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Research Article

Smart Vehicle Safety System with Drowsiness & Hazard Monitering System

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ABSTRACT

Road accidents are one of the global issues, and it usually results from insufficient adherence to safety measures. Advanced vehicle safety technologies that mitigate major risk factors, such as alcohol consumption, driver drowsiness, and improper vehicle maintenance, are investigated in this study. The proposed system is integrated with alcohol detection sensors, collision detection mechanisms, and monitoring of the engine temperature so that overall vehicle safety can be enhanced. Real-time communication technologies such as GSM and GPS also allow for immediate alerting and tracking of location, which enables timely intervention. This research, therefore, underlines the potential of advanced vehicular technologies in accident related fatalities and prevention of engine failures to promote safer driving practices by combining automated safety responses with intelligent monitoring. The outcome further pointed out to the necessity for further improvement in real-time safety systems, placement, and putting them into practice in commercial and public transport vehicles for the achievement of road safety worldwide.

Keywords: Vehicle Safety, Alcohol Detection, drowsiness, GPS and GSM

INTRODUCTION

Transportation today serves to be a huge part of our lives. Its development really affects our daily routines when moving faster and more efficiently to people and goods movements. However, a disadvantage in using more vehicles is the fact that road accidents are also on the increase especially in developing countries like in India. The leading position that India manages to hold in terms of road accident fatalities has been steady, mainly due to a variety of reasons such as careless driving, bad road conditions, and alcohol-related impairment. Road accidents have devastating consequences both on individuals, families, and communities; there are always many killed and others burdened economically and emotionally.

Emergency response services often reach accident scenes much earlier in urban cities and developed regions than potentially, reducing the number of deaths that might occur. The accident victims have to wait for a long time before getting help at all in more isolated or rural regions. Once such lack of prompt assistance occurs, most victims suffer through extreme consequences-in a fatal way-within some loss of lives due to delayed emergency response. This challenge has pushed the need for innovative solutions that can fast-track the response to emergencies, especially in areas where the nearest ambulance may be located far from the accident scene. Such a system may, therefore, become quite instrumental in preventing such fatalities, enabling faster and more effective action towards accidents on isolated or less-frequented roads.

In this regard, this project will address such a problem through the development of a system capable of detecting an accident and alerting emergency services quickly. The focus of the system will be placed on reducing mortality through sensors and communication technologies determining potential accidents given certain factors such as vehicle speed, acceleration, and levels of alcohol. The system further utilizes GPS for tracing the location of the vehicle and forwarding instant accident information to the nearest service center of an ambulance, which then immediately responds to the condition.

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RELATED WORK

Bernard M. Nyaga[15] presents a system which detects when an accident occurs and automatically identifies the coordinates—specifically, the latitude and longitude—of the accident site, which it then communicates to a rescue team. If the accelerometer registers an unexpected acceleration along with a significant vibration change, the system interprets these signals as an accident. At this point, the GSM and GPS modules are activated to pinpoint the location and send a message to emergency responders, providing details about the accident and its exact location. But, to reach the emergency services we need to manually press the buzzer. Pressing the buzzer may not be always feasible.

Vikranth Datta Chennupati [14] proposed an approach to detect the intensity of the accident. This system detects the intensity of the accident after its occurrence but does not alert the user and send notification to the surrounding emergency services for help. Five unique algorithms of machine learning applied were: Random forest classifier, XGBoost, Logistic regression, CatBoost, and Support vector machines. The MLP and CNN models are used here for comparing their performances. The used data is taken from a dataset of road accidents from the Leeds City Council, which is used to train models. This dataset comprises 2605 data points classified into three classes: slight, severe, and fatal. The features selection techniques made use of both the chi-squared test and mutual information in order to assess which of the features have the highest influence on prediction.

Nikhil Kumar[17] has presented an IoT-based automotive accident detection and classification system where the fusion of inbuilt and connected sensors on the smartphone have been used not only to detect but also report the type of accident. Five physical parameters related to vehicle movement, namely, speed, absolute linear acceleration (ALA), change-in-altitude, pitch, and roll, have been used in training and testing each candidate ADC model to determine the correct class of accidents, including collision, rollover, falloff, and no accident. NB-based ADC model is very accurate with mean F1-score 0.95, but no alerting system in this system

Earnest Paul Ijjina[16] presented work on accident detection from dash cameras by using techniques of computer vision. Variation in visual information during accidents has been analyzed to propose a computationally less expensive accident detection model which can be practically used. Hence, it identifies accidents based on changes in visual information during a mishap. It is tested on the new Dashboard Video Accident Detection (DVAD) dataset, proposed in this work. The experimental study suggests the effectiveness of the proposed approach for accident detection, that can be further extended to notify the concerned in case of an accident.

