Review Paper on Automated Fish Tank

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ABSTRACT:Fish keeping is popular these days, people from all age group like to keep fish in their home, office etc. in the aquarium tank that needs to be properly set up and maintained, or the fish will be destined to an unpleasant and short life. Hence it is difficult to monitor and control water conditions closely and enhance the water quality. Based on Arduino the Automated Fish Tank system that utilizes the aquarium sensors to monitor and control the water conditions. Proposed solution gives quick access to utilize the smart system to control various water parameters. The system contains automatic feeder which will ensure the food is to be fed adequate and at right interval of time, Turbidity sensor which is deployed alongside filter for maintaining clean water, pH sensor will display pH of water, Temperature sensor and heater, cooler is used to maintain water temperature and Bubbler will operate as a consequence of dissolved oxygen sensor to retain oxygen level.
KEYWORDS:Fish tank, Feeder, pH sensor, Dissolved oxygen sensor, Turbidity, Temperature sensor, Arduino Uno.

I. INTRODUCTION

Pet ownership has been increasing at a steady pace in the last 20 years. After cats and dogs, the most popular pet is now the freshwater fish. The maintenance of fish aquariums is a very difficult task itself. Whenever you have to clean up your fish pot/tank or you have to feed, you have to do a lot of things. The fishes need to be fed twice a day even this requires the owner to walk up to fish tank and feed the fish manually which makes the task of maintaining an aquarium much more difficult. At times when the owner is on vacation, he has no control over the aquarium and also can't feed the fish., so the key water parameters of a mini aquarium tank should be closely watched, and proper actions should be quickly taken when some critical situations are detected. Several studies indicate that small aquarium tanks are not suitable for maintaining healthy fish. The bigger the tank,

the less impact a mistake will have on fish, and aquarium tanks of at least five gallons are suggested. The project with which we came up is an Automatic Fish Tank. This project is an automated system to take care of fishes. It will replace the manual maintenance of fish aquarium with its automated functions. It will monitor the physical changes in the water and will maintain it to the ideal conditions, with required changes. The aquarium will perform all the steps automatically like temperature control, pH detection, turbidity of water, monitor lighting, feeding and water filtration. Overfeeding is the number one mistake made by fish owners, as uneaten food will pollute 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 negative impact on the health of fishes, since they don't know how much food to eat and end up eating excess and this would result in mortality of fishes and their behaviour could 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. Studies indicate that higher temperatures within the optimal temperature range of the species typically leads to healthier fish with stronger immune functions the optimal temperature ranges from 25◦ to 27◦C. Extreme changes in temperature are more harmful to fish than constant high or low temperatures. The dissolved carbon dioxide creates carbonic acid, which acidifies the water that can be measured by the pH sensor the ideal pH range for fishes is 6.8 to 7.6, although certain fish may require higher or lower levels. A fish tank needs oxygen to support the livestock. Decreased oxygen concentration combined with elevated carbon dioxide concentration in the water leads to suffocation. The oxygen requirements differ depending on the type and the weight of fish. Therefore, oxygen levels should be higher than a certain concentration (usually 2-4 mg/L) to avoid

oxygen depletion hence, DO sensor would monitor the DO level in the tank. When the amount of suspended solid increases, the water cloudiness or haziness increases. Turbidity represents the total amount of particles in the water and this feature controls waters visibility. Hence, turbidity is considered as the optical property of water. The ideal range of turbidity is from 1 TO 5 NTU (Nephelometric Turbidity unit) 1mg/L 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.

II. LITERATURE REVIEW

1)In this paper, they proposed a system and method for monitoring and controlling an aquatic environment thus regulating the aquatic environment and maximizing the stability of the aquatic ecosystem. This system uses sensor and data fusion algorithms to perform system anomaly analysis and predictive failure diagnostics based on the output of sensors associated with the aquatic environment control devices. [11]

2)This paper proposes a system which has an indoor breeding pond constructed in a step wise manner for breeding aquatic or marine products in staged breeding approach to increase breeding density and reduce required space. Breeding water is processed in advance by a recirculating water treatment System and water quality is constantly monitored by a water quality monitor and control System, which maintain the breeding water at the optimum condition. [12]

