# Accident Rescuing System for Vehicles in Road Traffic: A Smart Phone Application

Goutam Kumar Sahoo
*Dept. of ECE, NIT Rourkela*
*Odisha, India*
goutamkrsahoo@gmail.com

Harshit Srivastava
*Dept. of ECE, NIT Rourkela*
*Odisha, India*
harshitsrivastava2345@gmail.com

U. Nirmal Chathura Unagalle
*Dept. of ECE, NIT Rourkela*
*Odisha, India*
chathuraun@gmail.com

S. Arachchige Pasindu Mihiran
*Dept. of CSE, NIT Rourkela*
*Odisha, India*
mihiranp481@gmail.com

K. Dhananjani Jayarukshi
*Dept. of CSE, NIT Rourkela*
*Odisha, India*
dhanakaru123@gmail.com

Santos Kumar Das
*Dept. of ECE, NIT Rourkela*
*Odisha, India*
dassk@nitrkl.ac.in

Poonam Singh
*Dept. of ECE, NIT Rourkela*
*Odisha, India*
psingh@nitrkl.ac.in

***Abstract*—Vehicle accidents can have a tremendous impact on people's life which can cause serious harm or even death. Speeding violations are one of the most often occurring causes of vehicle accidents. The sooner emergency services can reveal information about an accident, the less impact it will have. We have designed an Android-based application using location tracking with Global Positioning System (GPS) technology for this purpose to detect an accident and send an emergency alert message to the nearest police station, health care facility, fire station and emergency contacts has made. In this study, an application named "Track" has been developed that uses Firebase's real-time database to detect accident signs, generate emergency alerts, and send them to the nearest emergency responders. It also sends a SMS to the emergency contact with the location coordinates of the accident. The system's real-time location tracking capabilities for victims will significantly improve the survival chances of accident victims by providing timely emergency care. The system will also assist in other disasters like fire, burglary and theft, and other medical crises.**

***Index Terms*—Vehicle Accident, Emergency Alert Message, GPS (Global Positioning System), Smart Phone.**

## I. Introduction

Even though they happen frequently, vehicle accidents are the worst thing for a road user. The worst part is that we don't learn from our road blunders. Most road users are well aware of the general safety precautions and regulations that apply when using the roads; However, accidents and wrecks occur only as a result of the carelessness of road users. Significant progress has been made by automobile manufacturers in resolving this issue, yet the potential negative consequences resulting from an accident have not been reduced [1]. Every year about 1.3 million people lose their lives due to road traffic accidents. Between 20 and 50 million more people suffer adverse injuries, many with disabilities [2]. Human errors such as drunk driving, speeding distracted, not paying attention to red lights, avoiding safety equipment such as seat belts and helmets, driving out of your lane and improper overtaking are the main causes of accidents and accidents [3]. Individuals, their families and entire nations suffer significant economic losses as a result of those accidents. These costs result in the cost of medical care, lost wages for individuals who have been killed or incapacitated by their injuries, and health care expenses for family members who are required to care for the injured.

It is necessary to develop a system that will rescue accident victims. This system's design makes it easier to send emergency messages to those on the victim's emergency contact list, as well as to the nearby police station and hospital, as well as the actual accident spot. By utilizing GPS and GSM module design, autonomous vehicle accident detection is achievable [4]. A work by Karthy *et al.* [5] proposed a vehicle tracking and motion monitoring system that uses GPS, GSM and Node-MCU. A prototype was built to obtain the required data, and the Firebase cloud platform was used to store the data for making decisions on accidents with a threshold-based speed limit. However, the work lacks generalized system implementation and deployment. Similarly, work by Mahariba *et al.* [6] proposed machine learning-based automated accident detection in a two-wheeler using accelerometer data and driver physiological data such as pulse rate from the on-board diagnostic (OBD) unit, to classify its severity. However, immediate rescue work is yet to be done based on the severity. A work by Prasana *et al.* [7] reported SOS, a personal safety application that seeks to reduce the time it takes to process rescue operations in a hospital by providing prior information about a victim's medical history. It uses the smartphone's onboard sensor data for vehicle accident detection and information along with geolocation data of the nearest available emergency response, saving time and resources for emergency services.