Mitra R, Singh RD, Jain VK, and Manohar S present an accident detection system by using the YOLO (You Only Look Once) object detection framework [11]. The system uses the real-time object detection ability of YOLO in recognizing accidents in images or video feeds. The system is able to capture accidents with high accuracy in the visual data analysis even for very dynamic and cluttered environments of busy roads. YOLO with its fast processing speed is good for real-time accident detection, making it suitable for prompt response and intervention. This has a great potential within the traffic monitoring systems, autonomous vehicles, and surveillance to improve road safety and enhance emergency responses.

Nasaruddin N, Muchtar K, Afdhal A, Dwiyantoro APJ [12] proposed a deep anomaly detection system using visual attention mechanisms in surveillance videos. This system draws attention to anomalies in video frames, thereby enhancing the accuracy and efficiency of anomaly detection through real-time event identification. The real learning of spatial and temporal features from video data is possible with deep learning models like CNNs; thus, it enhances the general ability of complex surveillance detection environments where conventional methods of anomaly detection would struggle. It could be used for a wide variety of applications in security, public safety, and automated monitoring by providing more solid and context-aware anomaly detection capabilities.

Kishwer AK, Qayyum A, Pannek J. [13], a prototype based on VANET and IoT has been proposed for automatic accident detection and management in a vehicular environment. The system integrates the communication of VANET with IoT sensors for real-time detection of accidents to take the immediate response in the form of alerting close-by vehicles, traffic management system, and emergency responders. The system, based on the VANET, uses the strength of vehicles, infrastructure, and emergency services to effectively communicate between these points of interest and thereby reduce the response time in case of an accident drastically. The proposed prototype can further be developed to include predictive analysis capabilities in order to prevent accidents. A practical example of such an application is the creation of smart transportation systems for safety on roads using VANET and IoT.

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Thakare KV, Dogra DP, Choi H, Nam G, Kim IJ [1] has developed an accident video detection system that generates synthetically multi-perspective accident videos. The emerging approach integrates computer vision technique with synthetic video generation to simulate accident scenarios from various perspectives. By training on such synthetic datasets, it enables the system to better detect accidents in real video footage. Overcoming the limitation of a shortage of accident footage for training, this approach presents a scalable way to improve accident detection systems. Synthetic data combined with multiview analysis enhances the possibilities for developing robust and accurate road accident detection technologies, thereby providing great application value to traffic monitoring and safety systems.

Singh D, Chalavadi KM [3] have provided a rich spatio-temporal representation of road accident detection, using the help of a stacked autoencoder. The system presented enjoys the strength of deep learning in modeling the spatial and temporal patterns present in the traffic data itself, which in turn enhances the accuracy of accident detection. Using stacked autoencoders, the system learns a compact representation of traffic videos, which enables it to identify the accident event with precision. Such an approach enhances the prevailing accident detection methods by incorporating dynamic temporal behavior and spatial features, making it more robust under different traffic conditions. The research demonstrates the applicability of deep learning models in leveraging real-time accident detection for improved road safety and thus promising applicability to intelligent transportation systems.

Zahid A, Qasim T, Bhatti N, Muhammad Z [5] proposed a data-driven approach for surveillance video for road accident detection using machine learning and computer vision. Since the real accident data is scarce, the authors simulated fake accident video frames in order to effectively train their model. Synthetic crash accident frames were created by modifying normal traffic footage to look like a crash scene but retaining scene contexts. The research fine-tunes pre-trained deep convolutional neural networks AlexNet, GoogleNet, SqueezeNet, and ResNet-50 on both normal and synthetic accident frames. According to their experiments, AlexNet, in particular, achieves an 80% true positive rate for accident detection on real-world surveillance video datasets, validating the effectiveness of synthetic data for training in accident detection.

