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Smart Automatic Aquarium Monitoring System

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ABSTRACT

In modern days, many people have fish as their pets at home. The fishes have been fed by the aquarist in the aquarium tanks which demands a proper setup for maintenance. The problems faced are changes in water quality, feeding the fish, maintaining the temperature, and difficulty checking the conditions of an aquarium manually. Therefore, it is necessary to monitor the physical parameters closely and enhance the water condition. So, this project proposes an IoT-based system for intelligent aquarium management. It uses sensors to monitor key parameters such as temperature, water pH level, water level, and feeding requirements. The system provides real-time data to electronic devices like mobile or PC, allowing users to track the aquarium's conditions remotely. By automating temperature regulation, water quality monitoring, and fish feeding, the system reduces manual effort and ensures proper care for the fish, preventing overfeeding or underfeeding. Overall, it enhances the efficiency of aquarium maintenance.

1. 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.

2-REQUIREMENT ANALYSIS

Functional Requirements

These are the requirements that refers to the specific actions, behaviors, or tasks a system or application is designed to perform. Functional requirements describe what the system must do to achieve its objectives and typically outline features, inputs, outputs, and interactions.

User Module:

- Setup Hardware
- Start system

- Connect to the Aquarium Network
- Open the local web interface 192.168.4.1View the readings
- Receive the alarm

Non-Functional requirements

These are the requirements that refers to the quality attributes or characteristics of a system that do not directly relate to its specific tasks but focus on how the system performs under certain conditions. These requirements address performance, usability, reliability, scalability, and other operational aspects.

- Scalability: Supports adding more sensors and aquariums without affecting system performance.
- Security: Ensures secure data transmission and access control for authorized users only.
- Compatibility: Works with various sensors, microcontrollers, and user interfaces.
- Portability: Can be deployed on different hardware platforms with minimal adjustments.
- Reliability: The system consistently monitors and controls the aquarium without failures or interruptions.
- Usability: The interface is easy to use and understand for users of all technical levels.
- Maintainability: The system is designed for easy updates, troubleshooting, and sensor replacements.
- Performance: The system responds quickly to sensor data and control commands in real-time.
- Life Cycle Model
- Waterfall Model is a classical software development methodology that was first introduced by Winston W. Royce in 1970. It is a linear and sequential approach to software development that consists of several phases that must be completed in a specific order.
- The phases include: Requirements Gathering and Analysis: The first phase involves gathering requirements from stakeholders and analyzing them to understand the scope and objectives of the project.
- Requirements: This phase involves identifying and understanding the problem that needs to be solved. Developers and stakeholders collaborate to define the project's objectives, scope, and constraints. It includes gathering user expectations, technical needs, and business goals to form a clear plan or strategy. A well-defined requirements phase ensures that the entire development process is aligned with what the end user actually needs.
- The main goal is to create a system that automates and monitors critical aquarium parameters such as water temperature, pH level, water level, and feeding times. For example, the system must integrate with sensors, support Wi-Fi or Bluetooth connectivity, and be compatible with mobile apps.

3-DESIGN

- 3.1 Architecture
- Design represents the number of components we are using as a part of the project and the flow of request processing i.e., what components in processing the request and in which order. An architecture description is a formal description and representation of a system organized in a way that supports reasoning about the structure of the system.
- Design refers to the logical and physical arrangement of system components, and the flow of information among them. In the Smart Automatic Aquarium Monitoring System, data flows from sensors to a microcontroller for processing, and results are then used to trigger actuators or notify users. This data-centric view of the system can be visualized using Data Flow Diagrams (DFDs).

