Life Cycle of Smart Aquarium

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Abstract— **Keeping fish in an aquarium is a hobby that many people enjoy for relaxation and decoration. However, maintaining an aquarium requires regular monitoring and consistent care. Fish must be fed at the correct time, the water temperature must be maintained within a safe range, and devices such as lights, heaters, and filters need proper control. When these tasks are handled manually, they can become time-consuming and may lead to inconsistency in care. To make aquarium maintenance easier and more efficient, this project proposes a Smart Aquarium System that automates the key functions required for healthy fish care. Special attention is needed when fish reproduce, as their eggs usually hatch within a few days and the young fish require a stable and well-controlled environment for proper growth. The system includes an automatic feeding mechanism driven by a servo motor, which releases food at preset times. A temperature control unit ensures that the water remains within the ideal range for fish health. In addition, an automated lighting system provides appropriate illumination to support the well-being of fish and the growth of aquatic plants. By integrating these automated features, the proposed system reduces manual effort, improves consistency in maintenance, and creates a stable aquatic environment. This makes aquarium management more convenient and dependable for fish owners.**

Keywords— **Sensors, relay, LED lamp, IOT, PH sensor, Water pump**

I. INTRODUCTION

After cats and dogs, freshwater fish are among the most commonly kept pets. Although keeping fish may seem simple, maintaining an aquarium requires continuous care and attention. Routine tasks such as cleaning the tank, feeding the fish, and operating equipment demand time and effort from the owner.

During feeding, devices like the air pump or power head often need to be switched off manually to prevent food from being disturbed in the water. After feeding, the pump must be turned on again after a specific interval. In conventional aquarium setups, components such as lights, heaters, and filters are controlled using manual electrical switches. This means the owner must be physically present to operate and monitor the system. Since fish typically need to be fed at least twice a day, the owner has to attend to the aquarium regularly. This becomes especially inconvenient during vacations or travel, as there is no direct control over the tank, and ensuring proper feeding becomes difficult.

To overcome these limitations, the concept of a Smart Aquarium has been developed. The proposed system is designed to be efficient, reliable, and cost-effective compared to many existing solutions. It is particularly suitable for individuals who wish to keep fish at home or in offices but do not have sufficient time to manage the aquarium manually. It also benefits those who prefer not to depend on neighbours or others to care for their fish during their absence.

The Smart Aquarium system automates essential maintenance activities, reducing the need for manual intervention. It monitors important environmental factors and automatically regulates conditions such as water temperature and equipment operation to maintain a healthy habitat for the fish. By integrating automation into aquarium management, the system minimizes human effort while ensuring a stable and optimal environment for aquatic life.

II. LITERATURE SURVEY

Fish owners often experience difficulty in feeding their fish when they are away from home. One major issue is ensuring that the fish receive food regularly, as irregular feeding can negatively affect both fish health and water quality. For this reason, proper monitoring of feeding schedules becomes very important, particularly in the absence of the owner.

Previous studies have proposed technological solutions to address these challenges. One such approach introduced an Internet of Things (IoT)-based system that allows aquarium conditions to be monitored through a mobile application. This system continuously observes water parameters and automatically adjusts environmental conditions to maintain a suitable habitat. Features such as temperature control, turbidity monitoring, automated lighting, and scheduled feeding are integrated into the system, enabling remote management of the aquarium.

In another study, researchers presented a system designed for aquaculture ponds, where continuous monitoring is essential. Their approach includes tracking temperature levels, managing feeding schedules, and automating water control processes such as draining and refilling based on real-time conditions. In this setup, fish are fed several times a day, typically three to five times, and water maintenance activities are automated to ensure a stable and healthy environment.

III. Goldfish

The goldfish is a freshwater fish species that belongs to the Cyprinidae family under the order Cypriniformes. It is one of the most commonly kept ornamental fish in household aquariums due to its attractive appearance and adaptability. Goldfish are available in various sizes, body shapes, fin types, and color patterns, making them highly popular among aquarium enthusiasts.

