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Automobile Blackbox System for Accident Analysis

Harshitha C, Sahana S, Shravana K, Dr Manjula A V

UG Students, Department of ECE, NIEIT, Mysuru, Karnataka, India

Associate Professor, Department of ECE, NIEIT, Mysuru, Karnataka, India

ABSTRACT: This study introduces an all-encompassing Automobile Black Box System (ABBS) tailored for detailed accident analysis and prevention. It harnesses cutting-edge technology, such as the ESP32 microcontroller, to streamline data processing and administration efficiently. The system incorporates an alcohol sensor for detecting driver impairment, a meme sensor for evaluating driver attentiveness, and a temperature sensor for monitoring environmental conditions. Additionally, GSM and GPS modules enable real-time communication and precise location tracking, facilitating prompt emergency responses. Furthermore, the integration of a motor driver enhances the system's functionality, enabling the monitoring and regulation of vehicle dynamics.

KEYWORDS: Blackbox, ESP32, Accident, sensors, GSM and GPS.

I. INTRODUCTION

The integration of an Automobile Black Box system represents a pioneering leap in vehicular safety and accident analysis, particularly with the utilization of cutting-edge technologies such as the ESP32 microcontroller, alcohol sensor, MEMS sensor, temperature sensor, motor driver, GSM, and GPS. This sophisticated system aims to revolutionize the understanding of vehicular accidents by capturing a comprehensive range of data before, during, and after collisions. At its core, the ESP32 microcontroller orchestrates the seamless operation of various components, ensuring efficient data collection and processing. The inclusion of an alcohol sensor serves a pivotal role in combating drunk driving incidents, detecting alcohol levels within the vicinity of the driver and potentially preventing accidents caused by impaired driving. Simultaneously, the MEMS sensor provides real-time insights into vehicle movements, offering a granular understanding of driving behavior leading up to accidents and enhancing the analysis of collision dynamics.

Moreover, temperature sensors offer crucial environmental context, shedding light on conditions such as extreme weather or road surface temperatures, which could influence driving behavior and accident occurrences. The integration of a motor driver adds an extra layer of functionality, allowing for the control of vehicle components to enhance safety measures or potentially aid in accident prevention mechanisms. However, perhaps the most groundbreaking aspect of this system lies in its incorporation of GSM and GPS technology. These features enable real-time communication and location tracking, ensuring prompt emergency response in the event of an accident. Furthermore, they facilitate post-accident analysis by providing accurate location data, enabling authorities and researchers to gain invaluable insights into the causes and consequences of vehicular accidents. Ultimately, the purpose of this advanced Automobile Black Box system transcends mere data collection; it aspires to catalyze a paradigm shift in road safety standards, leading to a reduction in road fatalities and the enhancement of overall transportation safety systems.

II. SYSTEM MODEL AND ASSUMPTIONS

This block diagram illustrates a sophisticated Integrated Basic car black box design to enhance both the safety and performance aspects of a vehicle. The system seamlessly incorporates various hardware components, each serving a specific purpose, to create a comprehensive and intelligent framework. Below is a detailed description of each component.

ESP32 At the heart of the system, the ESP32 serves as the central processing unit and communication hub. Its versatility allows for seamless integration with other components, making it the brain of the entire setup.

The power supply component represents the primary source of energy for the system, drawing power from the vehicle's

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12V battery. This ensures continuous operation and data logging without relying on external sources.

The Dallas Temperature Sensor is strategically positioned to monitor the engine's temperature. This crucial data aids in assessing the health of the engine, preventing overheating, and enabling preemptive maintenance.

