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Raksha: A Safety Intelligence Navigation

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Abstract: ***In a large and densely populated country like India, ensuring safety across all public spaces remains a significant challenge, particularly for individuals traveling alone or during low-activity hours. Many existing safety solutions rely on static data or require constant manual intervention, making them less effective in real-world scenarios.***
This paper presents Raksha, a real-time mobile safety application that enhances situational awareness and emergency response through a multi-layered approach. Unlike traditional navigation systems that attempt to determine the "safest route," Raksha overlays safety intelligence on standard navigation paths by highlighting safe, moderate, and high-risk zones using crowd-sourced incident reports. This enables users to make informed decisions without relying on potentially unreliable route optimization.
The system integrates multiple safety mechanisms, including a dual-channel SOS alert system with offline resilience, a timer-based proactive safety check with server-side enforcement, real-time proximity alerts based on spatial analysis, and live location sharing. Built using Kotlin, Firebase, and Google Cloud services, Raksha emphasizes reliability, responsiveness, and user autonomy. The proposed system demonstrates a practical and scalable approach to improving personal safety through real-time data and layered protection mechanisms.
Keywords: Personal Safety, Real-Time Systems, Crowd-Sourced Data, Risk Visualization, Emergency SOS, Mobile Application, Location Tracking, Proximity Alerts, Android, Firebase.

I. INTRODUCTION

Personal safety remains a significant concern, particularly for individuals traveling alone or during low-activity hours. In a large and densely populated country like India, it is difficult to monitor every street, and unsafe conditions are often associated with isolated areas, poor lighting, and low pedestrian presence. Incidents such as harassment and assault are more likely to occur in such environments, making situational awareness an important factor in ensuring safety. Various technological solutions have been developed to address this issue, including mobile applications, IoT-based devices, and emergency alert systems. While these systems provide useful features such as SOS alerts and location sharing, many of them are reactive in nature or depend on static datasets. Some approaches attempt to classify routes as safe or unsafe and recommend alternatives, but such methods often rely on limited or unreliable data, reducing their effectiveness in real-world scenarios. To address these limitations, Raksha is proposed as a real-time mobile safety application that enhances user awareness and emergency response. Instead of enforcing route changes, the system overlays safety information onto standard navigation paths using color-coded indicators (safe, moderate, unsafe) based on crowd-sourced reports and spatial analysis. In addition, Raksha integrates features such as a dual-channel SOS system, safety timer, proximity alerts, and live location sharing to provide a comprehensive and practical safety solution.

A. Need for Women Safety Application

Personal safety is a critical aspect of societal well-being, and the increasing number of safety-related incidents highlights the need for reliable technological solutions. Traditional safety measures are often insufficient in dynamic, real-world environments where risks can vary based on location, time, and activity. Therefore, there is a growing need for systems that provide real-time awareness and immediate assistance. Mobile applications offer a practical solution, as smartphones are widely accessible and capable of supporting location-based services, communication, and real-time data processing. However, many existing applications are limited to basic emergency features and lack continuous situational awareness or proactive safety mechanisms.

The main objectives of developing the Raksha application are:

1) To provide real-time safety awareness by overlaying risk information on standard navigation routes using crowd-sourced data.
2) To enable rapid emergency response through a dual-channel SOS system with live location sharing.
3) To incorporate proactive safety features such as safety timers and proximity alerts to assist users during travel.

4) Limitations and Challenges

Safety applications face several challenges, especially in real-world conditions where network availability may be limited. Many features rely on internet connectivity, while critical situations can occur in low or no network areas. Although Raksha incorporates offline mechanisms for emergency alerts, certain functionalities still depend on connectivity.

The effectiveness of the system also depends on user participation, as crowd-sourced reports form the basis of safety visualization. In areas with low engagement, the accuracy and availability of safety data may be limited. Additionally, since Raksha provides risk awareness rather than enforcing route changes, users may choose to ignore safety indicators. While features like automated SOS via safety timers improve reliability, factors such as battery constraints and continuous location tracking remain practical challenges.

II. LITERATURE REVIEW

Abhaya [10], an Android application for women's safety, can be activated with a single click during emergencies. Upon activation, the application retrieves the user's location using GPS and sends it via SMS to registered contacts while also initiating a call to a primary contact. A notable feature of this system is its ability to send continuous location updates at regular intervals until the alert is stopped, enabling faster response and tracking of the user's movement. Several safety applications have been developed with similar objectives, focusing on emergency alerting and communication. These applications typically provide features such as SOS messaging, location sharing, fake calls, and basic alert mechanisms. Some systems also include additional functionalities like alarm triggers, vibration alerts, and emergency service integration. However, most of these solutions are primarily reactive, requiring manual user intervention during critical situations. Applications such as Suraksha and Smart 24x7 focus on tracking user location and enabling communication with emergency services, while Shake2Safety introduces gesture-based triggering mechanisms. SafetiPin, on the other hand, collects safety-related data from users and evaluates areas based on multiple parameters to indicate perceived safety levels. While these approaches contribute to improving personal safety, they often lack real-time contextual awareness, proactive safety mechanisms, and integrated systems that combine both emergency response and continuous risk monitoring.

