# User Manual

AQUASENSE

Version: 1.0

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# 1. Introduction

## 1.1 Purpose of the system

The AquaSense System is an intelligent, real-time solution designed to automate and optimize the monitoring and care of aquatic life in both residential and research aquariums. It combines computer vision, sensor data acquisition, and automated control mechanisms to provide a comprehensive and user-friendly platform for aquarium management.

The system tracks fish behavior, monitors critical environmental parameters such as pH, turbidity, and temperature, and ensures stable living conditions through automated thermal regulation. Additionally, it provides real-time notifications and feeding control through a mobile interface, reducing the need for manual supervision and increasing reliability.

## 1.2 Key Features

**Real-Time Fish Tracking**

Tracks each fish individually in real time, even when they overlap or swim out of direct view. The system ensures that fish are monitored accurately throughout the day using intelligent behavior analysis.

**Abnormal Behavior Notifications**

Automatically detects behavioral anomalies such as long-term immobility or frequent surfacing, which indicates low oxygen level, and sends real-time alerts to the mobile app.

**Environmental Sensor Monitoring**

Continuously measures:

- pH levels – to detect acidic or alkaline shifts
- Turbidity – to identify water clarity issues
- Temperature – to ensure a stable aquatic environment

**Automated Temperature Control**

Keeps the water temperature within the optimal range of 24°C to 30°C by automatically activating a heating or cooling system as needed. This ensures a safe and healthy environment for the fish.

**Flexible Feeding System**

**Offers two feeding modes:**

- **Manual Feeding:** Users can input the number of grams via the mobile app, and the system will precisely dispense the correct amount of food.
- **Scheduled Feeding:** Allows users to set predefined feeding times, so the system automatically feeds the fish at those intervals without manual intervention.

**Live Video Stream**

Provides continuous real-time access to the aquarium's video feed through the mobile app or web dashboard, enabling remote observation of fish and system status.

## 1.2 Intended Users

The AquaSence System is specifically designed for home aquarium owners who frequently travel and require a reliable, automated solution to ensure their fish remain healthy and safe in their absence. With real-time monitoring, automated feeding, and mobile alerts, the system reduces the need for constant manual care while providing peace of mind from anywhere in the world.

Primary Users: This system is ideal for,

- Aquarium hobbyists or pet owners who cannot be physically present at all times.
- Pet owners seeking an automated, self-managing solution for fish health tracking, precise feeding, and environment regulation.

# 2. System Overview

## 2.1 Architecture Summary

The AquaSence system is built around a modular architecture combining hardware and software components to enable real-time fish monitoring, environmental sensing, and automated aquarium management. At its core is a Raspberry Pi 3B that processes live video input and sensor data, controls feeding and temperature systems, and communicates with a user interface via WebSocket for real-time updates and alerts.

## 2.2 Main Modules

### 2.2.1 Hardware Modules

**AquaSence Controller**

The central processing unit of the system, built around a Raspberry Pi 3B. It runs the fish tracking model, processes sensor data, controls the feeder and temperature modules, and manages communication with the mobile app. All core logic is embedded in this unit.

**Camera Module**

Provides a live video stream of the aquarium that users can watch in real time. The same camera feed is also processed by the system's AI models to monitor and track fish behavior continuously. This enables automatic detection of abnormal behaviors, triggering timely notifications to the user.

**Environmental Sensor Module (Sensor Suite)**

Continuously monitors critical water parameters, including pH, turbidity, and temperature, to ensure a healthy environment.

**Temperature Regulation Unit**Automatically regulates water temperature to maintain it within the optimal range of 24°C to 30°C, ensuring fish comfort and safety.

**Feeding Module**

Controls a servo-driven feeder to dispense food accurately, supporting both manual feeding commands and scheduled feeding routines.

