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Ubiquitous Aquarium Management System

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Abstract: In ubiquitous computing real world objects communicate with each other and act intelligently. Internet of Things is an emerging technology which realizes this ubiquitous nature of computing. Our paper proposesarchitecture for aquarium management using this technology. Aquarium management needs timely gathering of water parameter value changes. These changes may affect the life of aquatic animals in the aquarium. The proposed system collects the real time data from aquarium environment using sensors, processes it and applies the changes to the water in response of any unfavorable situations through actuators.It will reduce the manual effort required in large aquariums by automating the aquarium management process. Testing of the proposed system was done in a small scale aquarium and the notification was send to the user.
Keywords: Actuators,internet of things,IoT, sensors, Zigbee

I. Introduction

Nowadays internet of things is implemented in numerous real world scenarios such as smart TV, smart phones, smart homes, smart cars and smart cities etc. IoT comprises of sensors which senses different things in the environment and can transfer the collected data using some protocol to a receiving device or a system. Then the system processes the data and extracts information for analysis as well as to perform actions by actuators.

In large scale aquariums, monitoring is done manually. A person may do mistakes due to the very human nature. Gathering of data from the aquarium must be done in a timely manner and the changes need to be done to the environment. Unacceptable changes in the levels of water parameter values affect the life of aquatic animals.This motivated us to build a system which automates the manual work to maintain the aquarium with minimum persons required using IoT technology. The objective of this paper is to device a smart aquarium. Various water sensors are used in this system to sense the water data from the aquarium and information is displayed on the user's smartphone for the decision making.

After the introduction the remainder of the paper is structured as follows: Section II covers the summary of related work carried out in this area. Section III describes the proposed architecture of aquarium management system in detail. Section IV elaborates the testing done on the system. The paper is concluded in section V by mentioning the future scope of the research.

II. Related Work

In the last few decades there is a considerable growth in the development of sensors and actuators. IoT in our perspective can be viewed as things-oriented since we have made use of sensors and actuators. It can make use of heterogeneous devices to collect various data and actuators can perform differently.[1] The efficiency of the model is based on analysis of the collected data accurately. Whatever data is collected at the controller must be compared with given parameter threshold values and intelligently analyze the environment and take the decision accordingly. [2]

The system proposed by Luca Catarinucci et al. is to improve the efficiency of health care system. Their system uses a variety of sensors attached to the patient's body which gives various parameters like ECG, Blood Pressure, motion, temperature etc., are sent to the device using a wireless protocol (RFID). The device then constantly monitors the patient and helps in handling emergency cases immediately by notifying the doctors and nursing staff.[3]

The author has described the use of IOT sensors to make the ordinary city a smart city. The various sensors continuously monitor various areas such as structural stress on the buildings, water and air quality, humidity , temperature, noise , traffic , city energy consumption, parking , etc. Their proposed architecture was implemented in the city Padova, Italy. [4]The various parameters of the aquarium water used for analysis and favorable for growth of fishes have a threshold range. The controller should strictly monitor these parameters specified in the condition. If the value crosses any boundary it should be communicated with the user for immediate necessary actions. The values differ according to different parameters. [5][6][7]

The "Internet" in the IoT is the link that connects and communicates with the user. The ZigBee protocol can be used by model to send the data to the controller and then wirelessly communicate to the user.Theuser can be informedabout the status of various parameters collected by using internet as the medium.[8]IEEE802.15.4 specifies the standard ZigBee protocol which is used to create small area network with low power and low bandwidth. This protocol is basically used where the system architecture demands wireless connection and ZigBee is simpler and less costly than Bluetooth (IEEE 802.15.1) or Wi-Fi (IEEE 802.11)

III. System Architecture

This section details thearchitecture for smart aquarium management system shown in Fig. **1.**Variouswireless sensors installed in the aquarium to percept the water parameter values. Controller logic is used to do perform the processing and notify the user about the sensed parameter values. The system uses ZigBee wireless protocol to communicate between the devices and the network.

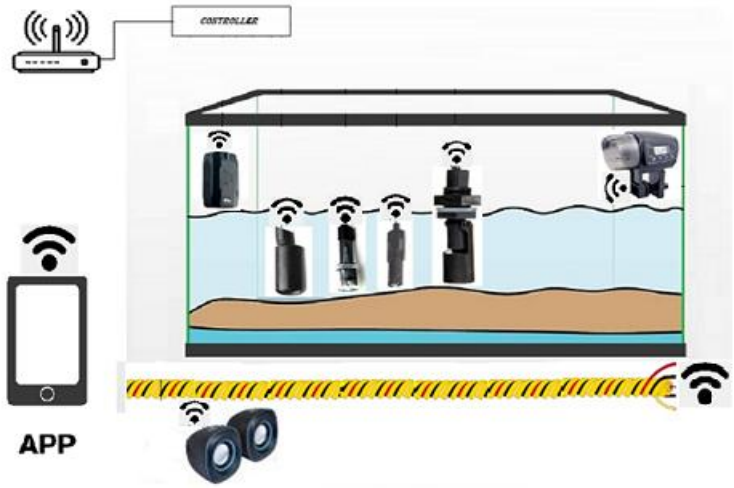

Fig. 1 System Architecture

The key water parameters to be monitored in the aquarium are temperature, chlorine level and ph level. These parameter values are captured using sensors in the proposed system. Temperature sensor senses the temperature of the aquarium water in real-time and sends to the controller. If the temperature is not in the acceptable range, controller sends signal to the water changing instrument. It will clear the current water content in the aquarium. If the water contains chlorine it can lead to a fatal result for fishes. The Chlorine controller will detect the chlorine level and sends it to the controller. The necessary chlorine remover liquid can be added to aquarium to make water chlorine free. The Ph which helps in proper growth of fishes if it is in proper proportion. It can also cause adverse effects if Ph values are unfavorable. The ph sensor in the model senses and sends the data to the controller which compares it with the permissible values.