Architecture is of two types. They are:

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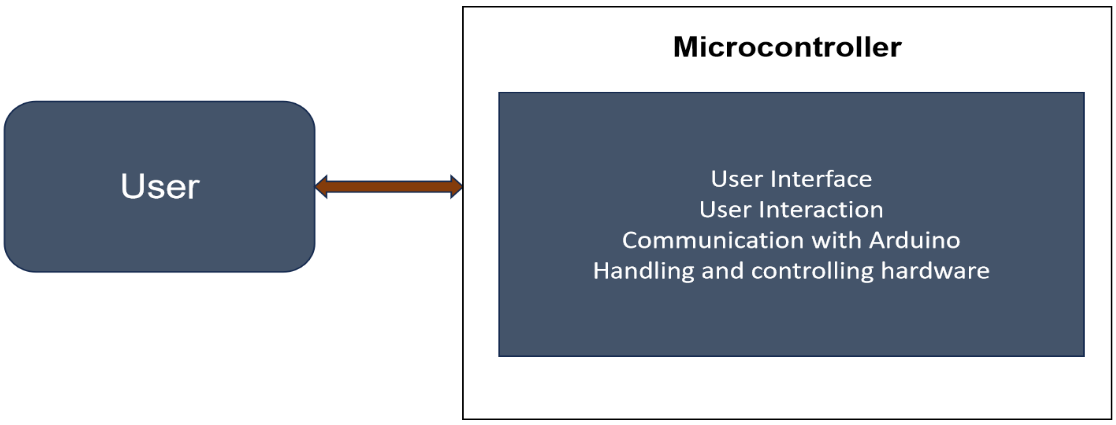
- 1. Software Architecture
- Technical Architecture

3.1.1 Software Architecture

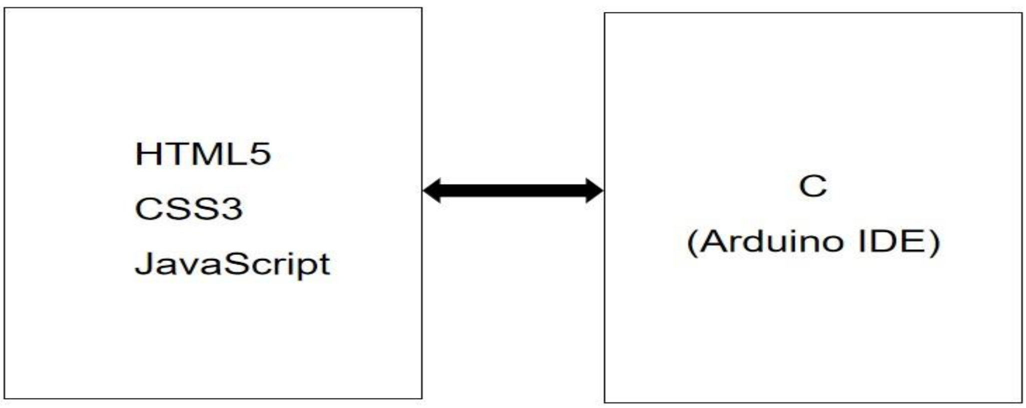
- Software architecture design tools help to build software that does not have security issues. This is key because there are software risks in all areas of the software development process. When teams avoid software flaws or bugs, they can move forward with confidence. However, since this is not always possible, software architecture design tools also need to have the ability to find flaws during the creation of software and correct them efficiently. When using software architecture design tools that can identify flaws, you will have the ability to analyse the fundamental software design, assess the chance of an attack, figure out potential threat elements, and identify any weaknesses or gaps in existing security.



Software Architecture

Technical Architecture

Technical Architecture is a form of IT architecture that is used to design computer systems. It involves the development of a technical blueprint regarding the arrangement, interaction, and interdependence of all elements so that system-relevant requirements are met.



Data Flow Diagram

A Data Flow Diagram (DFD) is a graphical representation used to visualize the flow of data within a system. It is a widely used tool in system analysis and design, helping stakeholders understand how data moves, where it is stored, and how it is processed.

A Data Flow Diagram (DFD) is a visual representation used in system analysis to show how data moves through a system. It illustrates how data is input, processed, stored, and output, making complex systems easier to understand and communicate.

