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Leveraging Smartphone Technology For Enhanced Personal Safety: A Solution Driven Approach

Rohan Bhande
Department of CSE
MIT-WPU
Pune, India

Dr. Sharmishtha Desai
Department of CSE
MIT-WPU
Pune, India

Abstract— **Leveraging smartphones as a solution to safety concerns, this application addresses various emergency situations where immediate assistance is needed. From accidental scenarios and nighttime attacks to elderly falls and child safety, this application provides a quick and efficient way to notify contacts and share the user's current location. By utilizing smartphones' capabilities, individuals can enhance their personal safety and that of their loved ones, mitigating risks and potentially reducing crime rates and accidents.**

Keywords—**Women safety, fall detection, mobile-based application, Java programming, elderly monitoring.**

I. INTRODUCTION

The execution of any action requires careful consideration of its safety implications. For instance, let's consider the scenario of visiting a friend during the day versus at night. Daytime visits are generally regarded as safer due to the lower incidence of reported crimes compared to nighttime when there are fewer people around. Safety considerations play a pivotal role in all our daily activities and choices. However, it is disheartening to observe the increasing rates of crime, accidents, and cybercriminal activities, all of which pose substantial risks to personal safety and the well-being of our loved ones.

The data provided by the National Commission for Women (NCW) in 2021 reveals a staggering rise of up to 30% in crime rates against women. The NCW received nearly 31,000 complaints, highlighting the prevalence of these concerning incidents. Furthermore, the number of reported cybercrimes in the first two months of 2022 alone has already exceeded the total recorded for the entire year of 2017. Figure

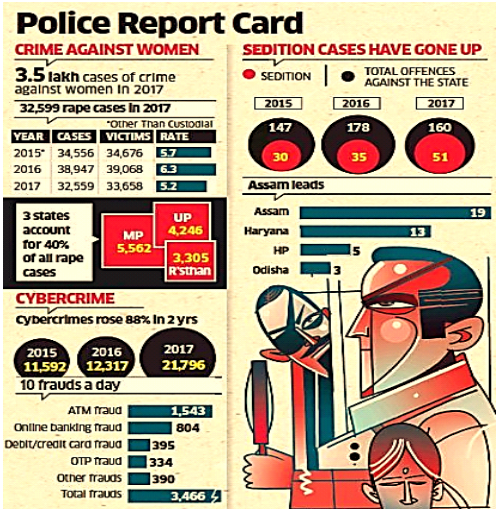

FIGURE 1 Police Report Card

1 presents a concise illustration of the statistics pertaining to crimes against women and the alarming surge in cybercrime.

The occurrence of daily accidents is a pressing concern, as even a minor incident can result in significant devastation. Startlingly, India witnesses approximately 1,214 crashes each day, leading to approximately 377 fatalities. This equates to a jumbo jet crashing daily. In light of these sobering statistics, a solution has been developed—an application designed to send automated distress messages whenever the user is in need. The objective is to provide immediate assistance with a simple shake or click. By utilizing this app, a few shakes can pinpoint the user's precise location (including longitude and latitude), triggering an automatic SMS to emergency responders. This application serves as a swift and efficient means to contact loved ones, enabling individuals to proactively safeguard their own well-being and mitigate the risk of unintentional accidents or incidents.

As we look ahead to the next 30 years and the projected demographic shift towards 2050, it is estimated that one in every five individuals will be aged 65 or above. Within the age group of 45 and older, falling poses a significant threat. The possibility of tripping and falling exists at any given moment, and the repetitive occurrence of such incidents can have a profound impact on an individual's well-being. Falls not only result in physical injuries like disabling fractures, but they also have far-reaching psychological, medical, and social consequences that can persist for an extended period of time.

To address this pressing issue, the implementation of a fall detection method becomes crucial. This technology enables the guardian or caregiver to receive an alert in real-time if a person experiences a fall, ensuring prompt assistance can be provided in case of an emergency. By deploying such a fall detection system, we aim to enhance safety measures and

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minimize the potential risks associated with falls, ultimately safeguarding the overall well-being of individuals in need.