3)This paper aims to design, a system through which users can monitor and maintain their fish aquarium regularly via internet, using devices such as smartphones and laptops. The major role of this system is to enable users to monitor and maintain their fish aquarium through a server of database, which include tasks such as feeding on time, water temperature, turbidity level reaches a predetermined unsafe point for the fishes. [10]

4)In this paper, they proposed asystem of fish tank which uses STC12C5A60S2 microcontroller as the control and can automatically light on, automatically change water, automatically feed, and automatically water cycle. The collected data and all of the operations can be accessed through the display which is easy for the user to observe and operate. [9]

III. WATER QUALITY CRITERIA

There are many water criteria that must be taken into consideration to maintain high quality of water. Water quality criteria such as Temperature, dissolved oxygen and pH are influence fish production. Dissolved oxygen, pH, temperature, total nitrogen (includes: ammonia, nitrite and nitrate) and water hardness represent the most water criteria that influence fish production in an aquarium. These criteria are influenced each other in addition to be influenced by many other factors such as surrounding environment.

1.pH

The pH of natural waters is greatly influenced by the concentration of carbon dioxide which is an acidic gas. Water pH is affected by water hardness, fish waste, topping off the water and water evaporation, and sudden changes in the water results in changes in blood pH, which leads to stress and death. Fish have an average blood pH of 7.4, a little deviation from this value, generally between 7.0 to 8.5 is more optimum and conducive to fish life. pH between 7 to 8.5 is ideal for biological productivity, fishes can become stressed in water with a pH ranging from 4.0 to 6.5 and 9.0 to 11.0 and death is almost certain at a pH of less than 4.0 or greater than 11.0. the suitable pH range for fish culture is between 6.7 and 9.5 and ideal pH level is between 7.5 and 8.5 and above and below this is stressful to the fishes. Ideally, an aquaculture pond should have a pH between 6.5 and 9. [1]

Remedies: Add gypsum ($CaSO4$) or organic matter (cow dung, poultry droppings etc.) and initial pre-treatment or curing of a new concrete pond to reduce pH levels, use of quicklime (CaO) to rectify low pH of aquatic body.[1]

2.Temperature

Fish are poikilothermic aquatic vertebrates therefore water temperature greatly affects their metabolism and immunity. Decrease in water temperature suppresses the fish immune response. Also, fish sensitivity to changes in water temperature varies throughout its life cycle. Fish are most sensitive to water temperature changes during spawning and larval development. Water temperature should not be changed more than about 1℃ / hour. Sudden stop of the heater in winter is followed by rapid drop in temperature (10℃ in one day) might cause many fish to die immediately. Temperature ideal Range is (20 ℃ - 25 ℃).

Acceptable range (20℃-30 ℃).[2]

Side effects of variation in temperature-
a) The First evidence of hypothermia in fish is a loss in colour followed by rapid breathing/gill movement. Additionally, erratic swimming may occur. The effects of hypothermia can lead to hypoxia, which basically means that the fish is starving for oxygen. While it is true that cold water holds more oxygen by its nature, because the fish/s metabolism is so slow it cannot adequately take up oxygen and suffers from low oxygen.

b) At low temperature Fish appear sluggish, depressed, and may be anorexic (not eating). Hypothermia can lead to an abnormal metabolism and dysfunction of the immune system.

c) Mortality varies and depends on species, temperature of the water, and duration of exposure.

d) Low pond temperature has been associated with an idiopathic syndrome known as winter kill.

e) High temperature associated with dyspnoea.

