System Architecture Document

Bath Secure – Smart Bathroom Fall Detection System

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Contents

1 Introduction

1.1 Document Overview

This document describes the architecture of the **Bath Secure** system. It includes:

- A general description of the system
- The logical architecture of software and top-level components
- The physical architecture of hardware
- The justification of technical choices made
- The traceability between the architecture and system requirements

1.2 Abbreviations and Glossary

1.2.1 Abbreviations

Abbreviation	Meaning
PIR	Passive Infrared Sensor
GSM	Global System for Mobile Communications
UART	Universal Asynchronous Receiver-Transmitter
SOUP	Software of Unknown Provenance
COTS	Components Off The Shelf

1.2.2 Glossary

- **Fall Detection:** Identifying prolonged immobility or suspicious motion suggesting a fall.
- **Manual Override:** Button press by user to cancel a false alert.

1.3 References

1.3.1 Project References

#	Document Identifier	Title
R1	PRS-001	Bath Secure Product Specification Requirement

1.3.2 Standard and Regulatory References

#	Document Identifier	Title
STD1	IEC 62304	Medical Device Software Lifecycle Standard

1.4 Conventions

UML diagrams and block diagrams are used. GPIO, UART, and power lines are labeled on component diagrams. Time sequences and alert flows are shown using structured lists.

2 Architecture

2.1 Architecture Overview

The Bath Secure system is a bathroom-based fall detection device that operates in home or hospital environments. It uses PIR motion sensors to detect movement, a microcontroller for processing, and a GSM module to notify caregivers. It provides:

- Motion-based fall detection using dual PIRs
- Local alert via buzzer
- Remote alert via GSM call or SMS
- Manual override by push button

2.2 Physical Architecture Overview

2.2.1 Network Diagram

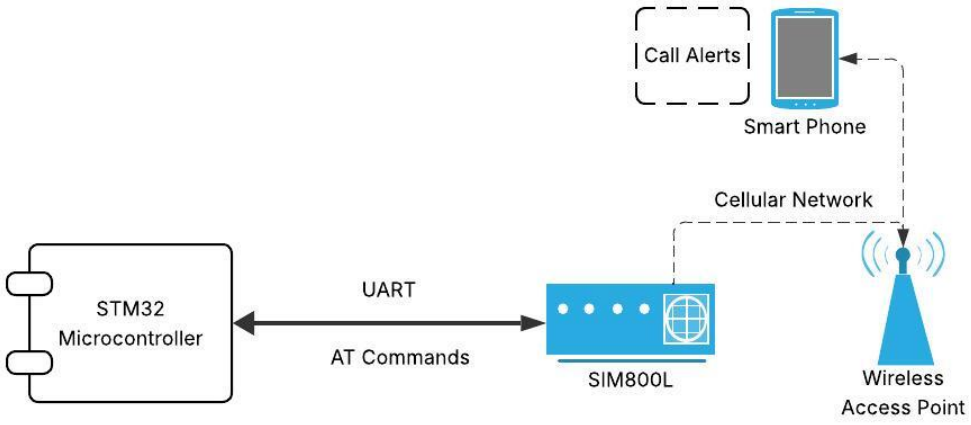

Figure 1: Network Diagram – Bath Secure System

2.2.2 Hardware Components

Component	Description
STM32F446ZE	Main processor, controls system logic and interfaces.

PIR Sensor 1	Detects upper-body motion.
PIR Sensor 2	Detects lower-body motion.
Push Button	Cancels false alerts via GPIO interrupt.
Buzzer	Inside bathroom; alerts user.
SIM800L GSM Module	Sends SMS/call alert to predefined number.
Power Supply	Regulates voltage to 3.3V (MCU) and 4.2V (GSM).