II. Related works

I. MyDistress

This application was developed to further enhance the capabilities of an organization for the sole purpose of security monitoring. In this application you can simply press the 'icon' button in order to seek help from the police patrol unit. Well, by doing so one will receive information and signals quickly. That was entirely the objective and use of this application. In the state of emergency from the control unit, the application is based on real-time activity so the fast reception of information helps to reach the control center quickly. Due to flaws in the execution of the application, the location provided was not quite accurate.

II. bSafe

It was developed to protect women from becoming victims of any of the crimes happening to them. The software used here is the same i.e. Android Studio Mobile. This application is designed specifically for emergency but it also provides an extra feature of connecting with the friends while they are on the move. Just like snapchat if something happens to a certain someone then their last location can be tracked by their friends in their contact list.

Sr.No	Author	Year	Methodology	Gaps	Conclusion
i	Neha R. Singh P.R. ROTHE A. P. Rathkanthiwar - Implementation of safety alert system for elderly people using multi-sensors.	2019	Develop a network which contains only bluetooth interface and Cardiotachometer and a bluetooth interface.	Does not provide any other features except fall detection.	Implemented wearable device-based fall detection system effectively detects accidental falls in consumer homes, promising improved personal safety and mitigating fall-related risks.
ii	Md. Elias Hossain , Mostafijur Rahman , Khandker M Qaiduzzaman , Asif Khan Shakir , Md Maruf Hassan:- Efficient Anti-Kidnapping and Anti-Harassment (Avoidance-Detection-Notification)	2019	Notification module, Sound module, Sensor module, and Spy module.	The implementation of the ear phone system is vague and might create false alarm in certain situations.	Application received a SUS score of 75.56, indicating its commendable usability. This suggests that users found the application to be user-friendly and efficient in meeting their needs.

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iii	Authors: G. Shri Krishna , M.P. Lokesh - Advanced SOS App in Smartphone	2020	The SOS application is specially designed to help the users in distress situations. The app has some special features that makes it different and give a stand out performance from the previous versions of SOS applications	Only the emergency message is sent to the helper, there is no conformity of receiver receiving the message. No audio or video feature involved.	SOS applications with variety of exclusive features and options on a monthly paid basis.
iv	A. Z. M. Tahmidul Kabir, Al Mamun Mizan, Tasnuva Tasneem	2020	The device operates in both online and offline modes, allowing users to access the nearest police box and volunteer support even without internet connectivity. It incorporates Arduino nano, GPS, GSM, Bluetooth, and other components, making it affordable and user-friendly.	Not a handy device which you can carry on a daily basis. The execution failed as the device which is shown to worn as a watch cannot be really used.	The current design of the smart band is slightly bulky, posing challenges for users when wearing it. Future efforts will focus on enhancing user-friendliness by leveraging 3D printing and nanotechnology advancements. However, expanding volunteer availability beyond the tested areas, such as North Dhaka, is necessary to gather a more diverse range of feedback and ensure widespread usability.

III. METHODOLOGY

Existing SOS applications often cater to specific demographics, such as providing protection exclusively to women. This limited focus restricts the usability of the applications, as they fail to extend safety measures to a wider range of individuals. To overcome this limitation, a new system has been designed and developed to offer safety provisions for everyone, regardless of their specific conditions or circumstances.

The system adopts a categorization approach based on age. Individuals below 18 years old are categorized as children, while those above 18 can act as guardians and also utilize the application for their own safety. Additionally, individuals aged 45 and above benefit from a specialized fall detection system. Figure 3.1 presents the flowchart outlining

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the registration and login process for users within the application.

By adopting this inclusive and comprehensive framework, the application aims to provide safety coverage for individuals of all ages and diverse needs. This ensures a more robust and adaptable safety solution, ultimately promoting the well-being and security of a wider user base.