3. Turbidity
Boyd and Lichtkoppler (1979) suggested that the clay turbidity in water to 30 cm or less may prevent development of plankton blooms, 30 to 60 cm and as below 30 cm - generally adequate for good fish production and there is an increase in the frequency of dissolved oxygen problems when values above 60 cm, as light penetrates to greater depths encourage underwater macrophyte growth, and so there is less plankton to serve as food for fish. According to Bhatnagar et al. (2004) turbidity range from 30-80 cm is good for fish health; 15-40 cm is good for intensive culture system and < 12 cm causes stress. According to Santhosh and Singh (2007) the secchi disc transparency between 30 and 40 cm indicates optimum productivity of a pond for good fish culture. [1]

4. Dissolved Oxygen
The oxygen requirements differ depending on the type and the weight of fish. For some species without additional organs, the result of low dissolved oxygen is immediate death. Some species have developed labyrinth organs to allow air breathing in hypoxic conditions. However, oxygen deprivation (hypoxia) still occurs when the oxygen tension is lower than the organism's requirement. Depending on the fish species, the oxygen levels should be higher than a certain concentration (usually 2-4 mg/L) to avoid oxygen depletion. [4]

The principal source of oxygen in water is atmospheric air and photosynthetic planktons. Obtaining sufficient oxygen is a greater problem for aquatic organisms than terrestrial ones, due to low solubility of oxygen in water and solubility decreases with factors like- increase in temperature; increase in salinity; low atmospheric pressure, high humidity, high concentration of submerged plants, plankton blooms. Oxygen depletion in water leads to poor feeding of fish, starvation, reduced growth and more fish mortality.

IV. COMPONENTS OF PROPOSED SYSTEM
The proposed system used Arduino platform to illustrate all its components. The following explains the used components:-

1. Microcontroller
The proposed system requires using two microcontroller. The role of each microcontroller is controlling, processing and analyzing the input signals from sensors.

2. Relay
A Relay is a switch that is electrically operated. Electromagnet is used by many relays to mechanically operate the switch and provide electrical isolation between two circuits.[5] Two Arduino cannot control high volt n amp, but a relay can do this job, which is the sole design of it. So the relay is used as switch to control high power devices. Relay circuits are used with 5 v, supply at specific time.

3. pH Sensor
The employed PH sensor is that it used to measure the acidity or alkalinity of a solution and it used with Arduino controller. The measuring range of this sensor is 0-14 pH.[6] This pH electrode needs to be calibrated before using it by putting it into the standard solution (KCL3N solution) whose pH value is 7.00. After calibrated pH sensor.

4. DO Sensor
Analog dissolved oxygen sensoris used to measure the DO in water with range from 0.01 to +35.99 mg/L. When the oxygen value reduced in tank the microcontroller energizes the air pump (via relay) to supply ponds with the oxygen.

5. Temperature Sensor
Water proofed digital sensor type isused and its range is from 25 to -28 C°. The function of this sensor is sensing the water temperature to maintain it within the required range.[5]A heater and axial fan are used to increase and decrease the water temperature respectively.

6. Turbidity Sensor

The used turbidity sensor is which consists of turbidity probe and turbidity circuit to derive data to the microcontroller. Turbidity represents the total amount of particles in the water and this feature controls waters visibility. Hence, turbidity is considered as the optical property of water and optical devices are used to determine the turbidity. When the amount of suspended solid increases, the water's turbidity level (and cloudiness or haziness) increases. When the sensed value is larger of required range the microcontroller switches on filter via relay.

7. Water Level Sensor

Water level is a critical factor that should be taken into consideration in ensuring optimum growth, nutrient utilization and survival of fish species.[8]Many fish farming culture systems have been jeopardized due to non-availability of water for culture of fish. Aquaculture production can be boosted through good site for construction of standard pond, provision of quality feeds, quality water and management skills. Nevertheless, water level is a crucial factor that must be considered, as this determines the growth, survival, yield and the well-being of the fish. Several findings had been reported by researchers on the effects of water level on survival, growth, behavior of different fish species.

8. Micro servo motor

The micro servo motor is used for feeder. It allows the shaft to be positioned at various angles, usually between 0 and 180 degrees.[7] It is possible to place a small cylindrical container carrying fish food by changing the angle of its rotation from where the food is carried out through small openings at a descent rate commensurate with the quantity of food supposed to be provided as well as the appropriate time and predetermined daily feeding schedule that can be ensured through the program in the microcontroller.

V. SOME COMMON MISTAKES
1. Overfeeding Fish and Invertebrates: -

It is important to supply fish with the sufficient food they need, but uneaten food just lays on the bottom of the tank, creatingammonianitriteand nitrate and overloading the biologicalfilter. 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.

