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# Automatic Control System for Dissolved Oxygen in Vanname Shrimp Pond Water

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**ABSTRAK**

Dissolved oxygen is an important parameter for the life of vanname shrimp ponds that are environmentally sensitive. The control system of dissolved oxygen is still done manually by pond farmers who have to go directly to the location of the pond to measure it. This was felt by pond farmers as being less than optimal and effective in maintaining dissolved oxygen requirements for vanname shrimp so that farmers often lose money. This project aims to make a system of controlling dissolved oxygen in water of vanname shrimp ponds automatically. The system has been realized 100% with the percentage of the calibration measurement results reading 99,45% dissolved oxygen and controlling the appropriate dissolved oxygen level reaching 100%. This system is expected to optimize the control of dissolved oxygen in vanname shrimp pond water so that the production and quality of shrimp increases.

**Kata Kunci**
*sensor, dissolved oxygen, vanname shrimp pond, control, automatically*

## I. Introduction

Dissolved oxygen is one of the important parameters for the life of vanname shrimp that is sensitive to the environment. The need for dissolved oxygen which is not sufficient or too high can cause a decrease in the quality of vanname shrimp and can even cause death so that pond farmers lose money.

Control of dissolved oxygen in vanname shrimp ponds is generally still done manually. Farmers have to see first hand the conditions of the ponds to monitor dissolved oxygen levels with an indicator of lack of dissolved oxygen levels in the water of vanname shrimp ponds, ie when vanname shrimp are seen on the surface of the pond water, not in the bottom of the water.

Manually controlling dissolved oxygen is not optimal and ineffective by pond farmers because control is carried out after vanname shrimp is completely deficient in dissolved oxygen. [1]

## II. Literature Review

The basic theory in this system includes: dissolved oxygen sensor, microcontroller, on/off controller, relay module, and DC motor.

### *A. Dissolved Oxygen Sensor*

Dissolved oxygen levels are one of the important parameters in the survival of vanname shrimp so that a system is needed to measure dissolved oxygen levels or Dissolved Oxygen Sensor. Dissolved oxygen sensor is part of an electrochemical sensor where the reaction of oxygen gas with an electrolyte solution produces an electrical signal with a quantity proportional to the amount of oxygen concentration. The main parts of the dissolved oxygen sensor include sensing electrode or working electrode, reference electrode, and counter electrode. These three electrodes are separated by 18 thin electrolyte solutions and the outside of the sensor is covered by membrane permeable gas. This membrane has a function to pass oxygen gas through a diffusion process so that it reacts with electrolyte solutions and prevents leakage of electrolyte solutions [2].

The sensing electrode functions as an electrode where the electrochemical process takes place. The reference electrode is used as a reference point for measuring potential differences against other electrodes, in this case the sensing electrode. While the counter electrode serves as an electrical connection to the electrolyte solution so that the current can flow to the sensing electrode [2].

Electrochemical sensors are divided into 2 types, namely polarographic and galvanic. DO sensors are optical using the working principle of emitting light received by the photodetector through a membrane layer [3].

The type of dissolved oxygen used is a type of galvanic sensor consisting of membrane parts, electrolyte solutions, anodes and cathodes. Anodes in galvanic DO sensors typically use zinc, tin or active metals, while the cathode is silver or precious metal. Whereas for electrolyte solutions use sodium hydroxide or sodium chloride [3].

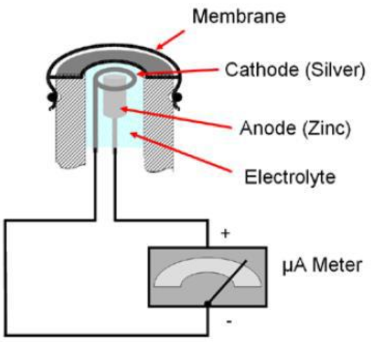


**Figure 2 . 1 Galvanic Dissolved Oxygen [3]**

The working principle of galvanic sensor is when oxygen passes through the membrane and is reduced by the cathode part, it will produce an electrical signal in the form of current. When oxygen passing through the membrane increases, the electrical signal in the form of current will increase while when the oxygen passing through the membrane decreases, the current will decrease. The amount of current generated from the electrochemical process produced is very small (in the order of µA) so that before it is sent to the microcontroller the signal from the reading of the oxygen level must be changed and amplified so that the microcontroller can be processed [3].