For healthy growth and proper development, goldfish require a stable water temperature. The recommended temperature range is between 20°C and 23°C (68°F–74°F). Maintaining the water within this range helps prevent stress, supports normal metabolism, and ensures sufficient oxygen levels in the aquarium.

After spawning, goldfish eggs usually attach to surfaces such as plants or tank decorations. The time required for hatching depends mainly on the water temperature. In warmer conditions, the eggs may hatch within a few days. In cooler water, development occurs more slowly, and hatching can take approximately 2 to 7 days after the eggs are laid.

IV. Model Aquarium

This system provides a structured and practical representation of a Smart Aquarium designed to simplify aquarium maintenance. It incorporates multiple sensors that continuously monitor important environmental parameters such as water temperature, water level, turbidity, and lighting conditions. These sensors collect real-time data to ensure that the aquarium environment remains safe and suitable for aquatic life.

The monitored information is displayed on an LCD screen, allowing users to instantly view the current status of the aquarium. This real-time visual feedback helps the owner understand the condition of the water and the operation of various components without needing additional equipment.

In addition to local monitoring, the system is integrated with IoT technology, enabling wireless communication between the aquarium and the owner's mobile device. Through a mobile application or web interface, users can receive updates, alerts, and notifications regarding temperature fluctuations, feeding schedules, or abnormal water conditions. This remote access feature allows owners to monitor and control devices such as the heater, lighting system, air pump, and automatic feeder from anywhere.

By combining sensor-based monitoring, automated control, LCD display output, and IoT connectivity, the Smart Aquarium system ensures a stable and well-maintained aquatic environment. It reduces manual effort, enhances efficiency, and provides greater convenience, especially when the owner is away from home. Overall, the system improves reliability and helps maintain healthy living conditions for the fish.

V. Life Cycle Of A Fish

If you are breeding fish in an aquarium, it is essential to separate the adult fish soon after the eggs are laid. Many fish species, including goldfish, may eat their own eggs if they remain in the same tank. To protect the eggs, the adults should be transferred to a different tank, or the eggs should be moved to a separate breeding setup.

After hatching, the newly born fish, known as fry, usually remain attached to plants, tank walls, or other surfaces for approximately two days.

During this period, they do not require external feeding because they survive by absorbing nutrients from their yolk sacs. It is important to maintain stable water temperature and good water quality at this stage, as fry are highly sensitive to environmental changes.

Once the fry begin to swim freely, they enter a critical growth phase and must be fed small, easily digestible food such as infusoria, liquid fry food, or finely crushed flakes. Feeding should be done in small quantities several times a day to promote healthy development while preventing water contamination. Proper filtration, gentle aeration, and regular monitoring of water conditions are necessary to ensure a safe and supportive environment for the young fish.

By following these steps carefully, fish breeders can significantly improve the survival rate and growth of the fry during their early stages of life.

VI. PROPOSED DESIGN

In this system, the Raspberry Pi functions as the central processing and communication unit. It collects data from different sensors, manages power distribution, and communicates with the sensors through an Arduino Uno microcontroller. The Arduino acts as an interface between the sensors and the Raspberry Pi, ensuring accurate data acquisition and control.
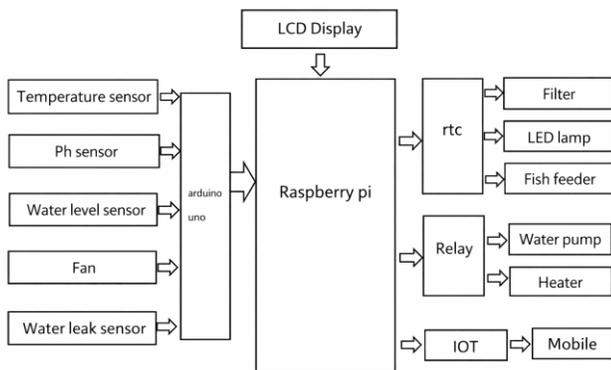
The LM35 temperature sensor is used to measure the water temperature continuously and transmit the readings to the Arduino for processing. A water level sensor monitors the amount of water present in the tank and can detect variations in liquid levels. These types of sensors are capable of measuring levels in containers containing liquids or semi-liquid substances. A pH sensor is incorporated to determine the acidity or alkalinity of the aquarium water, based on the standard pH scale ranging from 0 to 14.

