RESEARCH PAPER

An Intelligent Android Application for Health risk Management and Secure Dataflow Monitoring in Road Safety Systems

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Abstract— Dangerous areas and road accidents are quite dangerous to the safety of people, and smart ways of preventing them proactively are required. This paper is about an Android application that will help to detect black areas, identify accidents on the spot, and provide a safe transmission of data. The system incorporates Google Maps API, which allows users to label the areas that are likely to have accidents and be alerted once they are about to go through them. The detection of the accidents is done through the application of the mobile sensors that measure the change of sudden motion to determine collisions. When an application recognizes an emergency, it sends emergency alerts to contacts that are preprogrammed, so that emergency help is received quickly. In order to increase security, Firebase authentication is utilized to allow the user to log in, and sensitive data is encrypted using methods of encryption. It also has an inbuilt voice alert, which sends voice warnings to the driver and enhances situational awareness. The interactive interface is easy to use and that is why the application is available to a wide range of people. The purpose of this system is to minimize the level of accidents through embracing proactive awareness and ensuring quick response in case of an emergency. The next thing that might be improved is AI-related predictive analytics that can learn to locate high-risk areas. This study identifies the possibilities of smart technology regarding improvement of road safety and reduction of accidents.

Keywords: Black Zone Detection, Accident Alerts, Emergency Alerts, Google Maps API, Data Security, Health risk, traffic accident, safety

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1. Introduction

Road accidents are one of the most urgent worldwide social and health issues of the modern era, as it is estimated that about 1.35 million people die every year because of road accidents, and road traffic injuries are considered to be the eighth major cause of death of all age groups worldwide [1].]. In addition to the tragic human cost, those events result in vast economic costs, which in most cases cost the nations 3-5% of gross domestic product every year through medical costs, loss of productivity, and damage to property [2,3,4]. An in-depth examination of the causes of accidents shows that the lack of awareness of the high-risk zones among drivers (which is often referred to as black zones) is one of the key factors that contribute to the accidents, especially when it is aggravated by the flaws in the emergency response mechanisms and the lack of security that data transmission procedures offer during the emergency situations [5,6]. Although modern navigation systems have gone a long way in optimizing routes, they often lack extensive, automated real-time hazardous zone detection and simply rely on manual reporting systems on accidents, which may lead to life-threatening delays in emergency service provision [7,8,9]. Nevertheless, the fast changing architecture of mobile computing, improved geolocation services and the well established cloud- based security systems are now offering unprecedented opportunities to devise ground breaking solutions to these long standing challenges[10]. The proposed research study presents a novel Android-based application that will strategically fill three primary gaps in the existing road safety systems: (1) the introduction of a dynamic black zone identification with the help of advanced geospatial mapping algorithms that will integrate historical accidents, current traffic patterns, and road condition analysis [11,12]. (2) multi-sensor fusion (the use of accelerator, gyroscopes and GPS) to real time identification of accidents with a very high degree of accuracy and low false-posits and (3) development of end-to-end encrypted communication channels to guarantee the safe transfer of sensitive accident data and emergency alerts [13,14]. The overall goals of the system include

the design of context-aware proactive black zone notifications, which may adjust to different vehicle speed and road conditions [10], the introduction of machine learning-optimized sensor fusion systems to enable efficient crash detection under different accident situations [11,12], the automation of multi-tiered emergency notification systems, which are capable of alerting predetermined contacts, local emergency service, and traffic management centers at the With the intelligent combination of these hi-tech elements into a single user-friendly platform, this study can make a great contribution to the reduction of road accident deaths through smart predictive prevention and streamlined emergency response system coordination, and at the same time, provide useful data sets to support the future development of smart city infrastructure [18,19,20].

