# Software Requirements Specification

**for**

# Smart AquaCulture

**8th April, 2024**

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# 1. Introduction

## 1.1 Project Overview

Smart Aqua Culture System is an innovative project aimed at revolutionizing the way aquariums are managed and maintained. It leverages advanced sensor technologies and automation to create an intelligent ecosystem that ensures optimal conditions for aquatic life while providing convenience and peace of mind to aquarium enthusiasts.

**Key Features:**

**Real-time Monitoring:** Utilizing a network of sensors, the system continuously monitors crucial parameters such as pH level, oxygen concentration, water temperature, humidity, and chemical concentrations in the aquarium.

**Alert Mechanism:** The system is equipped with an alert mechanism that promptly notifies users via SMS, email, or mobile app notifications in case of any deviations from the optimal conditions. This ensures timely intervention to prevent any adverse effects on aquatic life.

**Automated Feeding:** Integrated feeding mechanism allows for automated dispensing of fish food based on pre-defined schedules or nutritional requirements. This ensures that the fish receive adequate nutrition even in the absence of manual intervention.

**Water Quality Management:** The system automates water quality management by monitoring parameters such as pH, ammonia, and nitrate levels. It triggers automatic water changes when necessary, maintaining a healthy and balanced environment for the aquatic inhabitants.

**User-friendly Interface:** A user-friendly interface, accessible via a mobile app or web portal, provides real-time data visualization, historical trends, and control options. Users can conveniently monitor the aquarium status, adjust settings, and receive alerts from anywhere at any time.

**Benefits:**

- Ensures optimal conditions for aquatic life, promoting their health and well-being.
- Reduces the manual effort and time required for aquarium maintenance.
- Provides peace of mind to users with real-time monitoring and alerts.
- Facilitates remote management and control, enabling users to stay connected to their aquariums from anywhere.

**Future Enhancements:**

- Integration with AI algorithms for predictive analysis and proactive maintenance.
- Expansion of sensor capabilities to include additional parameters for comprehensive monitoring.
- Integration with voice assistants for hands-free control and interaction.
- Collaboration with aquarium equipment manufacturers for seamless integration with existing setups.
- By implementing the Smart Aquaculture System, aquarium enthusiasts can elevate their aquarium experience to new heights, ensuring a thriving and vibrant aquatic ecosystem with minimal effort and maximum convenience.

## 1.2 Project Objectives

**Develop an Integrated Monitoring System:** Design and implement a comprehensive monitoring system that integrates various sensors to continuously track key parameters such as pH level, oxygen concentration, temperature, humidity, and chemical concentrations in the aquarium water.

**Implement Real-time Alert Mechanism:** Develop an alert mechanism that promptly notifies users through SMS, email, or mobile app notifications whenever any monitored parameter deviates from the preset optimal range, ensuring timely intervention to prevent any adverse effects on aquatic life.

**Enable Automated Feeding Mechanism:** Integrate an automated feeding mechanism that dispenses fish food based on predefined schedules or nutritional requirements, ensuring consistent and timely feeding even in the absence of manual intervention.

**Facilitate Water Quality Management:** Automate water quality management by monitoring parameters such as pH, ammonia, and nitrate levels, and implementing automatic water change procedures when necessary to maintain a healthy and balanced aquatic environment.

**Develop User-friendly Interface:** Create a user-friendly interface accessible via a mobile app or web portal, providing intuitive visualization of real-time data, historical trends, and control options, allowing users to monitor the aquarium status, adjust settings, and receive alerts conveniently.

**Ensure Compatibility and Scalability:** Ensure compatibility with a wide range of aquarium setups and scalability to accommodate future expansions or modifications, allowing seamless integration with existing equipment and easy adaptation to evolving user needs.

**Promote Sustainability and Environmental Responsibility:** Promote sustainable aquaculture practices by optimizing resource utilization, minimizing water wastage, and reducing environmental impact through efficient monitoring and management of aquarium conditions.
Encourage Education and Awareness:

Foster education and awareness about aquaculture and environmental conservation by providing insights into aquatic ecosystems, encouraging responsible pet ownership, and promoting conservation efforts through the dissemination of relevant information and resources.

## 1.3 Project Scope

**Development of Smart Aqua Culture System:** Creating the Smart AquaCulture System, utilizing various sensors and automation to monitor and manage the aquarium environment effectively.

**Selection of Sensors and Controllers:** Choosing the necessary sensors and controllers to monitor the aquarium conditions, including pH sensors, temperature sensors, and an automated feeder.

**Software and Hardware Development:** Developing essential software and hardware components, such as microcontroller programming, mobile app development, and interface design.