*B. Microcontroller*

The microcontroller itself is a chip or integrated circuit (IC) that can be programmed using a computer. The purpose of embedding the program on the microcontroller is that the electronic circuit can read the input, process the input and then produce the output as desired. The microcontroller serves as a 'brain' which controls the input, process, and output of an electronic circuit [4].

The microcontroller generally consists of CPU (Central Processing Unit), memory, certain I / O and supporting units such as Analog-to-Digital Converter (ADC) which has been integrated in it [4].

*C. On/Off Controller*

An on-off controller (bang controller) is a controller that changes alternately between two conditions. Mathematically the on-off controller is expressed by a curve as follows:

- m (t) = M1 if e (t) <0
- m (t) = M2 if e (t)> 0

Where:

- m (t) = controller output
- M1 = maximum price of m (t) (ON)
- M2 = minimum price of m (t) (OFF)

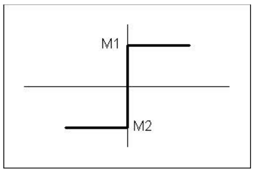


**Figure 2 . 2 On/Off Control Curve [5]**

*D. Direct Current Electric Motor*

Direct current electric motors have a working principle based on the Lorents experiment which states "If a current electric conductor is in a magnetic field, then a conductive wire will form a force". The force formed is often called the Lorents style. To determine the direction of the style you can use the rules of the Flemming left hand or the rules of the left hand [6].

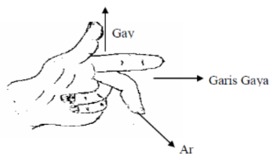


**Figure 2 . 3 Working Principles of DC Motors [6]**

If the thumb, middle finger and index finger are arranged like Figure 2.3, the magnetic force line corresponds to the direction of the index finger, the current flowing in the direction of the middle finger, the force formed on the conductive wire will be in the direction of the thumb. If the left palm rule is used, in determining the direction of the force it can be done as follows: "The left hand is stretched so that the thumb and the other four fingers are perpendicular to each other. If the magnetic force lines penetrate the perpendicular palm of the hand, the direction of the flow corresponds to the direction of the four fingers, then the direction will show the direction of force formed on the conductive wire " [6].

DC (direct current) motor are basic electromechanical devices that function to convert electric power into mechanical power which was originally introduced by Michael Faraday more than a century ago. A dc motor is a type of motor that uses direct voltage as its power source. By giving a voltage difference to the two terminals, the motor will rotate in one direction, and if the polarity of the voltage is reversed then the motor rotation direction will be reversed as well. The polarity of the voltage applied to the two terminals determines the direction of rotation of the motor while the magnitude of the voltage difference in the two terminals determines the motor speed [7].

**Figure 2 . 4 Direct Current Motor**

*E. Inter Integrated Circuit*

Inter Integrated Circuit or better known as I2C is one protocol that is often used in communication between components. This protocol was developed by Philips Semiconductor in the early 1980s. I2C communication protocols communicate in series synchronously. This means that data transmission is set based on the condition of the clock signal. I2C communication protocol uses 2 paths, namely SDA (Serial Data Line) and SCL (Serial Clock). In I2C communication the message will be sent in the form of a frame consisting of 7-bit slave address, 1-bit which shows read / write, 1-bit ACK / NACK and data frame consisting of 8-bit data [3].

*F. Liquid Crystal Display*

Liquid Crystal Display (LCD) is one of the electronic components that functions as a display of data, both characters, letters or graphics. LCD consists of two parts, the first is an LCD panel as an information display media in the form of letters or numbers two lines, each row can hold 16 letters or numbers. Liquid crystal display (LCD) is a viewer module that is widely used because it looks attractive. We use DDRAM to arrange the storage. The second part is a system formed with a microcontroller that is taped behind on the LCD panel, which functions to adjust the LCD display [8].

## III. SYSTEM DESIGN

This chapter discusses the stages of design, system functions, system descriptions, requirements, materials, and system design. Method and design are the most important part of the stages of system design stages.

