

Can-Based Intelligent Vehicle Automation And Real-Time Accident Detection With Automatic Alert System

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ABSTRACT

Modern vehicular systems increasingly rely on automation and intelligent monitoring to enhance safety, reduce human error, and ensure rapid emergency response. Conventional accident detection mechanisms depend on manual reporting, resulting in delayed assistance and increased fatalities. This research presents a Control Area Network (CAN)-based vehicle automation and accident alert system that integrates sensors, microcontrollers, and communication modules to detect collisions, monitor vehicle parameters, and automatically transmit emergency notifications. The system utilizes accelerometers, vibration sensors, and onboard diagnostics to detect abnormalities, while CAN provides reliable, high-speed, fault-tolerant communication within the vehicle. Upon detecting an accident, the system triggers automatic alerts containing vehicle ID, GPS location, and status information to emergency contacts or authorities. Additionally, automation features such as speed monitoring, obstacle detection, and automatic braking enhance driver safety. The integration of CAN ensures robustness, low latency, and reduced wiring complexity. The proposed system offers a cost-effective, scalable solution for intelligent transportation systems and next-generation automotive safety design.

Keywords: Control Area Network (CAN), Intelligent Vehicle Automation, Accident Detection System, Automatic Alert Notification, Vehicle Safety Monitoring, GPS-Based Emergency Alert, Accelerometer Sensor, Vibration Sensor, Onboard Diagnostics (OBD), Intelligent Transportation Systems (ITS).

I. INTRODUCTION

With the rapid growth in automotive technology, ensuring vehicle safety and intelligent operation has become a significant research and industrial priority. Traditional accident alert systems rely on human intervention, which often results in delayed emergency response and higher fatality rates. Vehicle automation, when combined with real-time monitoring, can significantly reduce human errors and enhance on-road safety. The Control Area Network (CAN) bus, widely adopted in modern vehicles, enables efficient, fault-tolerant communication among vehicle subsystems such as sensors, ECUs, and actuators. CAN's robustness makes it ideal for integrating accident detection, vehicle automation, and alert mechanisms. By enabling coordinated communication between components, the system can detect collisions, apply preventive actions, and send automatic notifications. This research focuses on designing a CAN-based

vehicle automation and accident alert system that enhances driving safety, reduces response time during emergencies, and improves overall vehicular reliability.

II. Related Words

Recent advancements in intelligent transportation systems have focused on improving vehicle safety through automated accident detection and real-time alert mechanisms. IoT-based monitoring frameworks have been widely explored to detect vehicle crashes and automatically notify emergency services. Bhatti et al. proposed an IoT-enabled accident detection and reporting system that integrates sensors and communication technologies to provide real-time alerts to emergency responders, significantly reducing response time in urban environments [1]. Similarly, Balfaqih et al. developed an accident detection and classification system using IoT devices that analyze sensor data to identify collisions and send alerts to concerned authorities [2]. Machine

learning techniques have also been incorporated into accident detection systems; Pour et al. introduced a multimodal sensor-based framework that utilizes intelligent algorithms to improve accident detection accuracy and reliability [3].

Several studies have focused on integrating vehicle sensors and communication modules to enhance safety mechanisms. Josephinshermila and Kumar designed a smart automotive black-box system capable of detecting accidents and storing vehicle data for analysis, which can help in determining accident causes and improving safety measures [4]. Beheramali and Sahoo presented a GPS and GSM-based accident detection system that automatically sends location-based alerts to emergency contacts when a collision occurs [5]. Additionally, research on in-vehicle data monitoring has demonstrated the importance of analyzing driver behavior using onboard data recorders to improve road safety and accident prevention strategies [6].

Vehicle communication networks such as the Control Area Network (CAN) play a critical role in modern automotive systems by enabling reliable communication between vehicle components. Khan et al. developed an intrusion detection system for CAN-bus networks to protect in-vehicle communication from cyber threats and ensure safe data transmission among electronic control units [7]. Abdenmour et al. demonstrated that CAN-bus data can also be utilized to identify driver behavior patterns and enhance vehicle security systems [8]. These studies highlight the importance of CAN-based communication frameworks in supporting advanced automotive safety applications.

Recent developments have also explored the integration of computer vision and intelligent analytics for traffic incident detection. Karim et al. proposed a computer vision-based system capable of automatically detecting traffic incidents through real-time video analysis, contributing to improved traffic management and accident monitoring [9]. Similarly, IoT-based pre-crash detection frameworks have been introduced to identify potential collision scenarios and alert drivers before accidents occur [10]. Other

studies have combined GPS tracking, mobile communication, and sensor networks to provide automatic accident notification and vehicle location tracking, enabling faster emergency response and improved rescue operations [11].

