Product Requirement Specification (PRS)

Document Title: Safe Within

Prepared by: Abhiram Krishna, Anandu V K

Date: 10/07/2025

Contents

1 Introduction

1.1 Purpose

The purpose of this document is to define the functional and non-functional requirements for the **Safe Within** project. The system aims to detect a fall or collapse within a confined space using motion sensing and alert mechanisms to ensure safety and timely response.

1.2 Scope

Safe Within is a smart fall detection device that utilizes dual PIR motion sensors, an STM32 microcontroller, buzzers, and a GSM module to monitor user movement, trigger alerts during suspicious events, and send emergency messages or calls to caregivers.

1.3 Definitions and Acronyms

- **PIR** – Passive Infrared Sensor
- **GSM** – Global System for Mobile Communications
- **UART** – Universal Asynchronous Receiver Transmitter
- **PSR** – Product Specification Requirement
- **SMS** – Short Message Service

1.4 References

- **Datasheets:**
  - STM32: https://www.st.com/resource/en/datasheet/stm32f446mc.pdf
  - PIR Sensor: http://www.handsontec.com/dataspecs/SR501%20Motion%20Sensor.pdf
  - GSM Module: https://www.e-gizmo.net/oc/kits%20documents/SIM800L%20module/SIM800L%20module.pdf
- **STM32F446ZE Reference Manual:** https://www.st.com/en/microcontrollers-microproc stm32f446/documentation.html

1.5 Overview of Document

This document includes the overall system description, hardware/software architecture, system and interface requirements, design constraints, and user scenarios.

2 Overall Description

2.1 Product Perspective

The device is a standalone embedded system intended for use in confined space. It operates automatically and only interacts externally when a fall is detected.

2.2 Product Functions

- Detect upper and lower body movement using PIR sensors
- Determine fall condition based on sensor inactivity
- Trigger buzzer, allow manual cancel via push button
- Send SMS/call alerts using GSM module

2.3 User Characteristics

- Elderly or mobility-challenged individuals
- Family/caregivers as alert recipients
- No technical knowledge required to operate

2.4 Assumptions and Dependencies

- Reliable power supply available (with backup)
- GSM network signal is present
- Proper sensor mounting location ensured

2.5 Constraints

- Designed for typical Indian bathroom size
- Potential false triggers due to heat/humidity

3 System Requirements

3.1 Functional Requirements

- Motion detection via dual PIR sensors
- Fall logic via inactivity pattern
- GSM alert and audible buzzer on fall detection
- Manual override button to cancel false alarm

3.2 Non-Functional Requirements

- React within 1 second after detecting fall
- Alerts (call/SMS) within 10 seconds after timeout
- Audible buzzer to be heard from outside

3.3 Performance Requirements

- PIR response time: 1 sec
- Alert timeout: 5 min inactivity + 2 min no button press
- High PIR accuracy indoors

3.4 Safety Requirements

- Water-resistant enclosure
- Short-circuit protection

3.5 Security Requirements

- Prevent unauthorized GSM commands
- Protect user contact data

3.6 Regulatory and Compliance Requirements

- Comply with EMI/EMC norms
- Prefer ISI/CE-certified parts

4 System Architecture and Design Constraints

4.1 4.0 Block Diagram

The following block diagram represents the overall architecture of the Bath Secure system. It visually outlines the interaction between core components such as the STM32 microcontroller, PIR sensors, alert mechanisms, and the GSM module for emergency communication.

