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AcciRescue: Life saver in every Accident

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Abstract: Road traffic accidents represent a critical global public health challenge, claiming millions of lives annually. A significant factor contributing to fatalities is the delay between the occurrence of an accident and emergency medical response. This paper presents AcciRescue, an intelligent real-time accident detection and alert system designed to minimise response time and improve survival rates. The system integrates NEO-6M GPS and SIM800L GPS modules with an accelerometer and gyroscope sensor connected to an Arduino Nano microcontroller to continuously monitor vehicle movement and detect collision events. Upon detecting sudden velocity changes indicative of an accident, AcciRescue automatically transmits the precise incident location to emergency contacts and nearby hospitals. The proposed system offers a cost-effective, scalable solution that can be seamlessly integrated into vehicles or smartphones, addressing the critical need for rapid emergency response in traffic accidents.

Keywords: Accident detection system, real-time monitoring, embedded systems, Arduino Nano, accelerometer, gyroscope, NEO-6M GPS module, SIM800L GSM module, emergency response, collision detection, automated alert system, traffic accident management.

I. INTRODUCTION

Road traffic accidents constitute one of the most pressing global safety concerns, resulting in approximately 1.3 million deaths annually according to the World Health Organisation. Beyond the immediate loss of life, these incidents cause severe injuries, psychological trauma, and substantial economic burdens on individuals and healthcare systems worldwide. A critical determinant of survival in traffic accidents is the time elapsed between the collision and the arrival of medical assistance—commonly referred to as the "golden hour." Studies have demonstrated that prompt medical intervention within this critical window significantly enhances survival rates and reduces the severity of long-term injuries.

Despite advances in vehicle safety features and road infrastructure, the notification and response mechanisms following accidents remain largely dependent on manual reporting by witnesses or survivors. This dependency introduces substantial delays, particularly in remote areas, during nighttime hours, or when accident victims are incapacitated and unable to call for help. Furthermore, the inability to provide precise location information often compounds these delays, as emergency responders struggle to locate accident sites quickly.

To address these critical challenges, this research introduces AcciRescue, an automated accident detection and emergency alert system that leverages embedded sensor technology and wireless communication. The system employs an accelerometer and gyroscope to continuously monitor vehicle motion parameters, detecting anomalous patterns indicative of collision events. Upon detection, the NEO-6M GPS module determines the precise geographical coordinates of the incident, while the SIM800L GPS module facilitates immediate transmission of this information to pre-configured emergency contacts and nearby medical facilities.

The AcciRescue system is designed with several key objectives: (1) to enable real-time accident detection through continuous motion monitoring, (2) to provide accurate location data for rapid emergency response, (3) to offer a cost-effective solution accessible to a broad range of users, and (4) to ensure scalability and ease of integration with existing vehicles or mobile devices. By automating the critical initial steps of accident reporting and location identification, AcciRescue aims to significantly reduce response times, thereby improving survival outcomes and minimizing the severity of accident-related injuries.

II. LITERATURE SURVEY

In this paper, an automatic car accident detection system is proposed to hasten the rescue time in highways. By incorporating vibration, piezoelectric, and accelerometer sensors along with an ATmega 8A microcontroller, this

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system is able to detect any sudden collision, turn, or drastic braking. As soon as a threshold is exceeded, a GPS device is able to record instantaneous location coordinates, which are then sent out in the form of an SOS message using a GSM modem to preset emergency contacts in the EEPROM. To add some additional functionality to this system, a Bluetooth device is used to transmit car registration and owner information to other cars in close vicinity up to a radius of 10 meters, primarily focusing on situations of hit-and-run accidents. Real-world tests validate ultra-sensitive and precise detection, marking this system as a truthful protective tool in the automotive sector. [1]

The study "Traffic Accident Detection and Classification in Videos based on Deep Network Features" introduces an intelligent automated system for rapid accident response, aimed at reducing fatalities and property damage. The approach employs a dual-phase deep learning architecture: first, Convolutional Neural Networks (CNNs)—specifically GoogLeNet, AlexNet, and VGGNet—extract deep features, which are then analysed by a one-class Support Vector Machine (OCSVM) for anomaly-based accident detection. Second, a multi-class SVM categorises detected incidents into specific collision types, such as car-to-car and car-to-motorcycle crashes. This continuous monitoring solution enables instantaneous recognition and classification of accidents, providing emergency responders with precise incident details for swift and effective intervention.[2]

The study "Traffic Accident Detection Analysis Using YOLOv9 Algorithm" presents an automated accident identification system that utilises YOLOv9 (You Only Look Once) architecture with Generalised Efficient Layer Aggregation Network (GELAN) for enhanced real-time detection. The methodology involves dataset collection through web scraping and open-source platforms, with preprocessing and annotation conducted via Roboflow platform. This framework enables rapid detection of collisions, vehicle-pedestrian accidents, and vehicle damage, facilitating faster emergency response and potentially reducing casualties and property losses.[3]