III. METHODOLOGY

This section gives information about Raksha dataset used in this research work and the workflow involved in developing a mobile application.

A. WSA Dataset

Figure 1 provides an overview of the safety-related data used in the Raksha application, consisting of crowd-sourced reports associated with different locations. These reports include attributes such as incident type, severity level, time of occurrence, and geographic coordinates. The data is continuously collected from users and stored in a real-time database, allowing dynamic updates of safety information across different regions. Unlike static datasets used for pre-trained models, Raksha relies on live, user-generated data to represent current safety conditions. This data plays a crucial role in identifying risk-prone areas and enabling safety visualization along navigation routes.

report_id	category	incidentType	description	location_lat	location_lng	severity	status	reporterUid	timestamp
R001	HARASSMENT	Indecent Exposure	Man exposed himself near ATM.	28.67711084	77.39620462	7	PENDING	Y5o0qX3KT8MUuprHrYiyw67v9802	1774375978470
R002	HARASSMENT	Verbal Harassment	Catcalled and passed inappropriate comments.	28.67388300	77.39391670	5	PENDING	G9pZkL7QmN3RvStW2aBxY8c9123	1774375894338
R003	HARASSMENT	Being Followed / Stalked	Felt like someone was following me on the way home.	28.66804708	77.39721112	6	PENDING	J4nQvD6RwP9TkMuX8zLcY1d2345	1774377266534
R004	HARASSMENT	Physical Harassment	Man tried to grab my arm in the bus.	28.66124500	77.38451200	8	PENDING	K7mRtF2LpV6ZmWxQ3bNyJ5e3456	1774378123456
R005	THEFT	Pickpocketing	Phone was stolen in a crowded market.	28.65789000	77.39123400	6	PENDING	L2xPdV8MnT1QwRyZ4cOpK6f4567	1774378456123
R006	THEFT	Bag Snatching	Bag was snatched while walking.	28.67012300	77.40567800	7	PENDING	M6rWsG3NtY5LpQzA7dRvL8g5678	1774378667123
R007	SAFETY	Poor Lighting	Street lights not working in area.	28.67451200	77.39012300	4	PENDING	N8tXuH9PmZ2RvBcD5eQwM9h6789	1774379001123
R008	SAFETY	Isolated Area	Very isolated area, no people around	28.68098700	77.36789000	5	PENDING	P1vYzJ4QwR7TkLmE6fNxN0i7890	1774379345123
R009	SAFETY	Drunk / Suspicious People	Group of drunk men loitering near park.	28.67123400	77.39876500	6	PENDING	Q3rTyU7PvW9XmJ2AkLdE1p9012	1774379556789
R010	HARASSMENT	Eve Teasing	Whistled and teased near college.	28.66678900	77.38567800	5	PENDING	R6aVzD8QpX1LmN3TyErF4q0123	1774379823123
R011	THEFT	Vehicle Theft Attempt	Someone tried to steal my scooter.	28.67345600	77.40098700	7	PENDING	S8bWqK9LmZ2NvB4UjHtR5s1234	1774380123456
R012	SAFETY	Construction Hazard	Open manhole without cover.	28.67890100	77.38901200	4	PENDING	T9cXpL0MnA3OwC5VkJuG6t2345	1774380456123
R013	HARASSMENT	Touching / Groping	Inappropriate touching in bus.	28.65987600	77.39234500	8	PENDING	U1dYqN3PoB4PxD6WkIvH7u3456	1774380765123
R014	SAFETY	Crowded & Unsafe	Too much crowd, felt unsafe.	28.66321000	77.38045600	3	PENDING	V2eZrO4QnC5QyE7XIKwI8v4567	1774381089456
R015	HARASSMENT	Stalking (Offline)	Same person keeps following regularly.	28.66954300	77.39567800	7	PENDING	W3fAsP5RoD6RyF8YmLxJ9w5678	1774381298123
R016	THEFT	Chain Snatching	Chain was pulled while on bike.	28.67234500	77.40234500	6	PENDING	X4gBtQ6SpE7SzG9ZnMyK0x6789	1774381612345
R017	SAFETY	No CCTV	No CCTV cameras in the lane.	28.67567800	77.38876500	4	PENDING	Y5hCuR7TqF8TaH0AoNzL1y7890	1774381890567
R018	HARASSMENT	Threatening Behaviour	Man threatened after I refused.	28.66891200	77.39178900	9	PENDING	Z6iDvS8UrG9UbI1BpOaM2z8901	1774382104123
R019	SAFETY	Traffic Violation Risk	Vehicles overspeeding at night.	28.66780100	77.40321000	4	PENDING	A7jEwT9VsH0VcJ2CqPbN3a9012	1774382398456
R020	SAFETY	Abandoned Building	Abandoned building causing insecurity.	28.66011200	77.38765400	5	PENDING	B8kFxU0WtI1WdK3DrQcO4b0123	1774382689123