The controller will check if the values for temperature, chlorine and ph are in normal range. Any deviation from the acceptable values will be notified to the user on their smart phone. If water temperature goes beyond the favorable value, controller sends signal to the water changing instrument. The aquarium water will be changed to make the temperature under control. For variation in the values of ph and chlorine, after the receiving the notification from the controller necessary calibrating contents can be added manually.

The water leakage through cracks in the glass walls of the aquarium is sensed by a leakage sensor and controller notifies the user about the leakage. Automatic fish feeder in the system keeps on feeding the fishes on regular intervals and in a fixed quantity without any manual intervention. When the quantity of food in the feeder goes below certain limit, it sends a signal to the controller and the controller will notify the user to refill it. In summer season due to the atmospheric heat in the climate fishtank water evaporates gradually with the time. The 1/3rd water level sensor is used to detect the level of water in the tank. It checks the level and sends the signal to the controller which can then turn on the water pump.

The speaker will keep on giving the information about the fishes in the tank.Thiscan be useful in the aquariums where visitors can be guided about the fishes and its breeds.The waterproof camera can click the images of the fishes and view it whenever the userwants to check the status remotely.

The ZigBee protocol can be used by our model to send the data to the controller and then wirelessly communicate to the user and inform the user about the status of various parameters collected by the controller by using internet as the medium to transfer data wirelessly over networks.[8]

The components used the in the system are given in detail:

- Waterproof Temperature sensor (used DS18B20 chips) which is encapulated by stainless steel with width 6x50mm & length 100cm and needs 3.0V~5.5V(approx) of power supply where temperature ranges from 55 ° c ~+125 ° c. There are 3 output lead wire Red used for VCC, white used for Data transfer and Black for ground.[9]
- Ph sensor is used to check ph level of water. As we know ph ranges from 0-14 but fish growth is limited up to less than 7.5 and fish dies if ph level decreases beyond 6.5.This sensor responses in less than 1min and for Ph meter and controller mostly BNC connector is used.[10]
- Chlorine sensor 499ACL is used to check chlorine and electrolyte in water because chlorine in water is not suitable for fish(0ppm mg/L) and minerals such as calcium, magnesium and carbonate are needed for fishes. This sensor responses in less than 22sec and electrolyte volume is 25mL(approx) where electrolyte life is 3months.[11]
- Leakage detector sensor is used to detect Leakage in the tank. It sends signal to the controller if it detects any water.[12]
- Automatic food feeding machine with a timer used to feed fishes up to 4times per day and it has a food drum with large capacity which is easy to fill. For daily use, it's safe and accurate way to feed your fishes.[13]
- VEGAFLEX 82 sensor is used to record the quantity of food in the feeder machine.[14]
- Water level sensor is used to sense the water level in the tank. And sends the value recorded to the controller. This can be used to activate a water pump or ring a alert bell. This sensor uses up to 100 volts AC. [15]

IV. Testing

The evaluation of the system is done in an aquarium of small size. The important parameters were observed. The threshold values for various water parameters are shown in Table 1.

Parameters	Minimum Value	Maximum Value
PH	6.5	7.5
Chlorine	0	0
Temperature(°F)	72	82

Table 1. Threshold values for water parameters

The data captured by sensors are sent to controller. The control logic at the controller processes the data to check for any abnormal condition and notifies the user. Test results notified to the user are shown below.Periodic reading of parameters is send to the user.In case of change of parameters beyond the allowed range the notification is send in real time. Fig. 2 represents the periodic reading of parameters. Fig. 3 shows the real time notification received by the user when the parameter values went beyond the threshold range. When the parameter value is deviated beyond the threshold range, the necessary action needs to be taken by the user to bring it back to the acceptable range.

Fig. 2 Periodic Parameter notification ,**Fig. 3** Real time parameter notification

V. Conclusion

Our primary goal behind this paper was to automate maximum aquarium work that currently donemanually. Keeping our goal along with IOT in vision our proposed model contains a infrastructure containing different sensors, protocols and a mobile application using which we can collect various real-time parameters. These parameters are analyzed and critical conditions are highlighted and notified to the user. This can help the user who cannot manually know about the exact problem by just looking at the water by displaying it in a understandable manner. The user will then exactly do the necessary required actions which will help in keeping the aquatic animals healthy and safe. Also with the help of parameters the emergencies can be handled efficiently.

Future enhancement of proposed model can be architecture for detectionof the live count of the fishes. Also depending on the parameters what remedies should be done will also be instructed to the user by the system. And finally, to make the manual work required for maintaining an aquarium to a negligible portion.

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