Journal Home: www.bioticainternational.com

Popular Article

Article: RT720

Biotica Research Today

Vol 3:9 741/744

2021

IoT based Smart Water Quality Management in Aquarium

C. Mercy Amrita*, D. Babiyola, M. Kamalakannan, S. Nivetha and P. Sivanesan

Tamil Nadu Dr. J. Jayalalitha Fisheries University, College of Fisheries Engineering, Nagapattinam, Tamil Nadu (611 001), India

Open Access

Corresponding Author

C. Mercy Amrita

e-mail: mercyamrita@tnfu.ac.in

Keywords

Actuators, Aquarium, Controlling, Sensors

How to cite this article?

Amrita *et al.*, 2021. IoT based Smart Water Quality Management in Aquarium. Biotica Research Today 3(9): 741-744.

Abstract

Water quality is the most important factor affecting fish health and performance in aquarium. Fish life totally dependent on the water they live. An IoT-based smart aquarium monitoring system is one of the solutions to cater the problems of water quality. The maintenance of fish aquarium is very difficult task, as continuous monitoring of water quality is required. The manual methods of determining the water quality parameters include instrumental, titration and kit methodologies. These methods are tedious, time consuming, not accurate and could not obtain instant results. Improved methods for monitoring and controlling water quality indicators in real time are required for constant monitoring of fish health. This paper proposes an IoT based system which is equipped with sensors and actuators to monitor and control the aquarium in real time. It is a low cost system with better efficiency. This designed prototype is useful for broodstock holders of ornamental fishes.

Introduction

In the aquarium, Aquatic lives are easily affected with the changes of the aquarium condition like dissolved oxygen, temperature, lighting and the feeding. For the large scale aquarium, man may do mistakes due to the human nature (Rewatkar *et al.*, 2018). Gathering of data from the aquarium should be done in a timely manner and the changes need to be done to the environment. IoT is an emerging technology which realizes this present nature of computing. Aquarium management require timely gathering of water parameter value changes. These changes may affect the lifetime of aquatic animals in the aquarium. The proposed system collects the real time data from aquarium environment using sensors, processes it and updates the temperature, dissolved oxygen of water in real-time in response of any unfavorable situations through temperature probe & DO sensor (Afifah *et al.*, 2019). The growth of fish in a fish tank is highly dependent on water quality conditions. When it comes to growing aquatic organisms, water quality is crucial. Water quality is different for different species; therefore it must be maintained to ensure growth and survival. The health of the organism as well as the costs of bringing a product to market are both affected by the quality of the water used in the manufacturing process. Temperature, dissolved oxygen, pH, alkalinity, hardness, ammonia, and nitrites are among water quality characteristics that are frequently evaluated in the aquaculture business. Carbon dioxide, chlorides, and salinity may be monitored as well, depending on the culture system. Some parameters, such as alkalinity and hardness, are rather constant, whereas others, such as dissolved oxygen and pH, change on a regular basis. As a result, establishing a uniform water quality testing procedure is essential (Ali *et al.*, 2020). Dissolved oxygen is

Article History

Received in 07th September 2021

Received in revised form 09th September 2021

Accepted in final form 10th September 2021

E-mail: *bioticapublications@gmail.com*

one of the most important parameters in aquarium tank, aquaculture pond, and hatchery. Maintaining good level of DO in the water is essential for successful production. Oxygen has a direct influence of disease resistance, feed intake and metabolism. A sub optimal level of DO is extremely stressful for fish. Lower level of DO *e.g*., 3 ppm of dissolved oxygen result in slower growth and decreased immune reaction and level below 1 ppm can be lethal. It is important to keep the dissolved oxygen levels in aquaculture system above 4 parts per million (ppm) (Lin and Tseng, 2019). All organisms' growth and survival are influenced by their environment's temperature. In most aquaculture systems temperature can't be controlled. Daily variations in water temperature, changes in water temperature, and seasonal trends in water temperature will occur as a result of weather patterns that can occur at any time of year. Aquaculture animals usually are classified as cold water, warmwater, and tropical species. Temperatures of 20 to 25 °C are too hot for cold water creatures to survive. Warm water species cannot breed or grow below 20 °C, although they can endure much colder winter temperatures. At temperatures of 10 to 20 °C, tropical species will die, and most will not grow at temperatures below 25 °C (Lin and Tseng, 2019).

Methodology

The proposed system operates for automated system to control the water quality of Aquarium. The hardware and software design of the system is discussed below.

