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# An Automatic System for Fishpond Ecology Monitoring and Control

**Muhammad Raimie Razam[1], Zazuli Mohid[1]***

[1]Faculty of Mechanical and Manufacturing Engineering,
Universiti Tun Hussein Onn Malaysia, 86400, Parit Raja, Johor, MALAYSIA

*Corresponding Author Designation

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**Abstract:** Expanding the industry and technology of controlled system requires developing the multifunctionality and performance of automatic system. Thus, a study on an automatic system for fishpond ecology monitoring and control for Ketutu fish had been conducted to identify the benefits to aquaculture field especially in fish productivity. Therefore, this project aimed to design, fabricate, and test a fishpond monitoring and control system. The scope of this study includes the development of system that focused on monitoring the water pH, and temperature. Moreover, this system is suitable for freshwater fish farmers who need to monitor their pond water quality. This monitoring and controlling system consist of Arduino Uno board, pH sensor, temperature sensor, dosing pump, relay module, shield data logger with DS1307 RTC, and LCD. Arduino Uno act as microcontroller to process signal from pH sensor and temperature sensor to get the real time monitoring value of pH and temperature of water to be display on LCD. The dosing pump function to supply buffer solution to water if the value of pH exceeds the range value between pH6.5 and pH7.5. Shield data logger with DS1307 RTC was use for easier collection of data. By realizing the control of aquaculture environment factors, and with helps of expert system, a real-time monitoring, data collection, read, store and comparison result had been successfully achieved. The study had revealed that if the value of pH exceeds the corresponding set points, it will automatically control to turn ON the dosing pump. The study also shows that when the system was ON, the water temperature slightly cooler compared to when the system is OFF. This automatic monitoring and control system is expected to be useful to monitor water quality for fishpond ecology.

**Keywords:** Ketutu Fish, Arduino, Real-time Monitoring and Control

## 1. Introduction

Ketutu or its scientific name Oxyeleotris Marmorata is considered as having a high economic value fish. In Malaysia, this fish is also called as 'Betutu', 'Belontok', 'Ikan Hantu', or 'Haruan Bodoh'. Ketutu fish live in fresh waters such as rivers, lakes, reservoirs, and swamps and prefer water that is shallow with muddy bottom and calm currents. This fish hides around plants that float on the water surface to protect themself. Ketutu fish also hunt their prey while staying at the bottom of the surface

*Corresponding author: zazuli@uthm.edu.my

of water [1]. Ketutu fish are usually found in Singapore, Thailand, Philippines, Fiji Islands, and Indonesia.

Ketutu fish have a high selling point and believed to have various benefit for humans. Ketutu fish are quite popular among Indonesian community because the flesh is soft, white, and not much fish bone. Ketutu fish meat contain protein (9-22%), fat (0.1-20%), mineral (1-3%), vitamins, lecithin, guanine and low in cholesterol. In fish farming, Ketutu fish has not been grown yet, it is feared it will be reducing the population and threatening its sustainability. Ketutu fish is one of the high potential freshwater fish to be commercialize.

In Malaysia, Ketutu fish is one of the types of freshwater fish which can boost the rural economic level. In Malaysia, less people commercialize this fish. Ketutu fish is usually can be catch between December and March every year in the main river because it is a seasonal fish. 500 to 700-gram of this fish is considered a small size fish which can cost RM80 to RM100 per kilogram, while 800 grams to one kilogram of this fish can cost RM100 to RM120 according to market price [2] whereas according to [1] one kilogram can cost about RM90. According to Jabatan Perikanan Malaysia shows that ketutu production during 2009 is about 30.45 metric tons which equals to approximately RM 1.57 million.

In fish farming, suitable quality of water is important to determine the success. Fish farming of Ketutu fish has started since 1970 using cage and pen culture in Sumatra and Kalimantan. In production of Ketutu fish, to sustain the fish seed of the species, quality of water is also important in fish farming [3]. The parameter that needs to be considered are temperature, level of pH, and dissolved oxygen (DO).