Gomathy CK, Rohan K, Reddy BMK, Geetha V [9] present an accident detection and alert system designed to expedite emergency response. The system uses an accelerometer to detect vehicle tilt and a heartbeat sensor to monitor rider health, assessing accident severity in real time. Upon detecting an accident, it communicates with a smartphone via GSM and GPS modules. An Android application sends text alerts containing the accident's location to nearby medical centers and emergency contacts, reducing response time and potentially saving lives through prompt intervention.

PROPOSED SYSTEM

The presented system will deal with the improvement in the vehicle safety that will occur through automated mechanisms which can detect alcohol and accidents. With the combination of GSM module and GPS module, it will monitor, detect and respond to incidents or accidents related to the use of alcohol in real time to ensure prompt action with regard to the concern of safety. The arrangement of sensors along with various communication technologies to heighten the act of monitoring and response denotes remedial measures against those traditional vehicle security systems that do not possess this functionality.

I. System Components and Setup

1. Arduino Microcontroller: Central component controlling the overall operation, interfaced with GSM, GPS, and various sensors.
2. GSM Module (SIM800C): Connected to Arduino through UART, enabling SMS notifications in case of alcohol detection or accidents.
3. GPS Module: Connected to Arduino via UART, providing real-time location tracking of the vehicle.
4. Alcohol Sensor (MQ3): Connected to a digital pin on Arduino to detect alcohol levels within the vehicle.
5. Accident Detection Sensor (Limit Switch): Connected to a digital pin on Arduino to detect impact events indicating an accident.
6. DC Motor (Simulated Vehicle Engine): Controlled via a relay to simulate the vehicle's engine status.
7. Buzzer: Alerts surrounding individuals to incidents by activating when any sensor triggers.
8. LCD Display: Shows real-time sensor data, providing insights into system status for the user.
9. Eye Blink Sensor: It used to check the drowsiness of the driver.

II. System Workflow

1. Vehicle Initialization: Upon ignition, the system activates the Arduino controller, which then performs initial checks on the alcohol and accident sensors.
2. Normal Operation: If no incident is detected, the motor remains active, allowing the vehicle to operate. The LCD continuously displays sensor data.
3. Location Tracking: During vehicle operation, users can obtain the current location by sending a request SMS to the GSM module. The system responds with GPS coordinates.

III. Communication and Notification

1. SMS Alerts: When an incident is detected, the system utilizes GSM to send alerts, including GPS data, to notify emergency contacts.
2. Real-Time Location Requests: Users can send a request SMS at any time to receive the vehicle's GPS coordinates, ensuring real-time tracking.

IV. Safety and Response Features

1. Engine Control: Immediate motor shutdown upon sensor activation to prevent unsafe operation.
2. Audible Alerts: Activation of the buzzer in case of an incident to alert people nearby and prompt quick response.
3. Automatic Location Sharing: GPS data is sent with each SMS alert, ensuring that the vehicle's location is accessible in case of an emergency.

V. System Evaluation and Refinement

1. Sensor Accuracy Testing: Regular testing ensures alcohol and accident detection sensors remain accurate and responsive.
2. Reliability of Notifications: Testing the GSM module for timely and reliable SMS delivery during simulated incidents.
3. Location Accuracy: Validation of GPS coordinates for precision in location tracking.

CONCLUSION

The " Smart Vehicle Safety System with Drowsiness & Hazard Monitoring " is a technology solution for safety problems related to vehicles. The mechanism for real-time detection and response provides an effective solution for the major problem of vehicle safety. Sensors used in this system include alcohol and accident detection sensors, temperature sensors, and eye-blink sensors ensuring the monitoring of driver drowsiness.Including them with the use of GSM and GPS technologies would ensure the incident being reported timely and the vehicle's location being traced precisely, which makes the occupants and the road safer.

The alcohol sensor offers a warning for the inebriated state of the driver; the eye-blink sensor aids in detecting drowsiness, with its warnings focused on avoiding accidents due to the bad conditions of either inebriated or drowsy driving. The temperature sensor monitors overheating or environmental dangers. The moment the system comes to the conclusion that the conditions are unsafe, the engine automatically cuts off and the alarm starts ringing while, with the exact location of the vehicle, emergency contacts receive SMS with that information in real time.

This solution demonstrates how the newest technology can be used to produce not only safer but also smarter vehicles that would address issues of impaired driving, driver fatigue, and the quickness of accident response. It can also be a basis for further development of intelligent vehicle systems and road safety, thus making it a very practical and pertinent move toward modern traffic management and accident prevention.

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