



Smart Aquarium Monitoring System

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Abstract:- Presently, many people maintain fish in aquarium tanks in their homes. The aquarist has been feeding the fish in the aquarium tanks, therefore appropriate setup and maintenance are required. The issues include shifting water quality, feeding the fish, keeping the temperature stable, managing the lights, and finding it challenging to physically verify the conditions of an aquarium. As a consequence, the physical attributes need to be checked regularly and the quality of the water should be improved. So, the system that this project propounds is sensor-fitted and may be utilized in real

time. It performs the function of renewal of water, aeration system, monitoring of temperature, and detecting the pH level. A system based on the Internet of Things is installed to monitor the aquarium and send feeds to the user's mobile application. This way, smart aquarium management has been implemented, ensuring that the fish are neither overfed nor underfed, thus lowering the amount of manual labor to be exerted in maintaining the aquarium. *Key words: Aquarium, Internet of Things, Fish feeding, Mobile Application, Turbidity Sensor.*

I. Introduction

The number of those keeping fish has been increasing over the last few years, but this is an index for the growing popularity of the aquarium as a hobby, also a quiet retreat from the rest of the world. Still, it might be quite a challenge to maintain the aquarium clean and healthy for the fish since it had to be constantly watched and looked after. With a traditional aquarium system, it is common to monitor and control many parameters, such as temperature, lighting, and feeding schedules. Many fish need to be fed twice a day, which is challenging to maintain on a continuous care program if the fish keepers are absent. Such situations can sometimes result in missed feedings and even dangerous conditions for the fish. To overcome these, we have developed IoT-Based Smart Aquarium System as a cost-effective solution that automates the maintenance process. This innovative system allows adding automatic controls to

any existing aquarium setup without requiring one to intervene manually. Live data from the Smart Aquarium System is sent to the user, with it continuously measuring important water parameters including temperature and pH levels. Fish enthusiasts can control lighting, temperature, and feeding schedules remotely through an intuitive interface so that their aquatic animals have the best possible conditions whenever they are away. Our research leverages the use of the Internet of Things in creating a smart, networked system that facilitates improvements in fish care while making the duties of an aquarist easier. The automated feeding feature prevents overfeeding or underfeeding of the fish while offering them the right amount of food at appropriate intervals. In addition, automatic lighting and temperature settings come close to simulating a natural environment that fosters their well-being.

Methodology

• Analyzing Requirements and System Design

Define the system's main objectives, including temperature control, water quality monitoring, automatic feeding and lighting management

Acquiring Requirements: Finding out what the users' special demands are, what factors (such as pH, temperature, and ammonia levels) are needed to be monitored, how often data needs to be collected, and what kind of user interface is needed.

Selection of Components: Select the proper actuators, sensors, microcontrollers and communication modules.

2. Development of Hardware Sensor Integration:

Temperature Sensor: Use a reliable temperature sensor (such as the DS18B20) to determine the water temperature.

To monitor the acidity or alkalinity of the water, use a pH sensor that can communicate with the microcontroller. Water quality sensors can optionally contain ammonia, nitrite, and nitrate sensors.

Feeding Mechanism: Using a servo or stepper motor, design and install an automatic feeder that dispenses food at preset intervals.

Lighting Control: Combine LED lights with programmable controllers to simulate the cycles of natural light.

Microcontroller: Use a microcontroller (such as an Arduino or Raspberry Pi) to communicate with sensors and actuators.

Connectivity Module: To enable remote control and monitoring, incorporate Bluetooth or Wi-Fi modules (such as the ESP8266).

4. Firmware Programming for Software Development:

Develop an insight called firmware instructing the microcontroller to collect data from sensor devices and to control actuators such as heaters, lightings, and feeders. This shall also be integrated to communicate with any cloud or server. Create a cloud server that processes and archives all data. Use Firebase, Google Cloud, and AWS IoT as your services. Create a web/mobile application where the data maybe: Tracked in real-time Notifications or alarms Remotely regulate aquarium settings User Interface: The program should thus be simple to use, easy to navigate and operate. Continuous data logging from sensors. Threshold Setting: Safe ranges should be defined for temperature, pH, etc. Program the system to generate warning alerts on range-out values. Automated Control Algorithms: create algorithms to enable Responding automatically like heating up if temp drops or dispensing food on certain time events.