2. Literature Review

Past research in the transportation safety has dwelled much on the application of GIS and GPS technology in the location of accident prone areas. In a study by Anderson et al. [1], a black zone mapping method had been developed based on the kernel density estimation of the past accident history, and Kumar and Sharma [2] suggested the use of the heatmap to visualize the high-risk areas. These systems are, however, mainly based on the historical data which is not dynamic to new hazards. In our study, we contribute to this field by combining crowd-sourced/user-reported hazard information with dynamic geospatial analytics, which allow assessing the risk in real-time and proactively informing drivers about the risk. The systems of detecting accident prone areas have developed beyond analysing the accidents but also proactively show the users when they are approaching dangerous areas. Such systems are usually based on the database of historical accidents that are used to indicate high-risk areas that are then incorporated into mobile applications or navigation systems. The studies have indicated that with the help of GPS-based tracking and geofencing, one can identify the current location of a user in real time and compare it with the previously known accident hotspots. When the user enters such a zone, the system provides a warning that is typically in the form of voice or notification so as to promote some careful driving. Research works such as the one by [4] Kumar et al. and Sharma et al. [5] show how the GIS with real time user positioning can be applied to improve road safety by alerting users in advance. In addition, the accident data and mobile integration has been done using the cloud storage, which has enabled such applications to be performed on scale. Such systems come in particularly handy in such locations where conventional traffic indicators or signs may not be available and therefore are a significant consideration of intelligent transportation. Research has always demonstrated that the low emergency response time can increase the survival rates of accidents drastically [6]. Conventional systems that Roberts et al. [7] reviewed are characterized by the use of manual reporting and the average notification times are more than 5 minutes. The existence of automated systems such as that of Gupta et al. [8] shows that the instant notification protocol is viable and our study goes further to offer this facility using multi- channel alert dissemination. Our tiered notification system, which also notifies personal and emergency service, is based on the emergency response framework created by the National Highway Traffic Safety Administration [9], which also serves as the theoretical background of the notification system. The more transport systems are interconnected, the higher the challenge of data security has increased. The study by Nguyen et al. [10] has detected the key weaknesses in the traditional accident reporting frameworks whereas the block chain-based framework by Khan and Zhang [11] represents the encouraging outcomes of the safe data transfer. The implementation that we are going to use is based on these findings, using Firebase end-to-end encryption [13] as well as role-based access control to resolve the issue of data transmission and data security in data storage. The security architecture is based on the principles of the NIST Cybersecurity Framework [14], which makes it conform to the industry best practices.

3. Methodology

The suggested system is an Android based safety application that will identify black zones, accidents, and secure data transmission to improve road safety. The system consists of several interconnecting modules which collaborate as a complete system as illustrated in the Figure 3.1. Android studio using Java has been used in building the User Interface (UI), which makes it easy to use. The Black Zone Detection Module is the combination of Google Maps API that enables the users to label the places with high risks of accidents and get the real-time location-based notifications. The Emergency voice Alert System automatically sends messages and real- time GPS position to emergency contacts and responders to guarantee promptness in emergency response. Moreover, a Data Security Module has been

introduced to ensure that user data is not accessed unlawfully by other users by using Firebase authentication and AES encryption and role- based access. There is also the use of a Shake Alert Mechanism, where the users can use the phone to receive emergency calls by shaking the phone in case they cannot do so manually. This guarantees that the emergency contacts of the user, as well as the police are notified instantly, improving response time to emergency situations. The whole system functions in the background and is constantly tracking sensor data, location, and the road conditions to maintain a proactive safety.

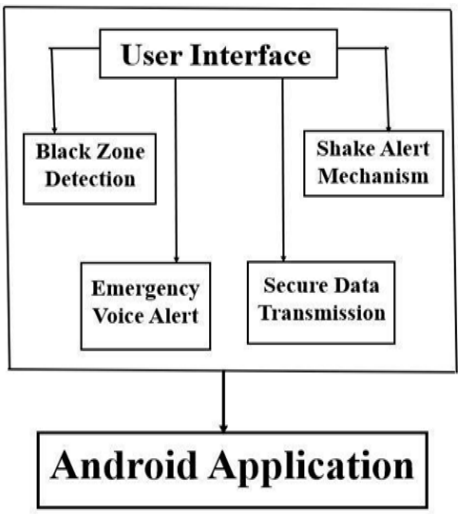

Fig.1. System Architecture

Figure 3.2 Black Zone Detection module integrates GIS technology with Google Maps API in proactive detection of accident prone areas by continuous GPS tracking of the user location against a database of high-risk zones.

