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CONTROLLING AND MONITORING WATER QUALITY IN SALTWATER AQUARIUM

Muhammad Hazim Hisyamuddin Said[1,a], S. Siti Hafshar[2,a] and S. I. Safie[3,c]

[1,2,3]Instrumentation and Control Engineering Section, Malaysian Institute of Industrial Technology (MITEC), Universiti Kuala Lumpur, Johor Bahru, Malaysia

[a]hazim.said@s.unikl.edu.my, [b]sitihafshar@unikl.edu.my, [c]sairulizwan@unikl.edu.my

*Corresponding author's email : sitihafshar@unikl.edu.my

Abstract

An aquarium water quality is very important to the fish because its influence their health. To maintain good water quality in a saltwater aquarium, several parameters that have significant impact to the water quality need to monitor and control such as dissolve oxygen (DO) and turbidity. In this study, various water quality parameters are monitor and control include pH value, temperature (°C), DO, level of water, salinity and turbidity. Maintain optimum value of water quality parameters is mean for the health of the fish. Clean water avoids the fish from stress or attack by diseases. In this study, a saltwater aquarium is developed by using Arduino Mega 2560. The IDE software which is Arduino software is used to make the system develop could monitor and control automatically the saltwater quality in an aquarium. Several sensors were installed to the system such as pH, water level, total dissolve solid (TDS), temperature and turbidity sensor to obtain good test result. The system also was include with auto feeding function for the purpose to feed the fish. The test conducted show that the system developed successfully could maintain optimum saltwater quality parameters in an aquarium. The result analysis findings show that the salinity parameter have directional proportional relationship with temperature and DO parameter.

Keywords: Water quality; Arduino mega; Dissolved oxygen; Turbidity.

1.0 INTRODUCTION

In recent year, breed saltwater fish is popular among businessman. This is because saltwater fish demand is increase for fresh or frozen food. To have high-breeding density and high-profit from this business, maintain good water quality of saltwater is very important [1]. Traditionally, test of fresh or saltwater quality was conducted manually, which is taking time, costly and require manpower [2]. The data provide also is not real time data.

In the commercial market, there are many control systems for water quality was developed, however, to have cost effective system is limited [2]. Hence, saltwater quality monitoring system that consist of a microcontroller and basic sensor is developed to monitor saltwater quality. In this study, the developed system consists of several sensors to measure various parameters such as pH value, level of water in the aquarium, total dissolved solid (TDS), the turbidity in the water, and also temperature.

2.0 EXPERIMENTAL

There are many important parameters to be measured for saltwater quality analysis. In this study, several parameters are selected to measures by the system developed as listed below [3,4,5,6]:

- pH
- water level
- total dissolved solid (TDS)
- turbidity
- temperature.

Basically, the system developed is divided into three main parts which is controlling, monitoring and maintaining as shown in Figure 1.

Fig. 1. Operating system overview

Figure 2 and Table 1 show the closed loop for pH water sensor. This pH sensor will control by sequence by detect the pH value inside the saltwater. The low pH value is set at 1 – 7.5 as acidic water, 7 for neutral and 8.5 – 14 as alkali water .

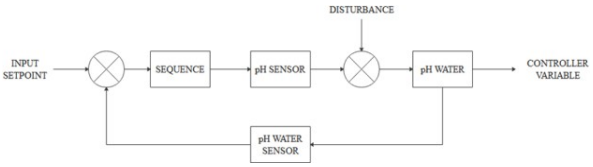

Fig. 2. Closed Loop for pH water sensor

Table 1. Explanation for closed loop pH control

Element	Description
Set point	pH value set up at 7.6 – 8.4
Controller	Sequence to detect the pH value inside the aquarium (pump pH up and pHdown)
Final control element	pH water sensor
Process	To detect the pH sensor
Sensor	pH water sensor will use to detect the pH value.