Firmware will include microcontroller commands that are instructed to collect data from the sensors, actuate their controlling heater, lighting, and feeders, and communicate with the corresponding cloud or server for such purposes. Cloud Integration: Create cloud servers for processing data and archiving. Services such as Firebase, Google Cloud, and

AWS IoT can be used. Develop a web/mobile application having the following features: Real-time data tracking. Notifications and alarms. Remote settings application for aquarium. User Interface: The application should be easy to use and intuitive. Continuous Data Collection: Data will be logged continuously from sensors. Threshold Setting: Establish safe ranges for temperature and pH and other parameters. Program the system to trigger an alert when values fall out of range. Develop Automated Control Algorithms: Such development of automation will enable correction in the heater when the temperature falls, as well as forced feeding at certain intervals..

5. Types of Testing and Calibration Bench Testing:

Perform preliminary tests to check the test of each component and together with others. Calibration: Calibrate the sensors for accurate readings. It might be necessary to calibrate pH sensors with buffer solutions. Field Testing: Finally, deploy the system in a real aquarium to monitor performance over the lifetime. User Feedback: Get user feedback from beta users in search for issues and improvement of the system.

6. Deployment and Maintenance Installation:

Develop instructions for the users on how to install and set up the system in their aquariums. User Training: Offer user tutorials and support that educate the users on how to use them effectively. Maintenance and Updates: Regular software updates are done to correct bugs and add features to ensure compatibility with new hardware. Performance Evaluation: Keep evaluating the system in terms of performance and reliability. Iterative Improvement: Improve performance by taking an iterative approach judging on performance data and feedback. Design

It includes all the sensors of a smart aquarium: temperature, pH, and water quality sensors, actuators including heater, feeder, pump, light, wi-fi/bt communications microcontroller such as Arduino or Raspberry Pi to enable remote monitoring, and an app on mobile/web through which the maintenance is automated, and living conditions for aquatic species optimized with AI and eventually voice control.

Existing system:

Analytical systems of water quality monitoring generally depend on manual sampling followed by analysis of the samples in the laboratory; hence results are subjected to delays and restricted spatial coverage. Such analytical systems are expensive, labor-collector, and impractical for continuous monitoring

.Proposed System

The proposed water quality monitoring system integrates TDS, turbidity, and temperature sensors with a NodeMCU microcontroller for IoT-based data acquisition and transmission. TDS sensors measure the concentration of dissolved solids in water, providing insights into water purity and salinity levels. Turbidity sensors detect suspended particles or sediment in water, indicating its clarity and potential for sedimentation. Temperature sensors offer information about water temperature variations, which can affect aquatic ecosystems and indicate potential sources of pollution or thermal stress. By combining these sensors with

NodeMCU's connectivity capabilities, the system aims to deliver real-time water quality data for informed decision-making and timely interventions.

Components:

1. Turbidity sensor



A turbidity sensor is a type of instrument that is employed in the determination of the cloudiness or haziness, as well as the total dissolved or suspended solids concentration in a solution. The analytical sensor, turbidity sensor, measures turbidity. Turbidity is a very effective and useful instrument for judging the clarity and particle content in any medium, such as water. Turbidity sensors find application in various industries focused on waste reduction, yield improvement, and water quality analysis. Turbidity sensors measure the amounts of scattered light produced by suspended solids in a liquid, typically water. The higher the total suspended solids (TSS) and dissolved solids (TDS) levels in a liquid, the higher the turbidity. Turbidity sensors give quantitative measurement of the haze or cloudiness-turbidity-in a liquid that normally indicates water quality.