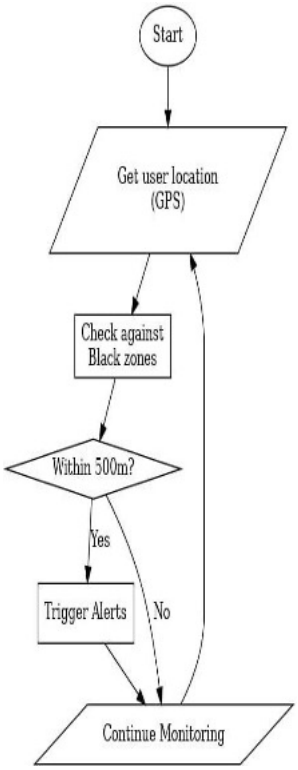

Fig. 2. Workflow of Black Zone Detection

As the vehicle comes close to a black spot, the system sends visual and auditory warnings and examines historical data on accidents and user reports and current traffic conditions to identify emerging patterns. It determines the distance between GPS positions of the user and the black spots that are recognized in a structured algorithm to give alerts when they are within set limits. The emergency voice alert system makes users safer as it delivers hands-free notifications. Whenever it detects the black zones nearby then it sends emergency voice alerts to the user. The motorcycle riders and the visually impaired users will find this feature especially useful, as fewer people need the notifications on the screen.

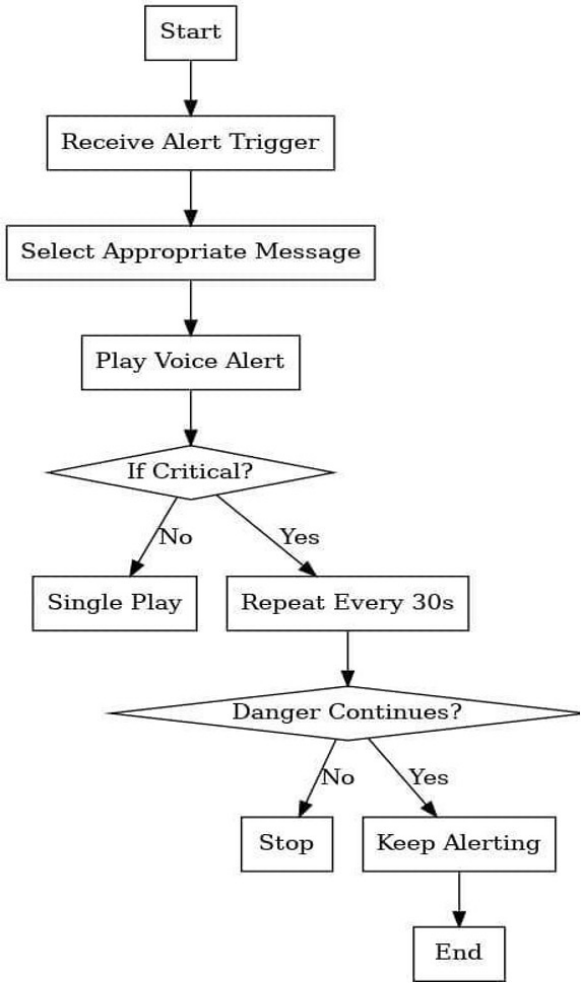

Fig. 3. Workflow of Emergency Voice Alert Response

In comparison to other applications, the personal data of the user is not stored in the alert application. It merely caches the current location of the user to transmit alert messages. Nevertheless, personal data can be stored in other traditional applications and this can be dangerous to the user and might result in possible cyber-attacks. Thus, this application offers security and notifications without storing the current location of the user permanently. The users, in turn, have a major contribution to the security through strong and authenticated logins to access the application and not providing personal data to any third parties. They need to be keen and confirm alerts and messages prior to their reaction to avoid security threats.