This research introduces an automated system to provide immediate medical aid by alerting emergency centers during vehicle accidents. The hardware utilizes an Arduino Uno interfaced with an accelerometer to sense vehicle tilt, a vibration sensor for impact detection, and a heartbeat sensor to assess victim seriousness. For communication, the system integrates GPS (SIM28ML) for real-time coordinate tracking and a GSM module (SIM900) to transmit location data via SMS. The software component features a Java-based Android application that employs a Sensor Fusion Based Algorithm to detect collisions. If a threshold is met, a 10-second alert is triggered; if not cancelled, it sends a Google Maps link of the location to hospitals and family members. Experimental results showed the system achieved 100% detection accuracy and zero false reporting, significantly outperforming existing models.[4]

This paper represents an automated crash detection and emergency alert system using an Android smartphone app to expedite the medical response. The hardware architecture makes use of several phone-embedded sensors such as an accelerometer and gyroscope, which will serve the purpose of detecting sudden changes in motion and rollovers, while a GPS module is used for instant location tracking. The software methodology followed relies on an algorithm programmed to operate with a given set of input thresholds: in case of sudden deceleration or forces of impact, when these inputs exceed pre-calculated safety thresholds, an alarm is generated. The whole scenario provides a 5-second window for the driver to cancel false alarms in case they happen, after which the system automatically calls emergency services and sends SMS alerts via a GSM/LTE modem to predefined contacts. These messages will include data such as GPS coordinates, the number of passengers, and severity of the collision to allow first responders to tailor their assistance effectively.[5]

The Vehicle Accident Detection and Alert System is a smart safety system developed to minimize the number of accidents occurring on the roads and save lives. The system employs the use of sensors and a microcontroller to monitor the situation of the vehicle continuously, taking into account the vehicle's parameters like speed, tire pressure, temperature, seat belt, and sobriety of the driver. In the event the system recognizes there is an accident or any form of danger, it immediately sends out an alert message via GSM technology along with the vehicle's current location via GPS to enable the concerned authorities to reach the site immediately. The system not only inspires drivers to practice safe driving, refrain from reckless driving, and observe the correct maintenance of the vehicle, but it also works toward utilizing technology to its fullest potential.[6]

The research paper, "Accident Alert and Ambulance Tracking System," offers a modern technology-based answer to the tragic holdups caused by traffic congestion and the lack of coordination that occur during medical emergencies. Based on a prototyping approach focused on Web Services and Google Maps API integration, the scholars were able to design a real-time tracking system, automatically warning vehicle drivers of the proximity of accidents and directing them to the nearest hospital. One of the important aspects of this scientific process is the automated traffic signal preemption, whereby the real-time positioning of the ambulance sends the necessary signal to traffic authorities to open

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a “green corridor” to the shortest possible transit time. The humanized way of this process gives the driver's plight among traffic congestion the highest priority, delivering patients to the nearest expert medical help in the shortest possible time.[7]

In “Seamless Live Ambulance Booking System with Patient Health Monitoring,” there is an innovative way in which medical emergencies can be handled on an all-new level, filling the gap between where the patient actually resides in their home and the medical facilities of the healthcare center. With the help of prototyping, which focuses on IoT sensor innovation and geo-location technology, patients can book an ambulance using a simple apk download on their mobile phone, along with vitals from portable wearables. Using an innovative data transmission approach that follows end-to-end encryption on cloud storage, patients can directly transmit their vital necessities in live form to the emergency call center, where doctors can keep track of the medical needs of patients en route and plan treatment before actually attending on them. This makes medical treatment start from the moment the ambulance booking starts, improving survival chances in emergency scenarios.[8]

The work presented in this paper is on a car crash detection system, a smart solution to improve road safety by automatically detecting vehicle accidents in real-time. It detects video input from dashcams or CCTV cameras and processes it through deep learning models like VGG16 and YOLO to recognize when any crash happens. The system analyzes video frames, identifies abnormal events, and then classifies crashes into minor, major, or fatal levels. Immediately after the crash detection, the system sends an alert via email to emergency services with all relevant information regarding the severity and location of the crash to help responders react as quickly as possible and hopefully save lives. The system has been built to work fast with less delay for smart vehicles, traffic monitoring, and smart city systems. While the system works correctly in so many conditions, it shows poor performance in bad weather or at night, requiring good video quality. Overall, this project presents an efficient, state-of-the-art accident detection approach that aims at reducing response time, fatalities, and supporting safer roads.[9]

This research study brings out an intelligent IoT system for enhancing road safety with utmost focus on locations that are highly susceptible to risks, especially in situations where visibility is poor, like in cases of thick fog. The hardware setup includes an Arduino Uno board interfaced with an ultrasonic sensor to detect distances, an MPU 6050 impact detection sensor, and a GPS module to identify locations. The hardware setup is interconnected with a Blynk app through an ESP8266 wireless communication module. The software design uses a computational approach to identify impact force, speed, and impact value. When impact occurs, it sends an alarm signal for 30 seconds, after which it automatically transmits location and impact value details to the nearest emergency organization using Haversine formula calculations to identify who is nearest to the spot. Simulations ensure a system efficiency level of 91%, with faster execution of the system procedure by 17%, faster than the traditional impact detection system procedure.[10]