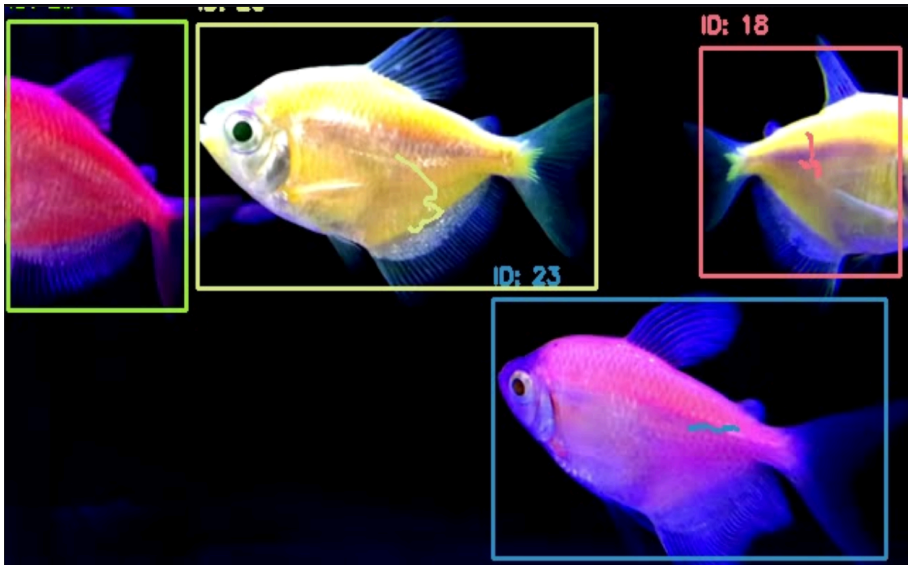
**Power Supply**

Convert 230V to 12V. Buck converter to convert 12V to 5V to isolate high-voltage (230V) from the low-voltage electronics.

## 2.2.2 Software Modules

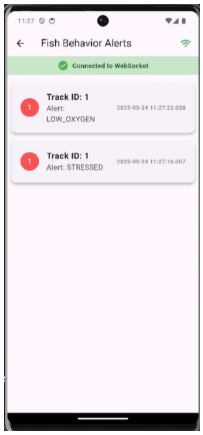
**Fish Tracking Module**

Processes video frames using AI algorithms to detect and assign unique IDs to each fish, maintaining consistent tracking even when fish overlap or move out of direct view.




**Abnormality Detection Module**

Monitors fish motion patterns to detect prolonged immobility or frequent surfacing behaviors indicative of stress or low oxygen.



**User Interface Module**

A mobile-only application designed for convenience and accessibility while traveling. It allows users to:

- View live video from the aquarium
- Receive instant notifications of abnormal behavior or environmental issues
- Monitor pH, turbidity, and temperature
- Manually feed fish or set automated feeding schedules

[IMAGE OF THE MOBILE INTERFACE]

# 3. Hardware Requirements

The AquaSence system is shipped as a complete plug-and-play hardware kit. All necessary sensors, actuators, and control units are pre-installed or included in the box. No additional hardware is required from the user's side.

This ensures a quick setup process, especially for home aquarium owners who want a ready-to-use solution without technical assembly.

## 3.1 Required Components

The following components are tested, bundled, and pre-configured by the AquaSence team. Make sure you have all the hardware components mentioned below.

| Component | Description |
|---|---|
| AquaSence Controller | Preloaded main unit with all software and logic onboard. |
| Camera Module | Mounted for overhead video capture and fish tracking. |
| Sensor Suite | pH, turbidity, and temperature sensors with waterproof probes. |
| Feeding Module | Automatic feeder with calibrated control. |

| | |
|---|---|
| Temperature Regulation Unit | Heater and cooler system to maintain 24°C–30°C range. |
| Power Supply & Wiring | 12V and 5V adapters as well as all required cabling. |

# 4. Software Requirements

## 4.1 Supported Platforms

**Embedded System**

AquaSence's Raspberry Pi 3B controller comes pre-installed with all required software, including fish tracking, sensor processing, control algorithms, and communication services. No additional installation is needed.

**Mobile Application**

Available for Android and iOS devices, supporting remote monitoring and control.

## 4.2 Required Libraries & Tools

**Embedded System**

All necessary libraries and dependencies (Python, OpenCV, AI models, WebSocket server, sensor interfaces) are pre-configured and ready to use on the Raspberry Pi unit.

**Mobile Application**

Requires installation of the AquaSence mobile app from the official app stores. The app includes built-in networking and streaming libraries; no additional tools are required on the user device.

# 5. Installation & Setup

## 5.1 Hardware Setup Instructions

AquaSense is designed for plug-and-play convenience. All hardware components are pre-installed and integrated. Follow these simple steps:

1. **Sensor Container Placement**
    - This container houses the pH, turbidity, and temperature sensors.
    - It comes with suction cups already attached.
    - Stick it inside the fish tank, ensuring the container is fully submerged and sensors are in contact with water.
2. **Electronics Container Placement**
    - This container includes the Raspberry Pi 3B, ADC, circuit board, and camera.
    - The camera lens is pre-aligned to face the tank.
    - Mount the container securely on the outside of the tank glass using the provided suction cups.
3. **Temperature Control Device Placement**
    - This unit contains a Peltier device, aluminium water block, cooling fan, and heat sink, all pre-assembled.
    - Mount it on the inside wall of the tank using the pre-attached mounting clips.
4. **Water Pump Setup**
    - The water pump is already connected to the aluminium water block with silicone tubing and pre-wired to the 12V power supply via a buck converter.
    - Simply place the pump into the water at the bottom of the tank.