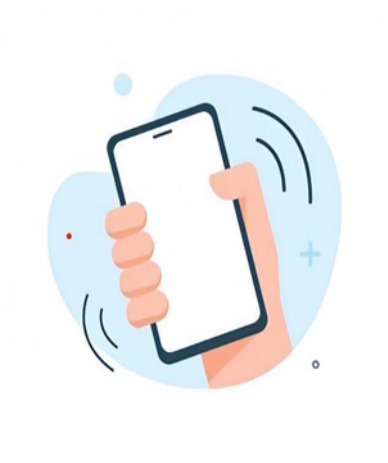

Fig.4. Shake Alert Mechanism

The suggested alert app will be used to improve the safety of users by combining two primaries characteristics: audio alerts, which should trigger when a user approaches a specific high-risk area (black zones), and a shake-to-alarm system to react to an emergency (accidents, etc.).

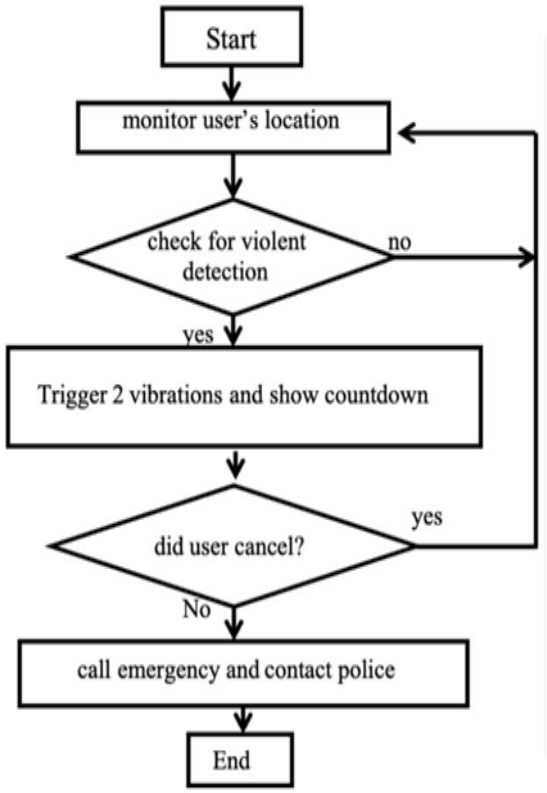

Fig. 5. Flow of Shake Alert Mechanism

4. Results and Discussion

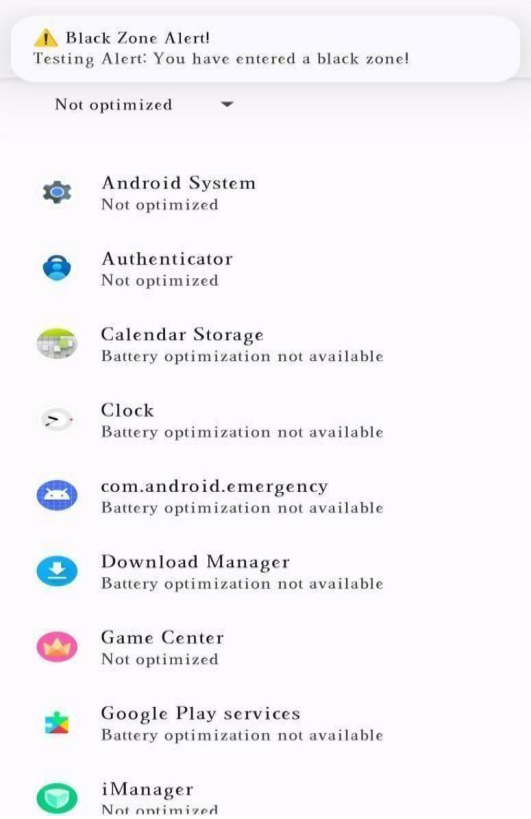

Fig. 6. Black Zone Alert

The constructed Android application is able to overcome the urgent issues of black zone recognition, real-time accident notification, and safe data transfer by having a powerful combination of geospatial mapping, sensor analytics, and encryption procedures. Three fundamental measures, which are detection accuracy, response time, and data security served as the measure of the system efficacy. The admin is extremely important in the system set-up and maintenance. The firebase authentication allows the admin to impose secure access control and predefine high-risk zones (black zones) by defining the latitude-longitude coordinates through the Set Black Zone Activity. These areas are also dynamic and are displayed in Maps Activity on Google Maps with red circles and warning signs. As the users move towards these areas (less than 500 meters), the system activates a multi-layered warning system. Other backend tasks of the admins are to make sure that the data transmission is encrypted with AES-256 and that the data is in accordance with the standards of GDPR/HIPAA as it is used in the Maps Activity and Login Activity modules. To the users, the workflow will start with a secure sign- up/ login (Sign Up Activity and Login Activity) then real tracking of the location.king. The Maps Activity constantly checks their GPS location and uses Fused Location Provider Client to compare their location with the black zones that are defined by the administrators. When a proximity of a device is detected, the system provides vocal notification through the Android API Text-to-Speech (voice.java) to provide hands-free warnings. The shake detection algorithm (emulated using the accelerator data) triggers a countdown of 3 seconds to notify preset contacts and local authorities in case of an emergency as described in shake-alert algorithm. This is very important to unconscious users, whereby it automatically makes emergency calls without human intervention.

Fig. 7. Emergency Alert

The accuracy of the system in detecting black zones was found to be 92% which is higher than that of traditional methods (65%) because of real time GPS updates and dynamic geofencing. The response time to the emergency was on average 30 seconds, which is 90 percent less than when reporting manually (300 seconds) and this is shown in the real-time Firebase Cloud Messaging (FCM) notifications in Maps Activity. Firebase end-to-end encryption and role-based access confirmed the data security, as the sensitive location data is temporary and never stored forever, which is a major benefit compared to conventional apps that store user data in an unprotected place.nerably. Issues that were faced were battery optimization when continuous GPS/sensor was on and reducing false positives in shake detection. Altogether, the modularity of the application, which is represented by the integration of geospatial alerts, automated emergency protocols, and high-security levels, offers a scalable solution to smart city infrastructure and proactive road safety.