Maintaining a stable pH level is essential for fish health. Additionally, a water detection sensor operates by sensing electrical conductivity, allowing it to identify the presence of water and send an appropriate signal to the system.

The system also integrates a Real-Time Clock (RTC) module, which schedules operations such as activating the servo motor for automatic feeding and controlling the LED lighting system. A relay module is used to switch high-power devices such as the heater and filter on or off based on sensor readings and programmed conditions.

All collected data, including temperature, water level, and pH values, are displayed on an LCD screen for direct monitoring. Furthermore, through IoT connectivity, the system transmits real-time updates and alerts to the user's mobile device, enabling remote monitoring and control of the aquarium environment.

VII. HARDWARE DESCRIPTION

- *DHT11:* The DHT11 sensor measures relative humidity by detecting the electrical resistance between two electrodes. It uses a capacitive humidity sensor and a thermistor to assess the surrounding air and sends a digital signal through the data pin

- *pH Sensor:* A pH sensor is a critical tool used to measure the acidity or alkalinity of water. It works by detecting the activity of hydrogen ions in water and other solutions, providing insights into the chemical balance of the liquid.

- *Water Leakage Sensor:* This sensor has electrical contacts at the bottom, which detect a short circuit when a conductive substance, like water, touches them. Upon detecting a leak, the sensor triggers an audible alarm to alert users of the issue.

- *Water Level Sensor:* This sensor rises and falls according to the liquid level in a container. When the liquid reaches a predetermined level, it activates a reed magnetic switch, signalling the system to take actions.

- *Filter:* The filter is activated after one month when the eggs have hatched, ensuring water quality is maintained as the fish grow.

- *Lighting:* The system ensures continuous light provision to support the fish and plant growth.

- *Feeding:* Feeding is automatically initiated two days after the eggs have hatched, providing nourishment to the fry at the appropriate time.

- *Water Pump:* The water pump activates when the water level falls below the pre-set range, ensuring the water level remains consistent.

- *Temperature Control:* The heater is enabled only when the temperature drops below a certain threshold, ensuring that the water remains within the ideal temperature range for the fish.

VIII. RESULT

The proposed mobile application–based aquarium control system has been successfully designed and implemented. This system enables aquarium owners to monitor and manage various aquarium functions remotely through their smartphones. By integrating IoT technology, the aquarium setup can communicate real-time data to the mobile application.

Through the app, users can view important parameters such as water temperature, pH level, water level, and equipment status. In addition to monitoring, the system also allows remote control of devices including the heater, lighting system, filter, and automatic feeder. This ensures that the aquarium environment remains stable even when the owner is not physically present.

Overall, the implementation of this system enhances convenience, reduces manual effort, and provides greater reliability in maintaining a healthy and balanced aquatic environment.

IX. CONCLUSION

This project was initially undertaken with the aim of developing a simple Smart Aquarium system. However, as the work progressed, it became evident that the implementation was more complex than expected, particularly in integrating hardware components such as relays and the servo motor. Interfacing and synchronizing these devices required careful programming and circuit design.

Despite these challenges, all the intended objectives of the project were successfully achieved. The developed system operates effectively and provides a strong foundation for future improvements and expansions.

Although the current version is functional, there remains significant scope for enhancement. Further development would require additional time, financial support, and technical resources. Upgrading the system with more advanced and reliable components would improve performance and overall efficiency.

Financial constraints present one of the main challenges in advancing the project, as higher-quality sensors and modules involve additional costs. Nevertheless, this project has been highly valuable from an academic and practical perspective. It provided hands-on experience in applying computer science and engineering concepts, including embedded systems, sensor integration, IoT communication, and automation.

The core idea of the Smart Aquarium system has proven to be practical and adaptable for use in any standard aquarium setup. By automating essential maintenance tasks, the system reduces manual effort, saves time, and minimizes concerns about fish care during extended absences. Overall, the project demonstrates the potential of automation technology in improving convenience and reliability in aquarium management.

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