RTOS-Based Traffic Accident Detection System

Functional Requirement Specification Document

Name of Document

RTOS-Based Traffic Accident Detection System

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Description of Content

Functional, Technical, and Operational Requirements

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Date of Approval

01/02/2025

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1. Introduction

1.1 Purpose

The purpose of this document is to define the functional, technical, and operational requirements for an RTOS-Based Traffic Accident Detection System. This project aims to develop a system that detects traffic accidents using various sensors and alerts emergency services with essential information, such as GPS location and accident severity.

This document serves as a guide for developers and stakeholders to ensure a structured approach to system implementation.

1.2 Background

Accident detection systems play a crucial role in improving road safety by providing timely alerts and information to emergency responders. Traditional systems may have limited real-time data processing capabilities, leading to delays in response time. By leveraging Real-Time Operating Systems (RTOS) and advanced sensors, this project ensures accurate accident detection and efficient data handling for faster emergency response.

The proposed system will:

- Continuously monitor vehicle conditions for accident detection using vibration and motion sensors.
- Analyze accident severity using MPU6050 and vibration sensor data.
- Send GPS coordinates and alerts through a GSM module.
- Provide real-time information display on an I2C LCD.
- Enable effective task scheduling and data processing using RTOS.

1.3 Scope

This project aims to implement a real-time accident detection system that:

1. Detects collisions and abnormal vehicle behavior using sensors.
2. Sends alerts with accident details and GPS coordinates through GSM.
3. Displays system status and information on an LCD.
4. Utilizes RTOS for task scheduling and optimized system performance.
5. Supports scalable integration for additional sensors or modules.

1.4 References

- ESP32 WROOM Technical Reference Manual
- MPU6050 Sensor Datasheet
- GSM Module Communication Standards
- RTOS Programming Guidelines
- GPS Module Specifications

1.5 Document Overview

This document provides an overview of the RTOS-Based Traffic Accident Detection System, its functionalities, target audience, and system interactions. It details system requirements, constraints, and dependencies, providing a clear roadmap for development and implementation.

2. Functional Requirements

2.1 Sensor Integration

Description: The system integrates multiple sensors to capture real-time data, process it, and trigger alerts for accident detection.

Functional Requirements:

SN	Functionality	Process	Remarks
FR 1.1	Data Acquisition	Sensors collect data at regular intervals	Supports vibration and motion sensors
FR 1.2	Sensor Calibration	Provides an interface for calibration	Required for accuracy
FR 1.3	Data Filtering	Filters out noise and incorrect readings	Uses threshold-based filtering

2.2 Data Transmission

Description: The system transfers sensor data efficiently between components and ensures timely alerts.

Functional Requirements:

SN	Functionality	Process	Remarks
FR 2.1	Data Transmission	Transmits sensor data to the processing unit	Real-time transmission
FR 2.2	Message Prioritization	Prioritizes emergency messages	Ensures critical message delivery
FR 2.3	Data Reception	Receives and processes incoming data	Reliable and timely processing

2.3 Notification System

Description: The system provides real-time alerts through audio and communication modules.

Functional Requirements:

SN	Functionality	Process	Remarks
FR 3.1	Buzzer Activation	Activates buzzer upon accident detection	Immediate alert
FR 3.2	GSM Communication	Sends alert messages with GPS coordinates	Supports emergency alerts
FR 3.3	GPS Location Data	Captures and transmits location data	Ensures accurate location sharing

2.4 Real-Time Monitoring

Description: The system displays relevant information and status on an I2C LCD.

Functional Requirements:

SN	Functionality	Process	Remarks
FR 4.1	Data Display	Displays system status on LCD	Real-time data visualization
FR 4.2	Status Indicators	Shows accident and system alerts	Immediate status indication

2.5 RTOS Features Utilized

- **Task Scheduling:** Efficient task execution using priority-based scheduling.
- **Task Synchronization:** Ensures consistent data sharing between tasks.
- **Inter-Task Communication:** Reliable communication between processes.
- **Real-Time Response:** Faster reaction time for alerts and emergency processing.

2.6 Communication Protocols

- **I2C:** For communication with LCD.
- **UART:** For communication with GSM and GPS modules.
- **RTOS Features:** Task scheduling, inter-task communication, and synchronization.

3. External Interfaces

- **Sensor Interfaces:** Vibration sensor, MPU6050
- **Display Interfaces:** I2C LCD
- **Communication Interfaces:** GSM, GPS, UART

4. System Architecture

- **Microcontroller:** ESP32 WROOM
- **Sensors:** Vibration sensor, MPU6050
- **User Interface:** I2C LCD Display
- **Communication Modules:** GSM, GPS
- **RTOS:** Real-Time Operating System for efficient task management

5. Performance Metrics

- **Response Time:** Less than 1 second for alert generation after accident detection.
- **Data Accuracy:** 95% accurate detection for impact events.
- **Power Consumption:** Optimized for low power operation.
- **System Uptime:** 99% uptime ensuring reliable functionality.

6. Assumptions and Constraints

- The system assumes stable GSM network connectivity for communication.
- GPS accuracy may vary depending on environmental factors.
- The power source should be stable for continuous operation.
- RTOS task priorities must be appropriately configured to prevent deadlocks.

7. Security Considerations

- **Data Encryption:** Secure data transmission for GSM communication.
- **Access Control:** Restricted access to system configuration settings.
- **Tamper Detection:** Alerts in case of system tampering.

8. Conclusion

The RTOS-Based Traffic Accident Detection System provides a reliable and scalable solution for detecting traffic accidents and alerting emergency services. By integrating advanced sensors, real-time data communication, and RTOS capabilities, the system ensures rapid detection and response to potential road hazards, enhancing road safety.