Figure 3 and Table 2 explain the close loop for water flow from storage tank to the aquarium tank. The water from storage tank will flow in if the water level sensor detects the minimum level of water in the aquarium tank and the water flow will stop filling if the level sensor detects the maximum water inside the aquarium.

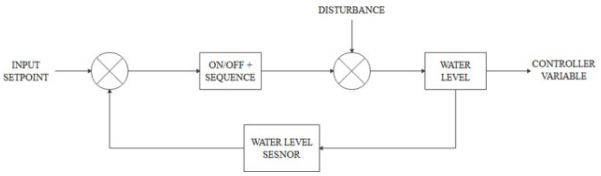

Fig. 3. Closed Loop for water level

Table 2. Explanation for closed loop water level control

Elements	Description
Set point	Minimum and maximum water set point inside the aquarium.
Controller	On/Off pump + sequence that will control bywater level sensor.
Final Control Element	Pump
Process	Water flow
Sensor	Water Level Sensor

As the whole, Figure 4 show the workflow of the system developed. This system has five input such as pH, TDS, water level, turbidity and temperature sensor. If the pH low than 7.5, pump acid that contain of alkaline solution will turn 'ON' and will turn 'OFF' if the pH reach 7.5. If pH higher than 8.5, pump alkaline that contain of acid solution will turn 'ON' and will turn 'OFF' when the pH decrease until 8.5. For water level function, the pump will turn 'ON' when the water level in the aquarium is below than 950.

A program automatically manages the device itself with all parameters. This program is essential in developing and changing the code to make the right decision.

This system is developed from the combination of the several types of instrument devices, electrical components with Arduino Mega 2560. The main components hardware and software are as listed below:

- Arduino Integrated Development Environment (IDE)
- water level sensor
- pH sensor
- TDS sensor
- turbidity sensor
- temperature sensor
- tater pump

Figure 4 show the side view and Figure 5 show the front view of the prototype.

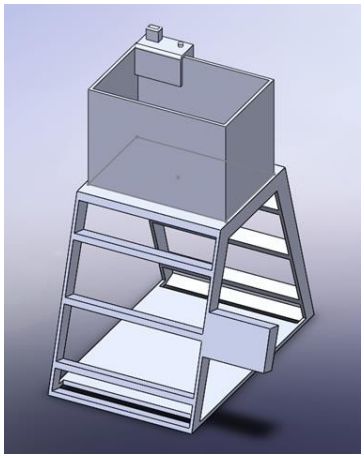

Fig. 4. Isometric View

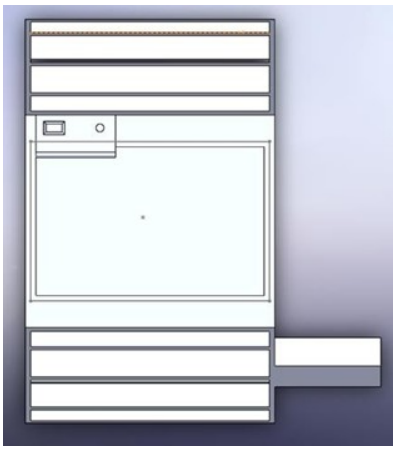

Fig. 5. Top View

Figure 6 show the wiring diagram for the prototype. In the circuit, Arduino Mega 2560 is the main microcontroller to control and manage all the system such as sensor, servo motor, LCD, and relay. Almost all device used 5V for supply and operating in device.

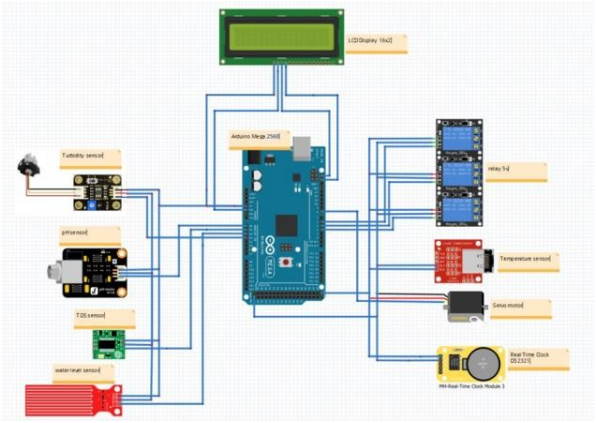

Fig. 6. Circuit diagram

Figure 7 show the piping instrument and diagram with Table 3 explain the symbol description.