2. Inadequate Filtration: -

There are a number of filtration methods,but not making the right filter selection for thetank can lead to a wide variety of problems. Whetherit be biological, mechanical, or chemical, it's better to have more, rather than too little filtration for the size of aquarium. The lack of good water flow throughout the system can lead to problems with low DO (dissolved oxygen), the build-up of nuisance algae.

3. Altering temperature: -

The body temperature of fish is the same as the water temperature which they live in because they are poikilothermic animals. The water temperature effects the fish metabolic rate and it is closely associated to it. Change in water temperature may also increase the mortality rate.

4. Replacing all the water: -

Changing water frequently or changing the entire water present in the tank and using tap water, it will destroy the beneficial bacteria and ecosystem which has built up in tank. Without these beneficial bacteria it will create a spike in ammonia which is toxic to fish.[8]

VI. FIGURES AND TABLES

Fish are considered as water quality indicators, especially due to their sensitivity to pollution. Fish raised in aquaria or in laboratory husbandry facilities have more or less reduced volumes of water available in comparison to a natural environment, so that it becomes essential to monitor the water parameters to ensure stable, controlled conditions for fish welfare. Water quality must be also monitored in relation to the possible presence of toxic substances such as pollutants, metals, chlorine and ammonia and the water flow should be set to levels supporting normal swimming. Any changes in water quality and conditions should be gradually applied allowing fish to acclimatize and adapt to them. Moreover, in the aquaculture context the complete life cycle of fish must be sustained.

The following table illustrates acceptable, desired and critical range of the various parameters involved in checking the water quality. [3]
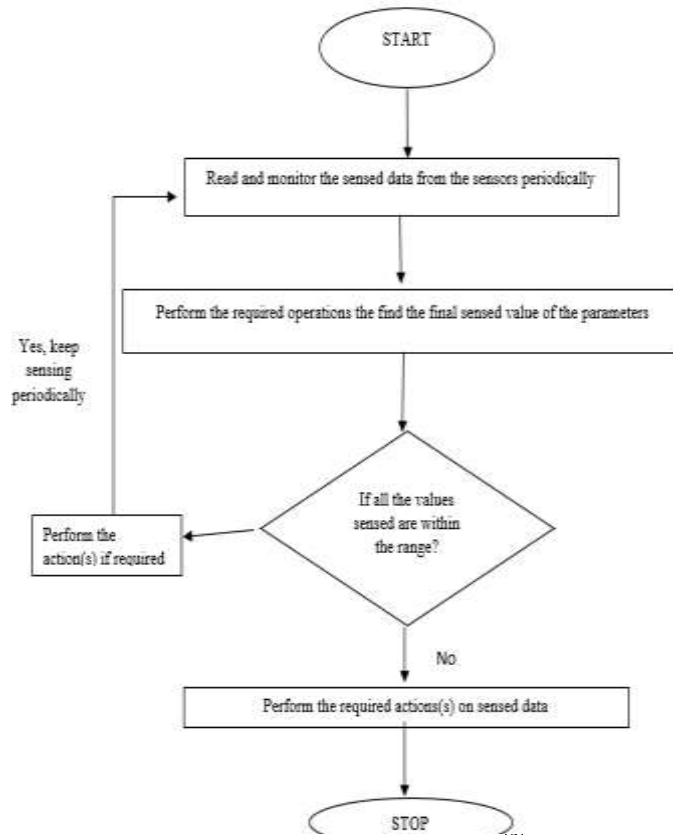
Fig1: Flow chart of the system. [3]

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)
H2S	0-0.02 (mg L-1)	0.002	Any detectable level
CO2)	0-10 (mg L-1	<5 , 5-8 (mg L-1)	>12 (mg L-1)

Table1: Water parameter which system will monitor. [3]

VII. CONCLUSION

The system automated fish tank is designed to minimize the problem of aquarists by shifting it from manual to automatic mode.

The proposed system automated fish tank would overcome all the objectives and enable control over the several issues of aquarium such astemperature variations, feeding schedule, turbidity level, pH and DO level.

We also designed a simple feeder, which will feed fish according to schedule.

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