I. Shake detection algorithm:

The Sensor Event Listener plays a vital role in receiving notifications whenever there is a change in sensor data. In the context of shake events, registration requires the detection of a G-Force greater than 1G. This criterion ensures that only intentional shakes are registered within the application, minimizing the occurrence of false alarms. Non-intentional shakes, such as those caused by the phone's movement in a pocket, while driving, or during physical activities like running, are effectively filtered out.

To further enhance shake detection accuracy, a count mechanism has been implemented. This mechanism registers an event only when the count value reaches three, indicating that the user has consecutively shaken the device three times. Moreover, a minimum time interval of approximately 500ms is considered between two consecutive shakes. If there is no activity for a period of 3 seconds, the count will reset to zero, ensuring a reliable and responsive shake detection system.

By implementing these refined algorithms and parameters, the application achieves a higher level of precision in recognizing intentional shakes while minimizing false alarms, thereby enhancing the overall reliability and effectiveness of the shake event detection feature.

II.Fall detection algorithm:

1. Initialization

The fall detection service initializes necessary variables, including threshold values for the Single Magnitude Vector (SMV) and degree of phone inclination. It also registers sensor listeners for the three-axis accelerometer and gyroscope. Additionally, it requests GPS location updates and retrieves the initial latitude and longitude.

2. Sensor Data Processing:

2. 1. Accelerometer Data

The service receives accelerometer sensor events and calculates the SMV by combining the data from all three axes. This SMV is used as an indicator for fall detection.

2. 2. . Gyroscope Data

The gyroscope data is processed to calculate rotation vectors, which help in updating the gyroscope-based orientation matrix. This information is used to determine the degree of phone inclination during a fall event.

3. Fall Detection:

3. 1. SMV Threshold

The fall detection algorithm compares the SMV with predetermined threshold value. If the SMV surpasses this threshold vector, it indicates a potential fall occurrence.

3. 2. Phone Inclination

In addition to the SMV threshold, the algorithm considers the degree of phone inclination. If the degree of inclination exceeds 35 degrees, indicating a significant tilt but not a complete fall, it is flagged as a dangerous situation for the user.

3. 3. Combined Analysis

To determine a conclusive fall occurrence, the algorithm examines if the head inclination, considering the normal head inclination as zero, surpasses a predefined degree threshold in conjunction with breaching the SMV threshold. This combined analysis enhances the accuracy of fall detection.

4. **Location Updates:** The fall detection service registers a location listener to receive GPS updates. Whenever there is a fall detection event, the latitude and longitude values are captured to provide the user's location during the incident.

5. **SMS Functionality:** The fall detection service incorporates SMS functionality to send text messages for immediate assistance. When a fall is detected, the service utilizes the appropriate class to send pre-defined alert messages, along with the user's location, to a designated emergency contact or monitoring system.

6. **Database Interaction:** The service interacts with a database using a dedicated helper class to perform database operations. This includes retrieving emergency contact phone numbers and other relevant user information.

7. **Periodic Tasks:** The fall detection service includes a periodic task that runs at a specified interval using a handler. This task updates a flag to indicate the service is actively monitoring for falls and ensures timely detection and response.

By leveraging the sophisticated approach outlined above, which combines the analysis of SMV, phone inclination, and head inclination, the fall detection algorithm significantly enhances accuracy and reliability in identifying fall incidents. This ensures that genuine falls are promptly detected, enabling timely assistance and proactive measures to ensure the user's safety.

III. Firebase :

To enhance the fall detection system's functionality, the service integrates with Firebase Firestore. It utilizes the Firestore instance to store and retrieve additional data related to fall incidents, such as timestamps and user-specific information.