5. **Power Connections**
    - Connect the included 12V power adapter to a wall socket.
    - Plug the Raspberry Pi power cable to a wall socket.

## 5.2 Software Installation Steps

No setup is required on the hardware side. All necessary software is pre-installed and fully configured on your AquaSense device.

1. **Download and Install the AquaSense Mobile App**
2. **Login or Register**
    - Open the app and create a new account or log in with your existing credentials.
3. **Start Monitoring**
    - Once logged in, your device will automatically connect (if powered on) and start displaying sensor data.
    - You can immediately
        - Monitor water quality
        - Control feeding
        - Configure Wi-Fi
        - Receive behavior alerts
        - View camera feed

**Note:** Do not attempt to modify or reset the Raspberry Pi. All internal configurations are preloaded and ready to use.

## 5.3 Configuration Settings

1. **WiFi Configuration**
    - Set via mobile app by providing SSID and password
2. **Feeding Schedule**
    - Set via app (instant or scheduled).

## 5.4 System Startup Instructions

1. Connect the included 12V power adapter to a wall socket.
2. Plug the Raspberry Pi power cable to a wall socket.
3. Wait for Raspberry Pi to boot ( about 1 minute).
4. Connect to AquaSense via the mobile app.
5. Confirm sensors are active and data is streaming.
6. The system is now operational.

# 6. Using the System

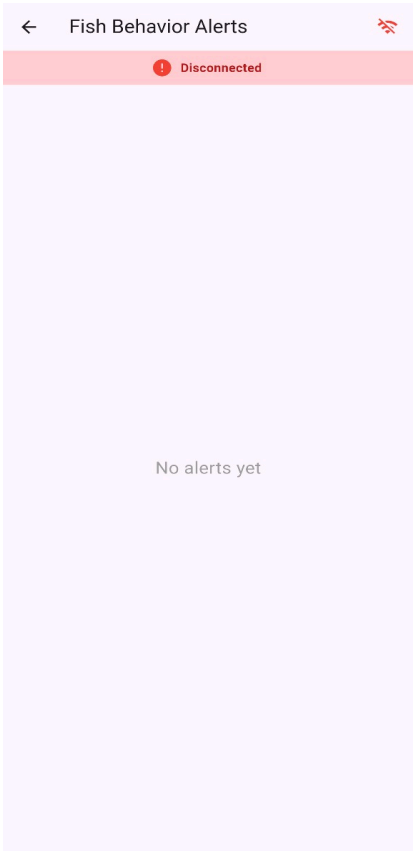
## 6.1 Fish Tracking Module

- The camera continuously monitors fish behavior.
- An AI model running on AWS EC2 checks if fish is stationary for too long.
- Alerts sent to users via mobile app if abnormal behavior is detected.

## 6.2 Notification System

**Alerts are pushed for**

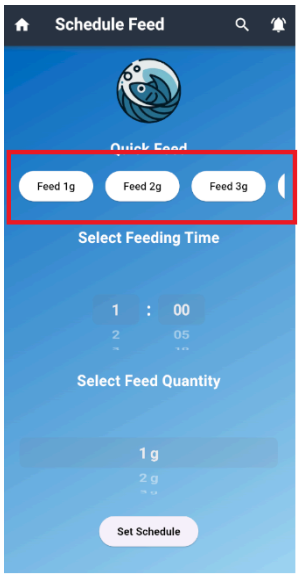
- Fish inactivity.



## 6.3 Feeding Mechanism

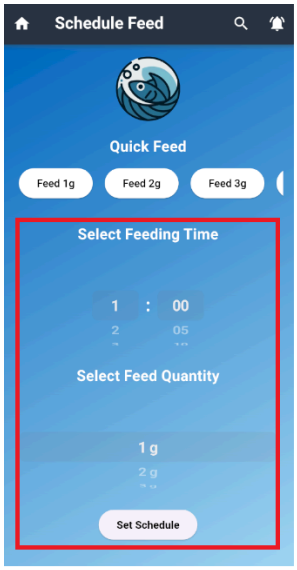
### Instant Feeding

- Tap the “Quick Feed” section in the app by selecting the grams.