2. TDS Sensor



A Total Dissolved Solids (TDS) sensor is used to measure the concentration of total dissolved solids in a liquid, usually water. Considered an important parameter of the quality of the water since TDS is the metric that represents dissolved minerals, salts, and metals affecting the taste and quality of water. TDS sensors usually measure the electrical conductivity of water. Since dissolved solids conduct electrical current, the TDS of the water is estimated from the conductance of the water. Conductivity, which increases with dissolved solids, finally is converted to TDS, expressed typically as ppm.

3. DS18B20 Temperature Sensor



The DS18B20 is one of the digital temperature sensors that have been utilized in many applications. It is the best in terms of accuracy, simplicity, and digital interface, specifically for hobbyist and embedded systems projects. It determines temperature through an integrated temperature sensor and sends the resultant digital value. It communicates through the One-Wire protocol which accommodates power and data over one wire. The three main modes are

Normal Mode: The sensor receives the power from the outside source.

Parasitic Mode: Power is taken from the data line eliminating the long dedicated wire.

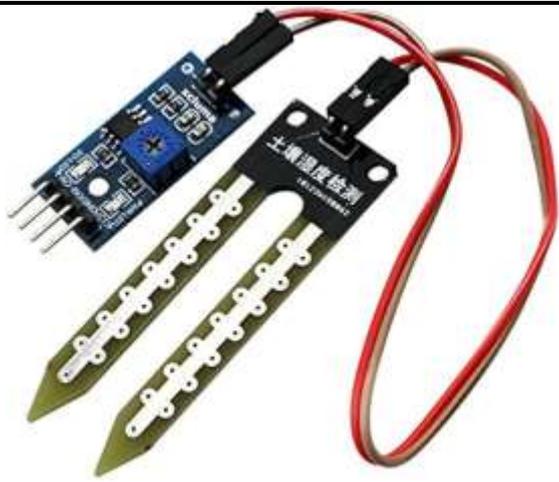
Sleep Mode: This puts the sensor in low power when no temperature is being taken.

4. Water level sensor



Water level sensors are devices used to measure the water level within reservoirs, tanks, and other systems. Essential as they are, they have found applicability in almost all important worked-out contexts-from industrial processes to domestic appliances for water supply management. A type of sensor is water level sensors that stand important in the control and monitoring of water levels in various systems. There are varieties of types of water level sensors, each with a different merit and application use. Selection for a certain kind of water level sensor that may be used in industry, environmental control, or home use entirely depends on the use of accuracy and range as pertaining to a given special application environment.

5. Soil moisture sensor



A soil moisture sensor measures the amount of water inside the soil. When testing the dielectric permittivity bandwidth of the ground cover, capacitive sensors are mainly used, while resistive sensors identify the presence of water by examining the electrical resistance between two probes. These sensors maximize irrigation, save water, and enhance plant health in horticulture, environmental monitoring, and agriculture. Precision irrigation systems that are automated can also be coupled with them. Resistive sensors are useful, but the type of soil they are in might affect how accurate they are, and they need to be maintained because of corrosion over time.

Working

The proposed IoT-based Smart Aquarium System offers a comprehensive solution for automated maintenance and real-time monitoring of aquarium conditions.

Sensor Integration:

The system incorporates various sensors to monitor key parameters such as:

Temperature: A temperature sensor (e.g., DS18B20) detects water temperature variations.

pH Level: A pH sensor measures the acidity or alkalinity of the water.

Water Quality: Optionally, sensors for ammonia, nitrite, and nitrate levels may be included to monitor water quality.

Turbidity: A turbidity sensor assesses the clarity of the water by measuring suspended particles.

The constant activity of these sensors is to take data of the habitat environment like the one in aquariums.

Actuator Control:

All these actuators are connected to the system, and based on collected data by sensors, the controlled actuators are to maintain optimal conditions: Heating-Heater adjusts the heater in water temperature as required for the stable. Feeding-An automatic feeder feeds those fish at specific time intervals to provide adequate food and nutrients. Lighting: At every time-the LED light is controlled under normal

circumstances according to natural light cycles for the help of aquaculture organisms.

