Controlling TDS and pH Parameters that are Effective on Living and Reproduction of Underwater Creatures

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***Abstract*— In this study, a system was designed and executed to maintain desired levels of the TDS and the pH which are the dissolved material amount in water, and a figure expressing the acidity or alkalinity of water, respectively, which are the most important parameters for underwater creatures.**

Also, with the executed system:
• Automatic stabilization of the pH value,
• Semi-automatic TDS control,
• Automatic and manual lighting control,
• Automatic temperature control,
• Scheduled or manual feeding control,
• Automatic and manual liquid level control was made possible.

Parameters were detected with water-resistant pH probe, TDS probe, electronic water-gauge and temperature sensor and required units were activated automatically.

With the executed system, pH, TDS, temperature and environmental units can be controlled by parameter inputs on a touch panel and enable the users to get stable values, save time and control the system from a single point.

***Keywords*— Arduino; TDS; pH; Temperature; Nextion; HMI.**

I. INTRODUCTION

Aquaculture, also known as aquafarming, is one of the important farming activities which is long-lasting and developing with various industrial sectors. With the developing technology, aquaculture also is making progress and various applications are being implemented. Providing an environment for the creatures that are to be farmed always attracts researchers' attention [1, 2].

Celik et al. (2008), done research to determine the factors that affect the reproduction of the discus fishes (Symphysodon spp). They reached the conclusion that the factors of the water's pH, conductivity, hardness, TDS, courtship behavior of creatures, and the water circulation in the culture tank affect the discus reproduction directly.

Even though it is monitored that the discus can reproduce in a wide range of pH, it was seen that their reproduction frequency is much denser between the ranges of 4-7 pH. Celik et al. determined that on the situations where the pH is lower than 4 and higher than 7, the reproduction rate shows a decrease. (Figure 1).

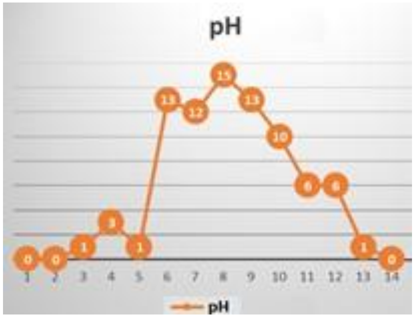

Fig. 1. *Reproduction graph of the discus between 1-14 PH range [3]*

It was seen on the discus that the reproduction rate increases when the conductivity is below 300μS. As is seen in the graph in Figure 2, most of the 64 reproductions occurred between 100-150μS. It was determined that above 200μS, reproduction behavior becomes less frequent, above 300μS it becomes rare (Figure 2).

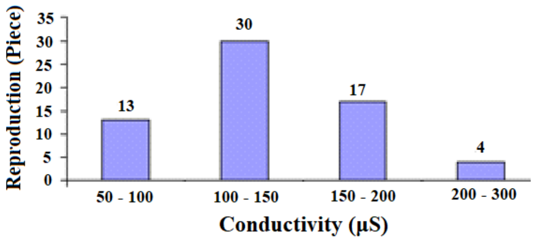

Fig. 2. *Reproduction graph of the discus between 50-300μs water conductivity [3]*

Celik et al. observed that the discus fishes reproduce in the soft water below 5 dH, and determined that as the water gets harder their reproduction rate decreases, becomes less frequent above 5 dH, and even stops (Figure 3).

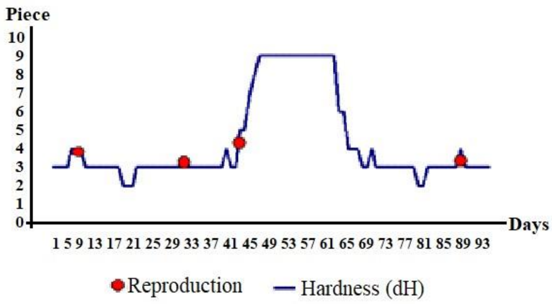

Fig. 3. *Reproduction graph of the discus between 0-10 dH water hardness [3]*

Celik et al. also carried out various photoperiod practices on three-month periods and reached the conclusion that the light/dark ratio is important for the Discus fishes. As observed in Figure 4, on the situations when the intensity of the dark or the light is high, the reproduction is low.

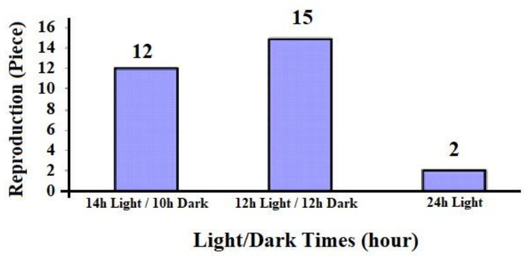

Fig. 4. *Reproduction graph of the discus in light/dark environments [3]*

Pervin et al. (2013), in the study they carried out, it was investigated that in the scope of the integration of automation with aquaculture which is shown as the World's most rapidly-developing food sector in the last thirty years; automation types used on feeding fish, the magnitude it has today, and the benefits it provides [4].

Kocaoglu and Kuscu (2015), in their study, executed automatic control of electronic components (feeding, light, water circulation) of an aquarium. In accordance with the working hours that were determined by the user, these components are automatically controlled by the central control unit. The status of the components and the current time information can be monitored on the screen located on the system [5].

With this study, an automation system was executed which automatically sets the parameters whose range was set by the user to create an environment that can imitate the natural environment of underwater creatures.

