1. Introduction

1.1 Purpose

The purpose of this document is to outline the requirements for the development of a smart water bottle docking station, named "FROST." The docking station aims to remind users to drink water, clean their bottle, and place their bottle on the dock. Additionally, it will enter standby mode during night time to conserve energy.

1.2 Scope

This document covers the functional, non-functional, hardware, software, and user interface requirements for the FROST docking station.

1.3 Change History

Revision	Description	Date of Release
V1	Initial draft (Basic requirements added for classic version)	12-July-2024

2. Product Overview

2.1 Product Features

- **Bottle Presence Detection**: Detects if a water bottle is placed on the docking station using an IR sensor.
- **Hydration Reminders**: Reminds users to drink water at regular intervals using a blue LED.
- **Cleaning Reminders**: Alerts users to clean their bottle after a set period using a red LED.
- **Standby Mode**: Uses an LDR sensor to detect ambient light and enter standby mode during low light conditions.
- **Power Options**: Can be powered via a USB-C connector or three AAAA batteries.
- **Mobile App**: To set reminders interval, Get Statistics, Control output actuators.

3. Product Functional Requirements (FR)

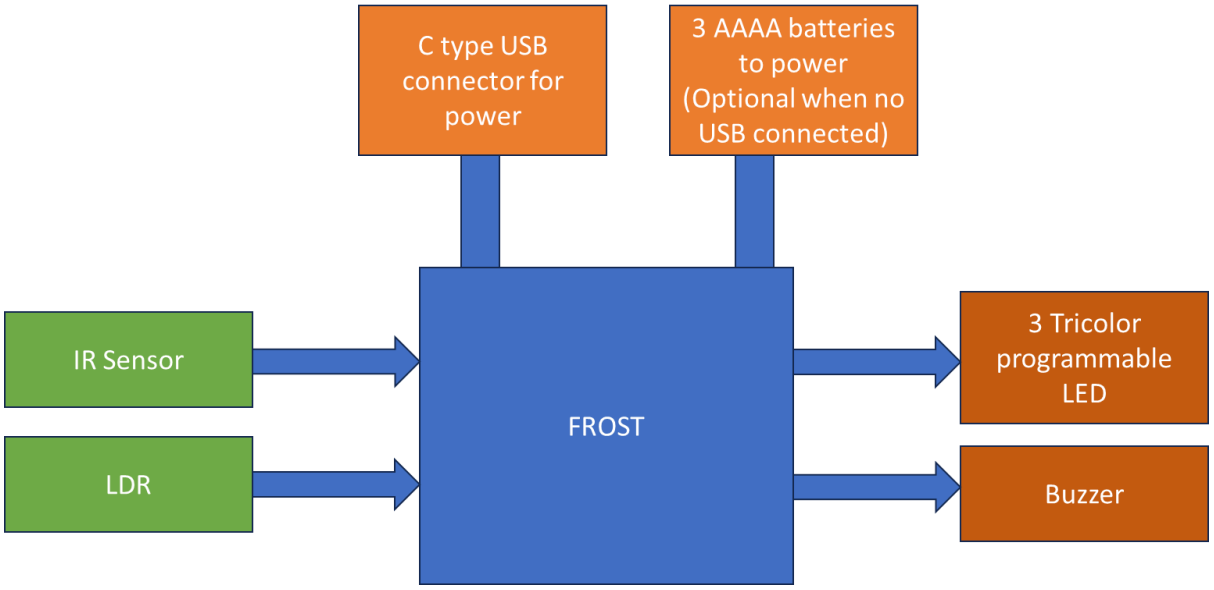
Req ID	Description	Implementation Reference
FR-1	The docking station must include an IR LED and receiver to detect the presence of a water bottle.	Hardware, Software
FR-2	The system should recognize and indicate when a bottle is placed on or removed from the dock.	Hardware, Software
FR-3	A blue LED should activate at adjustable intervals to remind the user to drink water.	Hardware, Software
FR-4	The default interval for the hydration reminder should be set to 1 hour, adjustable by the user.	Software
FR-5	A red LED should activate to remind the user to clean the bottle after 24 hours of use.	Hardware, Software
FR-6	The system should track and reset the cleaning reminder when prompted by the user.	Software
FR-7	An LDR sensor should detect ambient light levels.	Hardware, Software
FR-8	The docking station should enter standby mode during low light conditions and resume normal operation when light levels increase.	Hardware, Software
FR-9	Three tricolor LEDs should be used to indicate different statuses: Blue LED for Drink Water Reminder, Red LED for Clean Bottle Reminder, Green LED for Place Bottle Reminder.	Hardware, Software
FR-10	A buzzer can be used for additional audible alerts.	Hardware, Software

