IOT Based Automated Fish Tank

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1 Introduction

From last 20 years at a steady pace pet ownership has been increasing. Nowadays freshwater fish is the most popular pet. Fish aquarium maintenance is a very difficult task. Whenever you have to feed, or you have to clean up your fish pot/tank, you have to do a lot of things. The fishes required to be fed two times a day which causes the owner to give food to the fish manually which makes the duty of conserving an aquarium very difficult. At periods when the owner is not available, he cannot feed the fish and has no control over the aquarium. So for a mini aquarium tank the important parameters should be intimately observed and proper actions should be rapidly taken at the time of dangerous situations. According to several studies for maintaining healthy fish, small aquarium tanks are not suitable. General suggestion for aquarium tanks is five gallons which lead to the less impact of mistake on fish. YI-BING LIN proposed the Fish Tank system that utilizes actuators that drive with the aquarium sensors and also implemented an intelligent fish feeding system in which the fish is not either over fed nor under fed, and at the same time, the fish owner can enjoy watching fish feeding remotely [1]. Aaron Don M. Africa proposed system which is used to measure, monitor, and regulate all the important parameter factors related to aquarium system. In real-time temperature and pH measurement was relatively easy as compared to DO sensor [2]. Jui-Ho Chen proposed a system that uses mobile device to monitor the fish farm Environmental Data such as PH value, Temperature, water level sensing, dissolved oxygen. It uses Zigbee module for Wi-Fi. Noor proposed automatic fish feeder system based on PIC microcontroller applications. It consists

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of pellet stand storage, DC motor, former, and microcontroller. Controlling of pallet is done by DC motor the rotation speed [3].

The system with which we came up is an Automatic Fish Tank. In this chapter this system is a programmed system to take think about fishes. With this system fish aquarium manual maintenance will change with its automated functions. Functions performed by the system are as follows: This system will observe the physical changes in the water and with required changes will maintain as per the ideal conditions. The system will perform all the steps automatically like turbidity of water, monitor lighting, pH detection, temperature control, feeding and water filtration. Overfeeding is the number one problem arises due to fish owners, as unused food will contaminate the water inside the tank due to which the turbidity of water changes, the pH of water changes and the dissolved oxygen level might get low. Overfeeding would also have a harmful effect on the health of fishes, since they do not know how much food to eat and end up eating excess and this would just shorten the life of fishes and their behaviour would be altered. So, the feeding would be done by an automatic feeder that would always drop the precise portion of food time to time. The other parameters like temperature are controlled by the system. Survey indicates that higher temperatures within the optimal temperature range from 25 to 27 °C for the species typically lead to stronger and healthier fish. Rather than stable high or low temperatures, extreme changes in temperature are more dangerous to fish. The pH sensor is used to measure acidity of water which is created by dissolved carbon dioxide the ideal pH range for fishes is 6.8–7.6, even if certain fish may need higher or lower levels. A fish tank needs oxygen to support the livestock. In the water combination of decreased oxygen concentration and eminent carbon dioxide concentration leads to suffocation. The oxygen necessities change depending on the weight and the type of fish. The oxygen necessities will be different according to the type and the weight of fish. Therefore, to avoid oxygen depletion, oxygen levels should be higher than 2–4 mg/L hence DO sensor would monitor the DO level in the tank [5]. As the amount of suspended solid increases, the water muddiness or vagueness increases. Turbidity is the measure of relative clarity of water and waters visibility is controlled by this feature. The ideal range of turbidity is from 1 TO 5 NTU (Nephelometric Turbidity unit) 1 mg/L and is equivalent to 3NTU. The turbidity levels depend upon the type of fish so the range may differ accordingly. Turbidity sensor being used here helps to monitor the turbidity of the water, if the turbidity level is above the desired level, then the water filter controls the cloudiness of the water in the tank.

2 Factors for Water Quality

2.1 pH

pH of the water is affected by fish waste, topping off the water, water hardness, and water evaporation. Drastic changes in the water cause changes in blood pH, which

leads to tension and loss. The pH sensor will automatically monitor the pH of the water regularly and indicate it on the LCD screen. Suitable range of pH is 6.8–7.6.

