System of Water Quality Monitoring and Feeding on Freshwater Fish Cultivation

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Abstract. Monitoring system has been utilized in many ways. The monitoring system is very useful and helps to alleviate human activities. Starting from industry, livestock, fishery and plantation. For example is fishery monitoring system. This system has been widely used to monitor the quality of water used. Currently fish cultivation is in great demand because of the promising income, especially on freshwater fish. However, many cultivators have problems because of the many fish are dead and the crops that are not maximal. One of the factors that affect these is weather changes that result in an unstable water state. In order to get the expected results, factors that must be considered are water content, temperature and water salt levels that affect the quality of fish metabolism. The standard of water content in freshwater fish cultivation reaches 4 - 9 pH and the temperature must be maintained at 25.5 °C - 32.7 °C and the salt content is 105µS - 120µS. For the many factors that need to be considered then a system that can monitor the state of water at any time is required. This monitoring system uses Arduino uno as micro controller, equipped with ph sensor, temperature sensor, salinity sensor, LCD, and buzzer. The readable data will appear on the LCD and the buzzer will sound when one of the moisture levels is not at a standard number. Equipped with automated fish feeding system remotely to support this monitoring system.

1. Introduction

Technological advancements are now growing rapidly. This is evidenced by the many technological innovations. Technological innovations ranging from simple to sophisticated. Technological developments have long existed since ancient times and evolved to this day until it creates systems, that is techniques that can help human life.

Technology has been widely used by humans in helping everyday life. One of them is monitoring system. Monitoring system has been widely used by freshwater fish cultivators [1]. This system is used in improving the production output [2]. Cultivators have many problems, such as income which is get is not maximum and many fish that are dead [3]. Factors that cause one of these cases are temperature, acidity (pH), uncontrolled water salt content by cultivators due to weather changes [4]. Thus, a monitoring system that can monitor these factors at any time with accurate data accuracy is required.

From the results of sensors monitoring placed on the pool or water, it will get the data according to circumstances. The data will be sent to the Microcontroller IC, which can determine the survival values of freshwater fish. Data will be displayed on the LCD so it can be viewed at any time. If the value of any of the factors is not at the standard number then the warning buzzer will sound.
From the automatic monitoring system, the authors hope to help the cultivators in improving knowledge and technology so that it can help to improve the results of fish cultivation as a livelihood [5].

2. Methods
In general, this monitoring system works by reading the measurement numbers of the sensor, then buzzer will sound when the reading of numbers is not at a standard number. The readable data will appear on the LCD and feeding can be done remotely. In assisting the completion of this study, it requires equipment and materials. The equipment and materials used is in the table 1 as follow.

| No | Equipment and Materials | Information          |
|----|-------------------------|----------------------|
| 1  | Arduino UNO             | CH340/ATmega328PA    |
| 2  | Personal Computer       | Lenovo AMD A8        |
| 3  | Adapter DC              | 5 V                  |
| 4  | LCD                     | 16x2 character       |
| 5  | Sensor Ph               | SEN0161              |
| 6  | Temperature Sensor      | DS18B20              |
| 7  | Salinity Sensors        | Conductivity/TDS     |
| 8  | Motor Servo             | SG90                 |
| 9  | Box                     | 1 piece              |
| 10 | Push Button             | 2 pieces             |
| 11 | Switch on/off           | 1 piece              |
| 12 | Potentiometer 5k        | 1 piece              |
| 13 | Resistors 470kΩ         | 1 piece              |
| 14 | Resistors 100kΩ         | 2 pieces             |

The first stage is the design stage schematic circuit using Fritzing software while the second stage is schematic design on PCB board using Eagle software then print the design result on PCB. The next stage is assembling the tool using tools and materials according to the design. The third stage is the design stage of the program using Arduino software. The fourth stage is the making of mechanical design using Inkscape software as well as the design of the tool on the mechanical design. The last stage is the testing tool. Testing tools is done ranging from testing temperature sensors, salinity sensors and pH sensors. For feeding system, testing tools is done by open and close testing of motor servo and motor delay.

2.1. Hardware design
The monitoring system consists of DC 5v source, sensor, servo, buzzer and LCD, also Arduino Uno microcontroller. The function of the sources above is to activate the entire system of measuring instruments and indicators. Block diagram monitoring system and feeding system can be seen in figure 1.
From figure 1, it can be seen that the initial phase of DC 5v source activates the entire system while the PH Sensor is for measuring acidity of water. The sensors used in this monitoring system are glass electrodes that act as pH sensors connected to analog signals 0 arduino [1], vcc 5v and GND. Salinity sensors is used to measure water salinity. This sensor is one of the chemical sensors designed based on the electrical properties of water. The salinity sensor consists of two electrodes dipped in water. The data signal of the sensor is connected to analog data 1 arduino, vcc 5v and GND. Temperature sensor is DS18B20. The data obtained from the sensor will be sent to Arduino. Arduino will receive and manage data then displayed on the LCD. The buzzer will sound when one of the measurement values is not at the number specified in the Arduino program. Feeding system is done by pressing push button.