24ºC until 28ºC of water temperature is suitable in the growth of juvenile fish and 30ºC of water temperature is suitable for the adult fish [3]. Ketutu fish also can live in water temperature between 19ºC until 29ºC and can adapt until 30ºC. If the water temperature is too low, the fish may get into some bacterial disease especially from Aeromonas hydrophila, Pseudomonas sp., Inchthyophthirius multifiliis and mycotic disease caused by a fungus like Saphroregnia sp. For juvenile fish, the suitable temperature of water is between 24ºC until 29ºC and 70% can survive in growth. According to research that had been done by [4], Ketutu fish is a freshwater fish that lives in relatively hot waters more than 24ºC. The temperature in reservoirs, lakes or rivers tends to be stable between 27ºC and 32ºC in summer. Temperature will decrease below 28ºC during rainy season. Temperature is not stable in the transition from hot season to rainy season. According to [5] temperature is unstable and fluctuates (up and down) up to 4 - 5ºC.

According to research, level of pH that Ketutu fish can live is in the range of 7.5pH until 8.5pH [6]. Ketutu fish are usually found in freshwater that have level of water in rage of 5.5pH until 6.5pH. However, Ketutu fish still can live in 7pH until 7.5pH of water. According to [5], Ketutu fish can live in low pH of water which is in acidic condition (5.5pH until 6.5pH). However, at water pH 7.0 until 7.5, Ketutu fish can grow well. In another research, level of pH in Ketutu fishpond are at 6.5pH until 7.5pH [7].

Oxygen is one of the important parameters that need to be considered in fish farming. This is because oxygen act as a drain for metabolic processes in the water and as an indicator of water quality. Dissolved oxygen in water generally comes from the direct diffusion of oxygen from the air into the water through rainwater and through photosynthesis in water. Aquatic animals use oxygen in water for respiration causes the dissolved oxygen concentration in water decrease [3].

Dissolved oxygen between 0.366mg/l until 0.47mg/l with the rate of salinity 1ppt until 5ppt is suitable for Ketutu fish farming [8]. In research which conduct in a pond with floating net cage, the dissolved oxygen is between 2.9mg/l until 3.5mg/l [7]. This can be supported by [5] research which stated that Ketutu fish can live in poor quality of water. In low dissolved oxygen concentration, which is 2mg/l Ketutu fish still can survive. Ketutu fish will grow up well with dissolved oxygen more than 3mg/l.

Freshwater fish farming industry is reported to have big potential in boosting economic level of rural community. The demand for freshwater fish is very high but not able to be fulfilled. Freshwater fish needs high quality of water to survive and breed. The water temperature, oxygen level and pH value give big impact to the fish survival and growth. The knowledge and skill to control the pond water quality is one of the main issues in freshwater fish farming industry. A system to monitor and control the ecology of a pond is needed to increase productivity.

## 2. Methodology

### 2.1 Concept Design of monitoring and control system

In this part monitoring and control system for fishpond is design based on flowchart shows in Figure 1. This system is targeted to monitor and control the water quality based on Ketutu fish suitable condition for their living that can increased productivity.

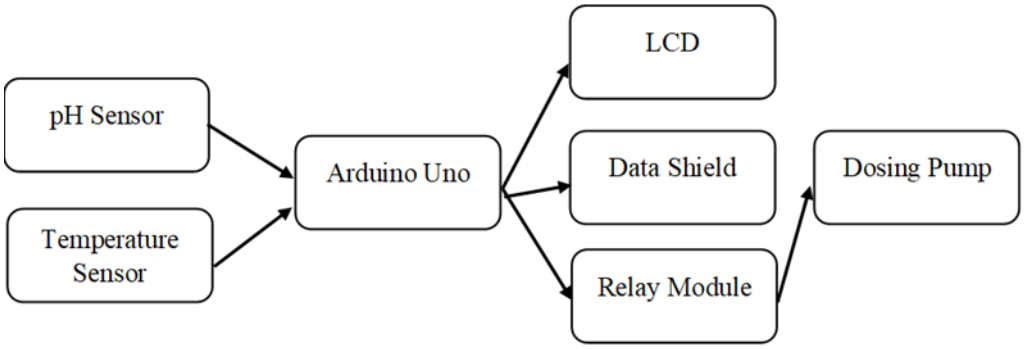


**Figure 1: Block Diagram for the Monitoring and Control System**

In this control and monitoring system, pH sensor (Gravity Analog) and Temperature sensor (DS18B20) as an input to the microcontroller which is Arduino Uno. Power supply (7.5V) is used to power up the Arduino Uno to function. LCD (Arduino 12C Serial LCD 16×2) is used to display the real time value of the parameter that is measured. To control the water quality, water filter and dosing pump is used in respond towards the sensors reading. Relay module is to send a signal to the dosing pump to turn ON or OFF. To collect data for the study purpose, data shield will be use.

