International Journal of
Solid State Innovations & Research

Volume 2, Issue 2, 2024
July–December
DOI (Journal): 10.37591/IJSSIR

https://journals.stmjournals.com/ijssir

Review IJSSIR

Enhancing Road Safety: A System for Vehicular Accident Detection, Prevention, and Rescue Alerts

Jayesh Khalane, Shraddha Tule*, Rupesh Kayande, Soumitra Kulkarni

Abstract

The Vehicular Accident Detection, Prevention, and Rescue Alert System is a comprehensive solution aimed at bolstering road safety by integrating multiple advanced technologies. It merges drowsiness detection, alcohol level monitoring, and instant emergency alerts to mitigate accidents and expedite rescue efforts. Modern computer vision and machine learning techniques are used by the Drowsiness Detection Alarm to track driver conduct and spot drowsiness indicators. Upon detecting drowsiness, an immediate alarm is activated, prompting the driver to refocus and prevent potential accidents. The Alcohol Level Indicator features a real-time alcohol level monitoring component that employs non-invasive sensors to continuously track the driver's alcohol level. If the alcohol level exceeds the legal limit, which varies depending on local laws and regulations, the system issues warnings and, if necessary, disables the vehicle's ignition system to prevent drunk driving. In the event of a vehicular accident, the Emergency Alert System automatically triggers an emergency alert mechanism. The device utilizes the LM35 temperature sensor, which is a compact and cost-effective integrated circuit capable of measuring temperatures ranging from –55 to 150°C. The data sources for a fusion process are not specified to originate from identical sensors. One can distinguish direct fusion, indirect fusion and fusion of the outputs of the former two. Direct fusion is the fusion of sensor data from a set of heterogeneous or homogeneous sensors, soft sensors, and historical values of sensor data, while indirect fusion uses information sources like a priori knowledge about the environment and human input.

Keywords: Vehicular accident detection, sensor fusion, rescue alert system, geo location (GPS), temperature sensor

INTRODUCTION

The Vehicular Accident Detection, Prevention, and Rescue Alert System represents a cutting-edge technological solution designed to revolutionize road safety and emergency response in the modern era of transportation. With the ever-increasing volume of vehicles on the road and the persistence of accidents as a significant global concern, this system emerges as a vital tool in the quest to mitigate the devastating impact of vehicular accidents. By seamlessly integrating advanced sensors, real-time communication networks, and intelligent algorithms, this system aims to swiftly detect accidents, prevent collisions through driver assistance mechanisms, and expedite the response of emergency services. In this introduction, we delve into the crucial aspects of this system, elucidating its overarching purpose in enhancing safety, reducing accident severity, and ultimately saving lives on our roadways. A Vehicular Accident Detection, Prevention, and Rescue Alert Systems cannot be

***Author for Correspondence**
Shraddha Tule
E-mail: shraddha.tule_skncoe@sinhgad.edu

Student, Department of Electronics & Telecommunication Engineering, Smt. Kashibai Navale College of Engineering, Vadgaon, Savitribai Phule Pune University, Pune, Maharashtra, India

Received Date: September 02, 2024
Accepted Date: October 07, 2024
Published Date: November 25, 2024

Citation: Jayesh Khalane, Shraddha Tule, Rupesh Kayande, Soumitra Kulkarni. Enhancing Road Safety: A System for Vehicular Accident Detection, Prevention, and Rescue Alerts. International Journal of Solid State Innovations & Research. 2024; 2(2): 7–11p.

overstated in today's world, where road safety and efficient emergency response are paramount concerns. The likelihood of accidents and their catastrophic outcomes keeps increasing as our road networks get more crowded. These techniques are crucial for lowering these risks and improving overall transportation safety standards. By quickly identifying accidents, notifying emergency services, and providing precise location data for quick response, these systems have the potential to save countless lives. These systems seek to lower the number of injuries brought on by traffic accidents by preventing collisions with driver assistance technologies and reducing the severity of collisions with automated interventions. These systems' ongoing data analysis and monitoring provide insights into accident trends, empowering authorities to implement preventative measures like better traffic control, road design, and signage to increase road safety.