The black box in Figure 2 contains a series of monitoring system support with dimensions of 18 x 11 x 6.5 cm. This box consists of 2 push buttons, namely for the sensor menu button and the feeding system button.1 LCD is as an indicator to display the data measurement results. The back is a buzzer and potentiometer that has function to adjust the LCD brightness. The bottom box is as a fish feed container which contains a servo motor that open the lid of the box.

### 2.2. Software design
Software functions is to provide instructions and run the programs. Instruction is done to take the information obtained from the reading sensors Ph, salinity and temperature. Then it is processed on micro controller with program language C. Arduino Compiler.
Fritzing schematic design serves as the design of electronic equipment after the manufacture of prototypes using the actual equipment. The prototype is made above the breadboard board so that if there is an error it is easy to fix. It is also connected to Arduino to give commands on the tools used. The schematic design on fritzing software is shown in figure 3.

![Figure 3. Schematic design on fritzing.](image)

Schematic design of the circuit on PCB using eagle-7.7.0 software and then it is printed. The circuit design will be used instead of the breadboard board which will then be assembled on the box. The following (Figure 4) is the circuit design on the PCB board on eagle-7.7.0 software.

![Figure 4. Circuit design on PCB.](image)

3. Results and discussion

The results obtained from the experiment and through identifying data that includes the effects of weather changes and time. This monitoring system can measure the pH, temperature and salinity. The pH level in water can measure on a scale between pH 0 and pH 14, for temperatures it can measure on a scale of -10°C to 100°C, whereas for salinity the pH level can measure 0 to 1000μS salt content.
The experiment was conducted in freshwater fish cultivation ponds. The data is then processed and conducted data comparison with research ever undertaken by previous researchers. Data retrieval is taken on average and generates data and is presented in tables and graphs.

Data are presented in tables and graphs. Then determine the rate of the measurement error. The error rate can be determined using the relative error formula is.

\[
\text{Error} = \frac{\text{measurement data} - \text{accurate data}}{\text{accurate data}} \times 100\%
\]

The value of measurement data was obtained from the experimental results of the tool. The data in the form of tables and graphs from the results of pH sensor experiments on freshwater fish ponds are as follow:

| NO | Sensor pH (n) | Research Data | Error (%) |
|----|--------------|---------------|-----------|
| 1  | 7.4          | 7.3           | 1.3%      |
| 2  | 7.5          | 7.45          | 0.6%      |
| 3  | 7.5          | 7.4           | 1.3%      |
| 4  | 7.4          | 7.5           | 1.3%      |
| 5  | 7.5          | 7.15          | 4.8%      |

**Error Average** 1.8%

**Figure 6.** Graph of pH.
Data in the form of tables and graphs from the experimental results of temperature sensors in freshwater fish ponds is as follow.

**Table 3. Result of temperature.**

| NO | Temperature Sensor | Research Data | Error (%) |
|----|--------------------|--------------|-----------|
| 1  | 25.3°C             | 24.81°C      | 1.9%      |
| 2  | 26.2°C             | 26.5°C       | 1.1%      |
| 3  | 26.3°C             | 26.62°C      | 1.1%      |
| 4  | 25.2°C             | 26.75°C      | 5.6%      |
| 5  | 26.2°C             | 27°C         | 2.9%      |

**Error Average 2.5%**

**Figure 7. Graph of temperature sensor.**

Data in the form of tables and graphs from the experimental results of temperature sensors in freshwater fish ponds are in Table 4.

**Table 4. Results of salinity.**

| NO | Salinity Sensor | Research Data | Error (%) |
|----|----------------|--------------|-----------|
| 1  | 106µS          | 107µS        | 0.9%      |
| 2  | 107µS          | 108µS        | 0.9%      |
| 3  | 108µS          | 110µS        | 1.8%      |
| 4  | 107µS          | 109µS        | 1.8%      |
| 5  | 107µS          | 109µS        | 1.8%      |

**Error Average 1.4%**
Figure 8. Graph of the salinity.

The following error rate data (Figure 9) from the three sensors in the form of experiment result graph.

Figure 9. Graph of error rate.

Figure 10. Graph of error average.

From figure 10, the rate of error monitoring system is fairly small. The average measurement error compared with research data is said to be quite accurate. The rate of monitoring system is below 3% and can be applied to freshwater fish cultivation.

4. Conclusions
In this research the monitoring system works by using Arduino UNO ATmega328PA micro controller as controller. Arduino is programmed using C language to run instructions. The monitoring system is arranged in several sections ranging from circuit box, ph sensors, salinity sensors, temperature and box feeding system sensors. This system makes it easier to monitor fresh water content in freshwater fish cultivation with a small error rate in every weather change comes. This monitoring system also has 3
sensors or measuring devices at once and also equipped with a remote feeding system. This study is expected to meet and increase production, income and reduce the rate of fish death in freshwater fish cultivation.

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