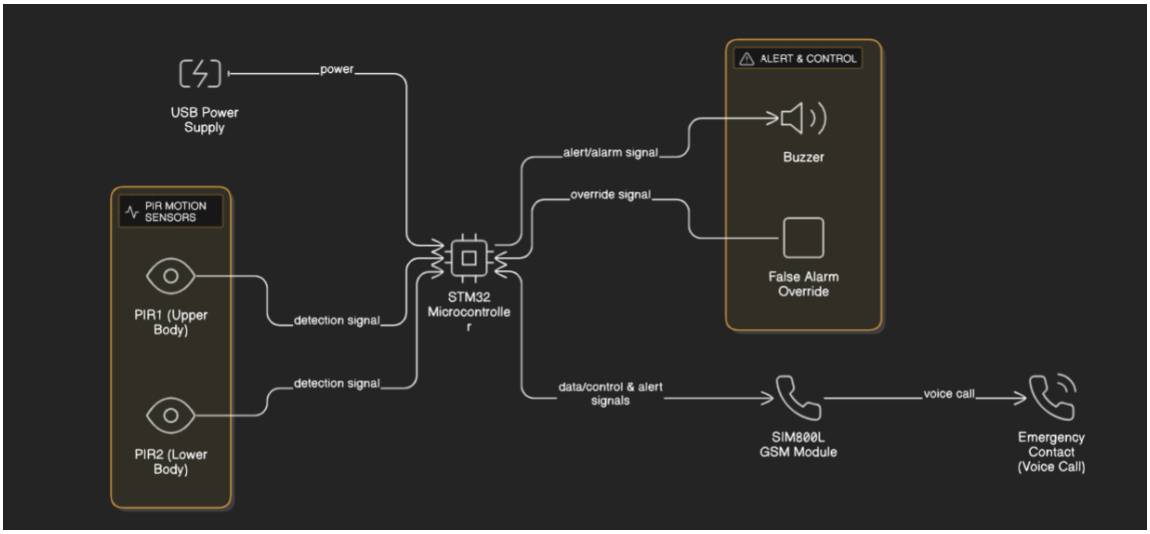

Figure 1: System Block Diagram of Bath Secure

4.2 Hardware Overview

- STM32F446ZE microcontroller
- PIR1 and PIR2 for upper/lower detection
- SIM800L GSM module
- Buzzer
- Push button

4.3 Software Overview

- STM32CubeIDE
- Embedded C
- No RTOS required

4.4 Interfaces

- UART for GSM
- GPIO for PIR, button, buzzer
- Optional: I2C/SPI for RTC

4.5 Power and Environmental Conditions

- Power: USB 5V
- Temp: 0°C–50°C

- Humidity: 95% non-condensing

4.6 Real-Time Requirements

- Use of hardware timers for real-time tracking
- GSM alert initiation within defined time

5 Hardware Requirements

5.1 Processor and Peripherals

STM32F446ZE:

- 180MHz Cortex-M4, 512KB Flash, 128KB RAM
- 114 GPIO pins
- Cost: 2,484

5.2 Memory Requirements

- Firmware storage: 100KB (Flash)

5.3 Communication Interfaces

- UART – GSM
- GPIO – PIRs, Buzzer, Button

5.4 Sensor/Actuator Requirements

Selected PIR: HC-SR501

- Cost: 57, Voltage: 5V–20V, Range: up to 7m

5.5 Power Supply and Consumption

- Powered via USB

5.6 Push Button Requirements

- Momentary NO button, waterproof

- Connected to GPIO with internal pull-up
- Cost: 5–10

6 Software Requirements

6.1 Operating System

Bare-metal embedded system, no OS required.

6.2 Middleware/Drivers

- STM32 HAL drivers for GPIO, UART, timer

6.3 Application Logic

- Fall detection using motion pattern analysis
- Buzzer and GSM logic via timer interrupts

6.4 Communication Protocols

- UART protocol for GSM command transmission

6.5 OTA / Update Mechanism

Currently not applicable. Could be added via UART bootloader.

7 User Interface Requirements

7.1 Display

Not applicable.

7.2 Buttons/Inputs

- Single push button for manual override

7.3 Indicators

- Buzzer for audio alert

- Optional LED for status indication

7.4 Mobile / Web App Interface

Not applicable. Alerts sent via SMS/call.

8 Use Cases and User Scenarios

8.1 Use Case 1 – Fall Detected and No Response

System detects fall (no movement), buzzer sounds, no button pressed → GSM alert sent to caregiver.

8.2 Use Case 2 – False Alarm Overridden

Buzzer sounds due to inactivity, user presses button within timeout → alarm cancelled, no alert sent.

9 Data and Communication Requirements

9.1 Data Logging

Future work.

9.2 Data Format

Basic alert message over GSM: predefined SMS.

9.3 Communication Frequency

Only on event (fall detection).

9.4 Connectivity

GSM (via SIM800L), 2G network.

10 Reliability and Maintenance Requirements

10.1 MTBF

System expected to operate reliably for over 2 years.

10.2 Diagnostics

Add test button or LED for hardware verification.

10.3 Serviceability

Modular design, replaceable GSM/PIR units.

11 Testing and Validation Requirements

11.1 Unit Testing

Each PIR, button, and GSM functionality tested individually.

11.2 Integration Testing

Full system test with all components connected.

11.3 System Testing

Simulated fall scenarios and expected alert flow.

11.4 Field Testing

Testing in real bathroom environments.

11.5 Acceptance Criteria

Fall detected → buzzer on → no response → GSM alert sent.

12 Appendices

12.1 Glossary

Included in Definitions section.

12.2 Document Revision History

Version	Date	Changes
v1.0	10/07/2025	Initial draft completed

12.3 Open Issues

- OTA update not implemented
- LED indicators not finalized

12.4 Future Enhancements

- Cloud logging via Wi-Fi
- Android/iOS alert app