Hardware Design

Aquarium can be automated by using sensors, microcontrollers, relay board as shown in Figure 1. Afifah *et al*. (2019) developed an automated system that monitor the water quality parameters changes and will maintain it to the ideal conditions and activate the respective actuators. Arduino UNO and relay board are used as the main controllers to monitor and control the sensor. The aquarium will perform all the operations automatically like temperature control, dissolved oxygen control, and light. In this setup, microcontroller will receive dissolved oxygen and temperature values through sensors and will automatically turn ON/OFF the respective actuator, if these parameters goes above or below its optimal range. We describe the relationship between the sensors in aquarium and the actuators and give concrete examples about the threshold setting (Lin and Tseng, 2019).

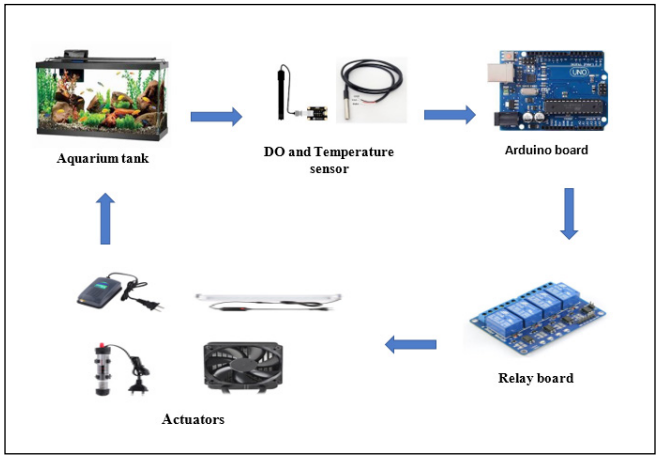

Figure 1: Hardware design

Sensors: Temperature sensor and DO sensor are always running and continues real time data collection. These two sensors are connected to the Arduino board. When sensors detect a problem, they will send a notice to the IoT platform, which will be marked as an alert, and it will be monitored automatically.

Microcontroller: In this system, Arduino microcontroller is centralize unit of system sensors, relay board and actuators are connected with Arduino UNO microcontroller (Rewatkar *et al*., 2018). The Arduino UNO is use as a controller to process the data that collected from the sensor. The processed data are transmitted to the relay for controlling the optimal range of parameters.

Relay Board: The relay board which automatically turns ON and OFF the actuators based on the ideal condition without human interference (Rewatkar *et al*., 2018).

Actuators: Simply said, an actuator works in the opposite direction of a sensor. It converts an electrical signal into physical action. In this system, actuators such as air pump, heater, cooler and light are connected with 4 channel relay board. In IoT systems, a sensor may gather data and communicate it to a control centre, which makes a decision and sends a command to an actuator in response to the detected input (Lin and Tseng, 2019).

Software Design

Figure 2 shows the Arduino IDE for designing software system. The Arduino integrated development environment (IDE) is a cross platform application that is written in the programming language Java. In this

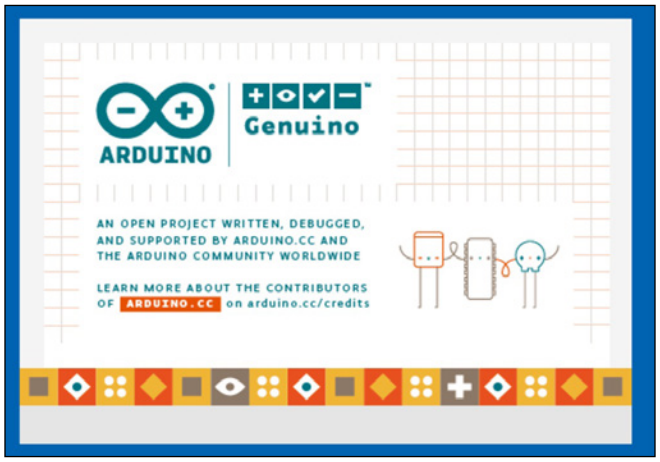

Figure 2: Arduino IDE

paper, it is used to write and upload programs to Arduino microcontroller. The data that collected will be used to determine the appropriate act to be done to control the system automatically.

As shown in Figure 3, this is a flow chart of the developed system. All sensor always running and continues data collection. When any problem is detected by sensors, it will send to relay board and control automatically.

