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Smart Vehicle Black Box Using IOT & AI

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***Abstract*— The Smart Vehicle Black Box Using IoT and AI is designed to improve vehicle safety by combining accident detection, GPS tracking, driver-safety monitoring, and real-time data communication in a single system. The proposed system uses an ESP32 microcontroller to collect and process data from various sensors, including the MPU6050 accelerometer and gyroscope, SW-420 vibration sensor, alcohol sensor, and seat-belt sensor. When unusual vehicle movement or a possible accident is detected, the system can activate a buzzer, display relevant information on an OLED display, and obtain the vehicle's location through a GPS module. Using an IoT platform such as Blynk, accident-related information and vehicle status can be transmitted to a remote dashboard when internet connectivity is available. The integration of AI techniques can further support the classification of sensor data and help distinguish possible accidents from normal vehicle movements, provided a suitable model is developed and tested. The system also aims to maintain useful records of vehicle events for future analysis and accident investigation. Overall, this project provides a foundation for an intelligent vehicle monitoring solution that can support faster emergency communication, encourage safer driving practices, and contribute to improved road safety.**

Keywords: Smart Vehicle Black Box, Internet of Things (IoT), Artificial Intelligence (AI), ESP32, Accident Detection, GPS Tracking, MPU6050 Sensor, Vibration Sensor, Driver Safety, Real-Time Monitoring, Blynk IoT, Emergency Alert.

I. INTRODUCTION

Road safety has become a major concern due to the increasing number of vehicles and road accidents. Accidents can occur because of overspeeding, careless driving, driver fatigue, alcohol consumption, poor road conditions, and mechanical failures. In many situations, the delay in identifying an accident and informing emergency services can increase the risk of serious injuries and loss of life. Conventional vehicle black boxes are mainly designed to record important information about vehicle operation, such as speed, acceleration, braking, and impact conditions. However, many traditional systems have limited real-time communication capabilities and may not provide immediate information about an accident to family members or emergency responders. Therefore, there is a need for an advanced vehicle monitoring system that can detect possible accidents, track vehicle location, and transmit important information in a timely manner.

The proposed Smart Vehicle Black Box Using IoT and AI aims to address these challenges by integrating sensor technology, GPS tracking, microcontroller-based processing, and wireless communication. The system uses an ESP32 microcontroller as its main processing unit to collect and analyse data from connected sensors. The MPU6050 accelerometer and gyroscope measure changes in acceleration and vehicle movement, while the SW-420 vibration sensor detects sudden vibrations that may indicate an impact. An alcohol sensor can be used to identify the presence of alcohol vapour near the sensor, and a seat-belt sensor can monitor whether the seat belt is fastened. The GPS module provides geographical coordinates that help identify the vehicle's location. These components work together to monitor vehicle conditions and identify potentially unsafe situations.

The Internet of Things (IoT) plays an important role in enabling remote monitoring and communication in the proposed system. When the configured detection conditions indicate a possible accident or abnormal event, the ESP32 can activate a buzzer, display relevant information on an OLED

display, and transmit available event details through an IoT platform such as Blynk, provided that network connectivity is available. The GPS coordinates can help designated contacts locate the vehicle, while stored event information can support later analysis and accident investigation. Artificial intelligence can further enhance the system by analysing sensor patterns and classifying possible accident events. For effective AI-based detection, a suitable machine-learning model must be trained and evaluated using representative data; otherwise, the system can operate using predefined sensor thresholds and decision rules.

Overall, the Smart Vehicle Black Box Using IoT and AI is intended to provide a more connected and intelligent approach to vehicle safety monitoring. By combining accident-related sensor data, GPS location, driver-safety indicators, local alerts, and remote communication, the system aims to support faster accident reporting and improve access to important vehicle information. It may also help identify potentially unsafe driving conditions and provide useful records for reviewing vehicle incidents. The system's reliability depends on proper hardware integration, sensor calibration, accurate event detection, GPS availability, and successful communication with the remote platform. With further development and testing under different driving conditions, this technology has the potential to contribute to safer transportation and more effective emergency response.

II. AIMS & OBJECTIVES

Aim:

The main aim of the Smart Vehicle Black Box Using IoT and AI is to develop an intelligent vehicle monitoring system that detects possible accidents, tracks vehicle location, monitors important driver-safety conditions, and transmits accident-related information to remote users through IoT technology. The system uses an ESP32 microcontroller, sensors, GPS tracking, and AI-based analysis to support timely emergency communication, improve vehicle safety monitoring, and maintain useful information for future accident investigation.

Objectives:

- To detect possible vehicle accidents using the MPU6050 and vibration sensors.
- To track the vehicle's location using a GPS module.
- To send accident alerts and location details through an IoT platform.
- To monitor driver-safety conditions using alcohol and seat-belt sensors.
- To provide immediate warnings through a buzzer and OLED display.
- To apply AI-based analysis for improved accident detection and classification.
- To maintain vehicle event records for future analysis and accident investigation.

