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Smart Vehicle Safety and Accident Avoiding System in Car

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Abstract: *The Smart Vehicle Safety and Accident Detection System is an advanced IoT-based vehicle protection system developed to improve road safety and reduce accident risks using modern embedded technologies. The system is designed using the ESP32 microcontroller along with multiple sensors such as an ultrasonic sensor, eye blink sensor, IR sensor, GPS module, and ADXL345 accelerometer sensor. The project continuously monitors vehicle safety conditions including obstacle detection, driver drowsiness, seat belt monitoring, and accident detection in real time.*
The ultrasonic sensor detects nearby obstacles and automatically stops the vehicle to avoid collisions. The eye blink sensor monitors the driver's eye condition and identifies drowsiness or sleep conditions. If the driver closes their eyes for more than a predefined time, the system automatically stops the vehicle for safety.

Keywords: *Smart Vehicle Safety System, ESP32, IoT, Accident Detection, Driver Drowsiness Detection, Ultrasonic Sensor, GPS Tracking, Telegram Alerts, ADXL345 Accelerometer, Embedded Systems, Vehicle Monitoring, Road Safety.*

I. INTRODUCTION

In recent years, road accidents have become a major concern across the world due to increasing vehicle usage, careless driving, driver fatigue, overspeeding, and delayed emergency response systems [1]. Many accidents occur because drivers fail to identify obstacles on time or lose concentration while driving, especially during long-distance and night travel [2]. Traditional vehicle systems mainly depend on human control and often lack intelligent safety mechanisms capable of automatically monitoring dangerous situations and preventing accidents [3]. Therefore, there is a growing need for smart and automated vehicle safety systems that can improve transportation safety and reduce accident-related deaths [4].

The Smart Vehicle Safety and Accident Detection System is an IoT-based intelligent safety solution developed using the ESP32 microcontroller and multiple sensors for real-time vehicle monitoring [5]. The system continuously monitors important safety conditions such as obstacle detection, driver drowsiness, accident detection, and emergency communication [6]. The ESP32 acts as the main processing unit and controls all sensors, communication modules, and vehicle operations efficiently through wireless technology [7].

An ultrasonic sensor is used to detect nearby obstacles and automatically stop the vehicle to avoid collisions [8]. An eye blink sensor monitors the driver's eye movement and identifies drowsiness or sleep conditions. If the driver closes their eyes for a long duration, the system automatically stops the vehicle to prevent accidents caused by fatigue [9]. The ADXL345 accelerometer sensor detects sudden impacts or abnormal vibrations during accidents and immediately activates the emergency alert system [10].

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II. PROBLEM STATEMENT

Road accidents are increasing rapidly due to driver drowsiness, careless driving, obstacle collisions, and delayed emergency response. Most traditional vehicles do not have intelligent systems to monitor driver conditions, detect accidents, or provide automatic safety actions during dangerous situations. In many cases, rescue services are delayed because the exact accident location is not available immediately. Therefore, there is a need for a low-cost and smart vehicle safety system that can detect driver drowsiness, identify obstacles and accidents, automatically stop the vehicle during unsafe conditions, and send emergency alerts with live GPS location using IoT technology to improve road safety and reduce accident risks.

III. OBJECTIVES

- To detect vehicle accidents using the ADXL345 accelerometer sensor.
- To monitor driver drowsiness using the eye blink sensor.
- To detect nearby obstacles using the ultrasonic sensor.
- To automatically stop the vehicle during unsafe conditions.
- To provide real-time GPS location tracking during accidents.

IV. LITERATURE SURVEY

Patel et al. (2024) presented an IoT-based vehicle accident detection and emergency reporting system using ESP32, GPS, and accelerometer sensors. The system continuously monitored vehicle vibrations and detected accidents automatically when abnormal acceleration values were observed. After detecting an accident, the system sent emergency alerts along with live GPS location to rescue teams and family members through wireless communication. The proposed system improved emergency response time and enhanced road safety. However, the system mainly focused on accident reporting and did not include driver drowsiness monitoring or obstacle avoidance features.

Sharma and Verma (2024) developed a real-time driver drowsiness detection system using eye blink monitoring and deep learning techniques. The system used infrared sensors and image processing algorithms to monitor eye movements and detect fatigue conditions during driving. When the driver's eyes remained closed for a specific duration, warning alerts were generated automatically. The system showed high accuracy in detecting driver fatigue and reducing accident risks. However, the proposed model required high computational resources and depended heavily on lighting conditions for accurate performance.

Kumar et al. (2023) proposed an IoT-based automated accident detection and emergency warning system using GPS, GSM, and accelerometer sensors. The system identified sudden vehicle impacts and automatically transmitted accident information and location coordinates to hospitals and emergency contacts. The researchers highlighted the importance of quick communication during emergencies to reduce fatalities. Although the system improved rescue response time, it lacked obstacle detection and intelligent vehicle control mechanisms.

Reddy and Rao (2023) introduced a smart vehicle safety system with ultrasonic sensor-based obstacle detection for collision prevention. The system continuously measured the distance between the vehicle and nearby objects and automatically stopped the vehicle when obstacles were detected within a dangerous range. The proposed method enhanced driving safety and reduced collision risks in smart transportation systems. However, the project did not include accident detection or driver monitoring functionalities.