### 2.2 Experiment Setup

In this experiment, fish tank is used to simulate as a fishpond. About ten Ketutu fish will be use in this experiment. The position of pH sensor, temperature sensor, and filter with pump in the tank will be as in Figure 2.

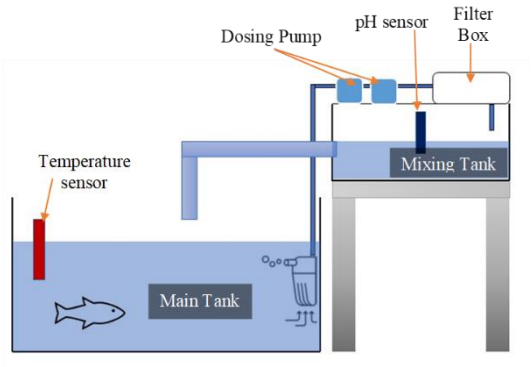


**Figure 2: Experiment Setup of Fish Tank with Monitoring and Control System**

### 2.3 Software

To develop and make the monitoring system function, a code is needed to be write for the Arduino Uno. The code is obtain from open source. The code then is write in the software that is call integrated development environment (IDE) as a sketch.

### 2.4 Data Collection

Data collection that is suitable for Ketutu fish will be monitor and control. Data collection involved physical and chemical parameter which will be collect from the water. The data that will be collect is pH value and temperature value. To control the data, water filter and dosing pump is use. Dosing pump will be triggered ON or OFF at a certain value of pH and temperature that were set in the programming. Expected value that is going to be control based on the suitable condition that Ketutu fish can live is as in Table 1.

**Table 1: Ketutu Fish Optimum Parameter Control Value**

| Parameter | Average Optimal Condition for Ketutu Fish live |
|---|---|
| pH | 6.5pH - 7.5pH |
| Temperature | 24ºC - 30ºC |

## 3. Results and Discussion

The results and discussion section presents data and analysis of the study. This section can be organized based on the stated objectives, the chronological timeline, different case groupings, different experimental configurations, or any logical order as deemed appropriate.

### 3.1 Design of System

Figure 3 and Figure 4 show the front view and the top view of the arrangement of the system.

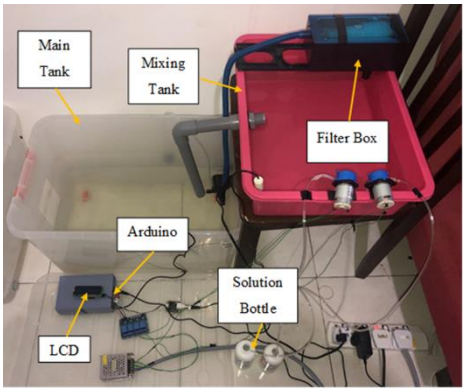


**Figure 3: Front view of the system**

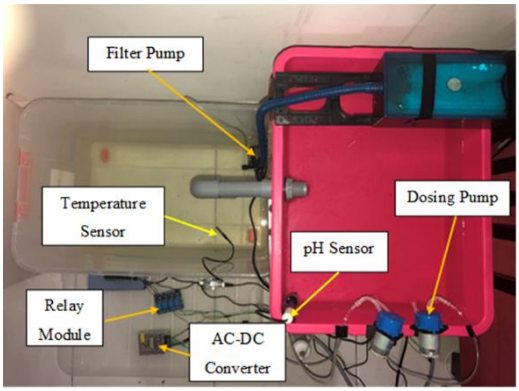


**Figure 4: Top view of the system**

### 3.2 Circuit Diagram

Figure 5 shows the circuit diagram in proteus software for the monitoring and control system.