**Real-time Monitoring and Alerts:** Establishing a real-time monitoring system that tracks aquarium conditions and sends alerts to users if any parameter deviates from the normal range.

**Automation of Feeding and Water Changes:** Implementing an automated feeding mechanism to ensure timely feeding of fish and integrating procedures for automatic water changes.

**User Interface Design:** Designing an intuitive and user-friendly interface for easy access to real-time data and adjustment of settings.

**Testing and Optimization:** Thoroughly testing each system component and optimizing them to ensure proper functionality and deliver optimal results to users.

**Documentation and Training:** Creating comprehensive project documentation outlining the system's operation and maintenance procedures, and providing training to users on how to utilize the project effectively.

## 1.4 References

**Websites and Online Resources:**

**The World Aquaculture Society** (https://www.was.org/)

**Food and Agriculture Organization (FAO) Aquaculture Website** (http://www.fao.org/aquaculture/en/)

## 2. Software Requirements

### 2.1 Functional Requirements

**Real-time Monitoring:** The system should continuously monitor key parameters such as pH level, oxygen concentration, temperature, humidity, and chemical concentrations in the aquarium water. It should update the data in real-time and display it on the user interface.

**Alert Mechanism:** The system should have an alert mechanism that notifies users via SMS, email, or mobile app notifications when any monitored parameter deviates from the preset optimal range.

**Automated Feeding:** Implement an automated feeding mechanism that dispenses fish food based on predefined schedules or nutritional requirements. The system should allow users to set feeding schedules and adjust portion sizes as needed.

**Water Quality Management:** Automate water quality management by monitoring parameters such as pH, ammonia, and nitrate levels. Implement automatic water change procedures when necessary to maintain a healthy aquatic environment.

**User Interface:** Develop a user-friendly interface accessible via a mobile app or web portal. The interface should provide real-time data visualization, historical trends, and control options for adjusting settings.

**Data Logging and Analysis:** The system should log and store historical data for analysis and trend identification. Provide tools for data analysis to help users make informed decisions about aquarium management.

### 2.2 Non - Functional Requirements

**Reliability:** The system should be highly reliable, with minimal downtime and accurate sensor readings. It should withstand environmental factors such as water splashes and humidity.

**Scalability:** The system should be scalable to accommodate different aquarium sizes and setups. It should be able to handle a growing number of sensors and users as the project expands.

**Security:** Ensure data security and user privacy by implementing encryption techniques for data transmission and storage. Implement user authentication mechanisms to prevent unauthorized access to the system.

**Performance:** The system should have low latency and respond quickly to user commands and sensor readings. It should be capable of handling a large volume of data without significant performance degradation.

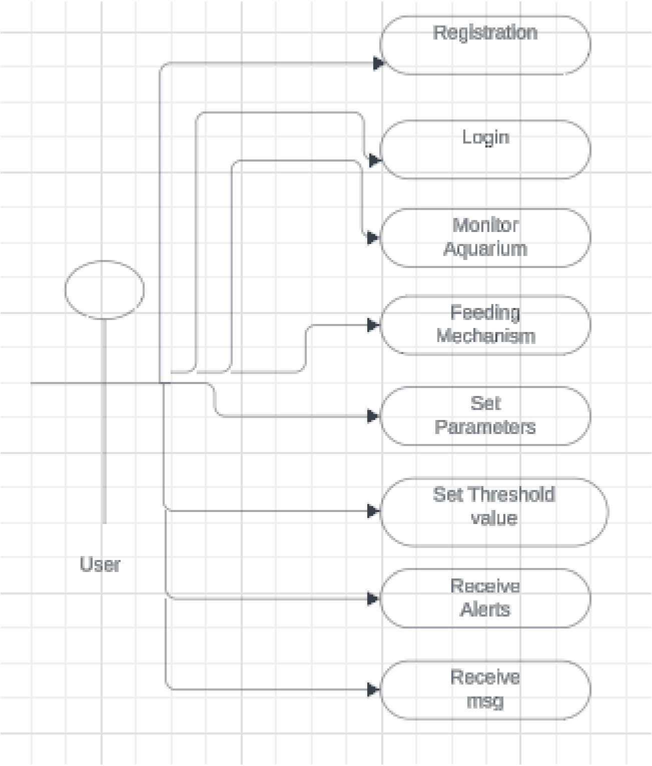
**Usability:** Design the user interface to be intuitive and easy to navigate, even for users with limited technical knowledge. Provide clear instructions and tooltips to guide users through the setup and operation of the system.

**Compatibility:** Ensure compatibility with a wide range of aquarium setups and equipment. The system should be compatible with different operating systems and devices, including smartphones, tablets, and computers.