2.2 Temperature

As fish are aquatic vertebrates, water temperature greatly affects their immunity and metabolism. The fish immune response is suppressed by decrease in water temperature. Sensor monitors the temperature of the water and displays the value on LCD screen. The Peltiers are used to manage the temperature of the water inside the tank, and it is used for both cooling and heating according to the temperature of the tank.

2.3 Turbidity

Turbidity sensor being used here helps to monitor the turbidity of the water, if the turbidity level is above the desired level, then the water filter controls the cloudiness of the water in the tank. The ideal range of turbidity is from 1 TO 5 NTU (Nephelometric Turbidity unit).

2.4 Dissolved Oxygen

Atmospheric air and photosynthetic planktons are principal source of oxygen in water. Due to low solubility of oxygen in water, obtaining adequate oxygen is a larger problem for aquatic organisms than terrestrial ones. Solubility of oxygen decreases with factors like low atmospheric pressure, high concentration of submerged plants, high humidity, increase in salinity, increase in temperature, plankton blooms. Reduction of oxygen in water cause starvation, reduced growth, more fish mortality and poor feeding of fish.

3 Components of Proposed System

The proposed systems main components with Arduino controller are shown in block diagram in Fig. 1.

The main objective of this system is to construct and design an automatic aquarium for the people who cannot take care of their fish aquarium daily and reduce the manual factor as much as possible. The system is extremely easy to operate and can be modified according to future requirement. Whenever there is a change in the aquatic parameter of aquarium such as turbidity level, pH level, dissolved oxygen

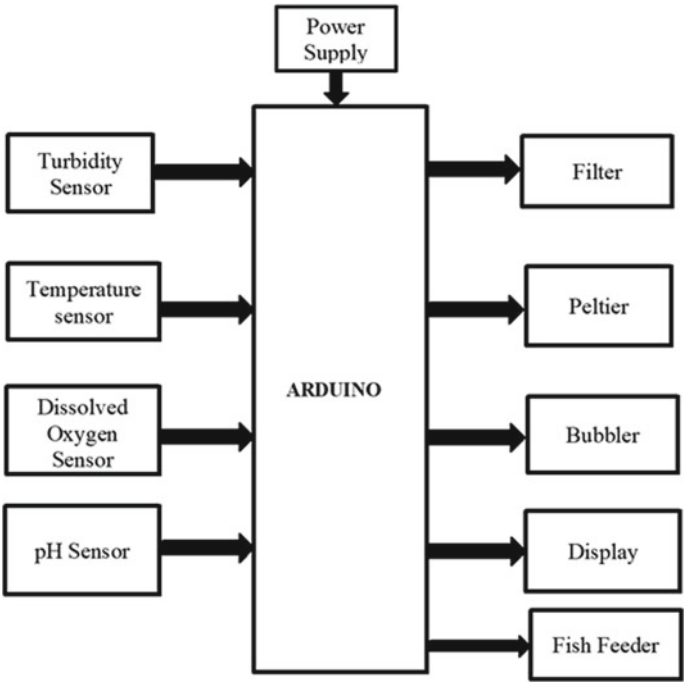

Fig. 1 Block diagram of proposed system

level or in temperature, the sensor will sense these changes, and these changes will then process by the Controller (Arduino Uno). Commands are send by Controller to the sensors, where to sustain the ideal conditions the output part will be observed working.

There will be a pH level sensor, temperature sensor, water level sensor, turbidity sensor, feeder, Peltier and LCD. All the sensors will be interfaced with the controller. If something changes, the controller will start functioning to get back to the ideal state. The normal temperature range of fresh water aquarium is considered to be 25–32 °C. If water temperature of aquarium exceeds, the Peltier will start cooling until the desired temperature is not achieved. If water temperature of aquarium goes down, the Peltier will heat up until the temperature does not reach to the normal temperature. After every 12 h the controller would turn on the feeder for feeding purpose. If the turbidity level has increased beyond the normal range, then controller will start the filter. The value of pH sensor will be display on LCD. The main components of the system are as follows.

