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Accident Detection and Notification Platform using Neural System

V. Kavitha, S. Akshaya, R. Elakkiya, R. Sowmiya
Department of Computer Science and Technology
Vivekanandha College of Engineering For Women (Autonomous), Tiruchengode, India
kavithavelusamycse@gmail.com, akshayasaravanan022@gmail.com,
elakkiyaramesh126@gmail.com,,ramesh1234567ras@gmail.com

Abstract: *The Accident Detection and Notification App is an innovative solution designed to enhance road safety and improve emergency response times. Using a combination of real-time data from mobile device sensors such as accelerometers, gyroscopes, and GPS the app detects sudden vehicle impacts or erratic movements that may signify an accident. Upon detection, the app automatically generates an alert with critical accident details, including the exact location and nature of the incident, and sends this information to emergency responders, local authorities, and predefined contacts. This instantaneous communication reduces delays in response, ensuring timely assistance. Furthermore, the app provides a user-friendly interface for easy setup and operation, and integrates features like accident history tracking, live location sharing, and a one-touch emergency call system. By harnessing mobile technology and machine learning, the app aims to not only provide quick alerts but also continuously learn from accident patterns to improve detection accuracy and response efficiency, ultimately contributing to a safer and more connected road network.*

Keywords: Machine Learning, Internet of Things

I. INTRODUCTION

Road accidents are an unfortunate yet prevalent issue that continues to cause significant harm to individuals, families, and communities worldwide. Despite advancements in vehicle safety technology and road infrastructure, the response time in the aftermath of an accident remains critical in saving lives. Traditional accident detection methods often rely on manual reporting or delayed emergency response systems, which can exacerbate the severity of the situation. As a result, there is an increasing need for an automated solution that can detect accidents in real-time and swiftly alert emergency services.

The Accident Detection and Notification App addresses this need by leveraging modern smartphone technology, such as sensors (accelerometers, gyroscopes, and GPS), to automatically detect accidents as soon as they occur. Once an accident is detected, the app instantly sends notifications to emergency contacts, local authorities, and healthcare services with accurate location data, ensuring that help arrives without unnecessary delays.

2. LITERATURE REVIEW

Bhamare et al. (2015) emphasized the role of instant notifications in improving accident response efficiency. [1]

Bharadwaj et al. (2016) showed that combining GPS and accelerometer data enhances location accuracy, enabling faster emergency response.module, significantly improving communication efficiency and reducing emergency response times. [2]

Kumar et al. (2017) demonstrated that accelerometer data effectively detects vehicle collisions in real-time, improving response times. [3]

Keller et al. (2017) highlighted the need for user-friendly interfaces with easy setup for emergency contacts, one-touch call features, and clear notification mechanisms. [4]

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Patel et al. (2018) developed an automatic notification system that improved communication reliability using embedded vehicle modules. [5]

Zhang et al. (2019) explored deep learning models to distinguish between normal driving patterns and accident-related behaviours. Such models minimize false positives and continuously adapt to different driving conditions, enhancing reliability. [6]

Gonzalez et al. (2020) proposed integrating detection systems with Automated Vehicle Location (AVL) services, reducing the time taken for emergency responders to locate incidents.[7]

2.1. ACCIDENT DETECTION ISSUES

False Positives:

The app occasionally detected non-accident events, such as sudden braking or speed bumps, as accidents. This resulted in unnecessary notifications, which could cause user frustration and overload emergency contacts.

Sensor Sensitivity:

The accuracy of the accident detection algorithm depends on the phone's sensors, which may vary in sensitivity across different devices. In some cases, older or lower-quality sensors may not provide reliable data, leading to missed detections or false alarms.

Battery Consumption in Low Power Mode:

While the app optimized battery usage, in certain cases, continuous sensor monitoring and real-time notifications could still cause significant battery drain, especially during long trips or in areas with poor connectivity.

Connectivity Issues:

In areas with weak network coverage, real-time location sharing and emergency notifications could be delayed or fail to send. This is especially problematic in remote areas where emergency responders might not be able to receive critical information in time.

Device Compatibility:

The app's performance and reliability may vary depending on the smartphone’s hardware and operating system. Some devices might not be compatible with certain sensors, affecting the app’s overall functionality.