In our work, we used GPS technology to know the location. The primary advantage of our system is that it provides immediate hospital, police and fire services, as well as accident location tracking. Vehicle signals such as latitude, longitude, altitude, acceleration and velocity are captured using GPS and IMU sensors. These data are used to track vehicle states and identify accidents [8]. These onboard sensors allow the required sensor data to be obtained with greater sensitivity. In this work, an Android application is developed using the Flut-

ter framework. The purpose of this function is to automatically detect accidents without any user interaction and automatically send alerts to the emergency responder. If the user wants to request an ambulance, police or fire manually, there is a panic button option to work [9]. The major contributions of this paper are:

- Developed an Android application, Panic Button for personal safety.
- Sending emergency alerts in case of accident with the victim.
- Providing the emergency response unit with the exact geographic location of the accident with a Google Maps drive directions link.
- Manually sends emergency request alerts to ambulance, police and fire.
- Maintain the medical history record of the victim which will be sent to the respondents along with an alert message.
- Keep a record of past accidents with relevant accident data.

The rest of the article is organized as follows: Section II consists of proposed work structure. Section III explains the results and discussion. Section IV contains the conclusions and future developments of the work.

## II. Proposed Work Structure

Road traffic accidents have emerged as an important public issue that needs to be tackled with a multidisciplinary approach. The number of fatal and disabling road accidents is increasing day by day and preventing it is a real challenge for all concerned agencies. When accident occurs, the person is not the state to notify their emergency contacts, the police or the hospital. A smartphone application, "Track", has been developed to solve this problem. This application is designed to help you with your life-threatening emergency. The requirements for a working framework setup are:

- Android Smartphone
- Visual Studio Code
- Android Studio
- Google Map API
- Firebase APIs (Real-Time Database, Firestore Database, Firebase Auth)
- Flutter Framework with dart dependencies

### A. Problem Formulation

The work setup is shown in Fig. 1. When an abnormal situation arises while driving, a smartphone with an integrated Android application will assist the user in getting support faster. The goal is to create a connected service that will collect all available support from each unit to rescue the accident victim. In order to provide faster rescue operations, this problem framework is striving to establish liaison between all emergency units. This "track" software attempts to create a route plan for getting to the accident site, obtains the victim's medical information for quick diagnosis, alerts the police to deal with the crisis and informs the family members of the accident. Fully accurate information Providing immediate assistance will be possible and effective if the victim installs the program before driving.


Fig. 1: Working Setup of the Application

### B. Algorithm Involved

The detail process as in Algorithm 1 explains the smartphone application "Track" that aims to reduce the rescue response time. A top-level use case of the app, which depicts interactions between emergency victims and responders, is shown in Fig. 2. A use case diagram is a graphical illustration of a user's possible interactions with a system. It shows the different types of users of the system and will often be accompanied by other types of diagrams.

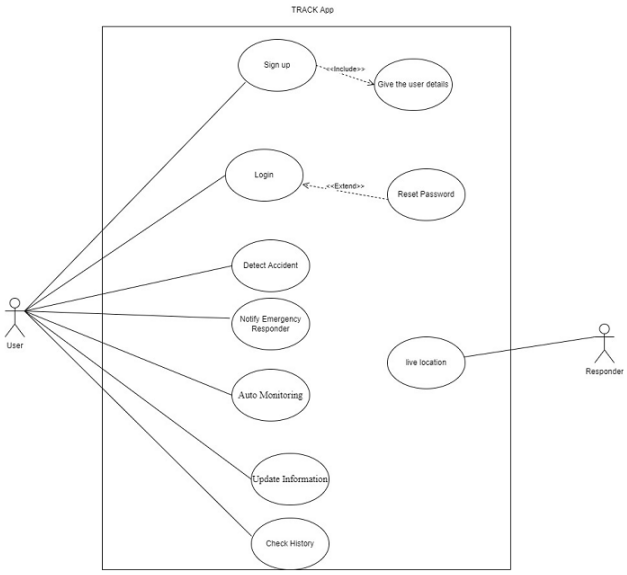



Fig. 2: Use Case Diagram

### C. Performing Behaviour of Track" Application

The "Track" mobile app was developed to immediately alert rescuers in the event of a traffic collision. Accident victims will not be able to call the police or the nearest hospital as they will

**Algorithm 1** : Algorithm for the "Track" application

1: **Installing the application on an Android device**
2: **Give the required permission to send SMS**
3: **Start**
4: **Open the application**
5: **Login into the application**
6: **In case of lost password Press Forgot password**
- By submitting the form a password reset link will be sent to the registered email.