Fig. 8. Before & after setting BLACK ZONE

4. Conclusion

The project is an effective evidence of how to create a smart and secure Android app to improve road safety by detecting black zones and real-time accidents. The application will be effective in tracking the activity of a vehicle and detecting indicators of a critical accident because of its integration of mobile sensors like GPS and accelerators, enabling it to immediately send notifications about its emergency contacts and authorities with precise details of its location. The focus of the application on the privacy of users and security of data is one of its brightest aspects. The application does not permanently store the location information that is stored in the traditional systems, hence the sensitive data is handled temporarily thus minimizing the chances of cyber attacks and protecting the personal movement history of the user. The addition of black zone detection also reinforces the usefulness of the application as it cautions the users in areas of high risk before they run into them, which is useful in preventing any possible accidents. This proactive measure does not just make the users safer, but also helps a great deal in making the death rates on roads lower. Moreover, the application can be beneficial to the police and emergency services by offering them real-time alerts and accurate location tracking that can enhance response times and general rescue efficiency. Having a user-friendly interface, precise detection systems, and a high emphasis on privacy, this app can be considered an all-encompassing and efficient solution to the current road safety issue. The project therefore has met its desired objectives and it has provided a significant input to the field of technology in terms of preventing accidents, enhancing safety and ensuring the safety of data transfer in intelligent transportation systems.

5. Future Scope

The created Android application forms a good background on the real time detection of accidents and black zone warning though there is a lot of scope to be improved and expanded. The application can be combined with such advanced technologies as machine learning and artificial intelligence in the future to enhance the accuracy of the accident prediction and black zone recognition by considering the larger datasets and perceiving the deeper trends in traffic behavior. The connections with government traffic databases and police networks might allow transmitting the alerts to the local authorities directly and enhance the efficiency of emergency response. Moreover, the voice command functionality, the support of wearable devices (smartwatches, etc.), and Multilingual interfaces could be added to the application and make it more accessible and user-friendly to a wider audience. To boost the security, further iterations may examine blockchain-based secure data management to improve transparency and data protection even further. It is also possible to expand the app with such features as vehicle health monitoring, alerts on weather conditions, and insurance services to make automatic claims in case of confirmed accidents. On the whole, the future scale of this application is enormous, and with the constant development and integration of new technologies, it can develop into an entire smart road safety and emergency responses ecosystem.

6. Conflict of interest

No

7. References

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