2.2.3 Component Diagram

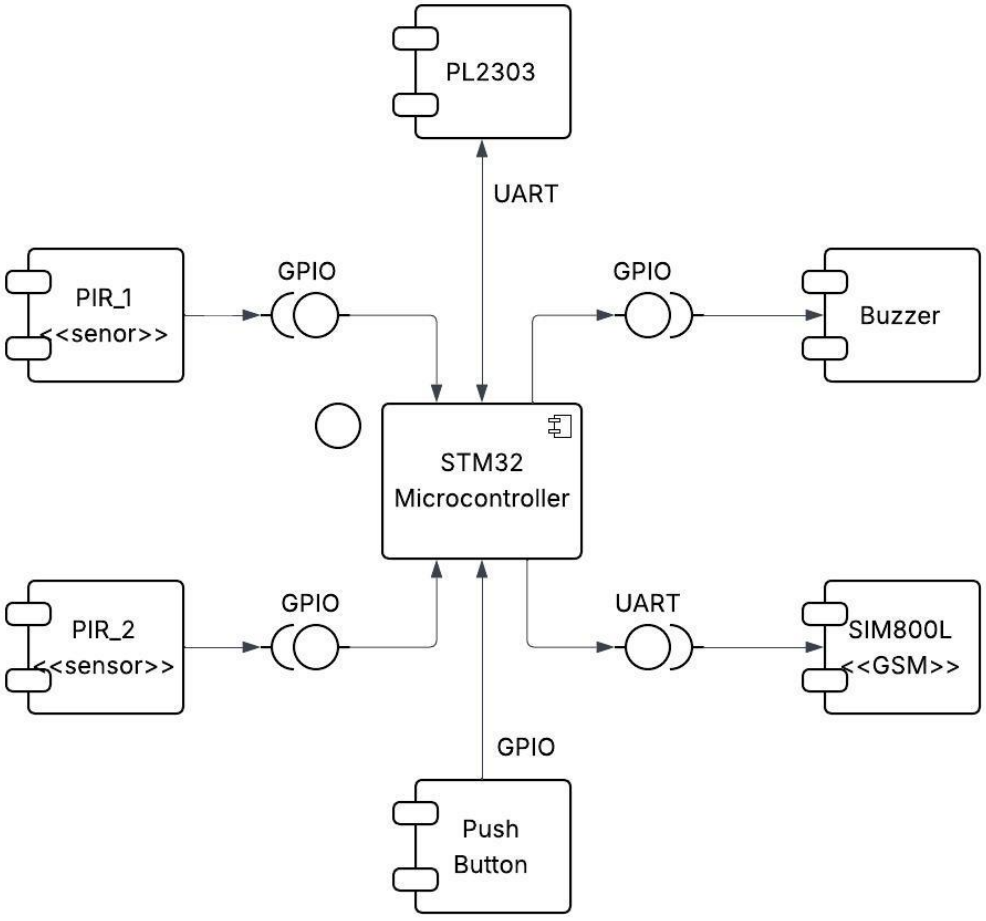

Figure 2: Component Diagram – Bath Secure

2.3 Logical Architecture Overview

2.3.1 Software Component 1: Sensor Handler

Reads values from PIR1 and PIR2 and updates flags.

2.3.2 Software Component 2: Fall Detection Logic

If PIR1 is LOW and PIR2 is HIGH for 5 minutes → starts alert sequence.

2.3.3 Software Component 3: Alert Manager

Handles buzzer activation, GSM alert, and button override.

2.3.4 Software Architecture Diagram

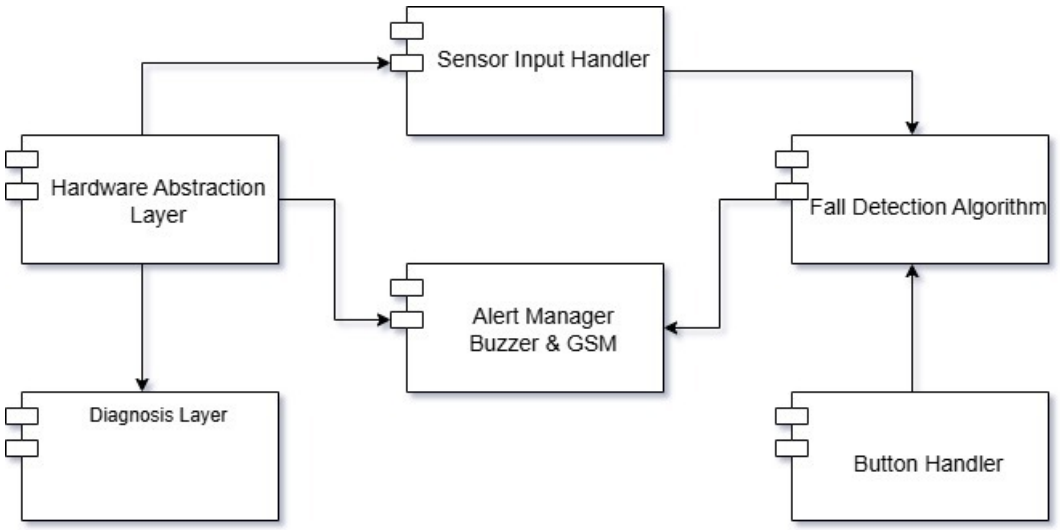

Figure 3: Software Architecture Diagram – Bath Secure Firmware Logic

2.4 Software SOUP

No SOUP components used. All software written in embedded C for STM32 using HAL drivers.