7: **New users can create an account, and once created, automatically log in to the application**
- Fill in all the registration information required.
- Enter the app after a successful registration.

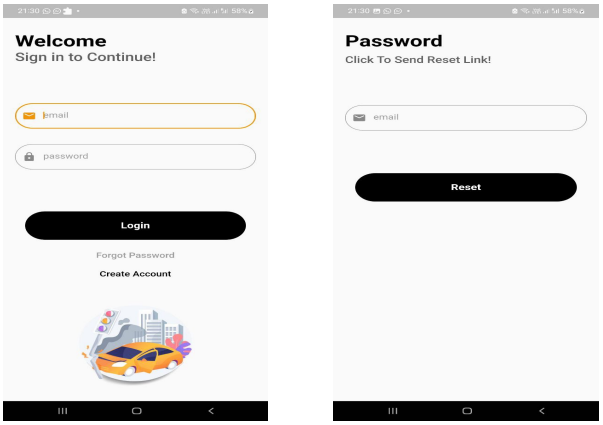
8: **Now switching to the main screen of the application, which includes:**
- Auto Monitoring on-off Button
  - Automatic Alerting System will start to monitor when Auto Monitoring turned on
  - Users can manually send requests when the switch is turned off.
- Live road map of the vehicle
- Camera Focus Button
- Latitude value
- Longitude value
- Speed value
- Request Emergency Button (PANIC Button)
  - Users can send emergency requests to Police, Hospital and Fire instantly by pressing the button (when auto monitoring is off)

9: **Navigation Drawer consists of:**
- User Details Panel
- Text Button links to History Page which is having:
  - Record of previous accidents
- Text Button links to Update Information Page, i.e.,:
  - an option to modify all the previous user details:
    - Blood group
    - Blood pressure
    - Allergies
    - Diabetes
    - Past surgeries
    - Genetic disorders
    - Emergency Mobile Numbers
- Navigator to the Emergency Contact Page consists of:
  - Form fields to add Name and the relevant mobile number of emergency contact
- Navigator to Change Password page

10: **If Auto Monitoring is on and the onboard processing unit detects a crash, So an alert screen will popup showing a countdown of 15 seconds.**
11: **If the user taps on "Cancel" the alert will disappear.**
12: **If the user is not able to cancel the alert within 15 seconds, the application automatically sends an SMS to all emergency contacts.**
13: **end**

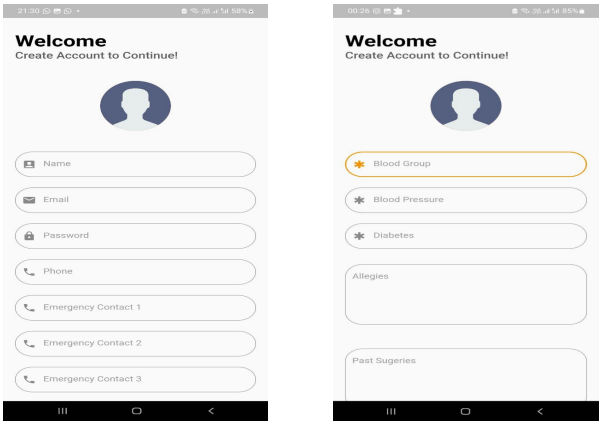
be very surprised. In some cases, physicians are unaware of the patient's medical history, including blood pressure, diabetes, blood type and prior procedures. As a result, a medical detail page has been created on the Android application with all the victim's information that the doctor, police or other emergency contacts may need to know. The Android application includes an emergency contact page for sending alert messages when the victim is in danger. Here, we are given the option to save multiple persons as emergency contacts. Additionally, it has a GPS location capability that sends a message with the GPS coordinates of the accident scene when the victim is hurt or in danger. This Android application must be installed on a phone with a network connection to help those who are in danger or who are in an accident. Figures 3 to 8 display the various screen pages of an Android application developed to be used for reporting vehicle accidents.