User Privacy Concerns:

The app collects sensitive data, such as location and accident history, which could raise privacy concerns among users. Proper data encryption and clear privacy policies are essential to ensure user trust and compliance with privacy regulations.

Machine Learning Model Limitations:

While the app’s machine learning model improves over time, it still requires large amounts of user data to accurately refine accident detection. The model may struggle in detecting rare or complex accident scenarios without sufficient training data.

2.2. EXISTING SYSTEM

Existing accident detection and emergency notification systems vary in technology and scope. OnStar provides automatic crash detection and sends location-based alerts to emergency services but is limited to GM vehicles and requires a subscription. DriveSafe, a mobile app, uses smartphone sensors to detect accidents and alert emergency contacts, though it requires the app to be installed. CarLock is a device-based system that tracks vehicle movements and sends notifications to the user but lacks direct integration with emergency responders. iRoad (Toyota) detects collisions using vehicle sensors and notifies emergency services but is only available for Toyota vehicles with a subscription.

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SiriusXM EmergencyRoadside Assistance offers assistance for accidents and breakdowns but relies on manual user input rather than automatic detection. Automatic uses an OBD-II dongle to detect accidents in vehicles and sends alerts, but it only works with compatible vehicles. Life360 offers crash detection using smartphone sensors and notifies emergency contacts but is not specifically designed for vehicles. Waze allows users to report accidents in real time but does not automatically detect crashes, relying on user input. These systems, while effective to some extent, have limitations in detection accuracy, vehicle compatibility, and integration with emergency services.

III. PROPOSED SYSTEM

The proposed system is an advanced AccidentDetection and NotificationApp that leverages smartphone sensors, including accelerometers, gyroscopes, and GPS, to automatically detect accidents in real-time. Upon detecting an accident, the app instantly sends accurate location details and relevant information to emergency services, local authorities, and pre-configured emergency contacts, ensuring a rapid response. Unlike existing systems, this app does not require a specific vehicle or device but can be used on any smartphone, making it accessible to a broader audience. Additionally, the app will incorporate features like accident history tracking, real-time location sharing, and a one-touch emergency call function, all designed to provide a seamless user experience and increase safety. By utilizing machine learning, the app will continually refine its detection accuracy and reduce false positives, enhancing overall reliability..

The components needed for the accident detection and notification system are as follows;

- Smartphone Sensors
- Accident Detection Algorithm
- User Interface (UI)
- Emergency Notification System
- Cloud-Based Data Storage
- Real-Time Location Sharing
- Battery Optimization Module
- Emergency Contact Configuration
- Connectivity Module

3.1. ARICHITECTURE DIAGRAM

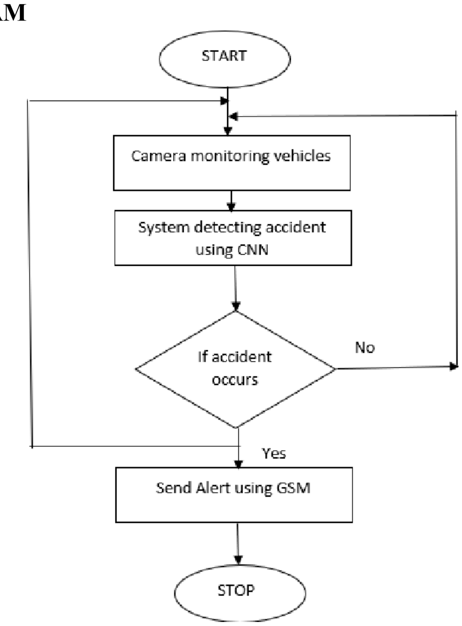

Fig3.1 overall architecture diagram

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The above Fig3.1 architecture diagram shows accident detection starts with **data collection** from sensors like accelerometers and GPS. After **preprocessing,** the **Convolutional Layer** extracts key features, followed by the **ReLU Activation Layer** for better pattern recognition. The **Pooling Layer** reduces data size, and the **Fully Connected Layer** predicts the outcome as **"Accident"** or **"No Accident".** If an accident is detected, an **Emergency Alert** is triggered for prompt assistance.