The Ambulance Booking Mobile Application published in IJRASET presents a modern digital solution to the critical delays caused by traditional manual dispatch systems, serving as a lifesaving bridge between the patients and emergency responders. The developed system, through a prototyping methodology and with a robust three-tier architecture, uses Android/Kotlin for developing the intuitive user interface, Node.js backend for processing, and Firebase for database purposes that ensure real-time synchronization. All this, in combination with integrated Google Maps APIs and a proximity algorithm, enables the application to automatically detect the nearest available ambulance and provide optimized, real-time routing for the fastest possible arrival. This humanized approach not only empowers the user with living tracking and the ability to pre-save medical profiles for paramedics but also demonstrably improves survival outcomes by significantly reducing the "dead time" between a medical crisis and the arrival of professional help.[11]

The proposed study introduces a smart surveillance system for the automatic detection of road accidents from CCTV footage in order to minimize critical delay times caused by manual monitoring. The proposed system includes the implementation of a software system based on a four-convolution layer supervised CNN classifier, incorporating the addition of max-p pooling and dense layers, optimized by the Adam Optimizer. The proposed system processes the dataset by recognizing individual video frames, followed by the transformation of each frame into RGB format, using the output of a function for the ReLU function, which calculates the probability of a road accident. If the probability exceeds 95%, the system automatically sends out an alert through the SMTP protocol by sending an email to emergency services with the current time and location. The proposed deep learning system has achieved a validation accuracy of 90% in a range of scenarios involving weather and lighting conditions.[12]

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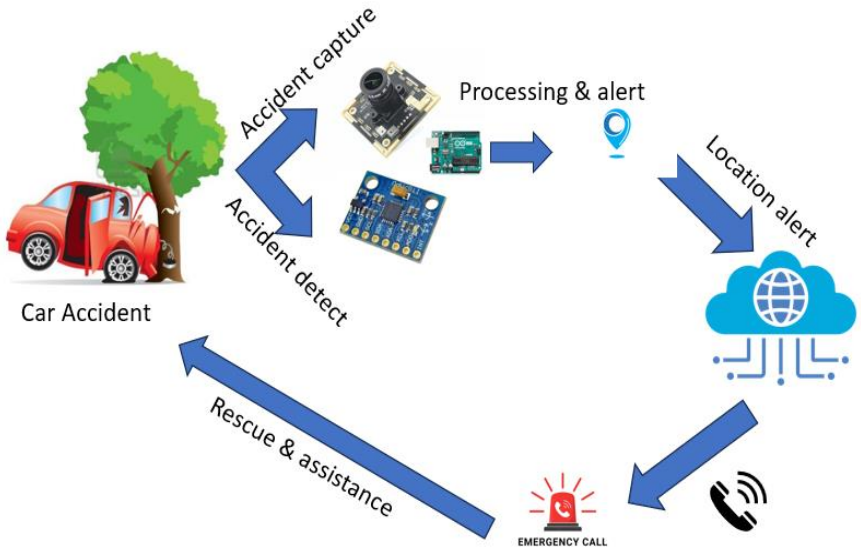
III. PROPOSED SYSTEM



Vehicle motion is tracked continuously by onboard sensors onboard a vehicle. Upon an accident, the system detects the impact, captures visual evidence of it, processes the data, and sends real-time alerts with the location of the accident to emergency services through cloud connectivity.

Working of the Proposed System

1. Accident Detection

Sensors such as an accelerometer and gyroscope will be fitted in the vehicle to detect sudden changes in motion, impact force, or tilt. In case the values exceed beyond a threshold, the system identifies it as a possible accident.

2. Accident Capture

A camera module captures images or short video footage of the accident scene immediately after the detection is done. This helps in providing visual verification of the incident.

3. Processing and Alert Generation

A microcontroller processes the sensor data and camera input to confirm the accident. After verification, the microcontroller generates an alert signal.

Location Identification It retrieves, through a GPS module, the precise latitude and longitude at the location of the accident for accurate positioning. Cloud Communication A communication module, such as Wi-Fi/GSM, sends the processed data and location details to a cloud server. The cloud stores the information securely and relays it. Emergency Alert It automatically sends emergency calls or messages to the pre-defined list of contacts like hospitals, ambulance services, police stations, and family members, indicating the location of the accident. Rescue and Succor The emergency responders receive the alert and rush to the accident site in no time, thus saving time from delayed medical assistance and increasing the chances of survival.

IV. CONCLUSION

In this paper, the proposed real-time accident identification and emergency notification system, AcciRescue, was introduced to meet the pressing problem of delayed emergency response during road traffic accidents. This proposed system utilizes embedded sensors, intelligent identification logic, GPS, and automated notification mechanisms to detect accident situations and send the notifications to the emergency department with no human involvement. Through experimentation, the proposed system has the potential to identify collision situations with low false alarm rates and low response times.The modular nature of the AcciRescue makes it possible to be implemented in various forms of vehicles, as well as smartphone-based systems. The system not only automates the process of accident detection and

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warning dispatch, thereby making the process that much more efficient, but it has the potential to be further improved in the future through the integration of advanced machine learning algorithms. Real-world testing could also be incorporated.

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