Fig. 4 depicts the mobile app sign-up interface. To register,




(a) Login screen. (b) Forgot password screen.

Fig. 3: Login screen and forgot password screen.




(a) (b)

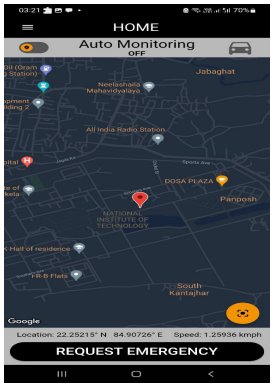
Fig. 4: New user Registration Screens.

users must enter their email address, password and additional information (such as their name, phone number and blood type). After registration all information will be saved in firebase database. In case the user forgets the current password, he/she can reset the password by giving his/her registered email address. Users of the mobile app can read a history of past events, update their information, add emergency contact information, change their password and sign out. If the user wants to change their password, emergency contact, update the information they can go to the sidebar and do the same by clicking on the respective options.

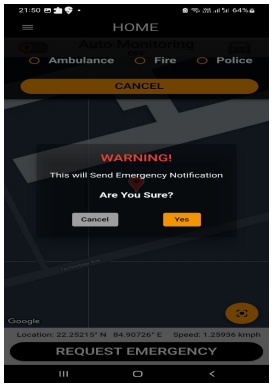
## III. Experimental Results and Discussion

### A. Application Back-End Development

In our suggested solution, push messaging, file sharing, user authentication and location sharing happened on a single cloud-based server called Firebase. We can use Firebase to authenticate users of their app with the Firebase Authenticator service and store and retrieve data from a NoSQL database called Firestore. Unlike Firestore, a real-time database is just

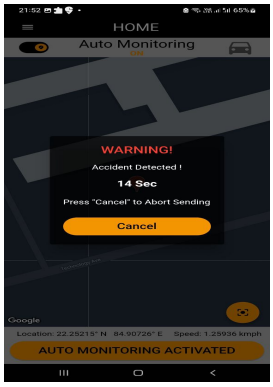



(a) Home Screen

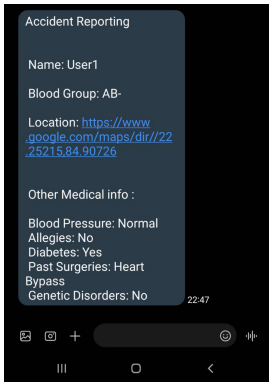



(b) Popup Alert

Fig. 5: Home Screen and Popup Alert for manual request.

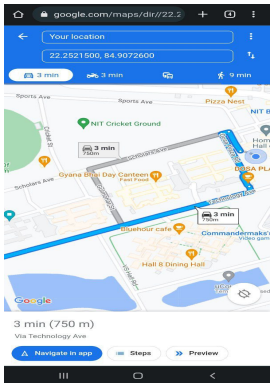



(a) Accident Detection.

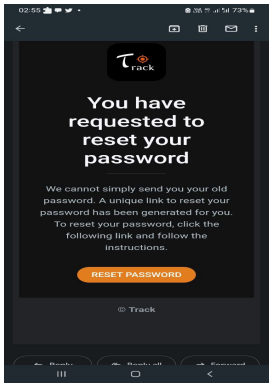



(b) Popup Alert for SMS sending.

Fig. 6: Automatic Detection Popup Alert and sent SMS.



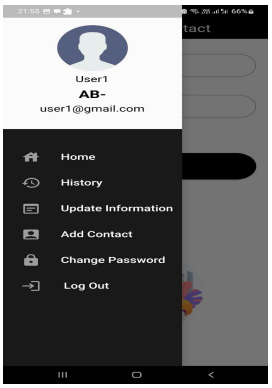

(a) Driving directions.




(b) password reset email.

Fig. 7: Driving directions to the accident location and password reset email (external screens).

a sizable JSON object that developers can control in real-time. The Firebase Authentication enables configuring data for applications [10]. Firebase Real-time Database stores data as JSON in a database kept in the cloud [11]. It provides secure back-end database access so that customers can build robust, collaborative applications. While offline and real-time events happen, data remains locally on the device, providing a responsive experience for the user. The real-time back-end database is immediately synchronized with local data changes that occurred while auto-merging any conflicts when the device regained Internet connectivity while the client was offline [12].