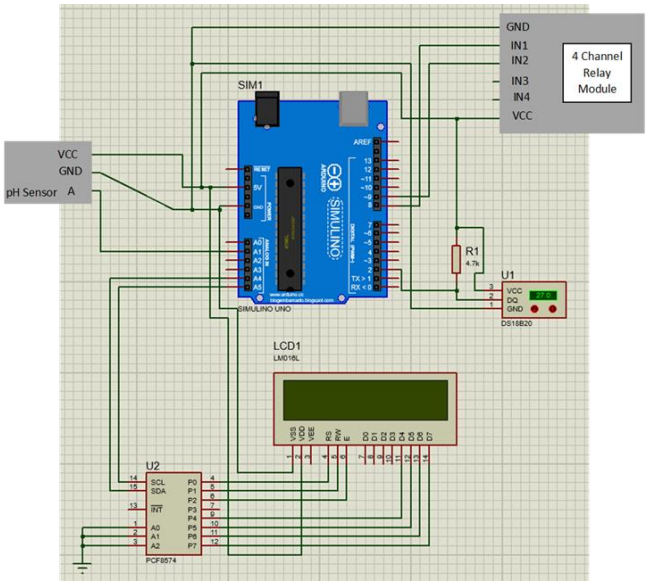


**Figure 5: Circuit Diagram of the System**

### 3.3 Coding Development

In developing the coding for this project, only Arduino software (IDE) was used. In this project the system was developed to monitor the temperature of water and the pH value. Base on the pH value it will turn on and off pump in certain time when it exceeds the range of pH6.5 and pH7.5 which is the optimal condition for Ketutu fish to live. To collect the data from the sensor, shield data logger with DS1307 RTC module were used to save the data in the SD card. Figure 6 show the program flow chart.

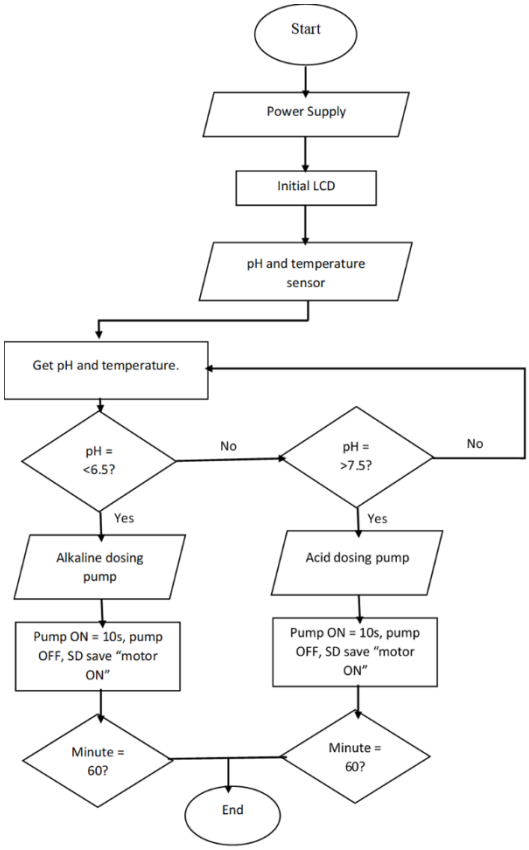


**Figure 6: Program Flow Chart**

3.4 Result

The pH sensor and temperature sensor were tested on a rectangular shape tank with initial water capacity of 30 litre. The initial value of pH and temperature of the water were 7.01pH and 30.0°C. Ten Ketutu fish were included in the main tank during the experiment. Figure 7 show the initial condition of water quality of the fish tank. Figure 8 show the condition of water quality after two days. Figure 9 and Figure 10 show the temperature value and pH value in experiment 1 when the system is OFF. Figure 11 and Figure 12 show the filter condition before and after the system is ON. Figure 13 show the condition of water after 48 hours the system ON. Figure 14 and Figure 15 show the temperature and pH value for 48 hours the system turn ON in experiment 2.