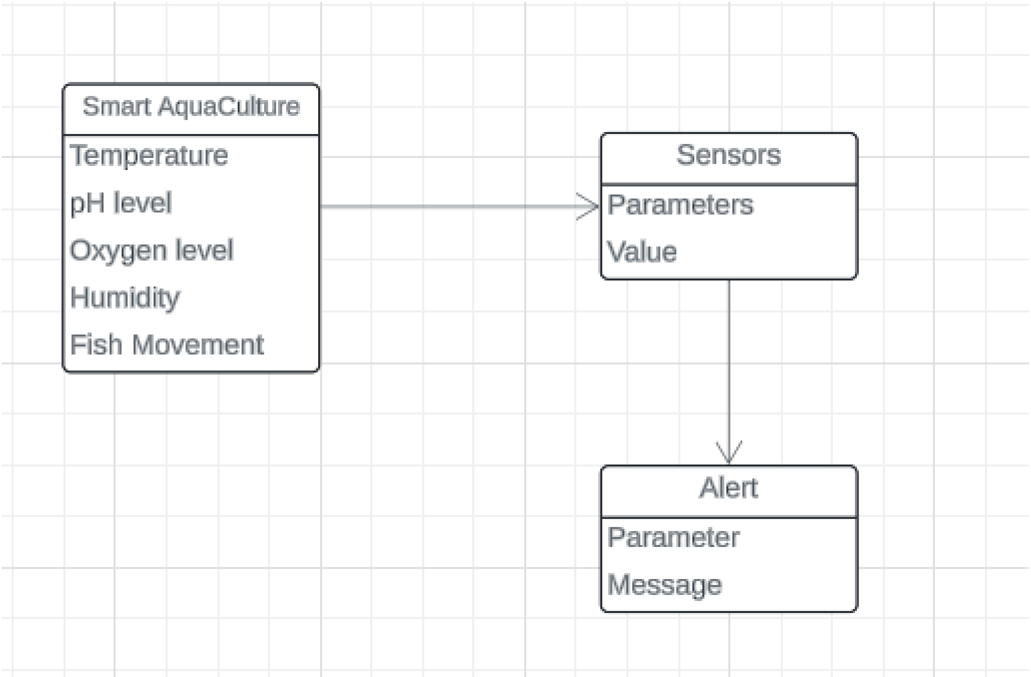
**Maintainability:** Design the system with modular components to facilitate easy maintenance and updates. Provide documentation and support resources to assist users in troubleshooting and resolving issues.