3.1 Controller

In this system controlling operations are performed by two Arduino Uno's. These controllers are having 14 digital I/O pins and 6 analogue input pins. Each microcontroller is used for analysing, controlling and processing the input signals from sensors. The Arduino Software (IDE) and Arduino programming language (based on Wiring) are required for writing instruction, based on processing [4].

3.2 pH Sensor

The working pH sensor is used with Arduino controller to find out the alkalinity or acidity of a solution, and it is used with Ardino uno. pH sensor measuring range is 0–14 pH.

3.3 DO Sensor

Analog DO sensor is used to determine the dissolved oxygen in water which range from 0.01 to + 35.99 mg/L. In the tank as dissolved oxygen value goes down the microcontroller boosts the air pump (via relay) to supply tank with the oxygen.

3.4 Temperature Sensor

Temperature sensor is used to measure the temperature of water and maintain it within the required range. The required range is from 25 to −28 °C.

Flowchart for operation of the system is shown in Fig. 2.

If the pH of water is too high or too low, it will effect aquatic ecosystem of an aquarium and results in demise of fish heavy metals and toxicity of chemicals and solubility in the water is affected by pH.

The majority of aquatic creatures preferred a pH range of 6.5–9.0, however some of aquatic creature live in water with pH levels outside preferred range. Same goes for temperature and turbidity.

Aquarium fishes are very sensitivity to temperature changes, for keeping your fish healthy and comfortable good temperature control is essential. The typical range lies between 25 and 30 °C. For controlling the temperature, we are using two peltiers, one is used to for cooling (if temperature is above the desired range) and the other is used for heating (if temperature is below the desired range). If a voltage is positioned across a Peltier element, one side is cooled and the reverse side simultaneously heats up [6]. In Peltier element the hot and cold sides can be swapped by changing the

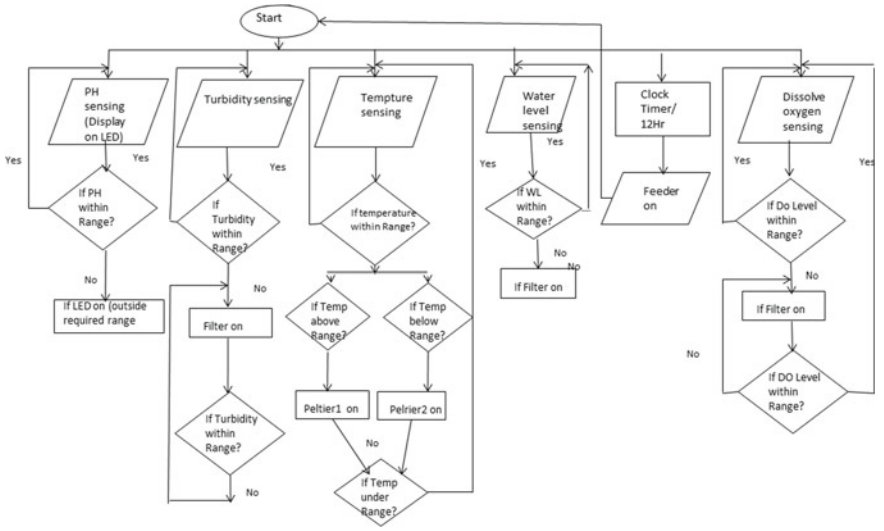

Fig. 2 Flowchart for operation

polarity of the supply voltage. The changes in temperature will be displayed on the LCD.

Inside the tank visibility is limited by cloudy aquarium water. Turbidity may appear in the form of milky-grey water, or as suspended particles visible to the naked eye, or as a greenish stain in the water. So, to avoid turbidity, we are using Turbidity sensor and Filter. If the turbidity is not within the range 70–140 ppm then filter is turned on and after filtration again the turbidity is checked for the required range, process ends when the ideal value is obtained. Mechanical design of system is shown in Fig. 3.