(a)


(b)

Fig. 8: Driving History page.

*1) User Authentication :* The user has to enter his/her name, email address, password, phone number etc. while registering with the system. Once a user is registered with the system a passive user ID is generated and it is always used to identify the user and gain access to the back-end.

*2) User Login:* The user has to enter his/her name, email address, password, phone number etc. while registering with the system. A passive user ID is generated after a user registers with the system and is always used to identify the user and gain access to the backend, as shown in Fig. 9.

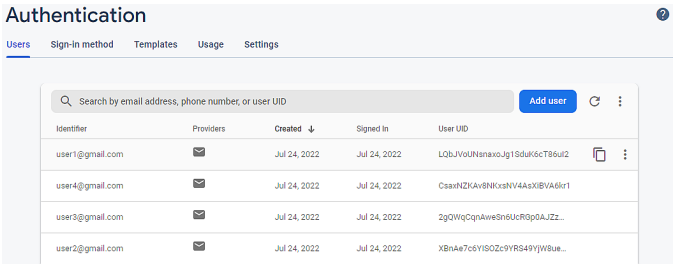



Fig. 9: Firebase authentication

*3) Real-Time Database:* Fig. 10 Displays the Firebase database node where real-time location information, application switch status, and crash detection information will be maintained.

*4) History:* This Firebase Firestore database node will contain details of prior crises that each responder has successfully handled. For each emergency, it will include the victim's ID, location, time, speed, altitude and etc.

*5) Data Handling between Back-End and Front-End:* Various APIs were used here to connect the back-end to the front-end. The Flutter framework allows those APIs to be accessed by various development dependencies [13]. We

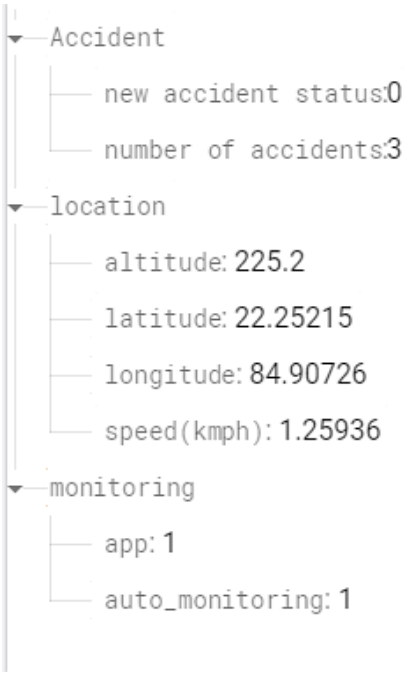



Fig. 10: Firebase Realtime Database

need to add them to get additional functionality. In this app, update, set & read methods are used to deal with Firebase. The functionality-wise details are as follows:

- Firstly, when a new user is registered in the app the data entered by the user is stored in the Firebase Firestore database. Firebase Auth is used to control email address and password for login purpose.
- Once the user has logged into the application some of the stored data must be retrieved again (sidebar user data, updated info page data, etc.).
- If a user wants to update their information then the relevant fields of the Firestore database should also be updated. Fig. 11 shows Firebase Firestore entry for a particular user.
- We need to fetch real time database data to the application (GPS data, speed, accident status, etc.).
- We then need to update the location coordinate variables of the Google Maps marker and camera according to that real-time data.
- The Auto Monitoring Switch is providing a signal through a real-time database to the Automatic Accident Detection System to track the vehicle for accidents and send detection signals.
- Meanwhile, if Auto Monitoring is turned on then the value of the ”New Crash Status” node in the real-time database should be started to listen.
- If that value changes from 0 to 1 an automatic crash detection alert should pop up.
- And the crash data should be updated on firestore immediately inside the relevant user’s document in the form of crash history.