## 3. Software Designing

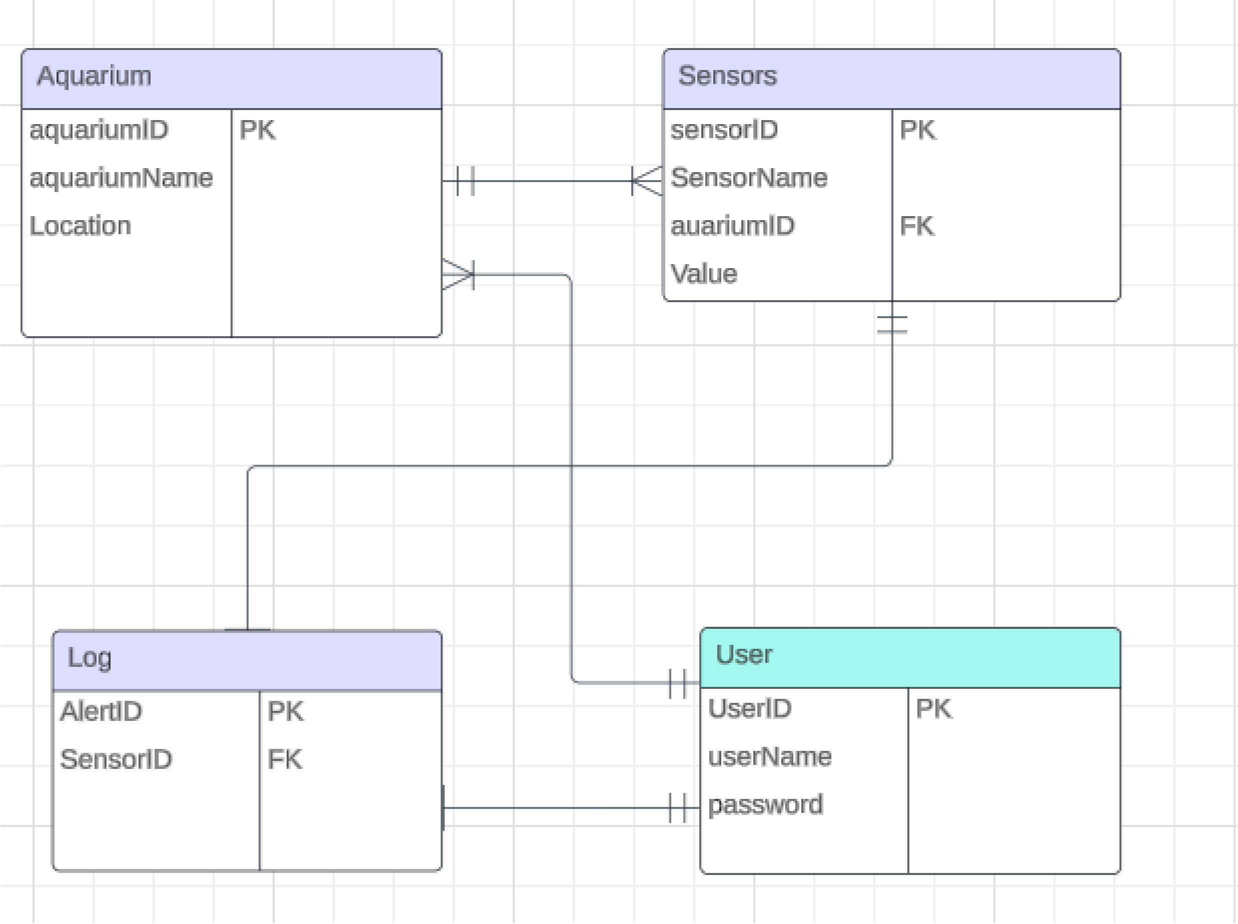
### 3.1 Use Case Diagram



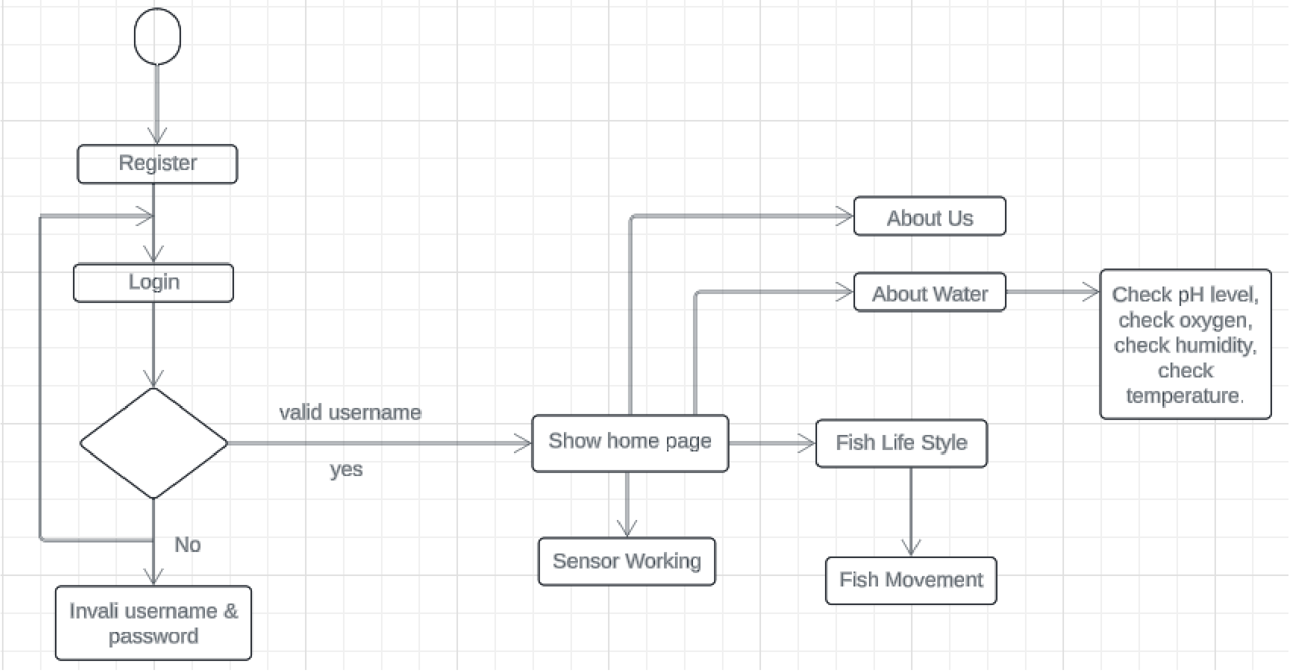
## 3.2 Class Diagram



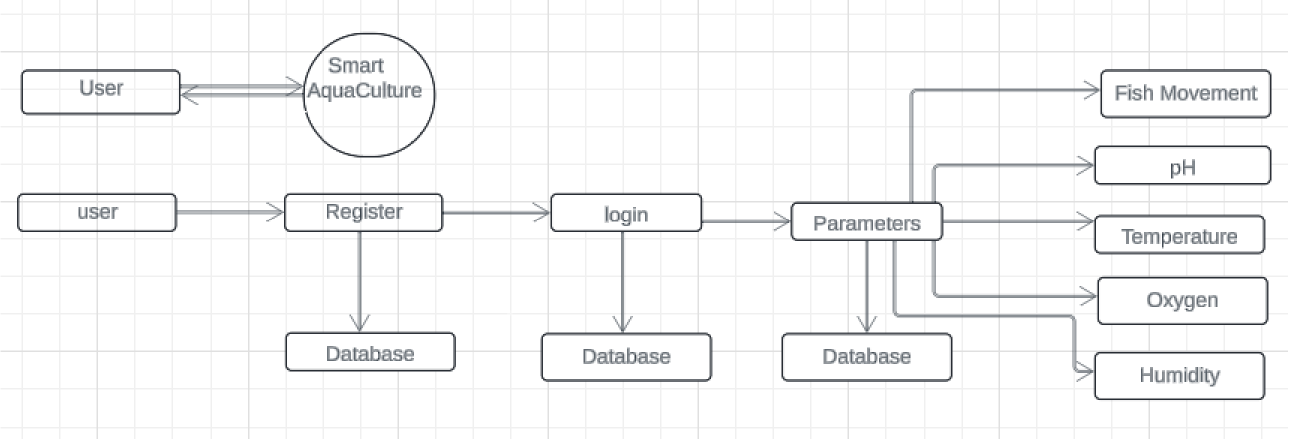
### 3.3 Entity Relationship Diagram



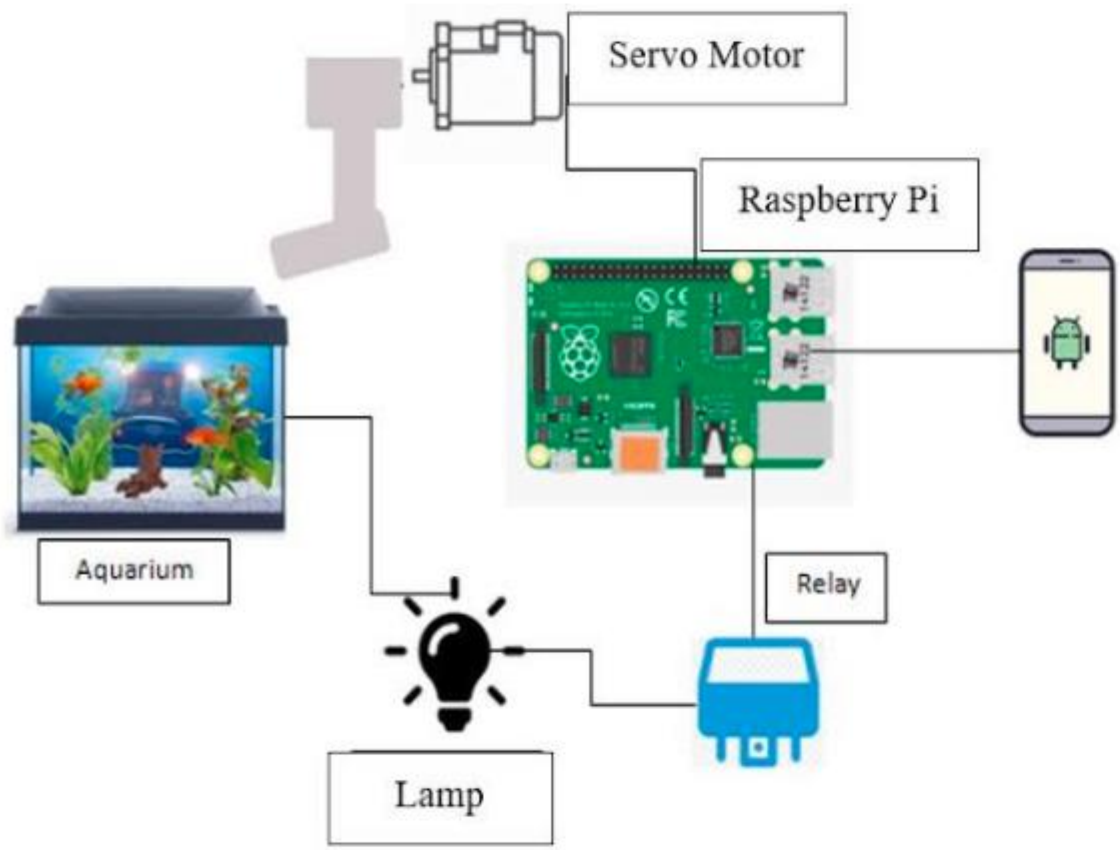
## 3.4 Activity Diagram



## 3.5 Data Flow Diagram



## 3.6 Architecture Diagram


Servo Motor
Raspberry Pi
Aquarium
Relay
Lamp

## 4. Tools and Technologies

**Sensor Integration:**

**Arduino or Raspberry** Pi*:*
Microcontrollers for interfacing sensors and controlling devices.

**Water Quality Sensors:**
Measure pH level, concentration, and saltiness of water.

**Cameras:**
Capture footage for fish movement analysis.

**Communication Protocols:**

**MQTT*:***
Lightweight protocol for IoT devices, facilitating efficient communication between sensors and server.

**HTTP/HTTPS*:***
Enable web-based communication for data transmission between devices and server.

**TCP/IP:**
Standard internet protocol suite for reliable data transfer.

**Data Storage & Processing:**

**MySQL or PostgreSQL:**
Relational databases for storing sensor data and analysis results.

**Python:**
Programming language for backend development, data processing, and analysis.