DFDs consist of key components: processes (which transform data), data stores (where data is held), data flows (arrows showing data movement), and external entities (outside sources or destinations of data). Each component helps define how information is handled within the system. DFDs are created in levels, starting with a Level 0 DFD (context diagram) that shows the entire system as one process. Higher-level DFDs break this down into more detailed parts, offering a clearer view of the system's internal operations.

4-IMPLEMENTATION

Technologies

The Smart Automatic Aquarium Monitoring System is developed using the C programming language, specifically designed for embedded systems. The system is implemented on an Arduino microcontroller platform, which enables precise and efficient interaction with various sensors and actuators. The use of embedded C allows low-level control of hardware, real-time data processing, and efficient use of system resources.

The Arduino platform supports writing code in a simplified version of C, which is compiled and uploaded to the microcontroller to control physical devices directly.

Embedded C for Arduino

Embedded C is a subset of the C programming language optimized for embedded systems and microcontroller programming. It is widely used in real-time applications where resource efficiency and direct hardware access are essential.

In this system, Embedded C is used to:

- Read sensor data (temperature, pH, water level)
- Control actuators (fan, water pump, feeder servo, buzzer)
- Perform logical decision-making (e.g., turn on fan when temperature > 35°C)
- Schedule events like automated feeding
- Display system status on the LCD
- Communicate with external interfaces (Serial for IoT, sensors)

Arduino's standard development environment (IDE) and rich library ecosystem simplify the development of embedded C code for hardware interaction.

5-RESULTS

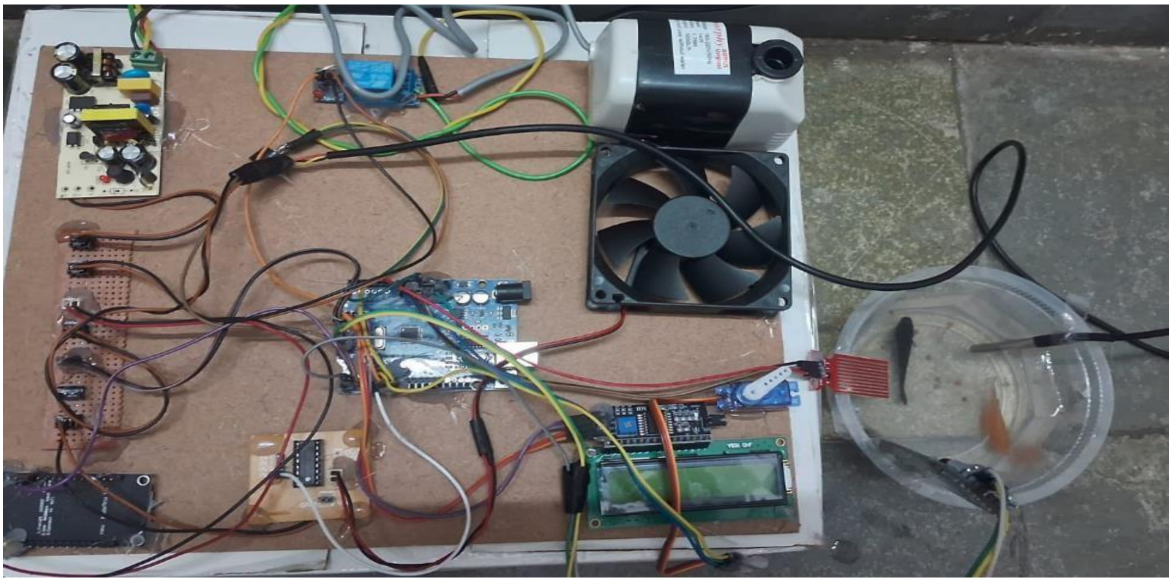


Fig 5.1 Hardware Setup of IoT Devices

1.First, connect your mobile or laptop to a Wi-Fi network. Then, enter the password and click the "Connect" button to join the “Smart Aquarium” network.

