Smart Vehicle Safety System with Fire and Accident Detection

Abstract

This SAE project presents a Smart Vehicle Safety System designed to detect accidents and fire hazards in real time using an ESP32 microcontroller. The system integrates an MPU6050 accelerometer and gyroscope sensor for accident detection and a flame sensor for fire safety. The MPU6050 continuously monitors three-axis acceleration and angular velocity of the vehicle. Sudden abnormal variations beyond predefined thresholds indicate collision, rollover, or accident conditions. Upon detection, the system immediately activates an emergency response. The flame sensor continuously monitors the surrounding environment for fire or flame presence. When fire is detected, the system instantly stops vehicle operation to prevent further damage. Both safety mechanisms work automatically without human intervention, ensuring fast and reliable response during emergencies. This system improves passenger safety, reduces vehicle damage, and is suitable for intelligent transportation, automotive safety systems, and accident prevention applications.

Working of the System

- ESP32 initializes the MPU6050 sensor, flame sensor, and communication interfaces.
- The MPU6050 continuously measures acceleration and angular velocity of the vehicle.
- Sudden spikes in acceleration or rotation beyond threshold values indicate an accident.
- On accident detection, the system triggers an emergency response and vehicle shutdown.
- The flame sensor detects fire or flame near the vehicle in real time.
- If fire is detected, the system immediately disables the vehicle to prevent damage.
- Both accident and fire detection systems operate continuously and independently.
- The system ensures automatic safety response without manual intervention.

Hardware Components and Circuit Description

1. ESP32 Microcontroller

The ESP32 acts as the **central control unit** of the system. It processes data received from the MPU6050 accelerometer and the flame sensor, makes safety decisions, and controls the motor driver. It also supports Wi-Fi communication for monitoring and alert systems.

2. MPU6050 Accelerometer and Gyroscope Module

The MPU6050 is a **6-axis inertial measurement unit (IMU)** containing a 3-axis accelerometer and 3-axis gyroscope. It continuously monitors vehicle acceleration and angular motion. Sudden abnormal changes in these values indicate **collisions, rollovers, or accidents**.

3. Flame Sensor Module

The flame sensor detects **infrared radiation emitted by fire**. When flame or fire is present near the vehicle, the sensor outputs a signal to the ESP32, triggering an **immediate emergency response**.

4. Motor Driver Circuit (L298N)

The L298N motor driver is used to control **DC motors**. It allows the system to stop vehicle motion instantly during fire or accident conditions.

5. DC Motors

DC motors provide the physical movement of the vehicle and are controlled through the motor driver circuit.

6. Power Supply Circuit

A regulated power supply provides stable voltage to the ESP32, sensors, and motor driver for reliable operation.