*A. Steps of Project Impelementation*

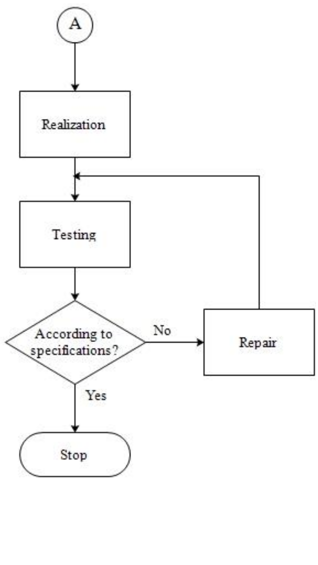


**Figure 3 . 1 Flowchart of Completion of the Project**

*B. Basic Concept*

The system created is a system of controlling dissolved oxygen in vanname shrimp pond water automatically with an on-off control using a relay that can drive 3 pieces of actuators in the form of a pinwheel so that the need for dissolved oxygen in vanname shrimp pond water is always sufficient and can be monitored remotely in real time using the mobile phone application.

*C. Block Diagram System and How System Works*

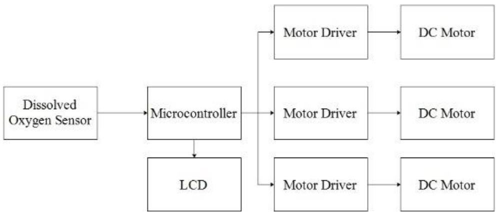


**Figure 3 . 2 Block Diagram System**

The system starts from reading oxygen dissolved in water by a dissolved oxygen sensor. Then, the reading is processed by a microcontroller that has been programmed with on-off control to drive 3 DC motors through a relay driver. When the dissolved oxygen level is less than 5.00 mg / L, the 3 actuators in the form of a mill will rotate. When the dissolved oxygen level is less than 5.50 mg / L and more than 5.00 mg / L then 2 actuators in the form of a mill will rotate. When dissolved oxygen levels are less than 6.00 mg / L and more than 5.00 mg / L then 1 actuator in the form of a spinning mill. Readings of dissolved oxygen and control of on-off DC motors are stored in the cloud so that they can be seen on the mobile phone application.

### *D. Designing Microcontroller Software*

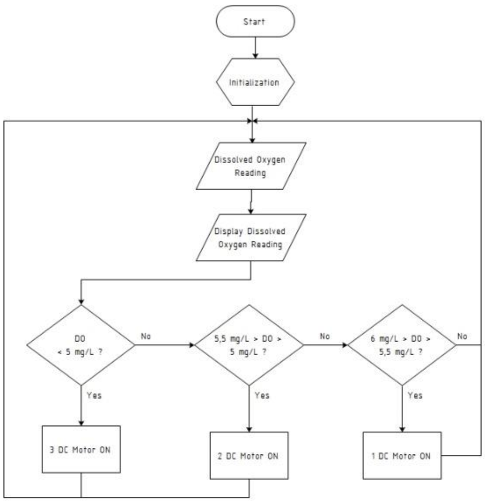


**Figure 3 . 3 Microcontroller Program Flowchart**

### *E. Mechanical Design*

The overall mechanical design design of the project.

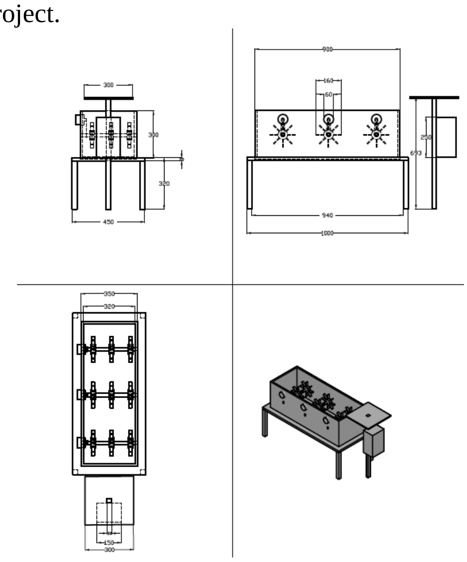

**Figure 3 . 4 Mechanical Design**

## IV. TESTING

System testing is divided into 3 parts: Sensor reading testing, control testing, and display testing.