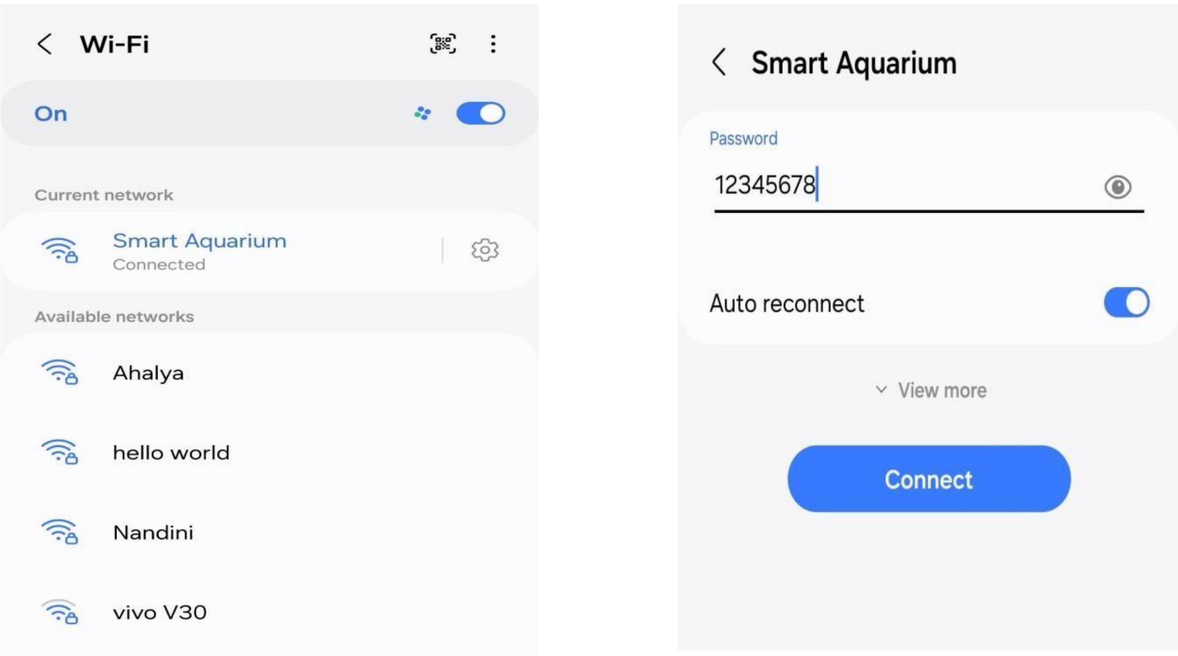


Fig 5.2 Connecting to the Wi-Fi Network

2.The temperature is detected using a temperature sensor. When it drops above 35°C, the cooling fan automatically turns on to help maintain the desired temperature.

Fig 5.3 IOT Device Interface Page

Fig 5.4 Temperature Sensor

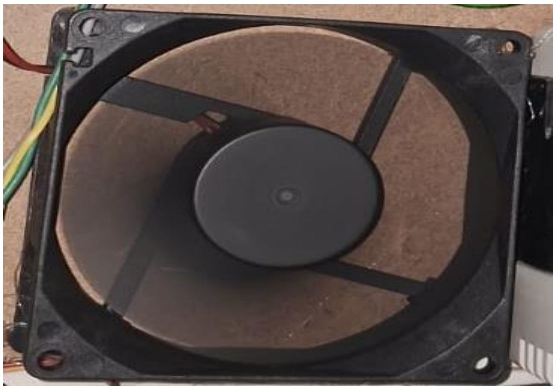


Fig 5.5 Cooling Fan

When the temperature rises above 35°C, the cooling fan automatically turns on to maintain a stable temperature.

3. The pH level is monitored using a pH sensor. When the pH drops below 7, the system triggers an alert message indicating poor water quality and automatically initiates a water change.