MOTIVATION

Vehicular accident detection, prevention, and rescue alert system spans a diverse range of research and development efforts aimed at leveraging technological innovations to enhance road safety. Numerous studies have focused on the utilization of sensor fusion techniques, incorporating data from sensors to improve the accuracy and reliability of accident detection algorithms. Machine learning approaches have been widely explored for their ability to recognize patterns indicative of accidents, enabling systems to predict and pre-emptively respond to potential collision scenarios. Furthermore, advancements in Internet of Things (IoT) technology have facilitated the implementation of real-time communication and data sharing between vehicles, infrastructure, and emergency services, enabling swifter response times and more effective rescue operations. Additionally, research has delved into the development of human-machine interfaces (HMI) within vehicles, providing drivers and occupants with timely alerts and warnings to enhance situational awareness and response capabilities. Academic, industry, and governmental collaborations have accelerated the development of vehicle accident detection, prevention, and rescue alert systems, paving the way for a time when integrating state-of-the-art technologies with preventative safety measures will greatly increase road safety. Road accidents that result in fatalities have been a terrible problem, with detrimental effects on the socioeconomic advancement of societies. Most developing nations are reporting higher numbers of fatalities from traffic accidents because they lack an efficient system for reporting incidents to emergency services for prompt rescue. Moreover, the chances of survival of any casualty of an accident are mostly dependent on how quickly the emergency medical services arrive at the scene and quickly reach the nearest hospital with the victims for treatment. However, on their way to and from the accident scene, these emergency vehicles are occasionally delayed by heavy traffic. The Global Positioning System (GPS) location of the accident scene is sent to designated security, medical, and family contacts by this study's robust automatic vehicle accident detection and alert system, which uses an accelerometer to detect tilting and collisions. The turnaround response of the suggested design was quicker than that of a traditional rescue system devoid of these features. Therefore, using technology to save as many lives as possible. Related work in the areas of vehicle accident detection, prevention, and rescue alert systems includes a range of additional strategies and techniques targeted at enhancing road safety, including sensor fusion, machine learning, Internet of Things technology, and human-machine interfaces. The new deep reinforcement learning-based autonomous braking system has been introduced in this study.

LITERATURE SURVEY

The purpose of the literature review is to examine current research in the field that has been developed under the current situation. Several papers were reviewed for selection of automatic braking mechanisms and development of ML models. Some of these papers are as follows:

A novel deep reinforcement learning-based autonomous braking system was proposed by Chae *et al*. When faced with a collision risk, the suggested autonomous braking system uses sensor data on the obstacle to automatically determine whether to apply the brake at each time step. Brake control design is formulated as a search for the best course of action in a Markov decision process (MDP) model, where the action space is defined as whether the brake is stepped, and the state is determined by the relative location of the obstacle and the vehicle's speed. Using computer simulations and the deep reinforcement learning technique known as deep Q-network (DQN), the brake control strategy is learnt. They provide a reward function that strikes a balance between the reward received when the vehicle quickly exits the danger zone and the damage done to the obstruction in the event of a collision in order to generate a desirable braking policy. DQN is prepared for the situation in which a car and a pedestrian are crossing an urban road. In a variety of uncertain circumstances, experiments demonstrate that the control agent demonstrates appropriate control behaviour and avoids collisions without making any mistakes [1].

Dairi *et al*. created a hybrid deep autoencoder (HAE) method for monitoring urban scenes that is based on stereovision. The benefits of autoencoders and deep Boltzmann Machines (DBM) are combined in this system. A one-class SVM based on unsupervised HAE was created to detect obstacles in driving situations. A density map-based quick obstacle tracking method was created. For validation, two publicly accessible datasets, Malaga and Daimler were employed. The detection results demonstrate the new combined HAE-OCSVM strategy's higher performance [2]. The goal of Naurois *et al*. was to ascertain whether the common information sources utilised to identify tiredness could also be used to forecast when a specific level of drowsiness would be attained. Additionally, they investigate if incorporating information like participant details and driving time enhances the precision of drowsiness detection and prediction [3].