Early research also explored communication-based accident detection frameworks that integrate vehicles with wireless communication networks to transmit emergency alerts after a crash event [12]. Literature surveys have highlighted the growing importance of automated accident detection systems in modern transportation infrastructure and emphasized the need for integrated sensor-based and communication-based solutions [13]. Furthermore, collision avoidance and emergency braking technologies have been studied extensively to reduce accident probability by automatically controlling vehicle speed and braking during dangerous situations [14]. More recently, IoT-based accident detection and rescue systems have been proposed to combine vehicle sensors, GPS modules, and wireless communication technologies to provide efficient real-time accident monitoring and emergency response services [15].

III. PROPOSED MODEL

The proposed CAN-Based Intelligent Vehicle Automation and Real-Time Accident Detection with Automatic Alert System is designed to enhance vehicle safety by integrating sensors, embedded controllers, and communication technologies. The system utilizes the Control Area Network (CAN) protocol to enable reliable communication among different vehicle modules and sensors. Various sensors such as an accelerometer, vibration sensor, obstacle detection sensor, and GPS module are connected to a microcontroller that continuously monitors vehicle conditions. The CAN communication protocol ensures high-speed and fault-tolerant data exchange between components, allowing the system to quickly analyze sensor data and detect abnormal conditions that may indicate a vehicle accident.

In the proposed model, the accelerometer and vibration sensors play a critical role in detecting sudden impacts or unusual vehicle movements that

may occur during collisions. These sensors continuously monitor acceleration patterns and vibration levels within the vehicle. When the measured values exceed predefined thresholds, the system interprets the situation as a potential accident event. The microcontroller processes the sensor data and communicates with other modules through the CAN bus to verify the abnormal condition. This distributed communication architecture reduces response delay and improves reliability in accident detection.

Once an accident is detected, the system activates the automatic alert mechanism. The GPS module determines the precise geographic location of the vehicle, while a communication module such as GSM or IoT-based wireless communication transmits the emergency alert message. The alert message contains important information including the vehicle identification number, accident status, and GPS coordinates of the accident location. This information is automatically sent to predefined emergency contacts, nearby hospitals, or emergency response authorities. By automating the alert process, the proposed system helps reduce rescue response time and increases the chances of saving lives.

In addition to accident detection, the system also supports vehicle automation features aimed at preventing accidents. The obstacle detection sensor monitors the distance between the vehicle and nearby objects to warn the driver about potential collisions. The system can also monitor vehicle speed and trigger warning signals when the speed exceeds safe limits. These automation features assist the driver in maintaining safer driving conditions and help reduce human errors that often lead to road accidents.

The integration of the CAN communication protocol significantly improves system performance by providing a robust, low-latency, and scalable communication framework within the vehicle. CAN allows multiple electronic control units to exchange information efficiently without complex wiring, thereby reducing system complexity and improving reliability. The proposed model offers a cost-effective and scalable solution that can be integrated into modern vehicles to support intelligent

transportation systems and enhance overall road safety through automated accident detection and rapid emergency notification.

IV. PROPOSED SYSTEM

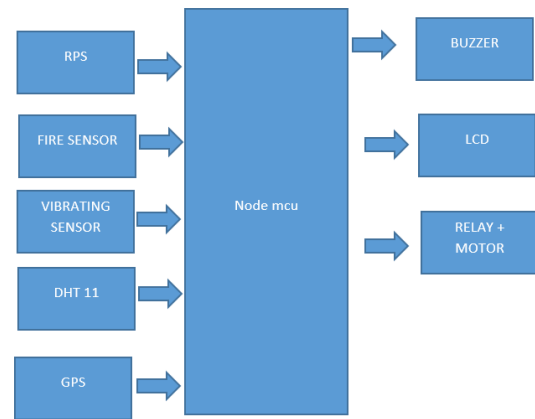


Fig.1. Block diagram

The presented block diagram illustrates the architecture of the intelligent vehicle monitoring and accident alert system based on the NodeMCU controller. In this system, the NodeMCU acts as the central processing unit that collects data from multiple sensors and processes it to perform safety monitoring and emergency alert functions. Various sensors such as the RPS (rotation/speed sensor), fire sensor, vibration sensor, DHT11 temperature and humidity sensor, and GPS module are connected to the NodeMCU to continuously monitor vehicle conditions and environmental parameters. The collected data is analyzed by the microcontroller to detect abnormal situations such as fire hazards, collisions, or unusual vibrations that may indicate an accident.

The RPS sensor is used to measure the rotational speed of the vehicle's wheel or motor. This information helps in monitoring vehicle movement and detecting sudden changes in speed that may occur during an accident or mechanical failure. The fire sensor detects the presence of flames or excessive heat within the vehicle, which can occur due to engine overheating, electrical short circuits, or fuel leakage. When a fire is detected, the sensor sends a signal to the NodeMCU so that immediate warning actions can be initiated.