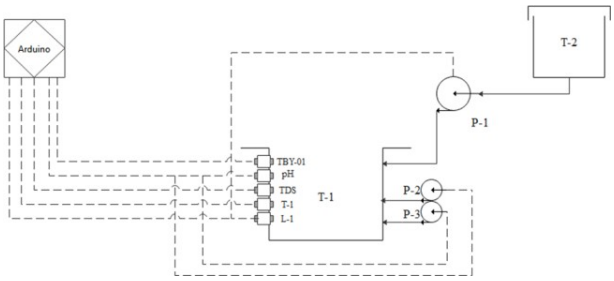

Fig. 7. Piping Instrument and Diagram (P&ID)

Table 3. Legend for P&ID

Symbol	Description
T-1	Aquarium Tank
T-2	Water Supply Tank
TBY-01	Turbidity sensor
pH	pH sensor
TDS	Total Dissolve Solid sensor
L-1	Water Level Sensor
P-1	Water Level pump
P-2	Pump acid
P-3	Pump alkaline
---------	Electrical signal
_____	Pipeline

Figure 8 show the water salinity level. Salinity is the concentration of salt in saltwater. More specifically, salinity is a measure of the dissolved sodium ions in the water, and it can be measured in parts per thousand (ppt). Most saltwater aquarists measure the salinity in their aquarium using a hydrometer, which measures the tank's specific gravity. Gravity in a saltwater aquarium is the ratio of saltwater to pure water. It is easier and less expensive to measure than the actual salinity because special equipment must measure saltwater salinity in ppt.

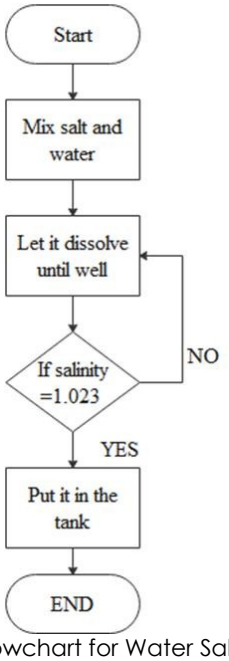

Fig 8. Flowchart for Water Salinity Level

3.0 RESULTS AND DISCUSSION

Several test were conducted to the system developed in order to test all the hardware used and software install to run the system. The reliability of sensor used also was test in the result analysis.

Relationship between days and pH value

The system need to maintain the pH value of saltwater inside the aquarium is at value 7.6 – 8.6. The sample of the water was start taking from 15 April 2021 until 21 April 2021. The samples of the water inside the aquarium are taking in every day for the analysis. Figure 9 show the graph of day versus pH value whilst Table 4 tabulated the changing of pH in a day during test was run.

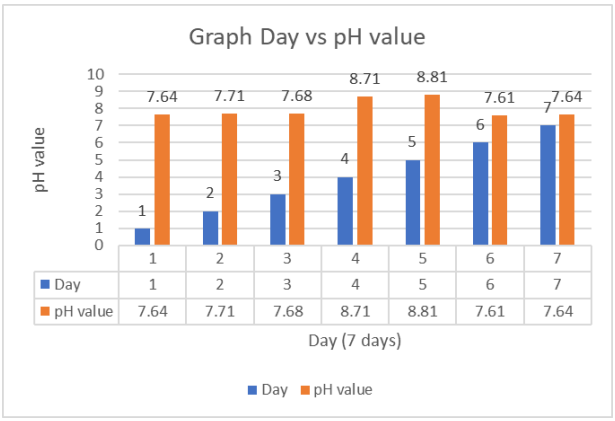

Fig. 9. Days versus pH value

Table 4. Relationship between test day with sample taken and the changing of pH value in 7 days