Even extremely complicated crash data, such as the outcomes of Finite Element Method (FEM) simulations, can be made available prior to a collision using the suggested approach by Müeller *et al*. Knowledge that can be used to activate and modify safety features like airbags or belt tensioners prior to a collision, alert occupants and the vehicle to an impending accident, or allow self-driving cars to do the manoeuvre with the least severe impact [4].

Alluhaibi *et al*. examined a number of approaches that have been put out to assess driving behaviour and pointed out the benefits and drawbacks of each [5]. Farhat Ullah *et al*. offered various methods designed for the various modalities within the past three years [6]. In a table format, they provided an overview of every task, broken down by "algorithm, parameter, result, advantage, and disadvantage". We outline the potential implementations proposed for each survey and examine the underlying assumptions. Block diagram of Vehicular Accident Prevention and Rescue Alert System is shown in Figure 1. Although remarkable progress was shown in a few scenarios, an examination of the requirements of next-generation systems exposes important gaps. They point out these weaknesses in the disadvantage block and offer potential avenues for future research. They list the suggested future solutions and investigate their underlying presumptions; while encouraging progress has been demonstrated in certain situations, an examination of the needs for next-generation applications reveals notable gaps [6].

IMPLEMENTATION

Proteus is an effective tool for designing and simulating the Vehicular Accident Detection, Prevention, and Rescue Alert System. Numerous sensors, microcontrollers, communication components, and power management units are all part of the intricately coordinated circuit. A microcontroller, like an Arduino or an ARM-based microcontroller, serves as the central processing unit and is at the heart of the system. This microcontroller communicates with a variety of sensors, such as gyroscopes and accelerometers, to identify abrupt shifts in orientation and velocity that could be signs of an accident. The accelerometer measures linear acceleration along three axes, while the gyroscope measures angular velocity, providing comprehensive data about the vehicle's movement and orientation. These sensors are connected to the microcontroller through analogue or digital inputs, with the data being continuously monitored and processed using embedded software. For accident prevention, the system integrates proximity sensors like ultrasonic sensors or Lidar, which detect obstacles around the vehicle [7–10]. These sensors are strategically placed around the vehicle's perimeter and connected to the microcontroller. When an obstacle is detected within a critical range, the system processes this information, and triggers audible and visual alerts to warn the driver. A GSM module that is attached to the microcontroller makes the rescue alert feature possible. In the event of an accident, as determined by the sensor data, the microcontroller sends an automated alert message including the vehicle's GPS coordinates, obtained from a connected GPS module to predefined emergency contacts and services. The GSM module interfaces with the microcontroller via UART (Universal Asynchronous Receiver Transmitter) communication. Powering this circuit is a crucial aspect; hence, a stable power supply is provided through a voltage regulator that ensures the microcontroller and sensors receive consistent voltage levels. Implementation of Vehicular Accident Prevention and Rescue Alert System is shown in Figure 2. Additionally, a backup battery is incorporated to maintain system operation in case the vehicle's main power supply is disrupted during an accident. Accurate detection, localization and tracking of obstacles in urban scenes is a key enabler to improving traffic efficiency and safety by avoiding accidents while driving.