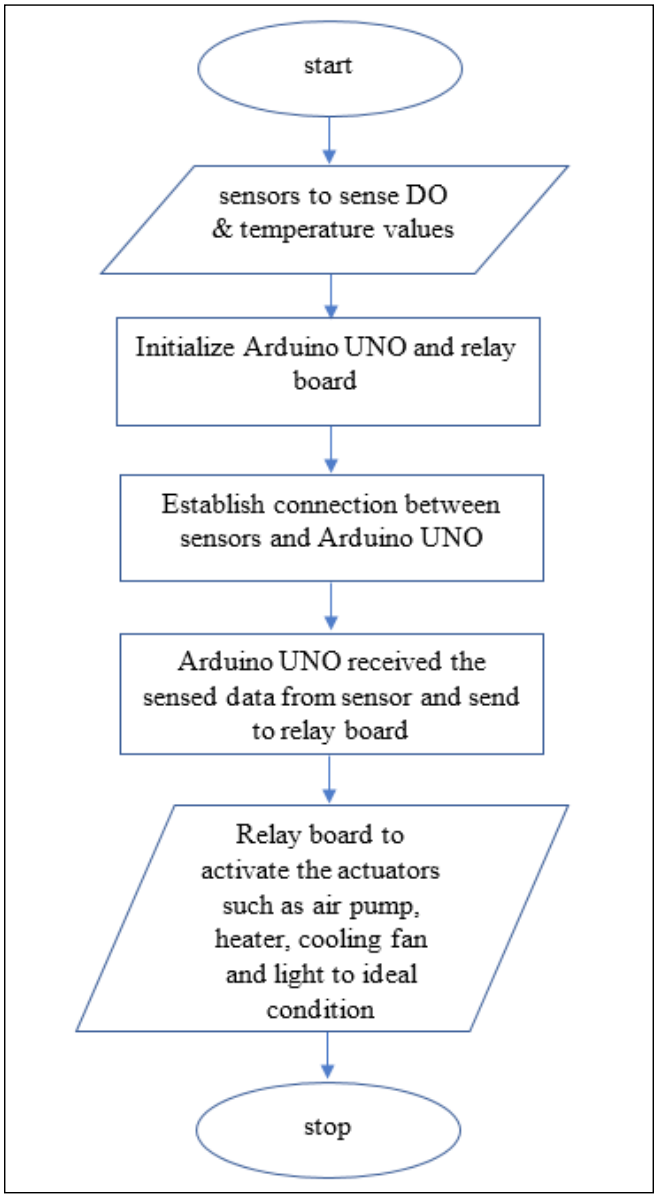

Figure 3: Flow chart of the developed system

Results and Discussion

Figure 4 shows the IoT based real time automated monitoring and controlling system for aquarium is developed. It is important to maintain the quality of water in real time, to ensure the safe growth of fish in the aquarium. If we fail to maintain the water quality in the aquarium tank, the fish will be stressed by deficient water conditions, will be more susceptible to disease, and will have a shorter lifespan. In this regard, we have developed an IoT based real time monitoring and controlling system for the essential water quality parameters of an aquarium setup is shown in Figure 5. These parameters are important for the fish health. In this smart system LM35 temperature sensor and DF robot DO sensor are used to measure temperature and DO values in real time. Air pump, light, heater and cooling fan are connected with a 4 channel relay board and used as actuators. These sensors, relay board and actuators are connected with Arduino UNO microcontroller. Microcontrollers receives the temperature and DO values from the sensors and drives the corresponding actuator through the relay board in real time, if temperature or DO value goes above or below optimum level. In this project, Arduino UNO and relay board are used as the main controllers to monitor and control the sensors, light, heater, air pump and cooling fan.

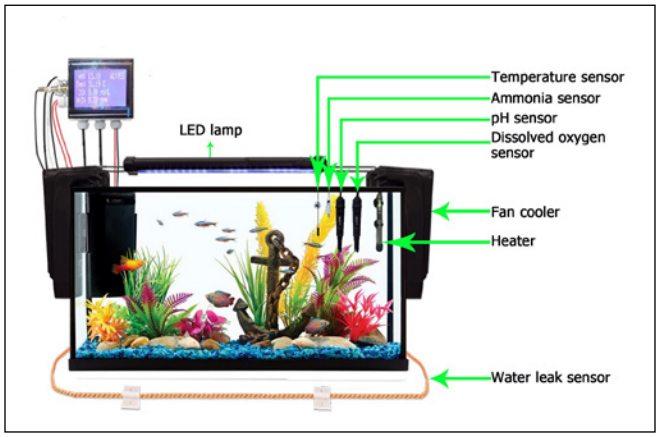

Figure 4: Aquarium setup

Temperature Control

Optimal temperature range of the species typically results in healthier fish with stronger immune functions. For most fishes, the optimal temperature ranges from 25 to 27 °C.

A heater is used to increase the water temperature in an aquarium tank. Unfortunately, small tanks are difficult to heat properly, and heaters specifically designed for mini aquariums should be selected. To reduce the water temperature, a fan can be used to blow across the surface of the tank water to increase evaporation. Water releases more energy when it transitions from water to vapor, which drops the temperature. Consequently, a fan blowing across the surface of the tank water reduces water temperature by increasing evaporation.