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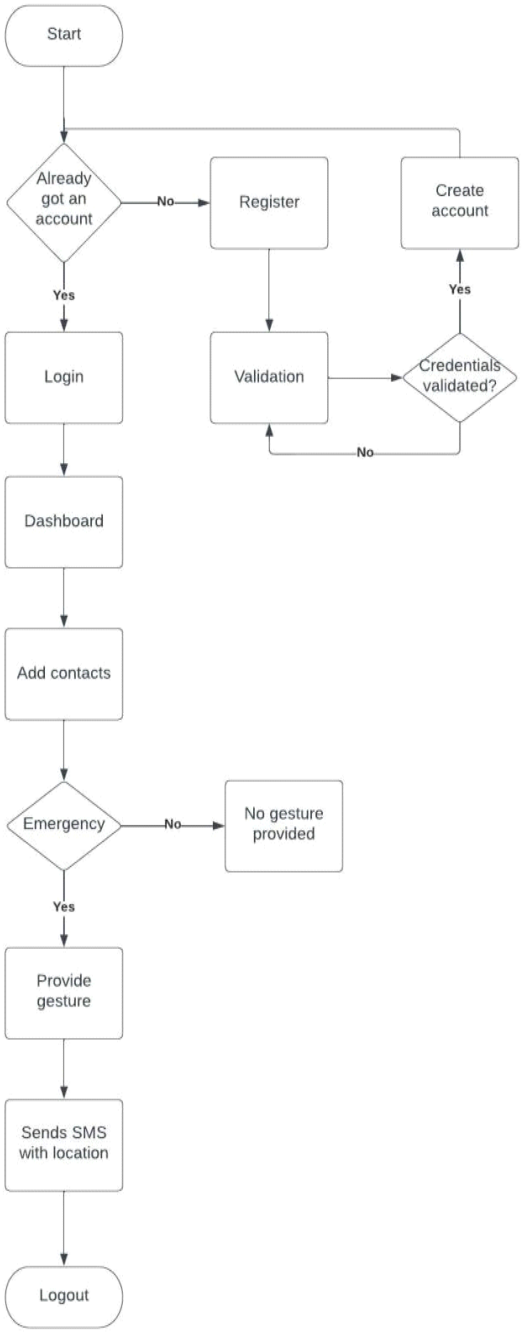

FIGURE 3.1 – Flowchart Registration & Logic

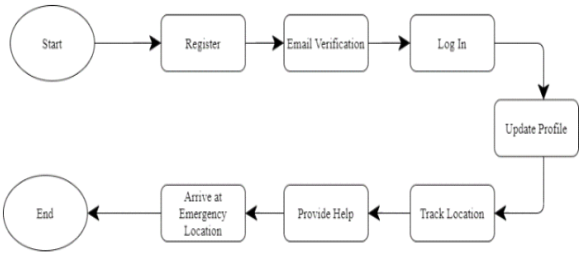

FIGURE 3.2 Flowchart – User (as a guardian)

Flow chart for the CitizenSafe application for the use of guardians is as shown in fig 3.2 where the user acts as a guardian. Here, one who is added someone else as a guardian will be able to see a maps option in their profile. The app will show the current victim location to the added emergency contacts numbers to guide them in order to reach the location.