**OpenCV:**
Library for image processing and computer vision algorithms, aiding in fish movement analysis.

***Web & App Development:***

**Django or Flask:**
Python web frameworks for backend development, providing robust server-side functionality.

**HTML, CSS, JavaScript:**
Frontend development languages for designing interactive web interfaces.

**React:**
Frontend frameworks for building dynamic user interfaces.

**Swift:**
Languages for native mobile app development, enhancing accessibility and usability.

**Alerting & Notification:**

**Twilio or Nexmo:**
APIs for sending SMS alerts, notifying users of critical events.

**Firebase Cloud Messaging (FCM):**
Service for delivering push notifications to mobile devices, ensuring timely updates.

**Security:**

**SSL/TLS:**
Protocols for securing data transmission, safeguarding sensitive information.

**JWT:**
Authentication mechanism for verifying user identity and securing access to system resources.

**Deployment & Hosting:**

**AWS or Azure*:***
Cloud platforms for hosting server and databases, ensuring scalability and reliability.

**Docker:**
Containerization tool for packaging application components, simplifying deployment and management.

### 3.1 Designing Tools

**Adobe Illustrator:**
To Design project logo, icons, and visual elements to establish brand identity.

**Adobe Photoshop:**
We will Edit and manipulate images for visual assets, enhancing the overall aesthetic appeal.

**Figma:**
For Collaboratively design and prototype interfaces, enabling efficient iteration and feedback.

**In Vision:**
To Create interactive mockups and user flows, providing stakeholders with a realistic preview of the final product.

**Canva:**
We Design social media graphics and promotional materials, enhancing project visibility and outreach.

**Pen & Paper:**
We will Sketch initial concepts and ideas, facilitating brainstorming and conceptualization of design elements.

### 3.2 Unity 3D:

- **Unity Game Engine:**
  - Develop interactive 3D simulations for visualizing aquarium environments and fish behavior.
- **C# Programming Language:**
  - Script game logic and functionality within Unity, enabling dynamic interactions and simulations.
- **3D Modeling Software:**
  - Blender or Autodesk Maya: Create 3D models of aquarium structures and fish species for realistic rendering.

- **Unity Asset Store:**
    - Access pre-made assets and scripts for accelerating development, reducing time and effort required for implementation.