Singh et al. (2024) designed a driver safety monitoring system using IoT and embedded technologies for detecting driver fatigue and unsafe vehicle conditions. The system integrated sensors for monitoring eye movement, seat belt conditions, and vehicle status in real time. The researchers concluded that intelligent monitoring systems could significantly improve transportation safety and reduce accidents caused by human negligence. However, the system lacked live GPS tracking and emergency communication support.

Mehta and Joshi (2024) developed an advanced smart vehicle safety and accident prevention system using ESP32 and wireless communication technologies. The project combined accident detection, obstacle monitoring, GPS tracking, and IoT-based alert notifications into a single platform. The system automatically stopped the vehicle during dangerous

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situations and sent live location alerts through internet communication. The proposed approach improved automation and vehicle safety effectively. However, sensor calibration and internet dependency affected system reliability in certain environmental conditions.

Comparison Table

Author & Year	Method Used	Advantages	Limitations
Patel et al. (2024)	IoT-based accident detection using GPS and accelerometer	Fast emergency alert and live location tracking	No driver drowsiness detection
Sharma and Verma (2024)	Eye blink monitoring with deep learning	Accurate driver fatigue detection	Depends on lighting conditions
Kumar et al. (2023)	GPS, GSM, and accelerometer-based accident system	Quick accident reporting	No obstacle detection feature
Reddy and Rao (2023)	Ultrasonic sensor obstacle detection	Prevents vehicle collisions	No accident monitoring
Singh et al. (2024)	IoT-based driver safety monitoring	Real-time driver monitoring	No GPS emergency tracking
Mehta and Joshi (2024)	ESP32-based smart vehicle safety system	Integrated safety and alert system	Requires internet connectivity

V. WORKING OF SYSTEM

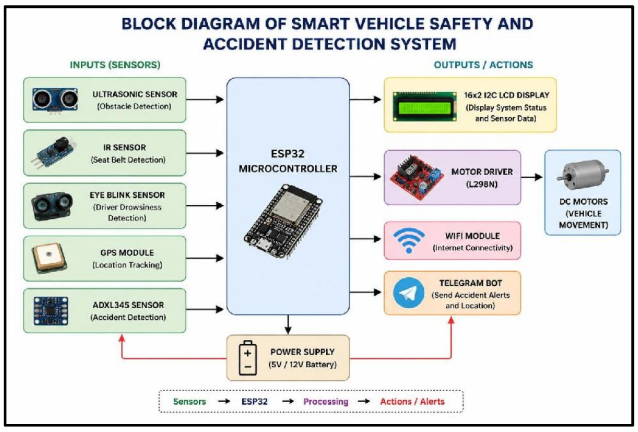

Fig 1: Design of the system

Obstacle Detection

The ultrasonic sensor continuously measures the distance between the vehicle and nearby objects. If any obstacle is detected within a short range, the ESP32 controller immediately stops the vehicle to avoid collision.

Seat Belt and Safety Monitoring

The IR sensor checks safety conditions such as seat belt status or object detection. When an unsafe condition is identified, the system restricts vehicle movement for protection.

Driver Drowsiness Detection

The eye blink sensor monitors the driver's eye movement continuously. If the driver keeps their eyes closed for a long time, the system detects drowsiness and automatically stops the vehicle to prevent accidents.

Accident Detection

The ADXL345 accelerometer sensor monitors sudden vibration or impact in the vehicle. If abnormal acceleration is detected, the ESP32 recognizes it as an accident condition.

Live GPS Tracking

During an accident, the GPS module provides the exact latitude and longitude location of the vehicle. This location is used for emergency tracking and rescue support.

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Emergency Alert System

The ESP32 sends an emergency notification through the Telegram Bot using WiFi communication. The alert message includes accident details and live GPS location.

Vehicle Movement Control

The L298N motor driver controls the DC motors for vehicle movement. Under unsafe conditions, the ESP32 sends stop commands to the motor driver to stop the vehicle automatically.

Real-Time Information Display

The 16x2 LCD display shows live system status, obstacle distance, safety alerts, and vehicle conditions for easy monitoring by the user.

Power Supply Operation

The battery power supply provides the required voltage and current to all sensors, modules, and motors for continuous system operation.

VI. SYSTEM DESIGN

1. System Overview:

The Smart Vehicle Safety and Accident Detection System is an IoT-based safety system developed using ESP32, sensors, GPS, and wireless communication technologies. The system continuously monitors obstacle detection, driver drowsiness, accident conditions, and vehicle safety status in real time. The ultrasonic sensor detects nearby obstacles, the eye blink sensor monitors driver fatigue, and the ADXL345 sensor detects accidents through vibration analysis. During unsafe situations, the ESP32 automatically stops the vehicle and sends emergency alerts with live GPS location through Telegram. The system improves road safety, reduces accident risks, and supports intelligent vehicle monitoring applications.