4. Non-Functional Requirements (NFR)

Req ID	Description	Implemented in
NFR-1	The system should respond to bottle placement/removal within 1 second.	Software
NFR-2	The standby mode should reduce power consumption by at least 80%.	Software
NFR-3	The LEDs should be clearly visible in both daylight and low light conditions.	Hardware
NFR-4	The device should be user-friendly with minimal setup required.	Hardware, Software
NFR-5	The system should operate reliably with a mean time between failures (MTBF) of at least 1 year.	Hardware
NFR-6	The docking station should be lightweight and portable, suitable for use in various environments (e.g., home, office).	Hardware

5. Hardware Requirements (HR)

5.1 Hardware Block Diagram



Module	Description	Specifications	Key Requirements
Microcontroller	ESP32-C3 for BLE communication and control of sensors and peripherals	- Voltage: 3.3V	Low-power operation, Bluetooth communication
		- BLE 5.0	
		- Wi-Fi capability	
Power Supply	3 x AAA batteries for portable power	- Voltage: 4.5V	Efficient power management, long battery life

		- Step-down to 3.3V	
Voltage Regulator	DC-DC step-down converter to regulate 4.5V from AAA batteries to 3.3V	- Output: 3.3V	Stable output for microcontroller and peripherals
RGB LED (WS2812B)	Programmable RGB LEDs for visual notifications	- 3 LEDs - WS2812B (controlled via GP10)	Display reminders with different colors and brightness
Buzzer	Piezoelectric buzzer for audio alerts	- Control pin: GP5	Multiple sound profiles for different reminders
IR Sensor	Infrared sensor for bottle presence detection	- Control pin: GP8	Detect when the bottle is placed on the docking station
LDR (Light Dependent Resistor)	Ambient light detection sensor	- Analog pin A0	Control LED brightness based on ambient light

Bluetooth Module (built-in)	BLE communication with mobile apps (ESP32-C3 has built-in Bluetooth capability)	- Bluetooth Low Energy (BLE)	Transmit settings, reminders, and notifications
OLED Display (optional)	Small display for showing visual feedback like time left for reminders (if included)	- 0.96" or 1.3" - I2C interface	Display remaining time for drinking or cleaning reminders
Battery Management Circuit	Battery management circuit for 3 AAA batteries to monitor voltage and provide low battery warnings	- Over-discharge protection - Voltage monitor	Efficient battery usage and notifications for low power

Temperature Sensor (optional)	Sensor to detect bottle temperature (optional future feature)	- DS18B20 or similar	Detect temperature of the water or environment
USB-C Connector	Optional USB-C for powering the device via an external source or recharging (if rechargeable battery is included)	- USB-C input: 5V	Optional external power source for future models
PCB Board	Custom-designed PCB to integrate all components and sensors	- Custom design for compact form	Efficient layout, low power consumption, and minimal size
Mechanical Components	Docking station structure, battery holder, and enclosure	- ABS or lightweight durable materials	Securely hold the bottle, withstand water splashes

Req ID	Description	Implemented in
HR-1	An Arduino-compatible microcontroller with sufficient GPIO pins to support all components.	Hardware
HR-2	IR LED and Receiver for bottle detection.	Hardware
HR-3	LDR sensor for ambient light detection.	Hardware
HR-4	Three tricolor LEDs for status indications.	Hardware
HR-5	USB-C connector for primary power and charging.	Hardware
HR-6	Compartment for three AAAA batteries for backup power.	Hardware
HR-7	Buzzer for audible alerts.	Hardware
HR-8	Resistors, capacitors, and other passive components as required for circuit design.	Hardware

6. Software Requirements (SR)

6.1 Software Design Diagram

6.2 Software State Machine

Req ID	Description	Implemented in
SR-1	Implement a state machine with the following states: INIT, IDLE, BOTTLE_PRESENT, REMINDER_DRINK, REMINDER_CLEAN, STANDBY.	Software

SR-2	Code to process signals from the IR LED and receiver to detect bottle presence.	Software
SR-3	Timer-based code to periodically activate the blue LED for drinking reminders.	Software
SR-4	Code to activate the red LED for cleaning reminders.	Software
SR-5	Code to read the LDR sensor and determine ambient light levels.	Software
SR-6	Logic to enter and exit standby mode based on light levels.	Software
SR-7	Code to handle user inputs, such as resetting reminders and adjusting timers.	Software