### Scheduled Feeding

- Set specific times in the app.

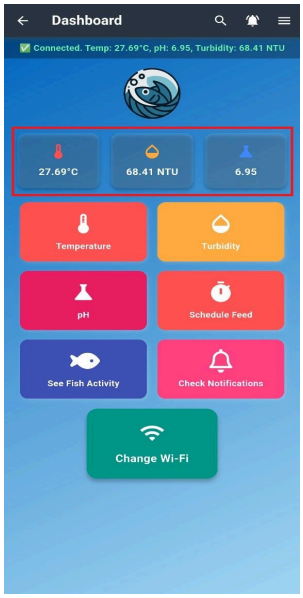


Mechanism triggers a food dispenser unit to release food.

## 6.4 Mobile App Usage

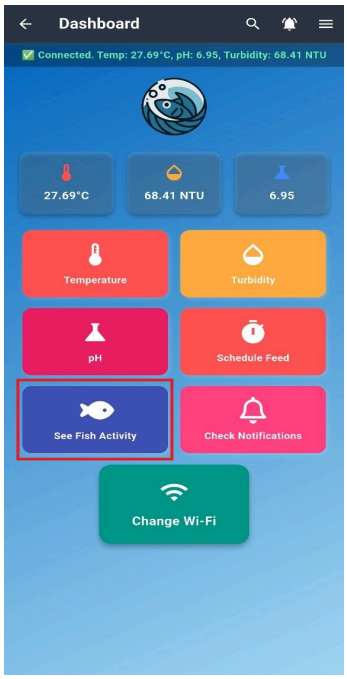
The AquaSense mobile app provides a user-friendly interface to control and monitor your smart aquarium. Once installed and connected, you can

- View real-time sensor data (pH, turbidity, temperature)

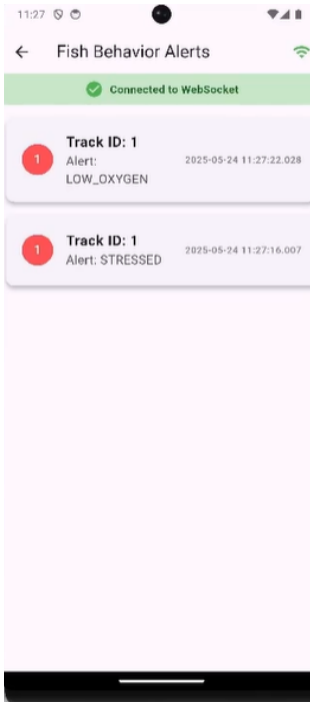



- Monitor fish activity via the camera feed

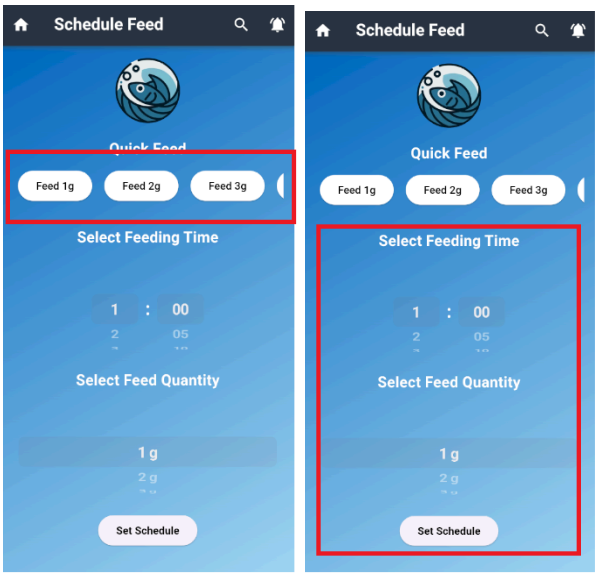
  You can monitor fish activity by clicking **See FIsh Activity** Button. Highlighting that using a red box.