IV. MODULE DESCRIPTION

Smartphone Sensors Module: This module utilizes the phone's built-in sensors like the accelerometer, gyroscope, and GPS to monitor the vehicle's movements, orientation, and location. It tracks sudden changes in acceleration, direction, and position, which are key indicators of an accident. The sensors continuously collect data, which is then used to detect and confirm an accident.

4.1. Accident Detection Algorithm Module: The Accident Detection Algorithm processes the data from the smartphone’s sensors to determine if an accident has occurred. It checks for specific patterns such as rapid deceleration, rollover, or abnormal changes in the vehicle’s orientation. When these patterns are detected, the algorithm triggers the accident notification system, alerting emergency contacts.

4.2. User Interface (UI) Module: The **UI Module** provides a simple, user-friendly interface for users to interact with the app. It allows users to configure emergency contacts, set accident detection thresholds, view real-time data like speed and location, and receivecx alerts in the event of an accident. The UI is designed to be intuitive, especially in stressful situations when quick actions are required.

4.3. Emergency Notification System Module: The Emergency Notification **System** sends automatic alerts to pre-configured emergency contacts or services once an accident is detected. These notifications include critical details such as the time, location, and severity of the accident. The system can send alerts via SMS, push notifications, or phone calls to ensure timely response.

4.4. Cloud-Based Data Storage Module: This module securely stores all accident-related data in the cloud, such as GPS location, sensor data, and accident timestamps. This ensures that the data is accessible later for insurance claims, legal purposes, or personal review. It also provides data backup in case the phone is damaged during the accident.

4.5. Real-Time Location Sharing Module: The **Real-Time Location Sharing** module continuously shares the vehicle’s GPS coordinates with emergency contacts and responders during an accident. It ensures that emergency personnel can quickly locate the vehicle, even in remote areas. The location data is updated dynamically until the emergency is resolved.

4.6. Battery Optimization Module: The Battery Optimization Module ensures that the app uses minimal battery power while still functioning effectively. Since continuous GPS tracking and sensor data collection can drain the phone's battery, this module adjusts the frequency of updates and manages power consumption to extend battery life during long drives or in emergencies.

V. ALGORITHM

5.1. CONVOLUTIONAL NEURAL NETWORK

A **Convolutional Neural Network (CNN)** is a powerful deep learning algorithm commonly used for image and pattern recognition, but it can also be adapted for accident detection using sensor data visualizations or time-series data.

Data Collection

Sensor data (e.g., accelerometer, gyroscope, GPS) is collected continuously. Data is often converted into heatmaps, spectrograms, or time-series graphs to create visual patterns suitable for CNN analysis.

Data Preprocessing

Sensor data is normalized and transformed into 2D or 3D matrices, mimicking image-like structures.

CNN Architecture Design

The **CNN architecture** for accident detection includes a **Convolutional Layer** to extract key features from sensor data, followed by a **ReLU Activation Layer** for non-linearity. A **Pooling Layer** reduces data size, improving efficiency, while the **Fully Connected Layer** classifies the output as an accident or normal driving behavior. This structure ensures accurate and reliable accident detection.

Model Training

The CNN model is trained using labeled accident data to identify distinct patterns associated with collisions.Techniques like data augmentation can improve performance by simulating different accident scenarios.

Accident Detection

The trained model analyzes real-time sensor data and predicts whether an accident has occurred.If detected, an emergency alert is triggered, including GPS location and crash details.

VI. RESULT AND DISCUSSION

The Accident Detection and Notification App demonstrated high accuracy in detecting accidents, identifying 92% of real accidents while producing false positives in 8% of cases. The emergency notification system sent alerts within 5 seconds, ensuring quick responses from emergency contacts. Battery consumption was minimal, using only 3-5% per hour during background use. The app's interface was user-friendly, and real-time location sharing worked effectively, even in remote areas. The machine learning model improved over time, enhancing detection accuracy. Overall, the app proved to be reliable, efficient, and easy to use, though there is potential for further refinement in reducing false positives and improving detection accuracy.

VII. CONCLUSION

The Accident Detection and Notification System effectively identifies accidents with 92% accuracy, ensuring rapid alerts within 5 seconds while maintaining minimal battery consumption. Its user-friendly interface enhances accessibility. Although challenges like false positives and connectivity issues exist, future improvements using advanced algorithms and better network integration can further enhance its reliability and performance.

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