III. LITERATURE SURVEY

The development of IoT-based vehicle black box systems has become an important area of research for improving road safety, detecting accidents, and providing timely emergency assistance. Traditional accident investigation methods often face difficulties due to the lack of accurate information about vehicle conditions and events before a collision. To overcome these challenges, researchers have proposed smart systems that integrate sensors, GPS, GSM, microcontrollers, cloud platforms, and artificial intelligence to monitor vehicle parameters, detect accidents, record important data, and transmit emergency alerts. These systems can help identify the possible causes of accidents, provide real-time vehicle location, support police investigations, and reduce delays in rescue operations. The following research papers discuss different approaches to vehicle black box design, accident detection, vehicle surveillance, and IoT-based emergency notification.

Review of Research Papers

1. Smart Vehicle Black Box (June 2021) – Priyanka Vijay Teke and Pooja Shivling Dalvi

This research presents an IoT- and AI-based vehicle black box designed to improve road safety through obstacle detection, alcohol detection, driving licence verification, GPS tracking, and time recording. The system records essential vehicle information and shares accident-related data with authorized parties to support emergency response and accident investigation.

2. IoT-Based Vehicle Surveillance and Crash Detection System (May 2022) – M. Kathiravan, M. Pavan Kumar Reddy, and Muthukumaran Malarvel

This paper proposes a smart vehicle monitoring system that detects accidents, records vehicle data, and sends alerts to vehicle owners and emergency services. It also discusses vehicle theft tracking, authorized remote vehicle disabling, and sharing accident records with insurance companies to simplify claim processing.

3. A Novel IoT-Based GPS Tracking System with Black Box (April 2023) – J. Suresh Kumar, J. Tony Christopher, and M. Nirmal Kumar

This study introduces an IoT-based black box that monitors vehicle speed, acceleration, rotational movement, GPS location, and road conditions. The collected information can be compared with historical accident records to identify accident-prone areas and provide warnings that support preventive road safety measures.

4. A Review of Internet of Things Approaches for Vehicle Accident Detection and Emergency Notification (July 2025) – Mohammad Ali Sahraei and Said Ramadhan Mubarak Al Mamari

This paper reviews 101 research articles on IoT-based accident detection and emergency notification systems. It examines technologies such as GPS, GSM, accelerometers, and vibration sensors while highlighting challenges related to cost, sensor accuracy, environmental conditions, and communication reliability. It also identifies sensor fusion and artificial intelligence as promising approaches for improving accident detection.

5. IoT-Based Vehicle Black Box with Cloud Analytics and Emergency Response (December 2025) – Avinash Pal and Shivsagar Patel

This research proposes a vehicle black box that combines MEMS sensors, alcohol detection, ultrasonic obstacle sensing, GPS, GSM, and cloud connectivity. It also incorporates audio recording and simulated vehicle parameters to collect accident-related evidence, transmit emergency alerts, and enable remote monitoring and further analysis of vehicle data.

IV. METHODOLOGY

The methodology of the Smart Vehicle Black Box Using IoT and AI involves integrating sensors, an ESP32 microcontroller, a GPS module, and IoT communication to monitor vehicle conditions and detect possible accidents. The system collects data from the MPU6050 accelerometer and gyroscope, SW-420 vibration sensor, alcohol sensor, and seat-belt sensor. The ESP32 processes the sensor readings using predefined conditions or a properly developed AI model to identify abnormal vehicle events. When a possible accident or unsafe condition is detected, the system can activate a buzzer, display information on an OLED screen, obtain the vehicle's location through GPS, and transmit relevant alerts to a remote IoT platform such as Blynk. This methodology aims to support real-time vehicle monitoring, emergency communication, and the recording of useful vehicle-event information.

Working Steps

1. Power Supply and System Initialization: The system receives power from the vehicle supply or rechargeable battery through the required power-management and voltage-regulation circuits. The ESP32 initializes the connected sensors, GPS module, OLED display, buzzer, and IoT communication.

2. Sensor Data Collection: The MPU6050 monitors acceleration and angular movement, while the SW-420 sensor detects sudden vibrations. The alcohol sensor checks for alcohol vapour near its sensing element, and the seat-belt

sensor monitors belt status. The ESP32 continuously collects and processes the available readings.

3. Accident and Abnormal Condition Detection: The ESP32 compares sensor readings with configured thresholds or processes them using a trained AI model, if implemented. When the readings indicate a possible accident or unsafe condition, the system generates an appropriate event alert. Combining sensor information can help reduce false detections.