IV. IMPLEMENTATION / DESIGN

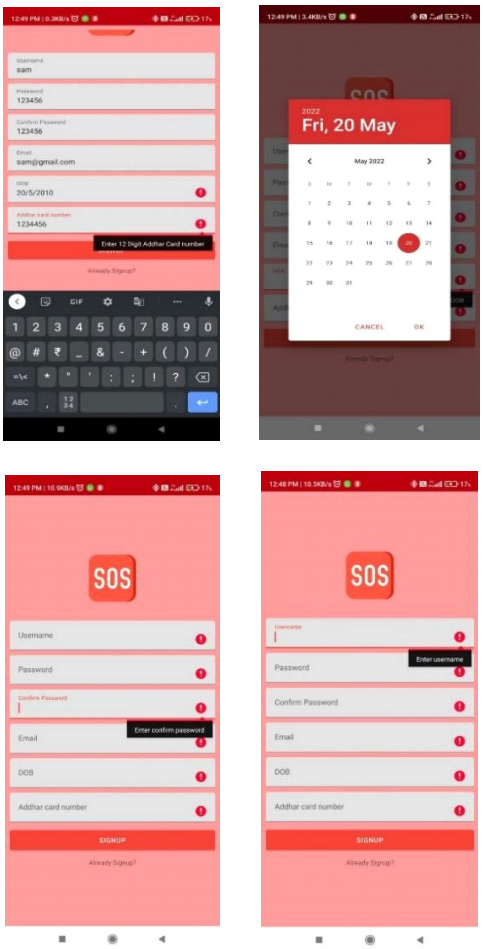

FIGURE 4.1 SNAPSHOT OF VALIDATION FOR REGISTRATION

Figure 4.1 provides a visual representation of the registration screen, offering insights into its appearance and the accompanying validation mechanisms. This screen serves as the initial step in onboarding users into the application, ensuring accurate and secure registration.

The fall detection feature operates by utilizing advanced algorithms and sensor data to identify potential falls. When a fall event is detected, the system triggers two distinct types of messages as depicted in Figure 4.4. The first message indicates that the user has indeed experienced a fall, alerting the necessary responders to the situation. The second message signifies a sudden movement without a fall, reassuring that the user is safe despite the unexpected

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motion.Figure 4.4 also showcases the final message generated by the application, displaying the real-time location of the victim. This automated feature ensures that accurate and up-to-date location information is provided to the designated recipients or emergency services. By promptly relaying the victim's precise location, this functionality plays a crucial role in expediting assistance and optimizing response times, ultimately enhancing the overall safety and well-being of the user.