- Receive alerts

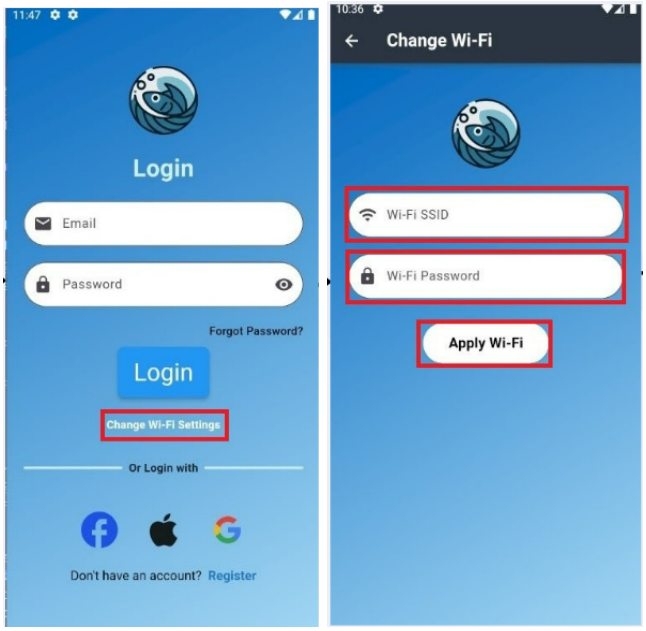


- Instantly feed your fish or schedule automatic feeding

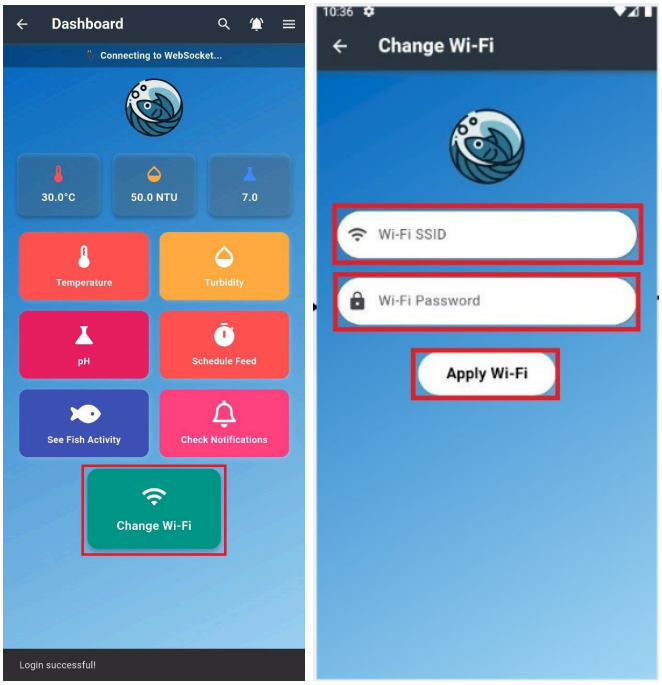



Instantly Feed Schedule Feed

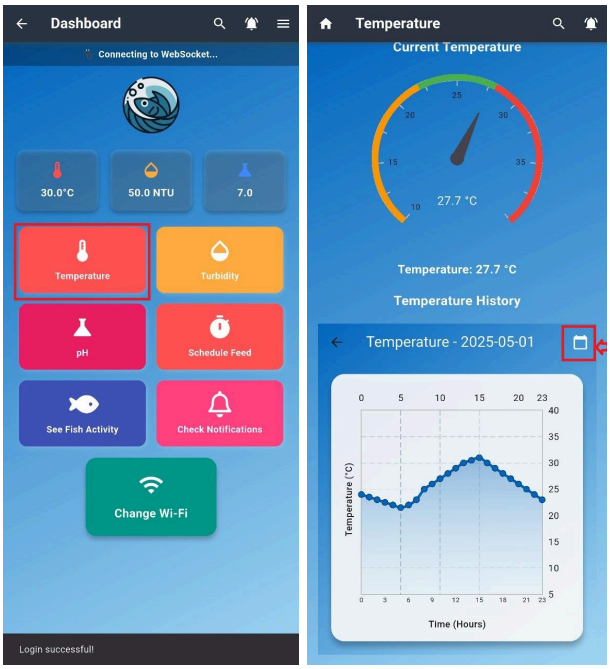
- Change the Wi-Fi configuration of your device



Users can change the wifi settings after logging into the app..




- View historical sensor data by selecting any date



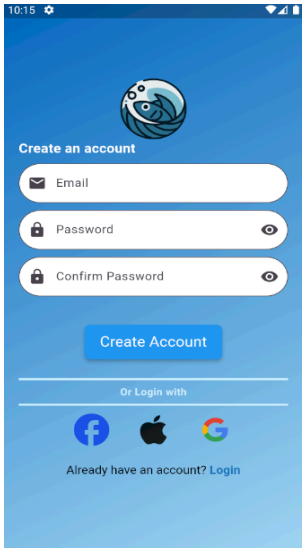
You can select the date that you want to see the sensor data  by clicking the calendar button. Highlighted that in the second image using the red box. And you can see other two sensor data by clicking the **turbidity** and **pH** button in the dashboard (first image).