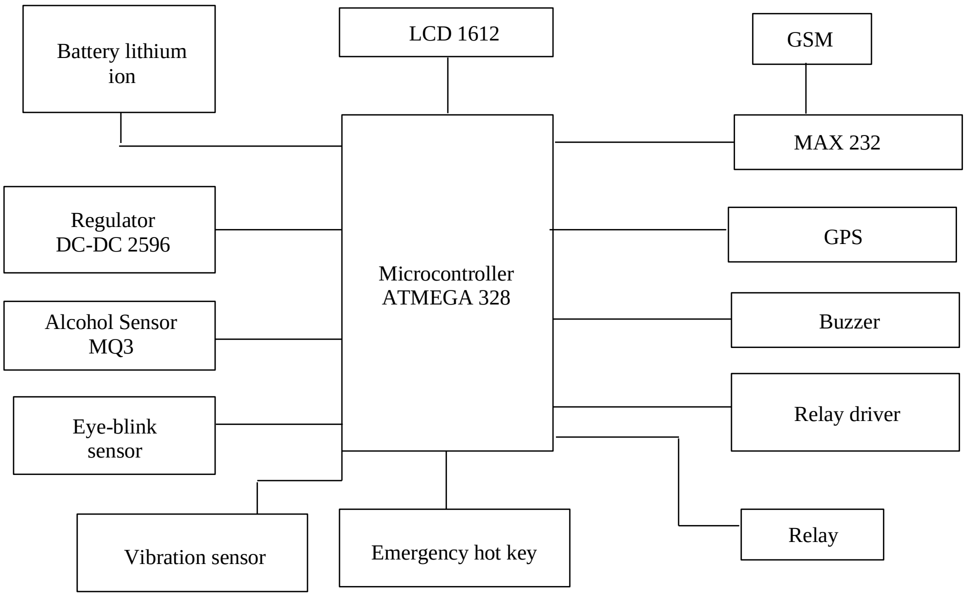

Figure 1. Block diagram of vehicular accident prevention and rescue alert system.

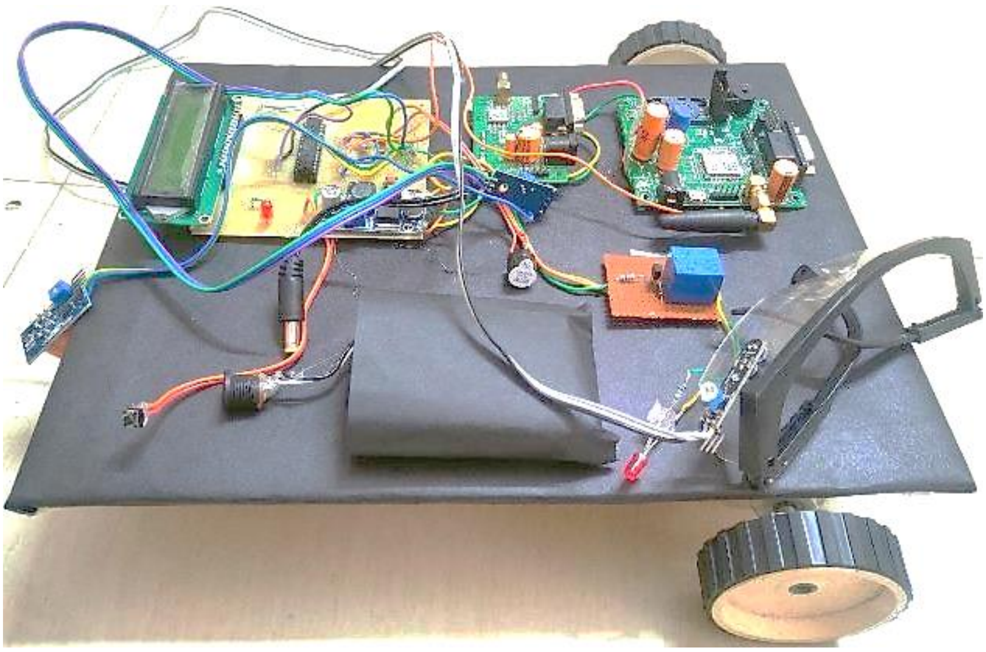

Figure 2. Implementation of vehicular accident prevention and rescue alert system.