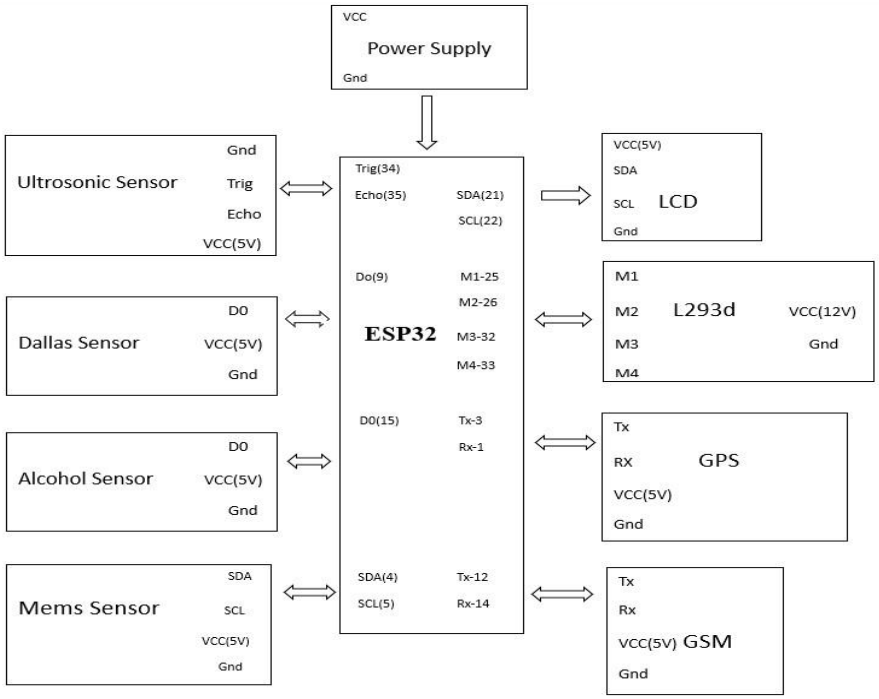

Fig. 1 System Model

Alcohol Sensor Integrated to enhance safety, the Alcohol Sensor detects the presence of alcohol in the driver's breath. This feature serves as a preemptive measure, alerting authorities or restricting vehicle ignition if alcohol is detected, promoting responsible driving habits . The MEMS Sensor plays a pivotal role in detecting accidents or abrupt changes in the vehicle's orientation. Upon detecting a collision or tilt beyond the normal range, it triggers immediate responses, such as emergency alerts or data logging for post-incident analysis.

The GSM module enables communication capabilities. It facilitates the transmission of critical information, such as accident alerts, engine health data, and alcohol detection warnings, to designated recipients or authorities. The GPS module provides location tracking for the vehicle. This data is invaluable for various applications, including route monitoring, accident reconstruction, and real-time tracking.

The LCD serves as the user interface, providing feedback on the system's status. It displays relevant information, such as engine temperature, alcohol detection status, and GPS coordinates, offering a user-friendly interface for both drivers and system administrators. This integrated system, fueled by the ESP32, forms a symbiotic network of components that collectively contribute to a safer and more efficient vehicle operation. From monitoring engine health to ensuring responsible driving practices, this system exemplifies a comprehensive approach to vehicle safety and performance.

III. METHODOLOGY

System Initialization: This flowchart illustrates the sequential steps involved in monitoring and enhancing vehicle safety. The integration of various sensors and communication modules allows the system to detect obstacles, accidents, engine heat, and alcohol presence, taking appropriate actions such as sending alerts and preventing the vehicle from starting in the case of alcohol detection.

Designing a basic car black box involves the integration of various components and sensors to capture and store critical information related to the vehicle's performance, safety, and operational parameters. The primary objective is to create

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a robust system that records data during normal driving conditions and in the event of accidents or irregularities. Additionally, incorporating GPS modules allows for accurate tracking of the vehicle's location and movement. This data can be crucial in reconstructing events leading up to accidents or for analyzing driving behavior. For safety considerations, integrating impact sensors or accelerometers, similar to those used in airbag systems, can help detect collisions or accidents. This information, combined with data from other sensors, can provide a comprehensive overview of the circumstances surrounding an incident. In terms of engine performance, the Dallas Temperature Sensor can monitor the vehicle's engine health and temperature, ensuring that any anomalies are recorded. This can be valuable for preventive maintenance and diagnosing potential issues before they escalate.