All features are accessible from the dashboard once the system is connected.

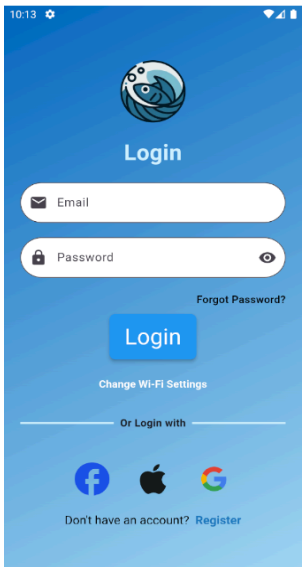
# 7. Account Management

## 7.1 User Registration & Login

- Register with email, and password.

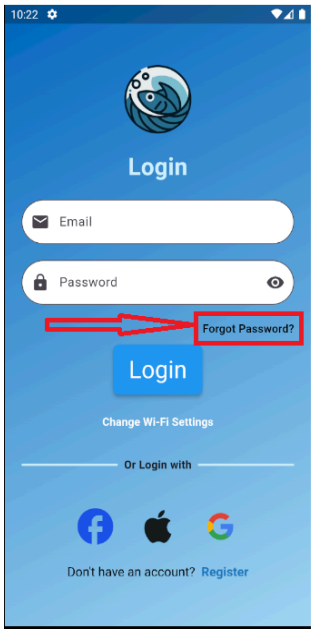



- Login with registered credentials.



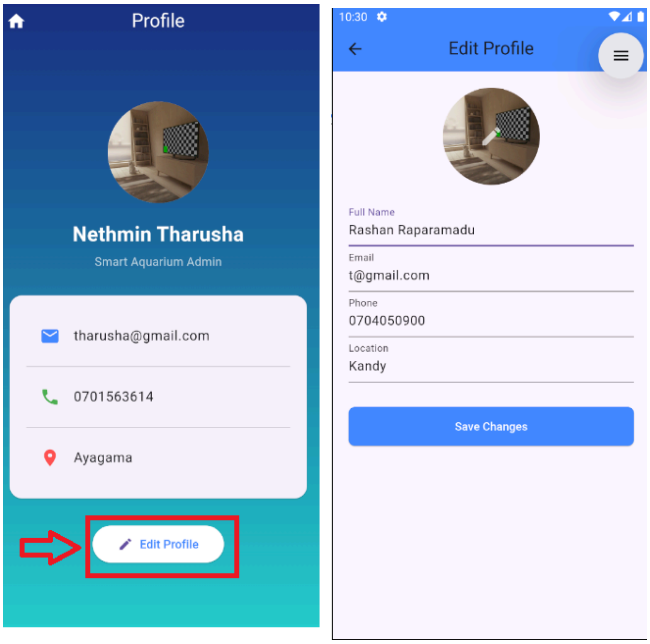

## 7.2 Password Reset

- Use the “Forgot Password” option to reset via email.



### 7.3 Profile Settings

- Update your name, profile picture, and preferences in the profile settings.




## 8. Maintenance & Updates

### 8.1 Cleaning & Care

- **Clean the fish tank weekly** to prevent algae buildup and residue that can affect sensor accuracy and water quality.
- **Wipe the sensor container** gently with a soft cloth or sponge. Do not use harsh chemicals.
- **Check suction cups** regularly to ensure containers are securely attached to the tank.
- **Inspect the temperature control unit** (Peltier device, fan, and water block) monthly for any dust or debris buildup.
- **Ensure the camera lens is clear** for uninterrupted fish behavior monitoring.

### 8.2 Software Updates

- Updates pushed from the mobile app.

### 8.3 Database Backup

- AWS RDS backups are automated.
- Users can export daily sensor data via app.

## 9. Troubleshooting

### 9.1 Common Issues and Fixes

| Issue | Possible Cause | Solution |
|---|---|---|
| No sensor data | Loose connections | Check sensor cables. |
| App can't connect | Wrong WiFi / SSID | Reconfigure WiFi in app |
| No camera feed | Camera misaligned | Ensure lens faces tank and is not blocked |
| Temperature not adjusting | Peltier device or fan not working | Check power and connections |