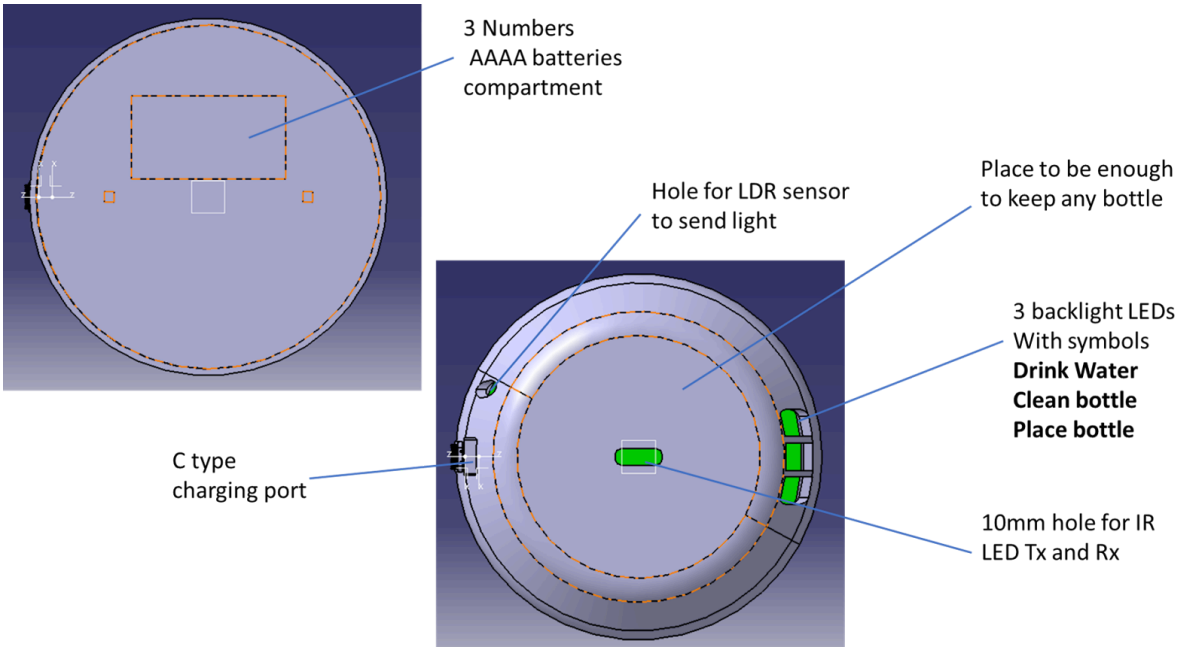
7. User Interface Design (UI)

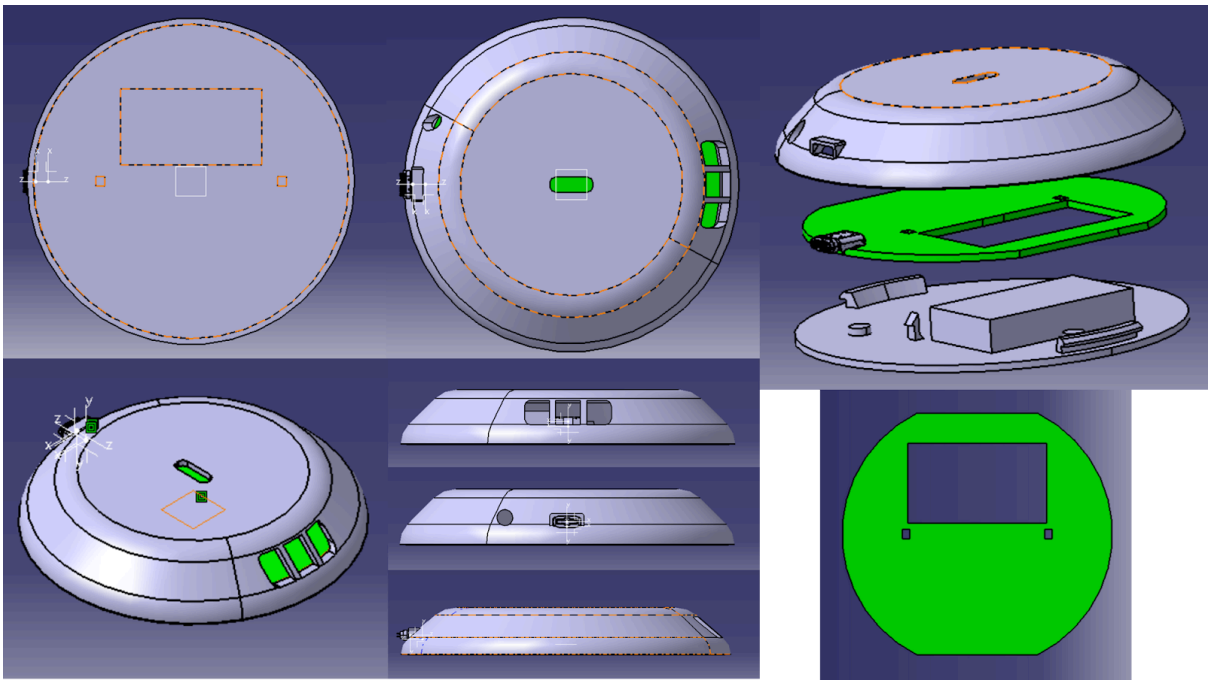
Req ID	Description	Implemented in
UI-1	Blue LED for Drink Water Reminder	Hardware
UI-2	Red LED for Clean Bottle Reminder	Hardware
UI-3	Green LED for Place Bottle Reminder	Hardware
UI-4	Use a buzzer to provide additional reminders and alerts.	Hardware