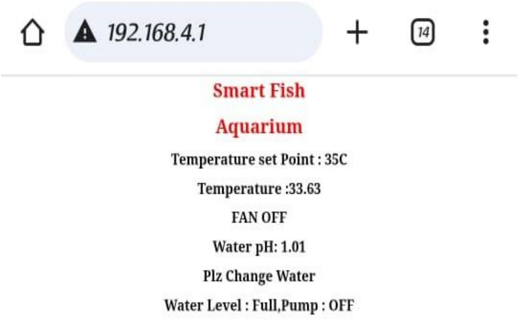


Fig 5.6 IoT Device Interface Page

Fig 5.7 pH Sensor

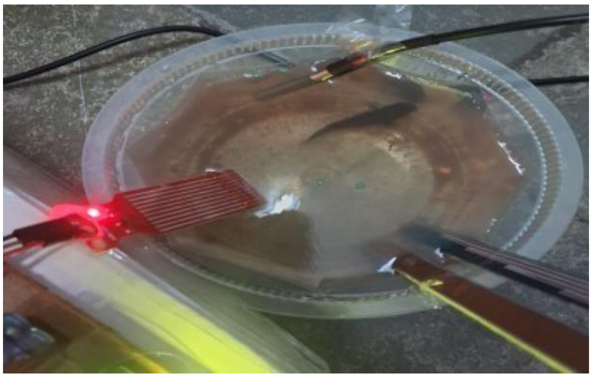


Fig 5.8 The water quality appears poor, and the pH sensor detects unhealthy levels, triggering alert to pH Sensor change water

4. The water level is monitored using a water level sensor. When the level drops below the minimum, the system activates the pump to refill the aquarium and maintain the appropriate water level

Fig 5.9 IoT Device Interface Page

Fig 5.10 Water Level Sensor

Fig 511 Servo Motor

When the level drops below the minimum, the system activates the pump to refill the aquarium and maintain the appropriate water level.

5.Feeding is done at regular intervals using an automatic feeder. The Real-Time Clock (RTC) module helps maintain accurate timing, ensuring that the fish are fed consistently on a scheduled basis.

Fig 5.12 LCD Display

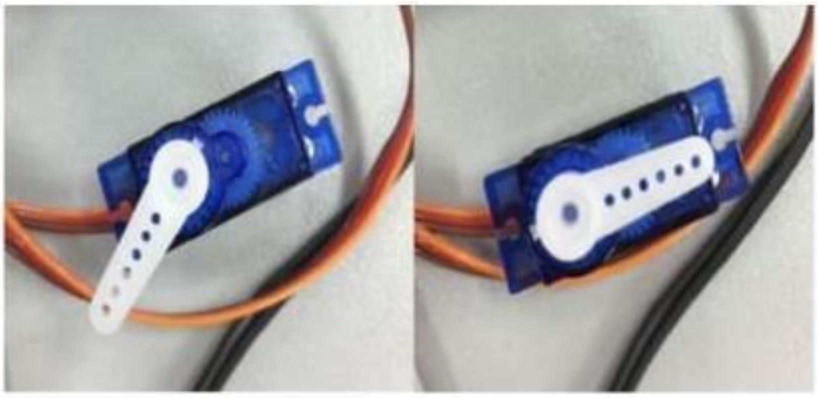


Fig 5.13 Micro Servo Motor

When the RTC provides accurate time, it ensures that the fish are fed consistently according to the set schedule.

6-CONCLUSION

The "Smart Automatic Aquarium Monitoring System" presents a modern, efficient, and user friendly solution for maintaining aquariums. By utilizing IoT technologies, the system automates key functions such as feeding, temperature regulation, and water quality monitoring, significantly reducing manual intervention. It ensures the health and safety of aquatic life through timely alerts and remote access, making aquarium management convenient and reliable. The successful implementation of this system demonstrates the effectiveness of combining automation with real-time monitoring to improve the overall aquarium experience.

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