Microcontroller:

The central processing unit for the entire system is a microcontroller such as Arduino or Raspberry Pi, which connects the sensor to data collected from the actuators following certain algorithms as defined by the user. Also, it communicates with the cloud server for remote access.

Connectivity Module:

The system includes Bluetooth/Wi-Fi, e.g., ESP8266 modules, which can afford the user remote monitoring and control. The user can be connected online or on his application via the mobile app, thus preventing a specific location.

Firmware Programming:

Microcontrollers have firmware that is programmed to:

Continuously gather sensor data. Control actuators based on pre-defined algorithms and user-inputs. Communicate with the cloud server to store and access data remotely.

Cloud Integration:

Data processing, storage, as well as remote access are performed within a cloud server. Firebase, Google Cloud, IoT AWS, etc., support this. A cloud-based platform that allows users to track real-time notification changes and adjustments to their aquarium settings over a user-friendly interface.

User Interface:

An application that works either on the mobile phone or on a computer will provide the users with a very graphical interface and will allow them to obtain data on the parameters associated with the aquarium as well as alert them and control the system from afar. Users will find it simple to adjust settings and immediately view real-time data because of its user-friendly and intuitive interface.

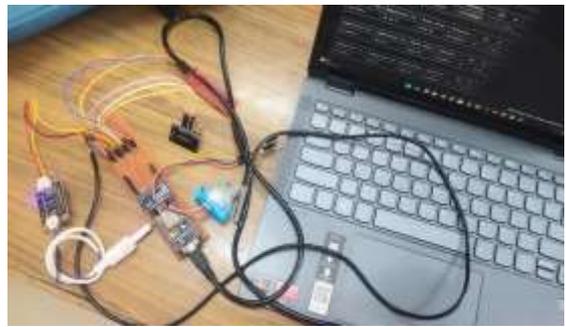
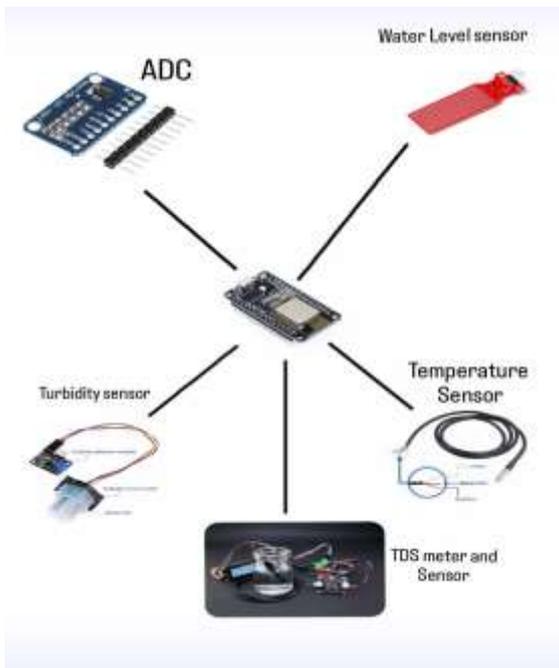
Testing and Calibration:

The system is then tested for verifying the operations of each component individually and integrated with other components before deployment. For example, sensors may be calibrated to measure accurately. The performance is often tested under actual aquarium conditions in the field.

Deployment and Maintenance:

Once testing is conducted through installing the system in the aquarium where the users are provided with installation guide and training. It will continue to undergo maintenance, upgrade, and enhancements toward better performance and compatibility with the ever-changing hardware or software updates. The Assessment and Refine: Performance and reliability of the system continue to be monitored. The Performance analysis and user feedback will evaluate iterative improvement to such performance for further improvements in the experience of use with the system.

Figure and table:



Results :

Table1

Turbidity value	Type of water
10 ntu	Drinking
15 ntu	Tap water
20 ntu	Bottled water
25 ntu	River water

Table 2

Temperaturevalue	Type of water
20	Drinking
22	Tap water
18	Bottled water
25	River water

Table 3

TDS value	Type of water
150 ppm	drinking
155 ppm	Tap water
148 ppm	Bottled water
160 ppm	River water

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