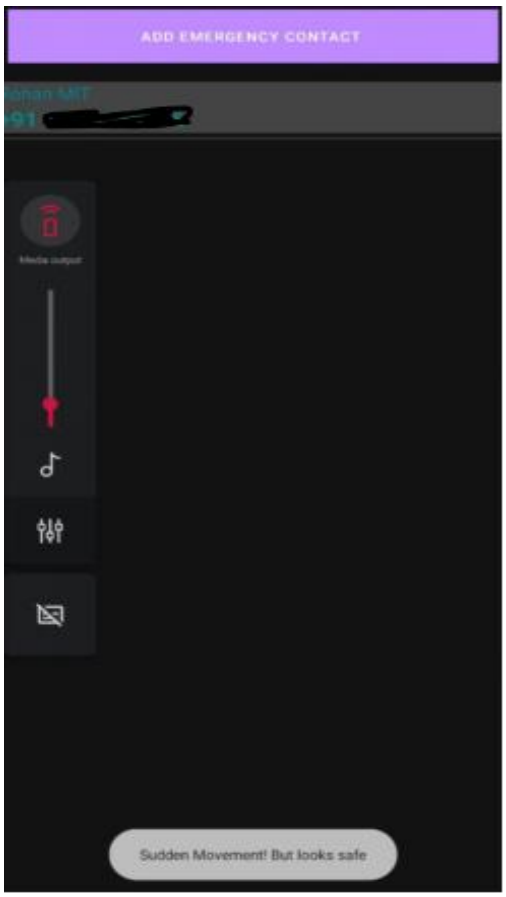

Fig.4.2

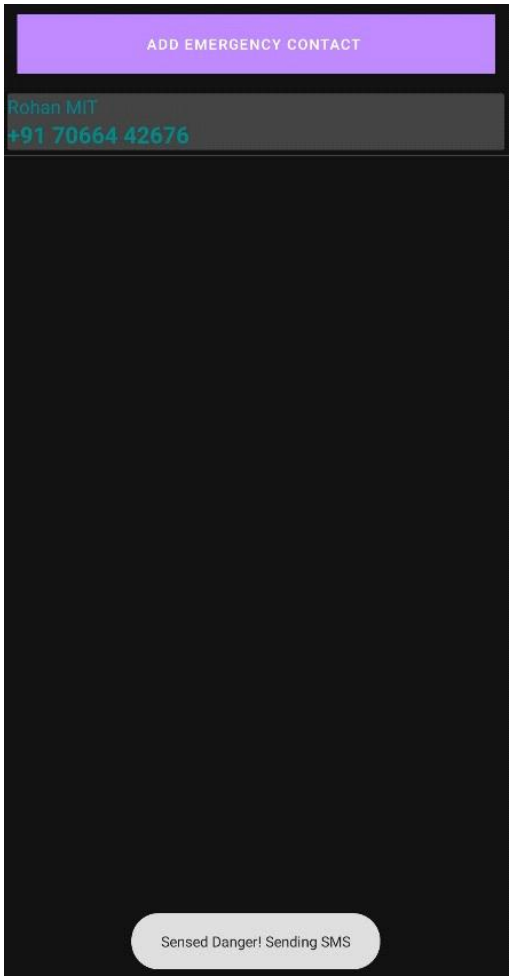

Fig 4.3

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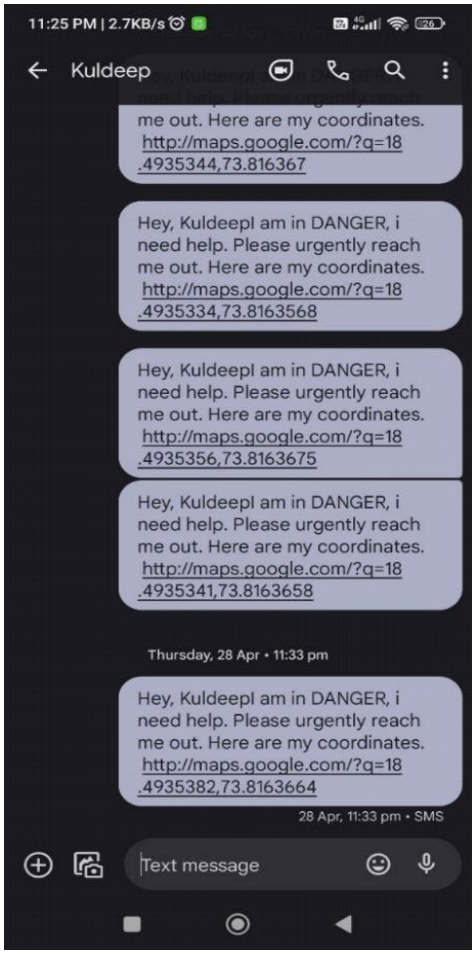

Fig. 4.4

V. Conclusion

By adopting an inclusive framework based on age categorization, implementing a refined shake detection algorithm, enhancing fall detection accuracy through sophisticated algorithms, and incorporating a guardian feature with real-time location updates for emergency contacts, the application provides comprehensive safety provisions for individuals of all ages and diverse needs. This ensures a reliable and effective safety solution, promoting the well-being and security of a wider user base.

This research paper introduces a mobile application designed to prioritize the safety of citizens. The application offers a simple yet effective method to alert contacts, loved ones, and guardians during emergency situations. By intentionally shaking the phone in an up-and-down motion, users can automatically send their GPS coordinates to ensure swift assistance. This innovative solution aims to minimize the occurrence of unwanted incidents, contributing to the reduction of crime rates and accidental scenarios.

Looking ahead, the development team is also focused on implementing a complementary module aimed at providing mental aid, particularly for children. This module involves recording audio data, which is then stored for further analysis. The recorded audio is converted into text format, enabling sentimental analysis. However, significant research and exploration are still required to refine the implementation process for this particular module. Overcoming this challenge is crucial to ensure its seamless integration and effectiveness in delivering much-needed mental support.

By combining these features within a single application, this research strives to make tangible contributions to citizen safety and well-being. By leveraging technology and innovative solutions, the application holds the potential to play a pivotal role in safeguarding individuals and communities.

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