The vibration sensor plays a crucial role in accident detection. It senses sudden shocks or strong vibrations that typically occur during a collision or impact. When

the vibration exceeds a predefined threshold, the NodeMCU interprets it as a possible accident event and activates the emergency response mechanism. The DHT11 sensor measures temperature and humidity levels inside or around the vehicle. Monitoring these environmental parameters helps in identifying abnormal conditions such as excessive heat buildup that could lead to fire hazards or system failures.

The GPS module is integrated into the system to determine the real-time geographical location of the vehicle. In case of an accident or emergency event, the NodeMCU retrieves the GPS coordinates and uses them to send location-based alert information to emergency responders or designated contacts. This feature ensures that rescue teams can quickly identify the accident location and provide immediate assistance.

On the output side of the system, several devices are connected to provide alerts and automated responses. The buzzer acts as an audible alarm that alerts the driver or nearby individuals when a hazardous condition or accident is detected. The LCD display is used to present system information, such as sensor readings, warning messages, or status updates, allowing the user to monitor vehicle conditions in real time. Additionally, a relay connected to a motor can be activated by the NodeMCU to control mechanical actions, such as stopping the motor or activating safety mechanisms during critical situations.

Overall, the proposed system integrates multiple sensors, communication modules, and automated alert mechanisms to create a comprehensive vehicle safety monitoring and accident detection framework. By continuously analyzing sensor data and responding quickly to abnormal conditions, the system enhances vehicle safety, reduces accident risks, and ensures faster emergency response through automated alerts and location tracking.

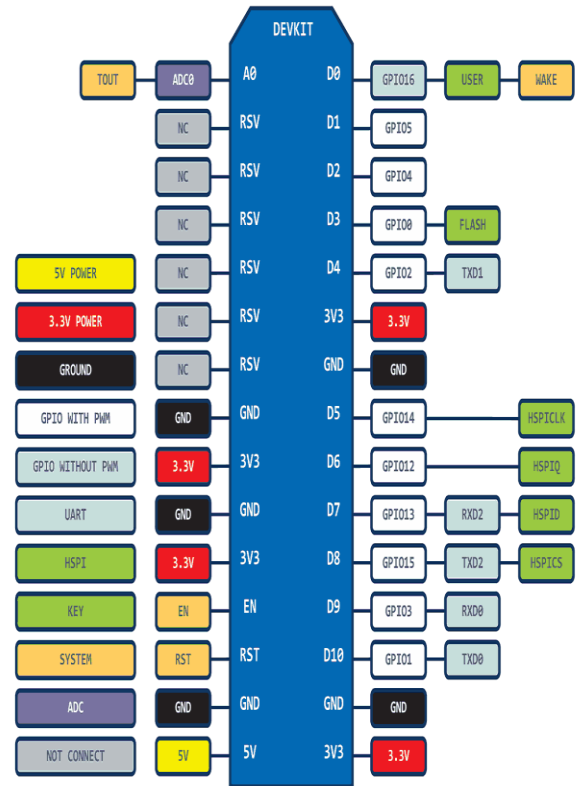


Fig.2. NodeMCU Dev Kit v0.9(V1) Pinouts

V. RESULTS AND DESCUSSIONS

The proposed CAN-Based Intelligent Vehicle Automation and Real-Time Accident Detection with Automatic Alert System improves vehicle safety by integrating sensor-based monitoring, embedded processing, and automated emergency notification mechanisms. The system continuously monitors vehicle conditions using sensors connected to the NodeMCU controller. Sensors such as the vibration sensor, fire sensor, RPS sensor, DHT11 temperature sensor, and GPS module detect abnormal conditions such as collision impact, fire hazards, environmental changes, and vehicle movement. When any abnormal event is detected, the NodeMCU processes the sensor data and activates the corresponding safety mechanisms such as alarms, display alerts, and automated control actions. This intelligent monitoring system helps improve vehicle safety and ensures rapid response during emergency situations. The specifications of the components used in the proposed system are presented in Table 1. The NodeMCU controller serves as the central processing unit responsible for collecting sensor data, processing information, and controlling output devices. The

vibration sensor is used to detect sudden shocks or collisions that may occur during accidents. The fire sensor identifies the presence of flames or excessive heat within the vehicle. The DHT11 sensor measures environmental parameters such as temperature and humidity, while the GPS module provides real-time location tracking of the vehicle. The RPS (regulated power supply) ensures stable power delivery for the NodeMCU and other electronic components.