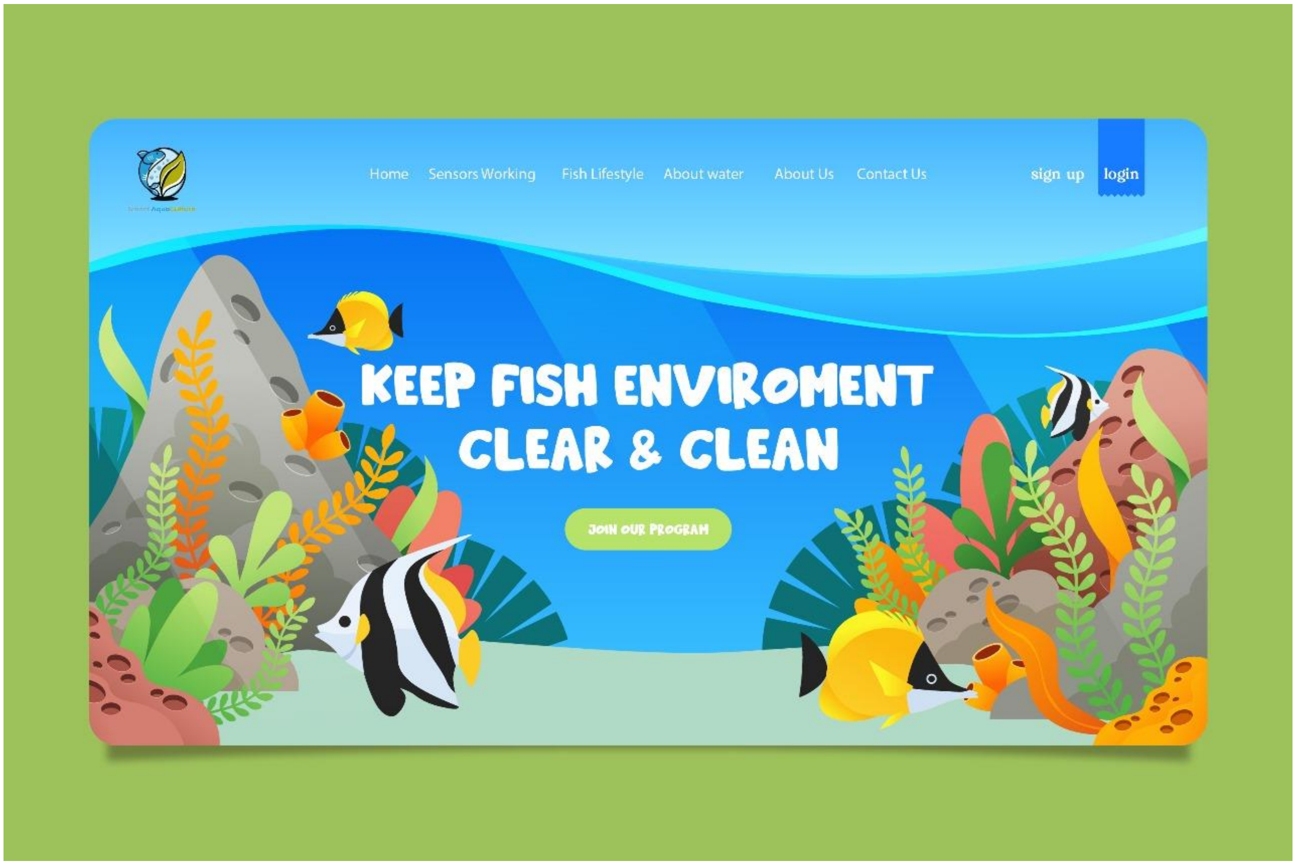
### 3.3 Documentation Tools

**Microsoft Word:**
Document project specifications, requirements, and progress reports, ensuring clear communication and alignment with project objectives.

**Google Docs:**
Collaboratively author and review documents, enabling seamless collaboration among team members.

**Git & GitHub:**
We will Use it for Version control and collaboration for code documentation, facilitating code review and integration of changes.

## 5. Screen Layout



**Screen Layout Documentation:**

1. **Home:**

- **DESCRIPTION**: The "Home" screen serves as the entry point to the application, providing users with an overview of available features and options.
- **FEATURES:**
    - Introduction to the application's purpose and functionality.
    - Quick access to other sections and features of the application.
- **DESIGN:**
    - Clear and concise layout with minimal distractions.
    - Use of engaging visuals or banners to capture user attention.
    - Navigation menu or buttons for easy exploration of the application.

2. **Sensors Working:**
    - **DESCRIPTION:** The "Sensors Working" screen provides real-time information about the status and performance of sensors installed in the aquaculture system.
    - **FEATURES:**
        - Display of sensor readings such as pH level, concentration, and salinity, temperature etc.
        - Graphical representation or data visualization for easy interpretation.
        - Alerts or notifications for abnormal sensor readings.
    - **DESIGN:**
        - Organized layout with clearly labeled sensor categories.
        - Color-coded indicators for sensor statuses (e.g., green for normal, red for abnormal).
        - Option to view historical data or trends for sensor readings.
3. **Fish Lifestyle:**
    - **DESCRIPTION**: The "Fish Lifestyle" screen offers insights into the behavior and health of fish living within the aquaculture system.
    - **FEATURES:**
        - Information on fish species, habitats, and preferred environmental conditions.
        - Tips for optimizing fish health and well-being.
        - Alerts for unusual fish behavior or signs of stress.
    - **DESIGN:**
        - Interactive elements such as clickable fish icons for accessing species-specific information.
        - Integration of images or videos showcasing fish habitats and behaviors.
        - Links to related resources or articles for further reading.
4. **About Water:**
    - **DESCRIPTION:** The "About Water" screen educates users about the importance of water quality in aquaculture and provides guidelines for maintaining optimal conditions.
    - **FEATURES:**
        - Overview of factors influencing water quality (e.g., pH, temperature, oxygen levels).
        - Best practices for water management and treatment.
        - Recommendations for addressing common water quality issues.
    - **DESIGN:**
        - Structured layout with sections or tabs for different aspects of water quality.
        - Use of visuals such as diagrams or infographics to illustrate concepts.
        - Links to additional resources or support materials for in-depth information.
5. **About Us:**
    - **DESCRIPTION:** The "About Us" screen introduces users to the creators or developers of the application and provides background information about the project.
    - **FEATURES:**
        - Team member profiles with photos and brief bios.
        - Mission statement or project objectives.
        - Contact information for getting in touch with the project team.
    - **DESIGN:**
        - Personalized and humanized layout to establish a connection with users.
        - Professional and approachable design elements reflecting the project's ethos.

