

Development of Smart Fire Safety System for Vehicles

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Abstract - Vehicle fire accidents are a significant increasing electrical complexity, fuel systems, and overheating risks. Early detection and immediate response are crucial to minimizing damage and preventing loss of life. This paper presents the development of a Smart Fire Safety System for Vehicles that uses temperature sensors, smoke sensors, and microcontroller-based automation to detect fire hazards in real time. The system continuously monitors temperature rise and smoke levels inside the vehicle. Once abnormal conditions are detected, an automatic alert is sent to the driver, and a fire suppression mechanism is activated to control the fire at an early stage.

The proposed system integrates Internet of Things (IoT) technology for remote monitoring and real-time alerts through mobile devices. The system is designed to be cost-effective, reliable, and suitable for installation in private vehicles, public transportation, and commercial vehicles. Experimental testing results demonstrate that the system responds quickly to fire conditions and significantly reduces fire damage risk. The implementation of such smart safety systems can enhance passenger safety, reduce vehicle loss, and improve overall road safety standards.

Key Words: Smart Fire Detection, Vehicle Fire Safety, IoT-Based Monitoring, Temperature Sensor, Smoke Sensor, Automatic Fire Suppression, Arduino Microcontroller, Vehicle Safety System

1. INTRODUCTION

Fire hazards in vehicles are becoming increasingly common due to electrical faults, fuel leakage, overheating engines, and short circuits. Traditional vehicle fire safety measures rely mainly on manual fire extinguishers, which require human intervention. However, in many cases, drivers may not detect the fire early enough or may not have sufficient time to react, leading to severe damage and risk to passengers.

Modern vehicles are equipped with multiple electronic components that increase the risk of fire accidents. Statistics show that vehicle fires occur frequently due to

engine overheating, battery failure, and fuel system malfunctions. Therefore, an automatic fire detection and suppression system is necessary to provide immediate response without depending on manual action.

The Smart Fire Safety System for Vehicles is designed to address these challenges by using sensors and automation technology. The system continuously monitors environmental parameters such as temperature and smoke levels. When abnormal conditions are detected, the system activates alarms and fire suppression mechanisms automatically.

The use of Internet of Things (IoT) technology enables remote monitoring of vehicle safety conditions. This allows vehicle owners and authorities to receive alerts on their mobile devices. The proposed system enhances safety, reduces damage, and improves emergency response efficiency.

2. Body of Paper

4.1 System Overview

The Smart Fire Safety System consists of sensors, a microcontroller unit, alarm modules, and fire suppression mechanisms. The sensors continuously detect environmental conditions inside the vehicle. If the detected values exceed predefined safety limits, the system activates an alert and initiates fire suppression automatically.

Main Components:

- Temperature Sensor (LM35)
- Smoke Sensor (MQ-2)
- Arduino Microcontroller
- Buzzer Alarm
- Water Pump / Fire Extinguisher Module
- GSM or IoT Module
- Power Supply Unit

Working Principle:

1. Sensors monitor temperature and smoke continuously.
2. Sensor data is sent to the microcontroller.
3. If abnormal values are detected:
 - o Alarm is activated
 - o Notification is sent
 - o Fire suppression starts automatically

4.2 Hardware Components

1. Arduino Microcontroller

The Arduino acts as the main processing unit. It collects sensor data and controls output devices such as alarms and pumps.

2. Temperature Sensor (LM35)

The LM35 sensor measures temperature changes inside the vehicle. If temperature exceeds the safe limit, it sends a signal to the controller.

3. Smoke Sensor (MQ-2)

The MQ-2 sensor detects smoke and flammable gases such as LPG, methane, and carbon monoxide.

4. Fire Suppression Unit

A small water pump or extinguisher nozzle is used to spray water or fire-retardant chemicals.

5. GSM / IoT Module

Used to send SMS alerts or mobile notifications to the vehicle owner.

4.3 Software Implementation

The system software is developed using Arduino IDE. The program reads sensor data, compares it with threshold values, and triggers safety actions.

Algorithm:

1. Initialize sensors
2. Read temperature value
3. Read smoke level
4. Compare values with threshold
5. If threshold exceeded:
 - o Activate buzzer
 - o Turn ON pump
 - o Send alert message
6. Repeat monitoring

4.4 System Advantages

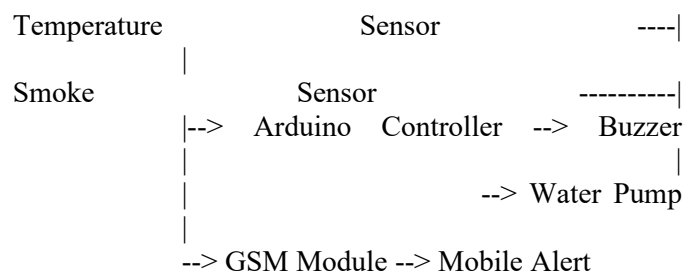
- Early Fire Detection
- Automatic Fire Suppression
- Real-Time Alerts
- Reduced Damage Risk
- Cost-Effective Design
- Easy Installation

Table 1: Hardware Components Used

Sr. No	Component Name	Quantity	Function
1	Arduino Uno	1	Main controller
2	LM35 Sensor	1	Temperature sensing
3	MQ-2 Sensor	1	Smoke detection
4	Buzzer	1	Alert generation
5	Water Pump	1	Fire suppression
6	GSM Module	1	Alert notification
7	Power Supply	1	

Fig -1: Figure

Figure 1: Block Diagram of Smart Fire Safety System



4. CONCLUSIONS

The development of a Smart Fire Safety System for Vehicles provides an effective solution for preventing vehicle fire accidents and minimizing damage caused by unexpected fire hazards. The proposed system uses temperature and smoke sensors to detect abnormal environmental conditions inside the vehicle. Upon detecting fire or smoke, the system automatically activates alarms, sends alert notifications, and triggers a fire suppression mechanism.

This system improves vehicle safety by enabling early detection and rapid response, reducing dependency on manual intervention. The integration of IoT and GSM technology ensures real-time communication with vehicle owners, allowing them to take necessary action immediately. The proposed system is cost-effective,

reliable, and suitable for various types of vehicles, including personal cars, buses, and commercial transport vehicles.

Future improvements may include integrating advanced sensors such as flame detectors, GPS tracking systems, and cloud-based monitoring for enhanced performance. The implementation of this smart system can significantly reduce fire-related losses, improve passenger safety, and contribute to safer transportation systems.

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REFERENCES

1. A. Kumar and R. Singh, **"Design of Smart Fire Detection System Using IoT,"** International Journal of Engineering Research & Technology (IJERT), Vol. 8, Issue 5, 2020.
2. S. Patel, **"Automatic Fire Detection and Suppression System,"** International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 7, Issue 3, 2019.
3. Arduino Official Documentation, **"Arduino Uno Microcontroller Board,"** Available: <https://www.arduino.cc>
4. MQ-2 Sensor Datasheet, **"Smoke and Gas Sensor MQ-2 Technical Specifications,"** Hanwei Electronics.

5. LM35 Temperature Sensor Datasheet, Texas Instruments, **"LM35 Precision Centigrade Temperature Sensor."**
6. National Fire Protection Association (NFPA), **"Vehicle Fire Safety Guidelines,"** NFPA Standards.
7. GSM Module SIM800L Datasheet, **"SIM800L GSM/GPRS Module Technical Manual."**

BIOGRAPHIES

1'st Author Photo

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