TABLE 1: SYSTEM COMPONENT SPECIFICATION

Sl.NO	Components	Specifications
1	NodeMCU	Operating Voltage: 3.3V, Wi-Fi Enabled Microcontroller
2	RPS (Regulated Power Supply)	Provides stable power supply for system components
3	Fire Sensor	Detects fire or flame presence in the vehicle
4	Vibration Sensor	Detects sudden shocks or collision impact
5	DHT11 Sensor	Measures temperature and humidity
6	GPS Module	Provides real-time vehicle location tracking
7	Buzzer	Generates alert sound during emergencies
8	LCD Display	Displays system status and warning messages
9	Relay Module with Motor	Controls mechanical response or vehicle components

The hardware implementation integrates the NodeMCU controller with multiple sensors and output devices to monitor vehicle safety conditions. During operation, the sensors continuously collect environmental and motion-related data and transmit it to the NodeMCU controller. The controller processes the received data and evaluates whether the sensor readings exceed predefined safety thresholds. If abnormal conditions such as strong vibrations or fire detection are identified, the NodeMCU

immediately activates warning mechanisms including the buzzer and LCD display to alert the driver or nearby individuals.

The system also supports real-time location tracking and emergency notification through the GPS module. When an accident or emergency event occurs, the NodeMCU retrieves the vehicle's geographic coordinates from the GPS module. This location information can be transmitted to emergency contacts or monitoring systems to enable rapid rescue operations. The buzzer generates an audible alarm to warn nearby people, while the LCD display provides visual information regarding the detected condition or system status. In critical situations, the relay module can also control a connected motor or vehicle mechanism to perform automatic safety actions.

The experimental results demonstrate that the proposed vehicle safety monitoring system effectively detects abnormal conditions such as vibration shocks, fire hazards, and environmental changes. The NodeMCU controller successfully processes sensor inputs and activates the corresponding alert mechanisms without significant delay. The integration of GPS tracking ensures accurate location identification during emergency situations. The system operates efficiently and provides reliable monitoring of vehicle conditions through sensor-based detection and automated response.

Overall, the implementation of the proposed system significantly enhances vehicle safety by enabling automated accident detection, real-time monitoring, and rapid emergency alerts. The integration of sensor technology, embedded processing, and communication modules reduces response time during accidents and improves the chances of timely assistance. The proposed system provides a cost-effective, scalable, and reliable solution for intelligent vehicle safety monitoring and can be applied in modern automotive systems and intelligent transportation environments.

VI. CONCLUSION AND FUTURE SCOPE

Conclusion:

The CAN-based vehicle automation and accident alert system provides a robust, scalable, and highly

reliable framework for enhancing automotive safety. By integrating CAN communication with sensors and IoT modules, the system ensures real-time accident detection, timely alert notification, and improved vehicle monitoring. Literature findings emphasize that while traditional systems lack the communication efficiency and automation capability required for modern vehicles, CAN-based systems offer low latency, reliability, and fault tolerance. The proposed system thus significantly improves response time during accidents, reduces wiring complexity, and enables intelligent vehicle automation. Future advancements may incorporate AI-based crash prediction, integration of LiDAR/radar modules, and cloud-based diagnostic analytics for next-generation intelligent transportation systems.

Future Scope:

The proposed CAN-Based Intelligent Vehicle Automation and Real-Time Accident Detection with Automatic Alert System provides an effective solution for improving vehicle safety and emergency response. However, future developments can further enhance the system by integrating advanced technologies such as artificial intelligence and machine learning for more accurate accident prediction and detection. By analyzing vehicle sensor data, driver behavior, and environmental conditions, intelligent algorithms could identify risky driving patterns and provide early warnings to prevent potential accidents before they occur.

In future implementations, the system can be expanded by incorporating additional sensors such as camera modules, ultrasonic sensors, and LiDAR sensors to improve obstacle detection and environmental awareness. These sensors can help the system detect nearby vehicles, pedestrians, and road obstacles more accurately, enabling advanced driver assistance features such as collision avoidance, lane departure warnings, and adaptive cruise control. This would significantly improve road safety and support the development of semi-autonomous and autonomous vehicle systems.

Another important future enhancement is the integration of cloud computing and IoT-based data

platforms. By connecting the vehicle monitoring system to a cloud server, real-time vehicle data can be stored, analyzed, and monitored remotely by transportation authorities or fleet management systems. This approach would enable large-scale monitoring of vehicles, predictive maintenance, and traffic analysis, which could contribute to smarter transportation infrastructure and improved road management.

Furthermore, the system can be enhanced by incorporating 5G communication technology and vehicle-to-everything (V2X) communication. These technologies would allow vehicles to communicate with other vehicles, traffic signals, and roadside infrastructure to share real-time safety information. In the event of an accident, nearby vehicles could automatically receive alerts and take preventive actions to avoid secondary collisions.

Finally, future research can focus on improving the reliability, scalability, and energy efficiency of the system by optimizing sensor networks and embedded processing mechanisms. The development of more compact and cost-effective hardware modules would make the system easier to integrate into commercial vehicles and public transportation systems. With these advancements, the proposed system has the potential to become an essential component of next-generation intelligent transportation systems and smart vehicle safety frameworks.

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