Moreover, the black box can include features like an alcohol sensor to detect the presence of alcohol in the driver's breath. If alcohol is detected, the system can trigger alerts and potentially prevent the vehicle from starting, contributing to enhanced safety measures. To make the black box user-friendly, incorporating an LCD display provides real-time feedback on the vehicle's status. Additionally, GSM modules enable communication capabilities, allowing the black box to send alerts or data remotely, further enhancing its functionality. In essence, the design of a basic car black box involves a thoughtful integration of sensors and modules to capture a comprehensive range of data related to vehicle performance, safety, and driver behavior. Such a system can be instrumental in post-incident analysis, preventive maintenance, and promoting safe driving practices

IV. SURVEY DESCRIPTION

A literature survey on vehicle automobile black box systems for accident analysis would comprehensively review existing research and developments in this field. An overview of different types of black box systems used in vehicles, including their components, functionalities, and deployment methods.

Data Collection Methods: Discussion on various sensors and data collection techniques employed in black box systems, such as accelerometers, GPS, cameras, and microphones. Accident Detection Algorithms Review of algorithms and methodologies used to detect and analyze accidents based on data collected by black box systems, including machine learning approaches, pattern recognition, and rule-based systems.

Data Analysis and Reconstruction: Examination of techniques for analyzing black box data to reconstruct accident scenarios, determine causation factors, and assess severity. Analysis of real-world case studies and applications where black box systems have been instrumental in accident analysis, prevention, and post-accident investigations.

Regulatory Frameworks and Standards: Exploration of existing regulations, standards, and guidelines governing the use of black box systems in vehicles, as well as emerging trends and future regulatory developments.
Challenges and Future Directions: Identification of challenges and limitations associated with black box systems, such as data privacy concerns, interoperability issues, and technological advancements needed for improved accuracy and reliability. Additionally, discussion on future research directions and potential innovations in this field.

Overall, the literature survey would provide a comprehensive understanding of the current state-of-the-art, challenges, and opportunities in automobile black box systems for accident analysis.

V. FUTURE SCOPE AND DISCUSSION

The system's robustness can be enhanced by encasing sensors for protection, utilizing materials like titanium or stainless steel to render them fireproof. Future iterations could integrate additional functionalities such as monitoring fuel levels, tire pressure, and headlight functionality prior to vehicle operation. Further enhancements may involve interfacing with vehicle airbag systems for optimized accident detection. Additionally, augmenting the system with components for voice and video recording, as well as impact location detection, can significantly improve its capabilities.

VI. CONCLUSION

The adaptation of aviation's black box into automotive drive recorders is pivotal, aiding in post-crash analysis by capturing vital vehicle data. A functional prototype integrating SMS alerts for road vehicles has been crafted, leveraging an ESP32 microcontroller, GPS tracker, and GSM module to swiftly detect and report accidents. This technology bridges the gap between accidents and medical assistance, potentially saving lives by providing prompt

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information to emergency responders. By utilizing GPS for pinpointing accident locations and GSM for instant SMS notifications, this system significantly enhances safety measures. Furthermore, the data retrieved from the black box can be utilized to analyze real-time vehicle behavior, offering advanced driver assistance during critical situations.

VII. RESULT

The Vehicle Black Box project leveraging the ESP32 microcontroller yielded compelling results, demonstrating its capability to comprehensively monitor and record crucial vehicle parameters. Through meticulous data acquisition and processing, including the integration of sensors like GPS modules and accelerometers, the system accurately tracked vehicle movements, speed variations, and driving behaviours in real-time. It shows “Accident Alert” when the vehicle is tilted and also shows “Obstacle detected” whenever any other vehicle comes in contact or near the vehicle. It also detects alcohol if the driver has consumed alcohol saying “Alcohol Detected”. It sends the message including current location of the vehicle saying the vehicle has under gone an accident. Below are the images regarding its results.

