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IoT Based Automatic Aquarium Monitoring System for Freshwater Fish

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KEYWORDS

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ABSTRACT

A monitoring system for an automated aquarium is not a new system in today's world. The machine allows the user to automatically control the pH level, temperature level, turbidity level, water level and feeding the fish. But it will be inconvenienced to check for the conditions of an aquarium manually. It is time consuming and required commitment. Here, Internet of Thing (IoT) connected system is proposed to monitor and control the whole aquarium maintenance using electronics and sensors which constantly communicate and transmitting real time status to user smartphone. The developed system will monitor the physical changes in the water and maintain it to the ideal conditions, with the required changes decide automatically by the system. The aquarium will perform all the operations automatically including the temperature control, pH control, turbidity control, feeding and water level control. It will reduce the manual effort required for the aquarium management process.

1.0 INTRODUCTION

Fish keeping is a popular trend nowadays. People from all the age groups like to keep fish at the homes, offices etc. for decoration purpose or as a hobby. Commercial fish farming and ornamental fish farming has become very popular. Over again it is difficult to check the conditions of an aquarium manually especially those who are frequently outstation and vacation. Hence, it's important to develop an automated aquarium that can be monitored and controlled remotely.

A monitoring system using IoT on an automated aquarium is not a new system in today's world; it is a machine that allows the user to automatically control the pH level, temperature level, turbidity level, water level, feed the fish etc. There are various ways to achieve this goal of allowing the user to control the machine at a long distance. As it is difficult to check the conditions of an aquarium manually. Here, IoT connected system is proposed to monitor and control the whole aquarium using electronics and will communicate or transmitting real time status to user smartphone.

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Freshwater fish are those that spend some or all the lives in fresh water, such as rivers and lakes, with a salinity of less than 0.05%. These environments differ from marine conditions in many ways, the most obvious being the difference in levels of salinity. To survive fresh water, the fish need a range of physiological adaptations. 41.24% of all known species of fish are found in fresh water. This is primarily due to the rapid speciation that the scattered habitats make possible. When dealing with ponds and lakes, one might use the same basic models of speciation as when studying island biogeography.

The project is an automated system to take care of fishes. 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 operations automatically like temperature control, pH control, turbidity control, feeding, water level control etc. It will reduce the manual effort required in maintenance of aquariums by automating the aquarium management process.

2.0 IOT TECHNOLOGY DEVELOPMENT FOR AUTOMATIC AQUARIUM MONITORING

Fueled by the recent adaptation of a variety of enabling wireless technologies such as RFID tags and embedded sensor and actuator nodes, the IoT has stepped out of its infancy and is the next revolutionary technology in transforming the Internet into a fully integrated Future Internet.

Rewatkar et. al., have implemented an IoT based system which monitor and control the whole aquarium automatically and provide real time status on user's Smartphone application. It contains water quality management in which 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, turbidity level control, light monitor, feeding, water renewal etc. Automatic food feeding system operated by servo motor mechanism which used to feed fishes on regular time intervals. Dead fish mechanism is there which will detect the dead fish. In addition, camera is connected to aquarium system using which user can see live operation occurring in system with the help of smart phone.

Chiu used network remote control system to manage all the sensors to monitor the aquarium. The sensors were connected to the personal computer (pc) controlling system via different module. The module is the analogue to digital which convert the analogue signal from the sensors to digital signal so that the network can read and classify the values. The strength of the product is the used of pc as the controlling system. Pc has high processing power and it can manipulate the data obtained from the sensors via modules faster compared to microcontroller which has limited processing power. However, there are some weaknesses exist in this product. At first is the cost of the product. The product consists of a pc as center of the system which control and managed the whole system. It is really expensive to allocate a whole pc just to manage the aquarium system. Second is the portability of the product. The used of pc as center part of system make it difficult to move the product from one place to another.

Noor et. al., used PIC16F886. The system developed combines mechanical and electrical system in controlling fish feeding activity. This device basically consists of pellet storage, former, stand, DC motor and microcontroller. The pellets controlled by DC motor which located under the pellet storage. A control system was then attached to this device allowing the fish to be fed at the right cycle time as required or predefined by user. Timer was employed in this device to control the motor rotation attached to sphere former, which dispense the pellets into the water. Anyhow, there is some weakness in the following system that is the user cannot change the DC motor speed remotely because the microcontroller is not connected to internet. The microcontroller just automatically dispenses pellets on desired area using DC motor at the schedule time.