II. CONTROLLING TDS AND PH PARAMETERS THAT ARE EFFECTIVE ON LIVING AND REPRODUCTION OF UNDERWATER CREATURES

The block diagram of the executed study is as in Figure 5, and the touchscreen for the user control is as in Figure 6. The system is being controlled by Arduino. In this study, the controlling of the pH and the TDS of the water used in aquaculture environment is done automatically and semi-automatically, respectively. Also, the water level control, maintaining the water temperature between the defined range, and feeding the cultured creatures between at determined periods are done automatically with this system. All these controls are performed on a touchscreen to make it easy for the user.

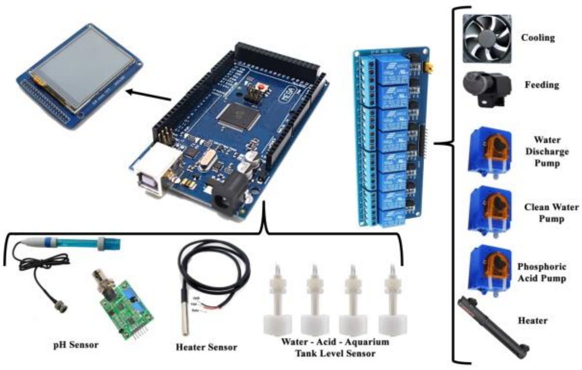

Fig. 5. *The block diagram of the executed system*

Fig. 6. *Touch screen home page*

A. *Automatic Stabilization of the pH Value*

OH^- density in the water would increase due to the filtering system being constantly on. Therefore, the pH level of the water in the aquaculture environment is in a constant tendency to increase. In the event of the increase of the water's pH level, the phosphoric acid dosage pump runs automatically and adds phosphoric acid in the water. Thus, because the phosphoric acid would increase the H^+ density, pH level would be decreased and stabilized.

The pH value can be seen at any moment and required pH range can be set on the home page of the touchscreen in Figure 7.

Fig. 7. *pH setting page*

B. *Semi-Automatic TDS Control*

TDS is in a constant tendency to increase because of the dissolved material amount due to evaporation of the water in the aquarium environment. The measurement of the dissolved material amount is done by the TDS meter in Figure 8.

Fig. 8. *TDS meter*

TDS value is observed on the LCD on the device and when it is high, the user activates the water discharge pump by pressing the "TDS High and Discharge Button" on the home page of the touchscreen (Figure 9). In this situation, because the water level in the water tank will fall, the water level control unit will automatically activate and add water to the water tank. Thus, the control of the TDS will have been carried out semi-automatically.

Fig. 9. *TDS high and discharge button*

C. *Automatic Liquid Level Control*

The required information for the aquarium liquid level is obtained from the electronic water-gauge as logic 0/1. When the liquid level is below the water-gauge (logic 1), the water pump runs until the water level gauge is logic 0. Also, water level control can be set to manual as shown in Figure 10 and automatic water filling can be canceled from the touchscreen's home page in Figure 6.

Fig. 10. *manual liquid level control button*

D. *Automatic Temperature Control*

The desired water temperature range of the water in the water tank is set from the setting page on the touch panel in Figure 11. Automatic temperature control unit ensures the activation of the cooling fan or the heater depending on if the water temperature in the water tank is out of the desired range.

Fig. 11. *Touchscreen temperature setting page*

The temperature is detected by the DS18B20 temperature sensor and it operates accordingly on the average of four temperature values measured at different times to prevent the system to oscillate. If the value read from the temperature sensor is lower 1°C than the defined temperature value on the touchscreen, the heater runs and an alert icon appears on the home page as seen in Figure 12.

Fig. 12. *Touchscreen resistance is active icon*

When the temperature value is 1°C higher, the cooling fan runs, and an alert icon appears as seen in Figure 13.

Fig. 13. *Touchscreen fan is active icon*

E. Feeding

Automatic Feeding: An automatic feeding unit was integrated into the executed system to automatically provide food for the underwater creatures. In Figure 14, 4 different time information is entered and saved on the touchscreen by the user. Feeding is done automatically on these saved times.

Fig. 14. *Feeding hours setting page on touchscreen*

Manual Feeding: A manual feeding was included in the system as an option so that the user can manually feed. The icon on the touchscreen in Figure 15 executes one-time feeding.

Fig. 15. *Manual feeding control tab*

F. Lighting

Automatic Lighting: An automatic lighting unit was integrated into the executed system to cater the need of the light of the underwater creatures. In Figure 16, the times for the light to turn on and off during the day are entered and saved on the touchscreen by the user. The light turns on or off at these saved defined times.

Fig. 16. *Touchscreen lighting range setting page*

Manual Lighting: A manual mode was included to be able to turn the lighting of the aquarium on or off during the day. The icon on the touchscreen, in Figure 17, is designed to become active when the light is off, and inactive when the light is on.

Fig. 17. *Manual lighting control tab*

III. RESULTS

Existing systems offer manual or temporary solutions to pH and TDS values. These processes take time and are not healthy for the creatures because of instability. On the executed system, pH value is fully automatic, and TDS is semi-automatic. On the next phase of the study, it is planned to integrate a TDS module to the system to make it fully automatic.

It is thought that because the executed system is a touchscreen controlled mobile device, it will be worthy of note in the literature (Figure18).

Fig. 18. *Executed mobile system*

This study was tested on the Discus fishes and found that there is a considerable increase in their reproduction.

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