Fig1. Accident Alert

Fig2. Alcohol Detected

Fig3. Obstacle Detected

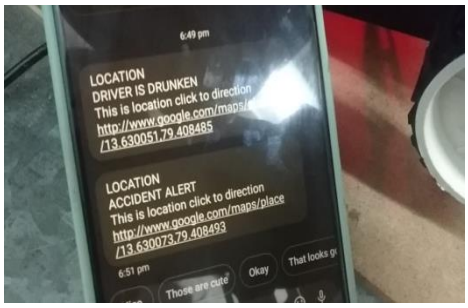

Fig4. Message Sent to the user

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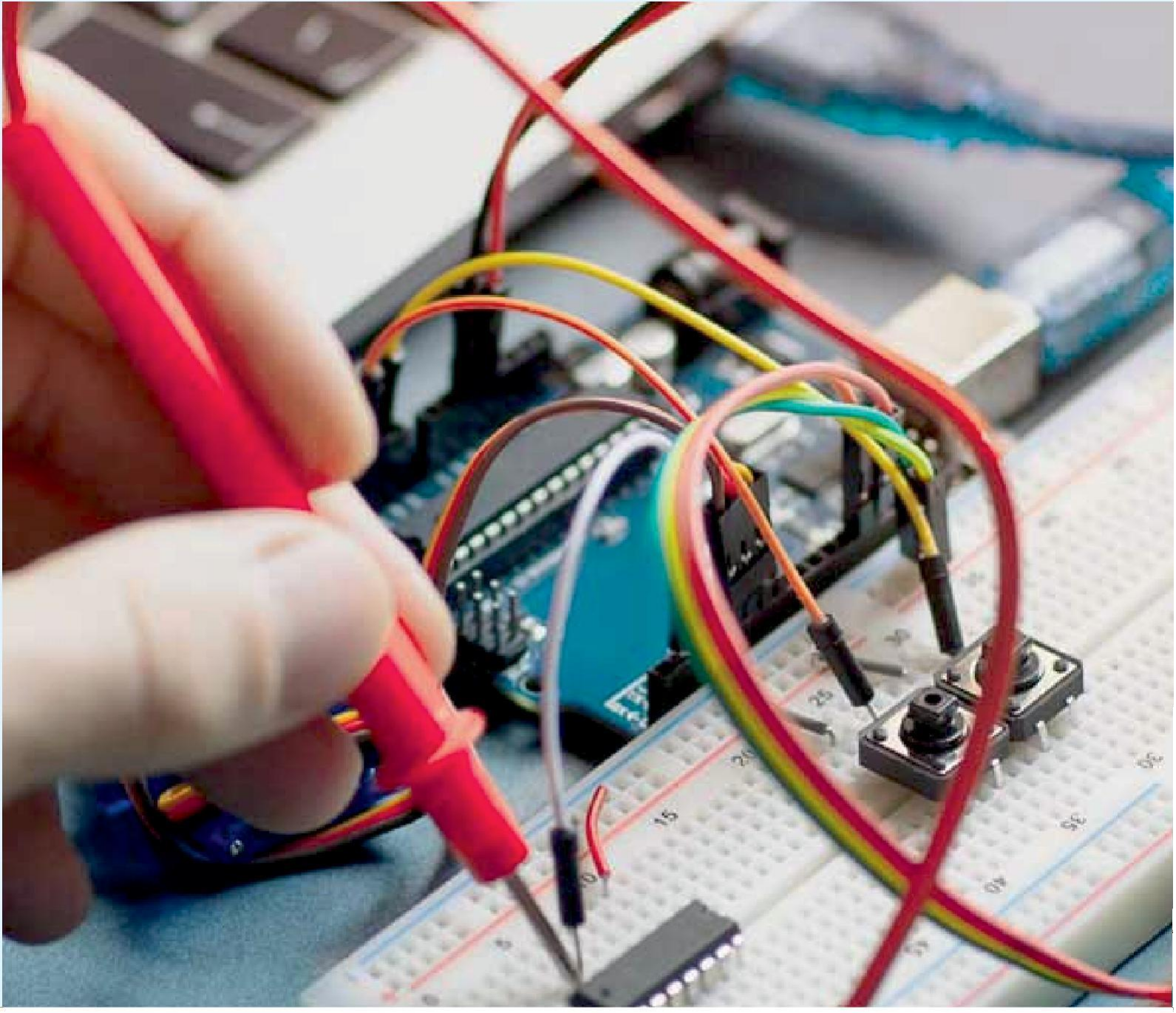

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