CONCLUSION

An important advancement in improving road safety and emergency response capabilities is the Vehicular Accident Recognition, Prevention, and Rescue Alert Systems. By integrating advanced sensors, microcontrollers, communication modules, and alert mechanisms, this system aims to detect accidents promptly, prevent potential injuries or fatalities, and alert rescue services efficiently. An effective smart car system that provides high driving security has been proposed. We have conducted a thorough analysis of the current automotive systems. We are putting forward the smart car method based on our analysis. The suggested system's benefits over alternative approaches include preventing unintentional injuries, enhancing driving safety, and discouraging reckless driving.

Acknowledgment

We express our sincere gratitude to all who supported and contributed to the successful completion of the first stage of our project. Special thanks to our project guide Mr. P. S. Kokare Sir for their invaluable support and guidance. We also appreciate the faculty members of the Electronics & Telecommunication Engineering department for their continuous encouragement. Our thanks extend to the staff and resources of Smt. Kashibai Navale College of Engineering, Pune. Special thanks to Dr. S. K. Jagtap, Head of Department (E&TC), and Dr. A. V. Deshpande, Principal of SKNCOE, Pune, for their continuous support and motivation.

REFERENCES

1. Hyunmin Chae, Chang Mook Kang, ByeoungDo Kim, Jaekyum Kim, Chung Choo Chung, and Jun Won Choi (Hanyang University, Seoul, Korea). Autonomous Braking System via Deep Reinforcement Learning. *2017 IEEE 20th International Conference on Intelligent Transportation Systems (ITSC)*, Yokohama, Japan. 2017; 1–6. https://doi.org/10.48550/arXiv.1702.02302
2. Abdelkader Dairi, Fouzi Harrou, Mohamed Senouci, Ying Sun. Unsupervised obstacle detection in driving environments using deep-learning-based stereovision. Robot Auton Syst. 2018 Feb; 100: 287–301.
3. Charlotte Jacobé de Naurois, Christophe Bourdin, Anca Stratulat, Emmanuelle Diaz, Jean-Louis Vercher. Detection and prediction of driver drowsiness using artificial neural network models. Accid Anal Prev. 2019 May; 126: 95–104.
4. Marcus Mueller, Michael Botsch, Dennis Boehmlaender. Machine Learning Based Prediction of Crash Severity Distributions for Mitigation Strategies. J Adv Inf Technol. 2018 Feb; 9(1): 15–24.
5. Sarah Kadhim Alluhaibi, Najim Al-Din Munaf S, Aiman Moyaid. Driver Behavior Detection Techniques: A survey. Int J Appl Eng Res. 2018; 13(11): 8856–8861.
6. Farhatullah, Muhammad Imad, Muhammad Abul Hassan, Hazrat Junaid, Faiza, Izaz Ahmad. Navigation System for Autonomous Vehicle: A Survey. Journal of Computer Science and Technology Studies (JCSTS). 2020; 2(2): 20–35.
7. Nejdet Dogru, Huval B, Wang T, Tandon S, Kiske J, Song W, Pazhayampallil J, Andrilukam M, Rajpurkar P, Migimatsu T, Cheng-Yue R, Mujica F, Coates A, Ng AY. An empirical evaluation of deep learning on highway driving. arXiv preprint, arXiv:1504.01716. 2015 Apr.
8. Lotfi Abdi, Aref Meddeb. Driver information system: a combination of augmented reality and deep learning. In Proceedings of the Symposium on Applied Computing (SAC'17). Association for Computing Machinery, New York, NY, USA. 2017; 228–230. https://doi.org/10.1145/3019612.3019873
9. Khan MQ, Lee S. A Comprehensive Survey of Driving Monitoring and Assistance Systems. Sensors. 2019; *19*(11): 2574. https://doi.org/10.3390/s19112574
10. Deng W, Wu R. Real-Time Driver-Drowsiness Detection System Using Facial Features. *IEEE Access*. 2019; 7: 118727–118738. doi: 10.1109/ACCESS.2019.2936663

