RTOS-Based Traffic Accident Detection System

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Introduction
This document outlines the design and implementation of an RTOS-based Traffic Accident Detection System using an ESP32 microcontroller. The system employs vehicle sensors to detect accidents and automatically alerts emergency services with real-time GPS location and accident severity data. This system aims to improve response times and enhance road safety.

Purpose
The purpose of this project is to design and develop an accident detection system that operates in real-time, using an RTOS on an ESP32 microcontroller. It aims to provide quick and accurate accident detection and reporting, ensuring emergency services are informed immediately with essential details such as location and severity of the incident.

Scope

This system is intended for installation in vehicles to automatically detect and report traffic accidents. It utilizes multiple sensors to monitor conditions and identify accident events. The system can be deployed in personal, commercial, and public transportation vehicles to enhance road safety. It supports real-time GPS tracking and wireless communication with emergency services.

Intended Audience
This document is intended for the design, development, and testing teams. It should be referred to during all stages of project development.

References

- ESP32 WROOM Technical Reference Manual

- MPU6050 Sensor Datasheet

- GSM Module Communication Standards

- RTOS Programming Guidelines

- GPS Module Specifications

Acronyms, Terms, and Definitions

FRS: Functional Requirement Specifications
User: Citizens and emergency response teams

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.

Basic Design Approach

To design an RTOS-based system for detecting traffic accidents and sending emergency alerts This Basic Design Approach ensures an efficient, real-time, and reliable RTOS-based Traffic Accident Detection System with ESP32, MPU6050, GPS, and GSM.

Risks

- GSM Network Failure
- GPS Accuracy Issues

System Overview

The RTOS-based Traffic Accident Detection System is designed to operate as an embedded system within a vehicle. It integrates an Esp32 microcontroller with various sensors to detect accidents. When an accident is detected, the system captures GPS location and severity data and transmits this information to emergency services. The RTOS allows for efficient task scheduling and multitasking to ensure real-time processing.

Architecture Design

- **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

Architecture Diagram:
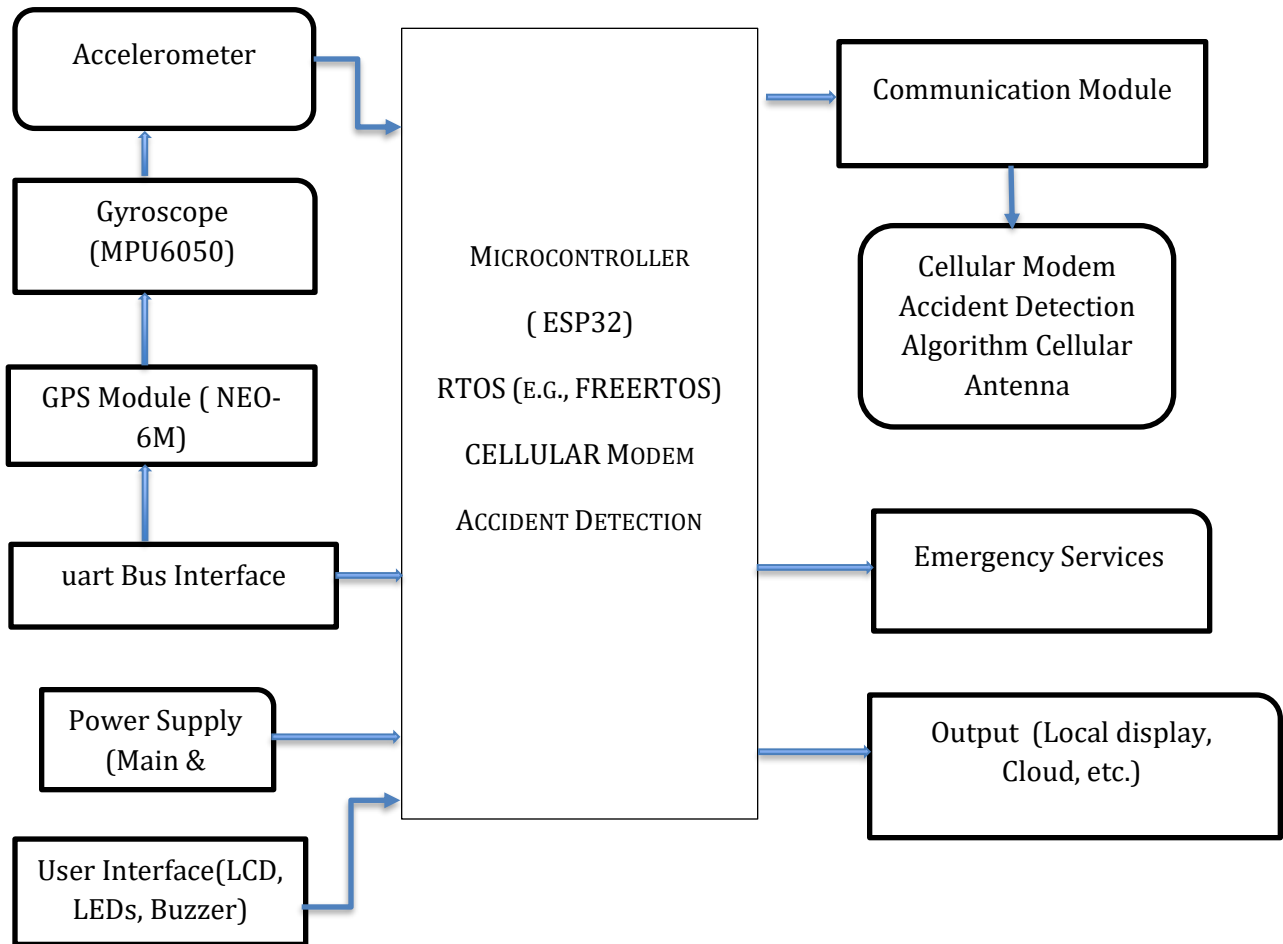
Component Design

1.MPU6050

Accelerometer & gyroscope for accident detection

2.GPS Module (NEO-6M)

Retrieves vehicle location

3.GSM Module

Sends SMS and calls to emergency services

4. LM2596 Buck Converter

Provides stable 3.3V/5V power supply

5. GSM Module

Sends SMS and calls to emergency services

Interface Design

- The interface design includes both hardware and software interactions, ensuring smooth communication between the user, sensors, microcontroller, and emergency services.

Specific Design Considerations

• **Real-Time Processing**: The system must detect and report accidents within seconds to ensure timely emergency response.

• **Hardware Constraints**: Limited processing power, memory, and input/output pins of the STM32 microcontroller.

• **Environmental Factors**: The system must function reliably in variable weather, temperature, and vibration conditions.

• **Power Efficiency**: The system must consume minimal power to prevent draining the vehicle's battery.

Testing
- System Testing:
- Crash Testing (Controlled and Ethical
- Integration Testing:

Cross Reference with System Requirement Specification
- System Requirement Specification Features
- Linking Tests to Requirements
  Requirements

Cross-Referencing in Action

SP32-WROOM/DEVKITC

MPU6050 Accelerometer & gyroscope for accident detection I2C

GPS Module (NEO-6M)

GSM Module (SIM800/SIM900/A7670C)

LM2596 Buck Converter

16x2 LCD / OLED Display Displays accident status and GPS data I2C/SPI

Buzzer

Appendices

Appendix A: Sensor Datasheets

Appendix B: API Documentation