8. Design Considerations (DC)

Req ID	Description	Implemented in
DC-1	Compact and aesthetically pleasing design.	Hardware
DC-2	Stable base to hold various sizes of water bottles.	Hardware
DC-3	Optimize power consumption, especially when running on battery power.	Software
DC-4	Ensure standby mode significantly reduces power usage.	Software
DC-5	Use safe materials suitable for household use.	Hardware
DC-6	Ensure the device is durable and resistant to spills and knocks.	Hardware

9. Mechanical Designs





10. App Requirements for FROST

The app will provide users with the ability to monitor hydration reminders, cleaning reminders, and manage settings for the docking station remotely.

10.1 App Product Features

- **Connectivity:** Connects to FROST docking station via Bluetooth.
- **Hydration Monitoring:** Displays hydration reminders and allows users to adjust reminder intervals.
- **Cleaning Monitoring:** Shows cleaning reminders and lets users reset the cleaning timer.
- **Power Status:** Displays power status and battery level of the docking station.
- **Custom Alerts:** Allows users to set custom alerts for hydration and cleaning.
- **User Profiles:** Supports multiple user profiles to personalize reminders and settings.

10.2 Functional Requirements

Req ID	Description	Implementation Reference
FR-1	The app must connect to the FROST docking station via Bluetooth.	App
FR-2	Display real-time status of bottle presence, hydration reminders, and cleaning reminders.	App
FR-3	Allow users to adjust hydration reminder intervals.	App
FR-4	Provide an option to reset the cleaning timer.	App
FR-5	Show power status and battery level of the docking station.	App
FR-6	Enable users to set custom alerts for hydration and cleaning.	App
FR-7	Support creation and management of multiple user profiles.	App
FR-8	Notify users of reminders through push notifications.	App

10.3 Non-Functional Requirements

Req ID	Description	Implemented in
NFR-1	The app should establish a Bluetooth connection within 5 seconds.	App
NFR-2	The user interface should be intuitive and easy to navigate.	App
NFR-3	The app should consume minimal battery power on the user's device.	App
NFR-4	Data synchronization between the app and docking station should occur in real-time.	App
NFR-5	The app should be compatible with both iOS and Android devices.	App
NFR-6	The app should ensure data privacy and secure communication between the app and docking station.	App

10.4 App Hardware Requirements

Req ID	Description	Implemented in
HR-1	Smartphone with Bluetooth 4.0 or higher.	Hardware
HR-2	iOS or Android operating system.	Hardware

10.5 App Software Requirements

Req ID	Description	Implemented in
SR-1	Implement Bluetooth connectivity module to communicate with FROST docking station.	Software
SR-2	Develop a user interface to display reminders, status, and settings.	Software
SR-3	Implement push notification service for reminders.	Software
SR-4	Create user profile management system to personalize settings.	Software
SR-5	Code for handling real-time data synchronization with FROST.	Software
SR-6	Secure communication protocol to ensure data privacy.	Software

SR-7	Optimize the app for minimal battery usage.	Software

10.6 Software Design Diagram

- Diagram to illustrate the interaction between the app, FROST docking station, and the user interface.

10.7 Software Architecture

- Architecture to outline the modular design of the app, including connection management, user interface, data handling, and notification modules.

10.8 User Interface Design

Req ID	Description	Implemented in
UI-1	Home screen displaying real-time status and reminders.	Software
UI-2	Settings screen for adjusting hydration reminder intervals and custom alerts.	Software
UI-3	Profile management screen for creating and managing user profiles.	Software
UI-4	Notifications screen for viewing past reminders and alerts.	Software

10.9 Design Considerations

Req ID	Description	Implemented in
DC-1	Ensure compatibility with the latest versions of iOS and Android.	Software
DC-2	Optimize the app for various screen sizes and resolutions.	Software
DC-3	Prioritize user data privacy and secure data transmission.	Software
DC-4	Design the user interface to be intuitive and user-friendly.	Software
DC-5	Implement robust error handling for Bluetooth connectivity issues.	Software

To do list for FROST success.