Figure 5 shows the temperature and DO readings. LM35 Temperature sensor measures the water temperature and sends it to the microcontroller. When the water temperature

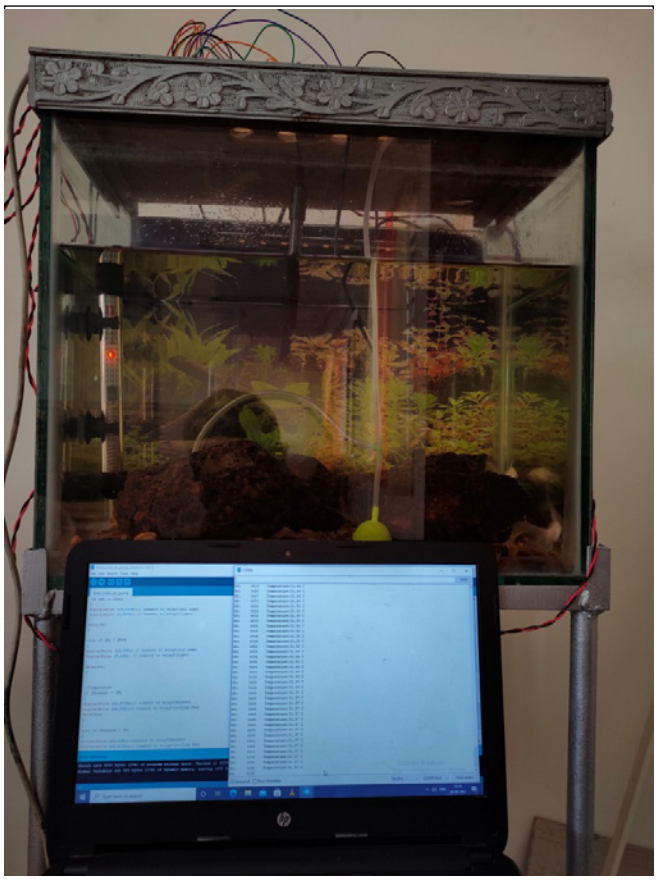

Figure 5: Temperature control (heater & fan) through Arduino

falls below 25 °C, the microcontroller automatically turns the heater ON. When the water temperature goes above 27 °C, the microcontroller automatically turns the cooling fan ON. When the water temperature is in between 25 to 27 °C, the microcontroller automatically turns the heater and fan OFF.

Dissolved Oxygen and Air Pump

In this paper, air pump is fixed at the top of the aquarium tank. Air stone is connected with air pump *via* airline tubing and placed inside the tank. Air pump forces air into the water, creates water motion with the rising air bubbles and also provide oxygen to the water with the use of an air stone. So, it will be helpful for fishes when dissolved oxygen level is low. For an aquarium tank, the dissolved oxygen level should be maintained above 5 mg/L.

In the setup which is shown in the figure 6, DF robot dissolved oxygen sensor measures the dissolved oxygen value and sends it to the microcontroller. When the dissolved oxygen level is below 5 mg/L, microcontroller automatically turns ON the air pump. When the dissolved oxygen level reaches 5 mg/L, microcontroller automatically turns OFF the air pump.

Figure 6: Light & DO control through Arduino

Conclusion

As the conclusion, this project can give many advantages to the people especially amongst the fish keeper nowadays. It is very helpful to monitor the temperature and dissolved oxygen of water. The development of the Internet of Things (IoT) is very helpful for the smartphone user in this era. As the result, user can know whether the condition of water is comfort or need to be replaced to the newer water. The experience to reveal the new thing is very useful especially on making new things in order to make it useful for people's future prospect. Lastly, this Smart IoT Aquarium is one of the new ventures and very useful for fish keeper all around the world.

References

Afifah, Y., Rosadi, R.A., Hafiz, M.R., 2019. The smart monitoring and automation control system for fish aquarium based on internet of things technology. In *AIP Conference Proceedings* 2097(1), 030018. AIP Publishing LLC, 2019, April.

Ali, K., Memon, S., Shakoor, A., 2020. Monitoring of Water Quality of Aquarium by using IOT technology. *Journal of Applied Engineering & Technology (JAET)* 4(2), 22-34.

Lin, Y.B., Tseng, H.C., 2019. FishTalk: An IoT-based mini aquarium system. *IEEE Access* 7, 35457-35469.

Rewatkar, R.M., Mahajan, M.H.T., Mahajan, M.P.P., Dhage, M.G.R., Kapse, M.P.A., Dubale, M.S.M., 2018. Design and implementation of Automatic Aquarium System using IOT. *International Journal on Future Revolution in Computer Science & Communication Engineering* 4(4), 354-356.