        - Social media links or buttons for further engagement and interaction.

6. **Contact Us:**
    - **DESCRIPTION:** The "Contact Us" screen enables users to reach out to the project team for inquiries, feedback, or support.
    - **FEATURES:**
        - Contact form for submitting messages or queries.
        - Email address or phone number for direct communication.
        - Links to social media profiles or community forums for additional support.
    - **DESIGN:**
        - User-friendly form with clear fields and instructions.
        - Option to attach files or screenshots for better communication.
        - Confirmation message or thank-you note upon successful submission.

## 4. Project Plan According to Agile Methodology

**Sprint 1:** Setup and Initial Development

**Duration:** 4 weeks
**Objective:** Establish the foundational framework and setup necessary for the smart aquaculture system.

**Tasks:**

- Gather project requirements from stakeholders and create the initial product backlog.
- Set up the development environment, including hardware and software components.
- Develop the basic user interface for real-time monitoring of aquarium parameters.
- Integrate fundamental sensors for monitoring critical parameters such as pH level, temperature, and oxygen concentration.
- Implement a rudimentary alert mechanism to notify users of significant changes in aquarium conditions.

**Sprint 2:** Sensor Integration and Data Collection

**Duration:** 4 weeks
**Objective:** Integrate additional sensors and enhance the system's capability to collect and manage data.

**Tasks:**

- Integrate a humidity sensor to monitor air moisture levels within the aquarium environment.
- Expand data collection capabilities to include monitoring of ammonia and nitrate levels for comprehensive water quality management.
- Develop functionality for logging sensor data to facilitate further analysis and historical tracking.
- Enhance the user interface to display additional sensor data and provide insights into historical trends.
- Conduct thorough testing to validate sensor integration and ensure accurate data collection.

**Sprint 3:** Automation and Feeding Mechanism

**Duration:** 4 weeks
**Objective:** Implement an automated feeding mechanism and enhance overall system automation.

**Tasks:**

- Develop and integrate an automated feeding mechanism capable of adhering to predefined schedules or user-defined triggers.
- Implement automated water change procedures based on monitored water quality parameters.
- Enhance the alert mechanism to provide notifications for feeding schedules and upcoming water changes.
- Conduct extensive testing of automation features to ensure reliability, accuracy, and seamless integration with existing functionalities.
- Solicit feedback from stakeholders and make necessary adjustments based on user experience and system performance.

**Sprint 4:** User Interface Refinement and Optimization

**Duration:** 4 weeks
**Objective:** Refine the user interface design and optimize system performance based on user feedback.

**Tasks:**

- Gather user feedback on the current user interface design to identify areas for improvement and enhancement.
- Refine the user interface layout, navigation, and visual elements to improve usability and accessibility.
- Optimize system performance by addressing any bottlenecks, improving response times, and enhancing data processing capabilities.
- Conduct usability testing with stakeholders to validate interface improvements and ensure alignment with user expectations.
- Prepare for the final release by conducting comprehensive testing, resolving any remaining issues, and finalizing documentation.

**Sprint 5:** Final Testing and Deployment

**Duration:** 4 weeks
**Objective:** Conduct final testing, address any outstanding issues, and prepare for the deployment of the smart aquaculture system.

**Tasks:**

- Execute thorough testing of the entire system to verify functionality, reliability, and performance.
- Address and resolve any remaining bugs or issues identified during testing to ensure a stable and robust system.
- Prepare comprehensive documentation, including user manuals and system guides, to facilitate smooth deployment and user adoption.
- Finalize the deployment plan and schedule for the release of the smart aquaculture system into the production environment.
- Deploy the system to the production environment, monitor its performance post-deployment, and address any issues or concerns that may arise.