ESP32 Microcontroller

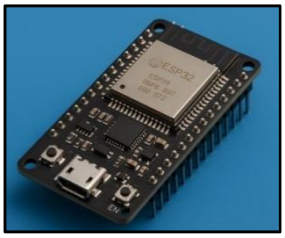

Fig.2.ESP32 Microcontroller

The ESP32 acts as the main controller of the system. It receives data from all sensors, processes the information, and controls the safety operations such as vehicle stopping, alert generation, and communication functions.

Ultrasonic Sensor (HC-SR04)

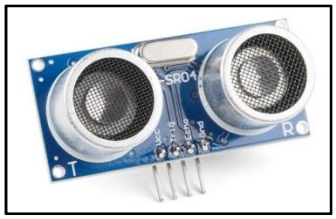

Fig.3.Ultrasonic Sensor

The ultrasonic sensor is used for obstacle detection. It measures the distance between the vehicle and nearby objects using ultrasonic waves and helps prevent collisions by stopping the vehicle automatically.

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IR Sensor Module

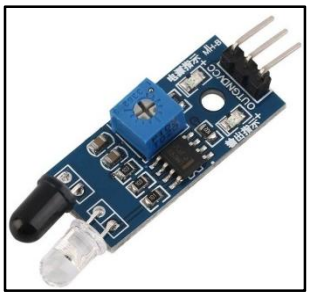

Fig.4.IR Sensor

The IR sensor monitors safety conditions such as seat belt status or object presence. It sends digital signals to the ESP32 whenever an unsafe condition is detected.

GPS Module

Fig.5.GPS Module

The GPS module provides real-time vehicle location tracking using satellite communication. During emergencies, it sends live latitude and longitude coordinates for quick rescue support.

L298N Motor Driver Module

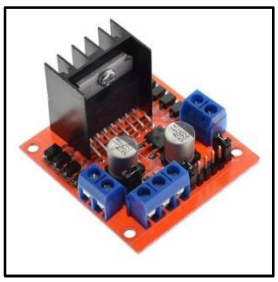

Fig.6.L298N Motor Driver Module

The motor driver controls the DC motors connected to the vehicle. It receives control signals from the ESP32 and manages motor movement and stopping operations.

DC Motors

Fig.7.DC Motors

DC motors provide movement to the vehicle. The motors move the vehicle forward during normal conditions and stop automatically during unsafe situations.

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VII. RESULTS

The Smart Vehicle Safety and Accident Detection System was successfully implemented and tested under different driving and safety conditions. The ultrasonic sensor accurately detected nearby obstacles and automatically stopped the vehicle when objects were detected within the predefined safety range, which helped in preventing collisions. The eye blink sensor effectively monitored the driver's eye condition and successfully identified drowsiness when the eyes remained closed for a long duration. During this condition, the system automatically stopped the vehicle to improve driver safety.

The ADXL345 accelerometer sensor successfully detected sudden impacts and abnormal vibrations during accident simulation tests. Once an accident was detected, the ESP32 immediately stopped the vehicle and activated the emergency alert system. The GPS module accurately provided live latitude and longitude coordinates, and the Telegram Bot successfully sent accident alert messages with Google Maps location links through WiFi communication. The LCD display continuously showed real-time sensor values, vehicle status, and warning messages clearly during system operation.

The overall system performed efficiently in real-time monitoring, accident detection, obstacle avoidance, and emergency communication. The project demonstrated reliable operation, low-cost implementation, and effective vehicle safety performance using IoT and embedded system technologies.

VIII. CONCLUSION

The Smart Vehicle Safety and Accident Detection System was successfully developed using ESP32, IoT technology, and multiple sensors to improve vehicle and driver safety. The system effectively monitored important safety conditions such as obstacle detection, driver drowsiness, accident detection, and emergency communication in real time. The ultrasonic sensor helped prevent collisions by detecting nearby obstacles, while the eye blink sensor identified driver fatigue and automatically stopped the vehicle during unsafe conditions.The ADXL345 accelerometer sensor successfully detected accidents through vibration analysis, and the GPS module provided accurate live location tracking during emergencies. The system also sent instant emergency alerts through Telegram using WiFi communication, which improved rescue response time. The LCD display provided continuous monitoring of vehicle status and sensor information.Overall, the project demonstrated a reliable, low-cost, and intelligent vehicle safety solution capable of reducing accident risks and supporting smart transportation systems using embedded and IoT technologies.

IX. FUTURE SCOPE

The Smart Vehicle Safety and Accident Detection System can be further improved by integrating advanced technologies such as Artificial Intelligence and Machine Learning for better driver behavior analysis and accident prediction. Camera-based monitoring systems can be added for face recognition, lane detection, and traffic sign identification to increase vehicle safety. Cloud storage and mobile applications can also be integrated for real-time vehicle monitoring, data storage, and remote control functions.

In future developments, the system can be connected with smart traffic management systems and autonomous vehicle technologies for fully automated transportation applications. Additional sensors such as alcohol detection, speed monitoring, and tire pressure monitoring systems can also be included to improve safety features. The project can further be upgraded with 5G communication, cloud computing, and advanced IoT platforms for faster emergency response and intelligent transportation management.

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