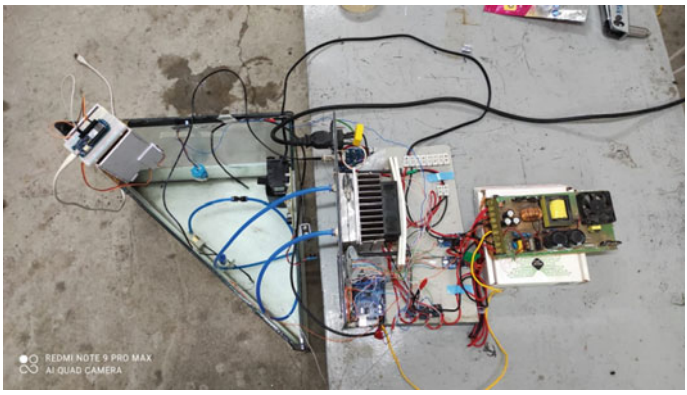

Fig. 3 Mechanical design of system

4 Some Common Mistakes

4.1 Overfeeding Fish and Invertebrates

Adequate supply of food to fish is important but uneaten food just lays on the bottom of the tank, creating ammonia nitrite and nitrate and overloading the biological filter, which ultimately increases the alkalinity of water. The fish food contains high protein that is fed regularly which leads to liver damage, affects metabolism and immunity.

4.2 Inadequate Filtration

There are a number of methods available for filtration but for the tank if proper filter selection is unavailable lead to a wide variety of difficulties. Whether it be biological, chemical, or mechanical, it is better to have more filtration for the size of aquarium. The short of good quality water flow all over the system can cause problems such as the build-up of nuisance algae with low DO (dissolved oxygen).

4.3 Altering Temperature

For the fish, the body temperature is the same as the water temperature which they live in because they are cold blooded animals. The water temperature affects the fish metabolic rate, and it is closely linked to it. Change in water temperature may also increase the mortality rate.

4.4 Replacing All the Water

Changing water frequently or changing the entire water present in the tank and using tap water causes destroy of the beneficial bacteria and ecosystem which has built up in tank. Deficiency of these beneficial bacteria lead to a spike in ammonia which is toxic to fish.

5 Results and Analysis

In the present world to reduce work pressure of human, everything is moving towards automation. Therefore in this chapter we proposed automated fish monitoring system that enables easy control over the several issues of aquarium such as temperature

Table 1 Additive complexity of CFFT

Water Criteria	Acceptable range	Desirable range	Critical
Temperature	25–30 (°C)	25–32 (°C)	<15, >35 (°C)
pH	7–9.5	6.5–9	<4, >11
Alkalinity	50–200 (mg L^{-1})	25–100 (mg L^{-1})	<20, >300 (mg L^{-1})
Hardness	>20 (mg L^{-1})	75–150 (mg L^{-1})	<20, >300 (mg L^{-1})
Turbidity		70–150 (ppm)	55, >250 (ppm)
Water color	Pale to light green	Light green to light brown	Clear water, Dark green & Brown
Dissolved Oxygen	3–5 (mg L^{-1})	5 (mg L^{-1})	<5, >8 (mg L^{-1})
Ammonia	0–0.05 (mg L^{-1})	0– <0.025 (mg L^{-1})	>0.3(mg L^{-1})
Nitrate	0–100 (mg L^{-1})	0.1–4.5 (mg L^{-1})	>100, <0.01 (mg L^{-1})
Nitrite	0.02–2 (mg L^{-1})	< 0.02 (mg L^{-1})	>0.2 (mg L^{-1})
H_2S	0–0.02 (mg L^{-1})	0.002	Any detectable level
CO_2	0–10 (mg L^{-1}	<5, 5–8 (mg L^{-1})	>12 (mg L^{-1})

variations, feeding schedule, turbidity level, dissolve oxygen level which contains sensors to collect the information mandatory for desired actuation using Arduino. The parameters like temperature, turbidity and pH will be displayed on LCD. Every parameter has a precise range in which fishes can live longer. The acceptable range and the ideal ranges are given in Table 1.

6 Conclusion

The main part of this chapter is the combination of actuators and aquarium sensors. This chapter is started with aim to achieve the simple looking task of designing an Automated Fish tank. As time pass away we experience that this was not an easy task in terms of interfacing the sensors and feeder. The critical issue is money required because for up gradation of this project much more stuff up gradation need to be done. As electronics engineering is concerned this chapter build our practical implementation knowledge. Having an Automated Fish tank will save our time and no need to worried for our fish and their aquariums for long time.

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