### *A. Sensor Reading Testing*

Testing of DO (Dissolved Oxygen) sensor module is done by calibrating, which uses a variable distilled water solution which results in dissolved oxygen readings compared to the reading using Dissolved Oxygen Meter.

**Table 4 . 1 Tables for Dissolved Oxygen Levels using DO and DO Meter Sensors**

| No. | DO Sensor Reading (mg/L) | DO Meter reading (mg/L) | Acurracy (%) |
|---|---|---|---|
| 1 | 4,84 | 4,80 | 99,17 |
| 2 | 4,93 | 4,90 | 99,39 |
| 3 | 4,92 | 4,90 | 99,59 |
| 4 | 4,93 | 4,90 | 99,39 |
| 5 | 5,05 | 5,00 | 99,00 |
| 6 | 5,02 | 5,00 | 99,50 |
| 7 | 5,00 | 5,00 | 100,00 |
| 8 | 5,13 | 5,10 | 99,41 |
| 9 | 5,12 | 5,10 | 99,60 |
| Mean | | | 99,45 |

The average value of accuracy obtained from the test results is 99.45%. The test results show that the dissolved oxygen sensor can work properly so that the reading results can be used to regulate the control of dissolved oxygen levels and reading values can be displayed on the LCD and mobile applications.

### *B. Control Testing*

The control system used is ON / OFF with an open loop system. This control system controls dissolved oxygen levels to always be in the range of 4.5 - 7.0 mg / L. The principle of ON / OFF control in this system is when the dissolved oxygen level is less than 5.00 mg / L then the 3 pin relay output is ON. When the dissolved oxygen level is less than 5.50 mg / L and more than 5.00 mg / L then the 2 pin relay output is ON and 1 pin relay output is OFF. When dissolved oxygen levels are less than 6.00 mg / L and more than 5.50 mg / L then 1 pin relay output is ON and 2 pin relay output is OFF.

**Table 4 . 2 On / Off Control with Relay**

| No. | Time | *DO Sensor Reading (mg/L)* | *Pinwheel* | | | *Accuracy of Control (%)* |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | |
| 1 | 15:53:30 | 4,52 | ON | ON | ON | 100,00 |
| 2 | 15:53:38 | 4,95 | ON | ON | OFF | 100,00 |
| 3 | 15:53:42 | 5,30 | ON | ON | OFF | 100,00 |
| 4 | 15:53:46 | 5,42 | ON | ON | OFF | 100,00 |
| 5 | 15:53:50 | 5,30 | ON | ON | OFF | 100,00 |
| 6 | 15:53:55 | 5,42 | ON | ON | OFF | 100,00 |
| 7 | 15:53:59 | 5,22 | ON | ON | OFF | 100,00 |
| 8 | 15:54:02 | 5,60 | ON | OFF | OFF | 100,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | 15:54:06 | 5,85 | ON | OFF | OFF | 100,00 |
| 10 | 15:54:10 | 5,60 | ON | OFF | OFF | 100,00 |
| 11 | 15:54:14 | 5,60 | ON | OFF | OFF | 100,00 |
| 12 | 15:54:18 | 5,95 | ON | OFF | OFF | 100,00 |
| 13 | 15:54:22 | 6,10 | OFF | OFF | OFF | 100,00 |
| 14 | 15:54:27 | 6,23 | OFF | OFF | OFF | 100,00 |
| 15 | 15:54:32 | 6,33 | OFF | OFF | OFF | 100,00 |
| Mean | | | | | | 100,00 |

The average value of accuracy obtained from the test results is 100.00%. The test results show that the control program can be run properly.

*C. Display Testing*

LCD testing is done by programming the microcontroller so that it can display characters on the LCD. The test results can be seen in **Figure 4.1 LCD testing**. The result of LCD testing is that the LCD can display characters according to what is written on the microcontroller program.


**Figure 4 . 1 LCD Testing**

## V. CONCLUSION

The system is created with the following functions:

- The accuracy of measuring dissolved oxygen levels 99.45%.
- Dissolved oxygen can be controlled with 3 rows of pinwheels that automatically use the on-off control

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