Nurliani et. al., create a system called as AURORA systems consist of Raspberry pi as microcontroller which is always online and it is connected to sensors like, ultrasonic sensor, temperature sensor and actuator like servo motor to feed, light for aquarium and water pump. The measure value of different sensors will be send to raspberry pi and uploaded to the cloud so

that the android based end devices can access the data and take the appropriate actions. The strength of this project is the implementation of Internet of things (IoT) concept. Android application is used to monitor and control the sensors and actuator that are connected to the microcontroller through the cloud services. This helps the user to access the information about the aquarium and control them from anywhere in the world through internet easily. The weakness of this project is although they have sensors to examine the aquarium condition and android apps to monitor and control the aquarium's actuator, the system still need human's interference to control the servo motor for feeding, to switch on or off the light for aquarium and to change water pump for the aquarium.

A.N.Prasad et. al., proposed Smart Water Quality Monitoring System. This system consists of a microcontroller board called Waspmote with external ADC connected to different sensors such as pH, water temperature, turbidity, conductivity sensors. All the water information will be collect by the Waspmote microcontroller board and store them in two places either sends to Cloud through GSM and or store in SD card. The strength of this project is the complexity of the product. This product is very easy to use just by connecting the sensors and connects the microcontroller across the internet; user can easily access the information about the water quality either in aquarium, lakes or pond easily using the end devices. However, although the product is easy to use, the cost of the product has to taken into account.

Taotao and Feng, develop a Fuzzy Decision System based embedded water quality monitoring platform. In simple, a system that can take appropriate decision based on the data get from the sensors. The advantage of this research is the research itself that is a system that can make appropriate decision. This type of system is very important because human can't monitor the aquaculture all the time. Besides, in critical situation, human might not able to make correct decision on correct time due to panic. With this system, when there are some changes in the aquaculture, the system able to monitor them and take an appropriate action for the changes.
The weakness of this project is it only the result of the decision-making is send to the aquaculture farmers via GPRS or messages. The farmers will be not notifying about the sensor values for example the temperature value or the pH value of water in real time.

Based on the previous related research, this project comes out with the solution. For the cost and portability issue can be solved by using a single board computer called Arduino/ESP8622 as main controller of the system. The system has the ability to make own appropriate decision based on the sensors value of the aquarium. The system will feed the fish on time and change the water of aquarium when the water turns cloudy automatically without human interferences.

3.0 METHODOLOGY

The project is an automated system that monitor the physical changes in the water and will maintain it to the ideal conditions. The aquarium will perform all the operations automatically like temperature, pH, turbidity, feeding time and water level. The IoT monitoring system will constantly transfer the status of the aquarium on the database and users can monitor them through the internet. Figure 1 shows the block diagram of the project. This project has input from IoT platform as a control device. For the processing device used in this project is microcontroller Arduino/ESP8266. For the output devices used in this project is database from sensors.

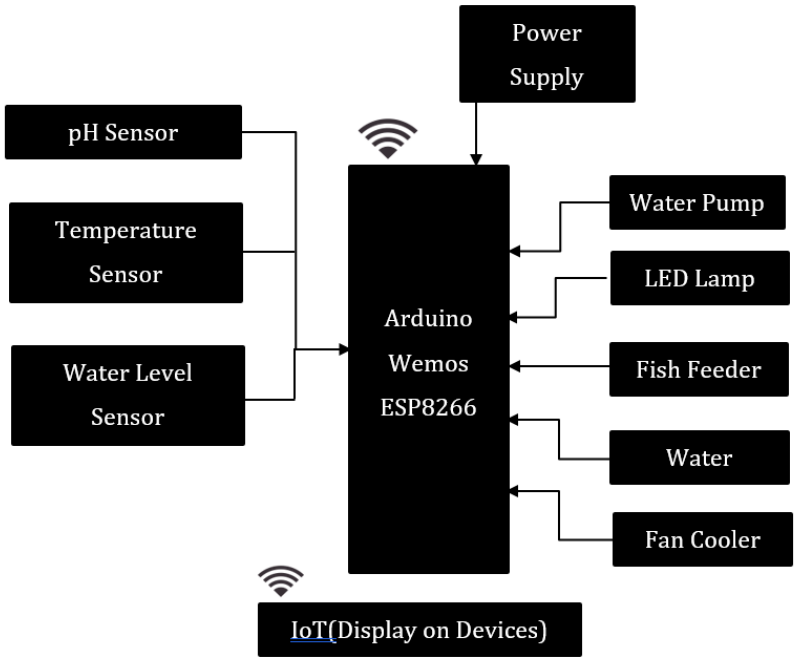

Figure 1: Project block diagram

As shown in Figure 2, this is a flow chart of the project. All sensor always running and continues data collection. When any problem is detected by sensors, it will send the notification at IoT platform to mention as an alert and it will monitor automatically.