**Figure 7: Initial Condition of Water Quality**

**Figure 8: Condition of Water Quality after Two Days**

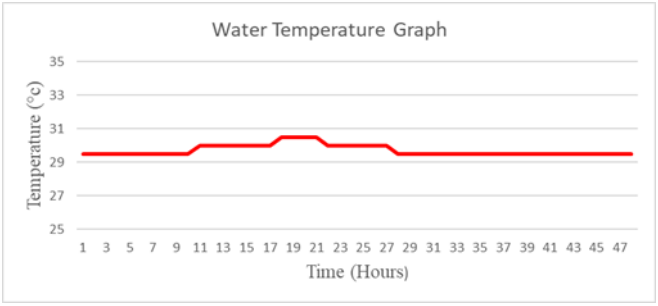


**Figure 9: Result of Water When System OFF**

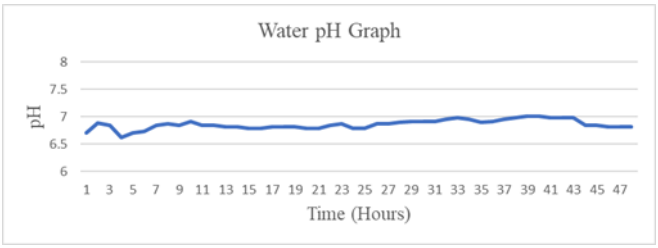


**Figure 10: Result of Water When System OFF**

**Figure 11: Filter Condition Before System ON**

**Figure 12: Filter Condition After System ON for Two days**

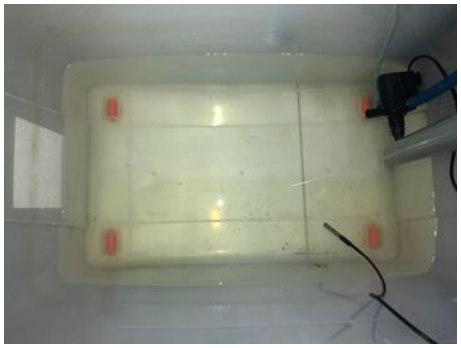

**Figure 13: Condition of Water After Two Day System ON**

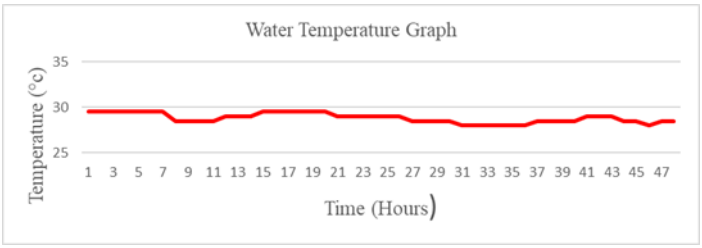


**Figure 14: Result of Water Temperature When System ON**

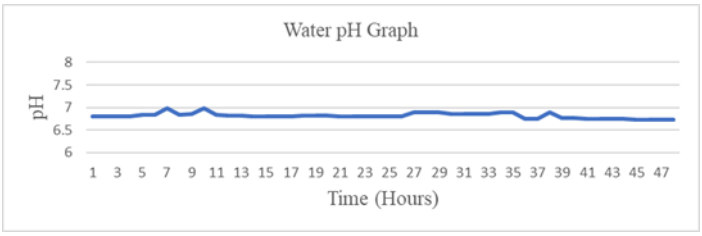


**Figure 15: Result of Water pH When System ON**

In the experiment when the system was ON and running for 48 hours, the pH value based on the pH graph still not exceed the range of pH6.5 and pH7.5. The dosing pump was off during the experiment. To ensure the dosing pump functional, another experiment was conducted separately. To faster the process of turning ON and OFF of the dosing pump, a short period of time was set in the coding. The dosing pump were set to turn ON when it detects a pH that exceed the range value of pH6.5 and pH7.5 within 10 reading of the sensor. Then it will OFF the pump for mixing phase within 22 reading of the sensor. If the pH value still exceeds the range value it will turn ON back the pump for another 10 reading of the sensor.