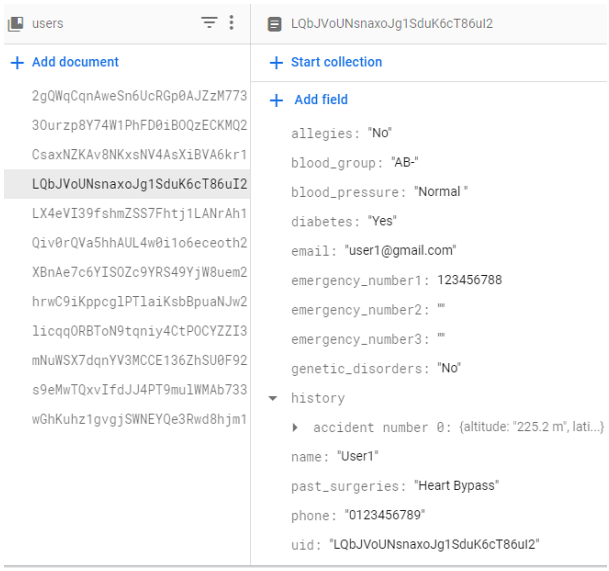



Fig. 11: Firebase Firestore entry for a particular user

### B. *Comparative Study*

Smartphone-powered accident detection systems have more functions and better user interface. When a tragic accident occurs, emergency victims usually cannot call an ambulance. In these circumstances, the intended system will immediately identify the accident and send a notification to the nearest emergency response to save the victim’s life. We have designed a comprehensive system for emergency victims. The system takes advantage of the quick spotting of accident signals and alerts local emergency services. Emergency responders can easily track down the exact location as the fastest route is already provided with a Google Maps direction link. Various types of emergency requests, such as those involving police, fire and hospital, can be made easily. The proposed system will offer much more features than what is provided by state-of-the-art systems. Table I gives the details of comparative studies with existing systems.

## IV. Conclusion and Future Work

In this work, we developed “Track”, an Android application to detect accident signals, generate emergency alerts, and send information to the nearest emergency responders. The details of the location coordinates of the accident were sent as SMS to the emergency contacts. The developed system provides real-time location tracking capability for victims, which greatly improves the chances of survival of accident victims by providing timely emergency care. The system will also assist in other disasters like fire, burglary and theft, and other medical crises. On real-time Google Maps, emergency responders will not only be able to pinpoint the location of the victim, but will also be able to get directions through SMS within just a single click on the given link. This system inevitably has false positives. To mitigate these problems, we have introduced some features to reduce false positives. Upon detection of a crash, the system will display a warning window

TABLE I: Comparative features of mobile phone applications developed for accident detection

| Reference | Advantages | Limitations |
|---|---|---|
| Prasana *et al.* [7] | • External embedded circuits are not required only the smartphone can detect the crash signal relatively fast as the Android application listens to the local computation process instead of the online server. | • Cell phone sensors are used to receive data. Therefore, the number of false positives may be high due to the activities of the user's phone.<br>• The calculation and identification is done using a mobile phone. The performance of crash detection calculations varies on the performance of mobile phones.<br>• Mobile phones have high application workload (sensor resource and power usage for real-time calculations), which may cause application crashes, and drain the mobile battery relatively fast. |
| Thompson *et al.* [14] | • The system is activated only when plugged in to prevent excessive power usage. The speed filter is used to track the occupants of the vehicle.<br>• Drops and sudden stops are prevented from triggering accident warnings by the acceleration filter. | • Mobile phone sensors detect the crash but the warning part is done by a server that needs to be connected to the device. There may be a delay in giving the warning. |
| Khan *et al.* [15] | • The victim can simply use the smartphone to detect the crash signal and also track the emergency responder. | • High false positives and application workloads on smartphones lead to frequent crashes of mobile applications and battery power draining.<br>• The Emergency Response Unit is required to install the application for location tracking. |
| Yaacob *et al.* [16] | • Microcontroller PIC 16F877A is used by Microchip to control the system so that the power consumption is low. | • Emergency responders are provided with only GPS data (latitude, longitude) of the accident location. |
| Proposed | • A developed IMU-based in-vehicle embedded system only detects accidents. This helps to reduce those false positives as well as stabilizes the performance of the calculations.<br>• In our proposed system, the mobile application automatically sends emergency alerts once an accident is detected without user intervention, hence reducing the delay.<br>• Only the accident detection signal listener and GPS data listener (data being received from Firebase) are working in real-time, and there is no use of mobile phone sensors. Hence, the workload and resource utilization is comparatively less. This helps in tracking the vehicle continuously for a comparatively long time.<br>• There is no need for application installation for emergency respondents. The direction from the respondent's location to the victim's location is provided through the Google Maps Directions API link in the alert.<br>• The respondent just needs to click on that link, then automatically, the Google Maps application opens and shows the direction to the victim. | • An accident detection signal needs to be transmitted to the mobile application via the Internet. Connectivity issues can affect functionality. |

with a 15-second countdown, which the user can dismiss if there was no accident. In the future, it will be studied in depth to improve the reliability and accuracy of crash detection with optimized code to make it useful for low-end smart devices..