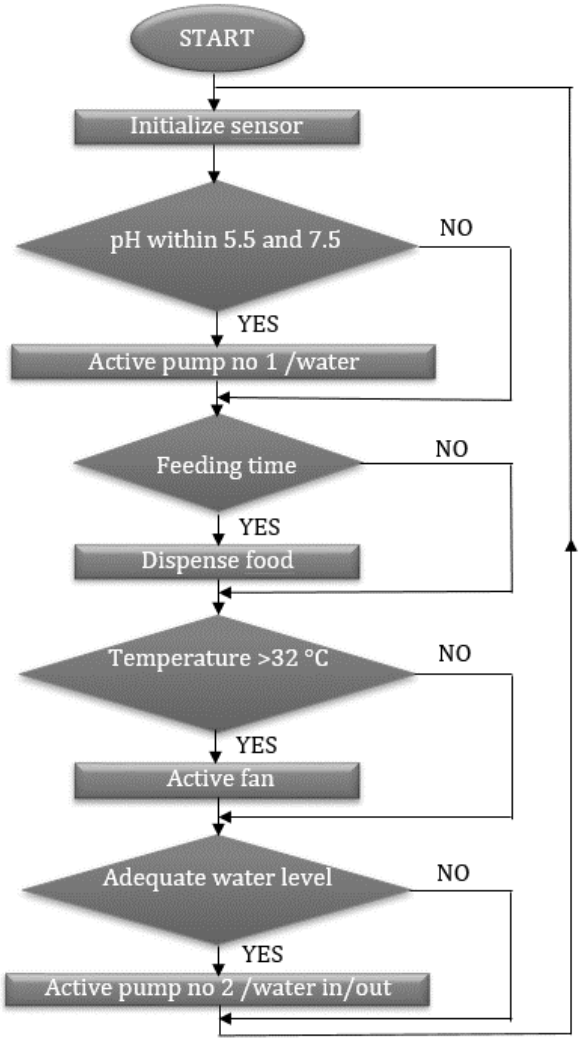

Figure 2: Flow chart

3.1 Hardware Development

The data for monitoring system for freshwater fish will be collected by using the pH sensor module and temperature module. The Arduino ESP8266 is use as a controller to process the data that collected from the sensor. The circuit for arduino and all sensor modules for this project are wired in the electrical box. The Figure 3 shows the complete wiring circuit for the arduino that act as a controller with the sensors that uses for data collection.

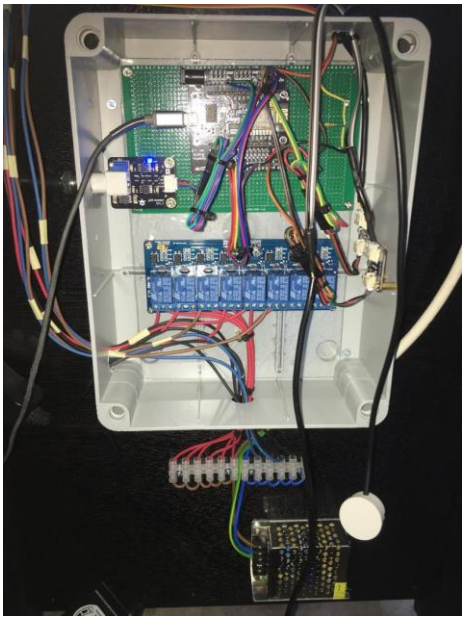

Figure 3: Circuit wiring of the system

Figure 4 shows the complete hardware design where all sensors, water pump, heater, LED lamp, fish feeder and fan cooler are arranged in aquarium.

Figure 4: Project design

3.2 Software Development

This project use thinger.io as the IOT platform. The pH sensor module, temperature module and water level sensor module coding as shown in Figure 5, Figure 6 and Figure 7. The data that collected will be used to determine the appropriate act to be done to control the system automatically.

pH_Meter

```
const int analogInPin = A0;
const int analogOutPin = D9;

int sensorValue = 0;
float outputValue = 0;

void setup() {

  Serial.begin(9600);
}

void loop() {
  // read the analog in value:
  sensorValue = analogRead(analogInPin);
  outputValue = map(sensorValue, 0, 1023, 0, 14);
  analogWrite(analogOutPin, outputValue);

  Serial.print("sensor = ");
  Serial.print(sensorValue);
  Serial.print("\t output = ");
  Serial.println(outputValue);
  delay(2);
}
```