Date	Day	Control Range: 7.6 – 8.6
15 April 2021	Day 1	7.64
16 April 2021	Day 2	7.71
17 April 2021	Day 3	7.68
18 April 2021	Day 4	8.71
19 April 2021	Day 5	8.81
20 April 2021	Day 6	7.61
21 April 2021	Day 7	7.64

Relationship between days and TDS

Figure 10 show the graph of day versus TDS value whilst Table 5 tabulated the TDS value in a day during test was run.

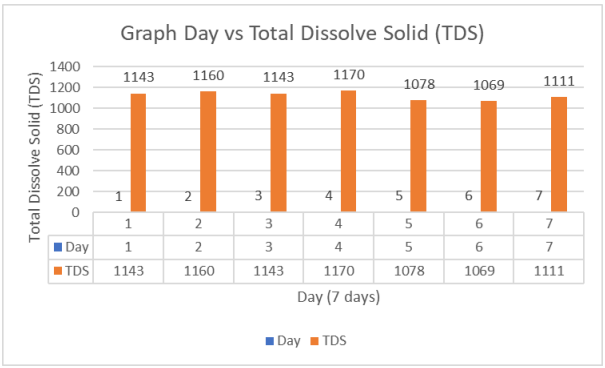

Fig. 10. Days versus TDS value

Table 5. Relationship between test day with sample taken and TDS value in 7 days

Date	Day	Control Range: Above 999
15 April 2021	Day 1	1143
16 April 2021	Day 2	1160
17 April 2021	Day 3	1143
18 April 2021	Day 4	1170
19 April 2021	Day 5	1078
20 April 2021	Day 6	1069
21 April 2021	Day 7	1111

According to the graph in Figure 10, the value for the TDS is above value of 999. This mean that the DO is exceed than the optimum level and good for the fish. DO is basically require by fish for breath. According to research, the best value of TDS must above than value of 999 to have good DO level. However, the DO level will decrease exponentially with increasing of water salinity [7].

Relationship between days and temperature

Figure 11 show the graph of day versus temperature value whilst Table 6 tabulated the changing of temperature in a day during test was run.

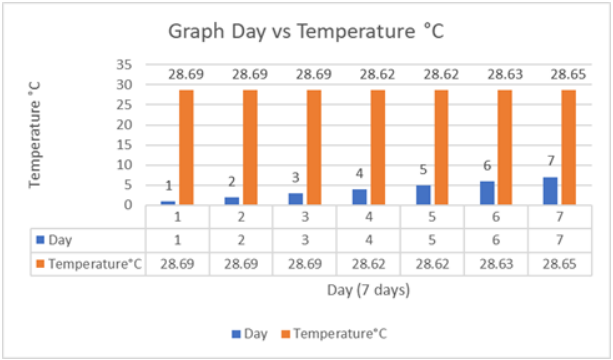

Fig. 11. Days versus temperature value

Table 6. Relationship between test day with sample taken and the changing of temperature value in 7 days

Date	Day	Control Range: 25°C - 30°C
15 April 2021	Day 1	28.69
16 April 2021	Day 2	28.69
17 April 2021	Day 3	28.69
18 April 2021	Day 4	28.62
19 April 2021	Day 5	28.62
20 April 2021	Day 6	28.63
21 April 2021	Day 7	28.65

The best temperature for water inside marine aquarium is between 25°C to 29°C [9]. According to the graph show in Figure 11, the temperature is maintaining at suitable range inside the aquarium. The sun is the most important heat source for water, the temperature may also be affected by input water temperatures such as precipitation, surface water runoffs, groundwater, and upstream tributary water, air heat exchanges and heat loss or condensation heat [8].

Relationship between days and water level

Figure 12 show the graph of day versus water level value whilst Table 7 tabulated the changing of TDS in a day during test was run.