## REFERENCES


[1] S. Gopalakrishnan, "A public health perspective of road traffic accidents," *Journal of family medicine and primary care*, vol. 1, no. 2, p. 144, 2012.

[2] World Health Organization, *"Road Traffic Injuries"*. [Online accessed June 22, 2022]. Available: https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries.

[3] Transport Department Goverment of Jharkhand, *"Causes of Road Accidents"*. [Online accessed July 24, 2022]. Available: http://jhtransport.gov.in/causes-of-road-accidents.html.

[4] S. G. Fernandez, R. Palanisamy, and K. Vijayakumar, "Gps & gsm based accident detection and auto intimation," *Indones. J. Electr. Eng. Comput. Sci*, vol. 11, no. 1, p. 356, 2018.

[5] G. Karthy, P. S. Hemanth, M. V. Rahul, and S. V. Vamsi, "Vehicle speed monitoring and auto light adjust system with node mcu," in *Proc. IEEE 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE)*, 2022, pp. 459–462.

[6] A. J. Mahariba, A. Uthra, and G. B. Rajan, "An efficient automatic accident detection system using inertial measurement through machine learning techniques for powered two wheelers," *Expert Systems with Applications*, vol. 192, p. 116389, 2022.

[7] K. Parasana, G. K. Sahoo, S. K. Das, and P. Singh, "A health perspective smartphone application for the safety of road accident victims," in *Proc.IEEE Advanced Communication Technologies and Signal Processing (ACTS)*, 2021, pp. 1–6.

[8] M. S. Amin, M. B. I. Reaz, S. S. Nasir, and M. A. S. Bhuiyan, "Low cost gps/imu integrated accident detection and location system," *Indian J. Sci. Technol*, vol. 9, no. 10, pp. 1–9, 2016.

[9] A. Suryawanshi, "SOS-an android application for emergencies," 2014.

[10] Athul Sharma, (2018), *"How to use Firebase with Flutter"*. [Online accessed July 28, 2022]. Available: http://medium.com/47billion/how-to-use-firebase-with-flutter-e4a47a7470ce.

[11] Firebase Documentation-Google, *"Structure Your Database"*. [Online accessed July 24, 2022]. Available: https://firebase.google.com/docs/database/web/structure-data.

[12] Javin Paul, (2021), *"Why Frontend Developers Should Learn Firebase in 2022"*. [Online accessed July 28, 2022]. Available: https://dev.to/javinpaul/why-frontend-developers-should-learn-firebase-in-2022-1kga.

[13] Tutorial, *"Flutter Using Packages"*. [Online accessed July 24, 2022]. Available: https://docs.flutter.dev/development/packages-and-plugins/using-packages.

[14] C. Thompson, J. White, B. Dougherty, A. Albright, and D. C. Schmidt, "Using smartphones to detect car accidents and provide situational awareness to emergency responders," in *International Conference on Mobile Wireless Middleware, Operating Systems, and Applications*. Springer, 2010, pp. 29–42.

[15] A. Khan, F. Bibi, M. Dilshad, S. Ahmed, Z. Ullah, and H. Ali, "Accident detection and smart rescue system using android smartphone with real-time location tracking," *International Journal of Advanced Computer Science and Applications*, vol. 9, no. 6, pp. 341–355, 2018.

[16] N. Ya'acob, A. E. Azhar, A. L. Yusof, S. S. Sarnin, D. M. Ali, and A. Anuar, "Real time wireless accident tracker using mobile phone," in *Proc. IEEE 7th Int. Conf. Syst. Eng. Technology (ICSET)*, 2017, pp. 111–116.