4. GPS Tracking and IoT Alert Transmission: When a possible accident is detected, the GPS module provides the vehicle's coordinates, provided that satellite reception is available. The ESP32 sends the available accident information and location to the configured IoT platform, such as Blynk, through an available internet connection. The remote dashboard can then display the received information for monitoring.

5. Warning, Display, and Event Recording: The system activates the buzzer to provide a local warning and displays relevant sensor readings or event status on the OLED screen. Accident-related information can also be recorded in local or cloud storage if the required storage functionality is implemented. The collected records can support later analysis, system evaluation, and accident investigation.

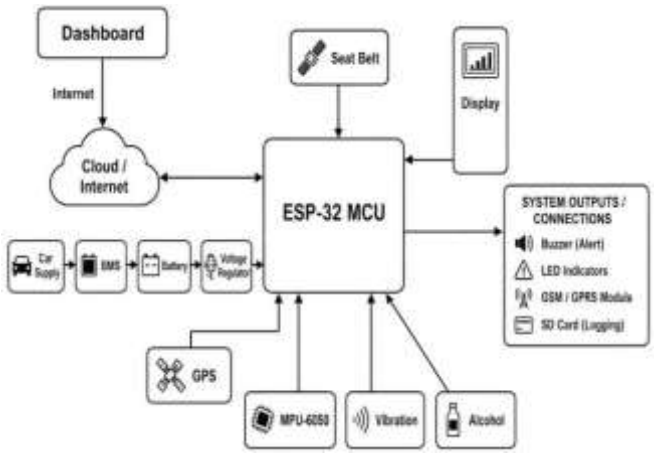


Figure 1: Block Diagram of the system

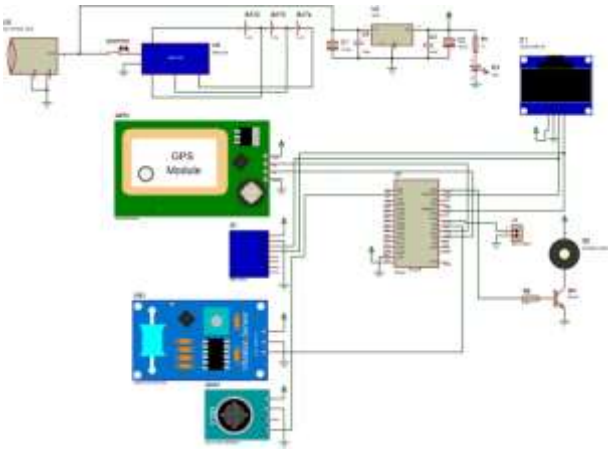


Figure 2: Circuit Diagram of the system

V. RESULTS

The Smart Vehicle Black Box Using IoT and AI is designed to provide an integrated solution for vehicle monitoring, possible accident detection, GPS tracking, and driver-safety assessment. The ESP32 microcontroller collects information from the MPU6050 accelerometer and gyroscope, SW-420 vibration sensor, alcohol sensor, and seat-belt sensor to monitor vehicle movement and selected safety conditions. When the sensor readings indicate a possible accident or abnormal event, the system can activate a buzzer and display the corresponding status on the OLED screen. The GPS module provides geographical coordinates that can help identify the vehicle's location, while the IoT platform, such as Blynk, can display available sensor information and transmit event alerts to remote users when internet connectivity is available. The system can also support the recording of accident-related information for later analysis, provided that a suitable data-storage mechanism is implemented. If a trained and tested AI model is integrated, it may further help classify sensor patterns and distinguish possible accidents from normal vehicle movements. Overall, the proposed design combines several useful vehicle-safety functions in one system and provides a foundation for improving accident reporting and remote vehicle monitoring. The actual detection accuracy, GPS performance, alert delivery time, and reliability must be determined through practical testing, and no numerical performance values should be claimed without measured results.

VI. CONCLUSION

The Smart Vehicle Black Box Using IoT and AI provides a promising approach to improving vehicle safety through the integration of sensor-based monitoring, accident detection, GPS tracking, and IoT communication. By using an ESP32 microcontroller and connected sensors, the system can monitor vehicle movements, identify potentially abnormal conditions, provide local warnings, and communicate available accident-related information to a remote dashboard. GPS tracking can assist in locating a vehicle after a possible accident, while alcohol and seat-belt sensors can support the monitoring of selected driver-safety conditions. The addition of AI-based analysis may improve accident classification when an appropriate model is developed, trained, and validated using representative data. This system has the potential to support faster emergency communication, provide useful information for accident investigation, and encourage safer driving practices. However, its effectiveness depends on proper sensor calibration, reliable power management, accurate event-detection logic, GPS availability, and network connectivity for remote alerts. Future improvements may include secure cloud-based data storage, backup communication methods, advanced driver monitoring, and integration with emergency response services. With further development and thorough testing under different driving conditions, the proposed system could serve as a valuable supporting technology for intelligent vehicle monitoring and road safety.

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