The data were collect using SD card module with RTC. The data will be saved to SD card in txt format. The data then imported to Microsoft excel to show the result of turning ON and OFF of the dosing pump. In figure 4.21 show the phase of the pump operate.

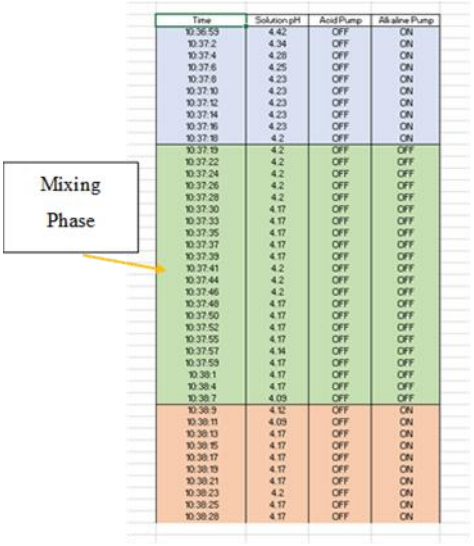


**Figure 16: Mixing Phase after Pump ON**

### 3.5 Discussions

In this project an automatic system for fishpond ecology monitoring and control was developed and fabricate for freshwater fish farmer. This system function as real time monitoring to monitor pH value and temperature value of water in fishpond. The system uses Arduino uno board as the microcontroller. To test the system, three experiments were conducted throughout this project. The first two experiment were conducted in a close system of tank. Close system means that the water in the tank recirculating in the same container.

The first experiment was conducted with the system was OFF and the second experiment was conducted with the system was ON. From the result obtain, the pH value for experiment 1 and experiment 2 does not exceed the range value of pH6.5 and pH7.5 which is the best condition for Ketutu fish live. Although the pH does not exceed the optimum value that had been set, the water changes to cloudy after two days. This is because in closed system Ketutu fish perform all their vital activities in water such as breathe, feed, and excrete wastes. All these activities effect the quality of water. This is where the filter come into place. After two days the control system was turn ON. This causes the water to flow from the main tank into the filter box with the help of filter pump. After two days filtering the water, the result can be seen as the water become clearer. For long period of time, no system completely closed because some water must be added periodically to replace evaporative loses and that used to flush out waste material. As for closed system, water need to be change regularly since no filter is 100% effective.

However, in experiment 1 and experiment 2, the temperature of water slightly cold when the control system was ON. This because the water circulates from the main tank to the mixing tank and lastly it will flow back into the main tank influence the temperature of the water.

As in experiment 1 and experiment 2, the water pH does not exceed the limit that had been set, dosing pump does not turn ON. It always OFF when the system runs. To see the functionality of the pump, another experiment was conducted. The experiment was to submerge the tip of the pH sensor into buffer solution which exceed the value that had been set. After submerged the tip of the pH sensor, the dosing pump immediately turn ON for ten second and then after that it will automatically OFF because of setting in the coding. The sensor will recalculating the pH value for certain of time that has been set in the coding. If the pH sensor detect that the pH value still exceeds the limit point it will continue to turn ON the dosing pump, if not it will continue turning OFF the pump. The process will be repeated as long the Arduino uno bord been powered by the power supply.

In collection of data for all the experiment, shield data logger module with DS1307 RTC was used. This module will automatically save the data into SD card and LCD for the real time monitoring. With this module the collection of data become easier. It can be said that this project will be useful for freshwater fish farmer to monitor the quality of their pond water.

## 4. Conclusion

An automatic system for fishpond ecology monitoring and control was successfully developed and fabricate. When testing, the system was able to get real time reading for water quality that consist of pH and temperature value. In this project, the monitoring system was tested when the control system was OFF and ON.

Both sensor able to measure the quality of water such as temperature and pH value of the pond ecology. The system able to turn ON the dosing pump at certain time set if the value of water pH exceeds the range value between pH6.5 and pH7.5 to control the pH water. This system also capable of collecting data automatically and save the data in SD card for research purpose.

Based on the result, the water was slightly cold when the system was ON compared to when system OFF. When the system ON it can filter the water from cloudy water to clear water. Lastly, this system can be said as successful project as all the objectives had been achieved.

**Acknowledgement**

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