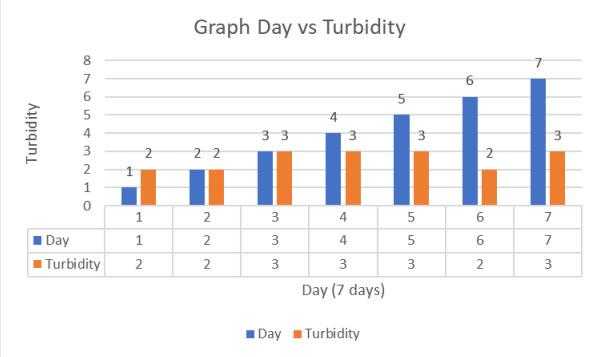

Fig. 12. Days versus temperature value

Table 6. Relationship between test day with sample taken and the changing of TDS value in 7 days

Date	Day	Control Range: 970
15 April 2021	Day 1	988
16 April 2021	Day 2	988
17 April 2021	Day 3	988
18 April 2021	Day 4	988
19 April 2021	Day 5	988
20 April 2021	Day 6	986
21 April 2021	Day 7	986

According to the graph show in Figure 12, the water level inside aquarium can be maintain by adding system auto refill. Sometimes, the water inside the aquarium also can be drop because of the natural evaporation process in the environment.

Relationship between days and turbidity

Figure 13 show the graph of day versus turbidity value whilst Table 8 tabulated the changing of turbidity in a day during test was run.

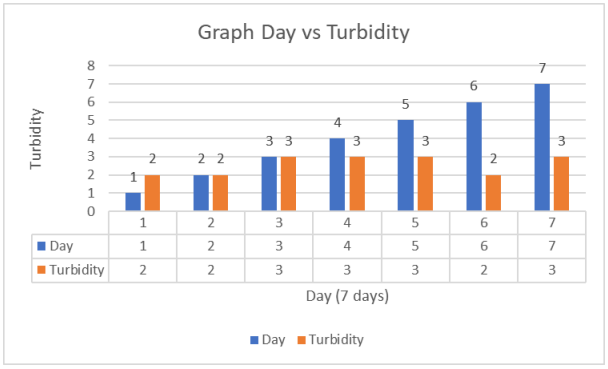

Fig. 12. Days versus turbidity value

Table 7. Relationship between test day with sample taken and the changing of turbidity value in 7 days

Date	Day	Control Range:0 - 12
15 April 2021	Day 1	2
16 April 2021	Day 2	2
17 April 2021	Day 3	3
18 April 2021	Day 4	3
19 April 2021	Day 5	3
20 April 2021	Day 6	2
21 April 2021	Day 7	3

Graph in Figure 13 shows the relationship between days with the rate of change of turbidity inside the aquarium. The turbidity of the water was analyzing from the sample that already taking before. The result shows the stability of the turbidity starting from day 1 until day 7. The turbidity of the water will be cloudy after day 7 because waste food will be cause cloudiness of the water. Water is low in turbidity is show that low in total suspended solid (TSS). If, water turbidity is increased considerably, therefore, water conductivity is also increased. Finally, the conductivity in the water also increases as water turbidity rises. If the total suspended solid (TSS) within the water increases, there is also an increase in the electricity charge (EC). The aquatic ecosystem will therefore be affected. The turbidity is the main needs to be measured to maintain optimum quality of the water [8].

4.0 CONCLUSION

These project objectives to developed a system that can controlling and monitoring water quality in saltwater by using Arduino Mega 2560 was successfully achieved. Issues in controlling parameters such as salinity level, temperature value, and dissolve oxygen (DO) of saltwater can be eliminated by using developed prototype. Maintain optimum parameters for saltwater is good for fish health and performance of aquarium. The analysis results indicate that water quality parameter influences other water quality parameters. As a conclusion, maintain good water quality is very important in fish breed activity as poor quality of water can affect their health and growth rate.

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