Figure 5: Coding for pH sensor

Temp_Meter

```
#include <OneWire.h>
#define ONE_WIRE_BUS D5
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);

void setup(void)
{
  thing.add_wifi(SSID, SSID_PASSWORD);
  Serial.begin(115200);
  sensors.begin();
  thing["Temperature"] >> [](pson & out)
  {
    out ["temp"] = sensors.getTempCByIndex(0);
  };
}
void loop(void)
{
  sensors.requestTemperatures();
  Serial.println("Temperature is: ");
  Serial.println(sensors.getTempCByIndex(0));
  delay(500);
  thing.handle();
}
```

Figure 6: Coding for temperature sensor

```
Water_Level_Sensor

int Liquid_level=0;

void setup() {
Serial.begin(9600);
pinMode(D1,INPUT);
pinMode(D2,OUTPUT);
}

void loop()
{
Liquid_level=digitalRead(D1);
if (Liquid_level == 1)
{
digitalWrite(D2, HIGH);
Serial.print("Liquid_level= enough");
Serial.println(Liquid_level,DEC);
}
if (Liquid_level == 0){
digitalWrite(D2, LOW);
Serial.print("Liquid_level=low");
Serial.println(Liquid_level,DEC);
}
delay(1000);
}
```

Figure 7: Coding for water level sensor

4.0 RESULTS AND DISCUSSION

The result was collected from thinger.io platform as shown in Figure 8. The pH value and temperature is displayed in real time.

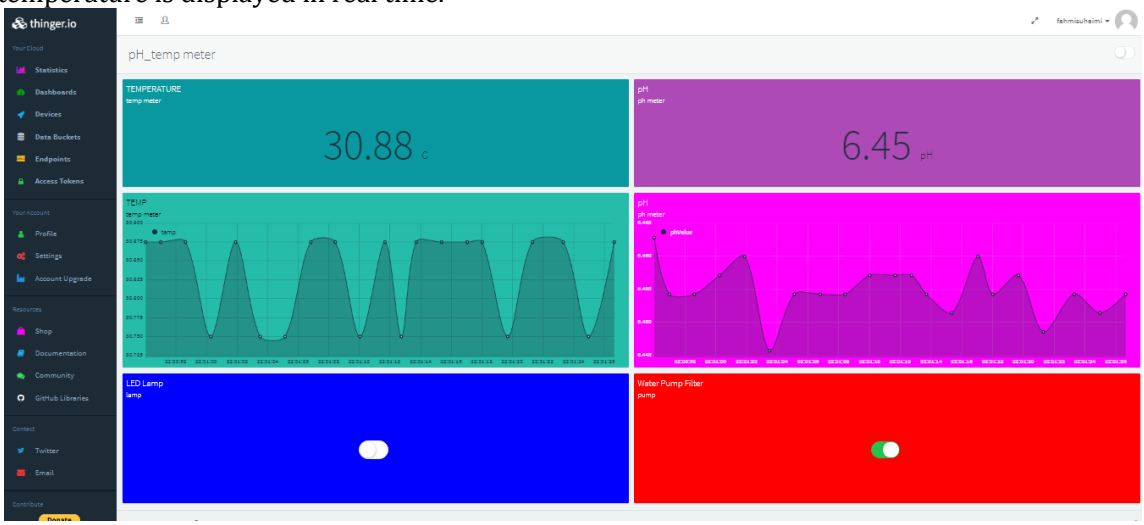

Figure 8: Result from thinger.io dashboard.

The food or pallet that sink in the tank and dissolve in water aquarium can be cause an increasing the ammonia, pH level, temperature, turbidity, odor, and decreasing dissolver oxygen Freshwater fish thrive in a range between 5.5 and 7.5 while the temperature must in ranging between 24°C to 32 °C. The result shown in Table 1 is the average value taken daily for one week. The automatic design system proved to be able to maintain the appropriate condition for the freshwater fish to live in.

Table 1: pH and Temperature display

Days	Temperature	pH
1	28.0	7.1
2	28.8	7.3
3	28.8	7.3
4	28.9	7.3
5	29.3	7.4
6	29.5	7.5
7	29.0	7.6

5.0 CONCLUSION

In conclusion, an IoT based aquarium monitoring system is developed in this project. The main goal of this system is to assist the aquarium owner in maintaining and monitoring the aquarium in more convenient and easier way. This aquarium monitoring system is reliable with real-time based ability to update the users on the current situation. Besides, the system also performed own decisions making based on the preprogramed instruction without the user interferences. The quality of the water based on temperature sensor and pH sensor is kept at appropriate level to in help the cultivation of freshwater fish.

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