of information (whether drawn or not drawn by the system). Generally *precision* and *recall* can be formulated as follows:

Table 2 Formula of *Precision and Recall*

$$\text{recall} = \frac{TP}{TP + FN}$$

TP = *True Positive*
FN = *False Negative*

		ACTUAL VALUE	
		TRUE	FALSE
VALUE FORECASTS	TRUE	TP (TRUE POSITIVE)*corect RESULT*	FP (FALSE possitive)*UNEXPECTED RESULT*
	FALSE	FN (FALSE NEGATIVE)*MISSING RESULT*	TN (TRUE NEGATIVE)*Absence of corect RESULT*

$$\text{Precision} = \frac{TP}{TP + FP}$$

A test on water pH sensor calculates the success rate of how much the system can be run. From the experimental results, the system is performed by 20 (twenty) times with the following result

The results of the experiment as follows:

1	Condition ofappropriate water phcontent	15kali
2	Condition of inappropriate ph water content	5 times
3	Data is not recognized	0 times

Thus, the value of *Precision* and *Recall* is as follows:

Table 3 Implementation of *Precision and Recall* Formula

		Actually Value	
		TRUE	FALSE
System Value	TRUE	15	5
	FALSE	0	0

$$\text{Precision} = \frac{TP}{TP+FP} = \frac{15}{15+5} = 0.55 * 100\% \quad 75\%$$

$$\text{Recall} = \frac{TP}{TP+FN} = \frac{15}{15+0} = 1 * 100\% \quad 100\%$$

After testing by using precision and recall, the *precision* value obtained was 75%, this indicates that the pH control system by using arduino runs well.

Recall indicates the value of 100% indicating that pH control system worked very well,pH sensor is always able to read water pH level repeatedly that it never occurred error

IX CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

pH control system forpond water pH is able to work and function as planned.It is indicated by precision and recall test results with the value of 75% for precision and 100% for recall value.

9.2 Suggestions

The following suggestions and input:

1. Updating these systems into android that the owner can watch the pond extensively.
2. Adding Phsensors that the data obtained are more stable.

ACKNOWLEDGMENT

We would like to express our special thanks of gratitude to our leader (Dr. Soetomo University) for the golden opportunity to do this wonderful project on the topic (Fish Pond Water Circulation Automation Using pH Control System), also for our roommateswho have helped us in doing the research. There are many new things I know and am really thankful to them. Secondly we would also like to thank family and friends who helped us a lot in finalizing this project within the limited time frame.

REFERENCES

www.djpb.kkp.go.id (Direktorat Jendral Perikanan Budidaya). di akses pada tanggal 30 Desember 2013

ww w.dfrobot.com. ”Sensor Analog pH meter v1.0” diakses hari senin 25 maret 2014.

digilib.mercubuana.ac.id/manager/n!@file_skripsi/Isi2996033463371.pdf

https://www.academia.edu/13414149/WATER_LEVEL_SENSOR_Deskripsi.

Simanjuntak, Armanto Pardamean, Rozeff Pramana.,ST,MT., (2013). Pengontrolan Suhu Air Pada Kolam Pendederan Dan Pembenihan Ikan Nila Berbasis Arduino. Universitas Maritim Raja Ali Haji. Kepulauan Riau.

Bibitikan.net. Analisa Usaha Budidaya Pembesaran Ikan Nila. 10.00 WIB. 05-02-2016

Kendal & Kendal. Systems Analysis and Design Fifth Edition. Prentice-Hall