3 Dynamic Behaviour of Architecture

3.1 Workflow / Sequence 1 – Normal Entry

- PIR1 = HIGH, PIR2 = HIGH → motion detected
- No alert; user is active

3.2 Workflow / Sequence 2 – Suspected Fall

- PIR1 = LOW, PIR2 = HIGH persists for 5 minutes
- Buzzer activates for 2 minutes
- If button pressed → cancel

- Else → GSM module sends alert

3.2.1 System Prototype Workflow Diagram

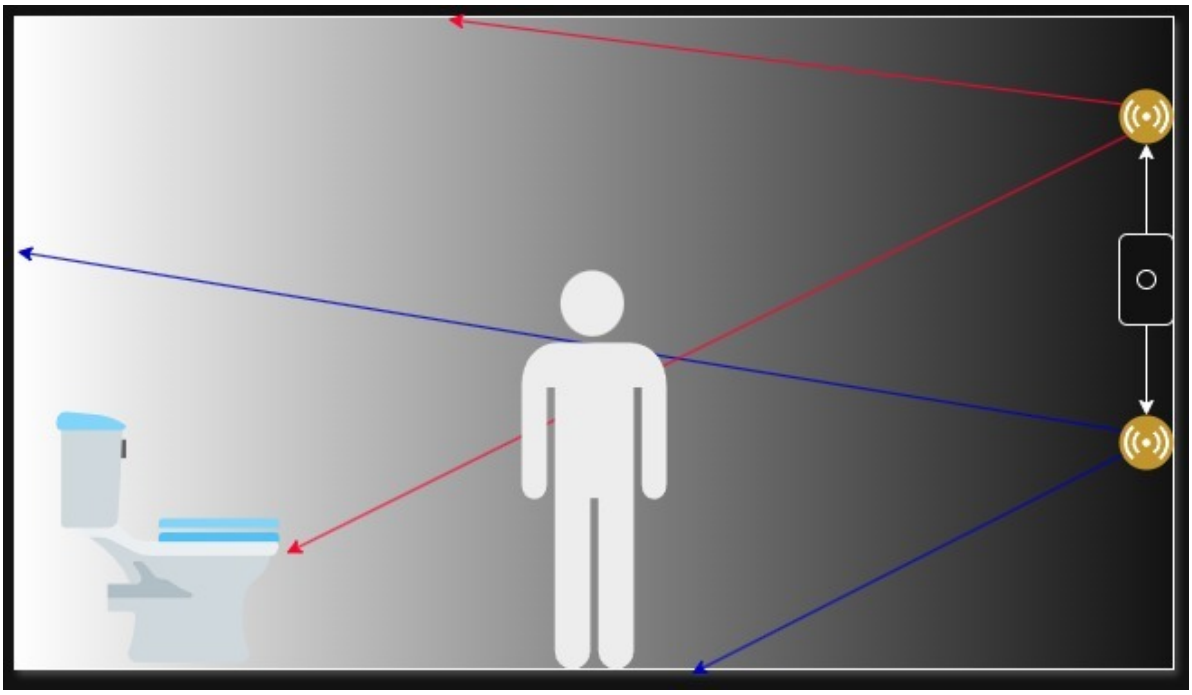

Figure 4: Prototype Workflow Diagram – Bath Secure Fall Detection Logic

4 Justification of Architecture

4.1 System Architecture Capabilities

- Fast fall detection and response
- Low power consumption
- Minimal hardware footprint
- Easy manual override

4.2 Network Architecture Capabilities

- GSM ensures alert even without Wi-Fi
- UART for reliable SIM800L communication

4.3 Risk Analysis Outputs

- Buzzer gives user chance to cancel alert
- Capacitor filtering prevents GSM noise reset

4.4 Human Factors Engineering Outputs

- Only a buzzer and button – simple interface
- Waterproof enclosure

4.5 SOUP Integration

Not applicable.

5 Requirements Traceability

Requirement	**Component**	**Comment**
REQ-001: Fall detection	PIR1, PIR2, STM32	Logic evaluates persistent lower-body-only detection.
REQ-002: User alert	Buzzer	Notifies occupant of detected fall.
REQ-003: False alarm cancel	Push Button	Allows user override before GSM triggers.
REQ-004: Remote alert	SIM800L	Sends call/SMS to caregiver.