FIGURE 1. WSA Dataset Pertaining to Ghaziabad Area in Uttar Pradesh

B. Workflow

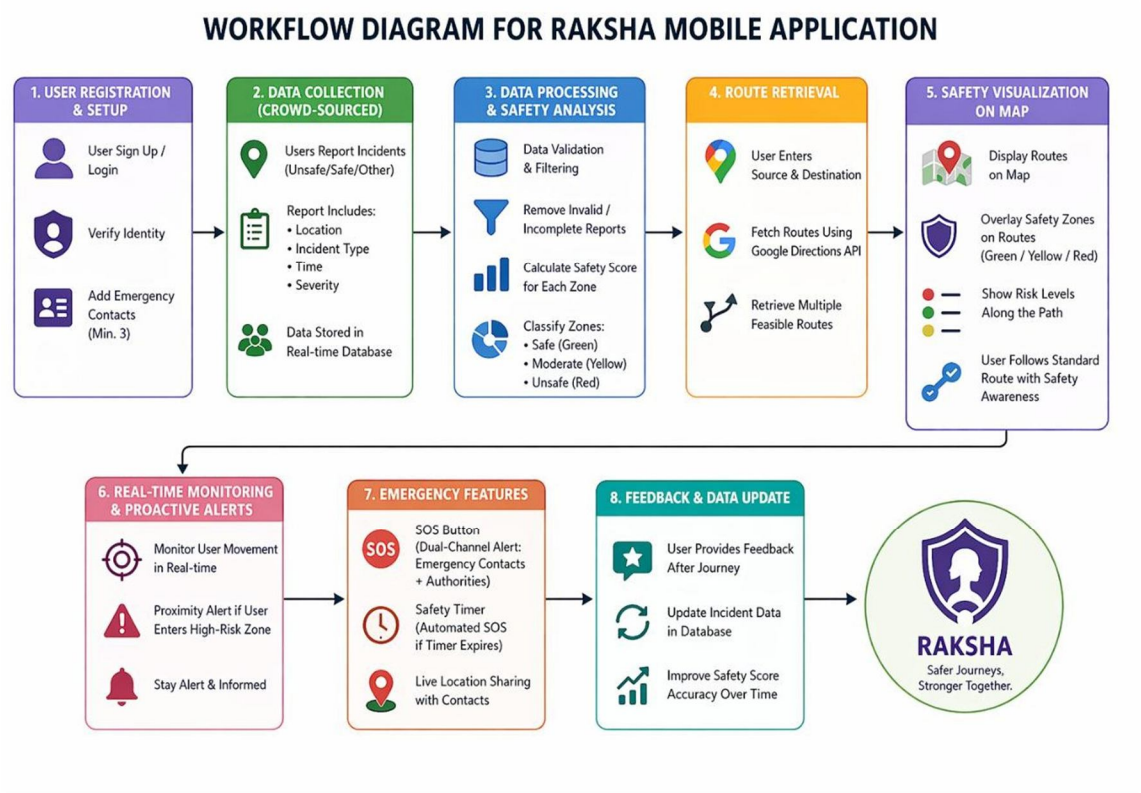

FIGURE 2. Workflow Diagram for Raksha Mobile Application

The application verifies the user through authentication and allows adding emergency contacts for communication during critical situations. Safety data is collected through crowd-sourced reports and stored in a real-time database, which is continuously updated based on user activity.

When a user enters a source and destination, the route is retrieved using the Google Directions API and displayed on the map interface. Instead of modifying the route, Raksha overlays safety information along the path using color-coded indicators representing different risk levels. Proximity alerts monitor the user's movement relative to reported incidents, while features such as safety timer and SOS ensure emergency response when required.

The following modules are involved in the overall functioning of the system:

- Data Collection and Report Management
- Route Retrieval and Visualization
- Mobile Application Design and Implementation
- Real-Time Safety Monitoring and Alerts
- Emergency Response and Notification System

C. Data Collection and Preprocessing

Raksha does not rely on a static dataset but instead utilizes dynamically collected, crowd-sourced data. Safety-related information is gathered through user-submitted reports, which include attributes such as incident type, severity level, geographic coordinates, and time of occurrence. This data is stored in a real-time database and continuously updated based on user activity.

The collected data may vary in quality and completeness, and basic filtering is applied during processing to maintain consistency. The system prioritizes recent and location-relevant reports to represent current safety conditions. Data collected across different regions enables the application to reflect dynamic safety levels based on real-time user input rather than predefined datasets.

D. Mapping Feasible Routes

The system retrieves navigation routes using the Google Directions API and displays them on the map interface. Instead of classifying areas as strictly safe or unsafe, Raksha evaluates safety conditions based on crowd-sourced reports associated with locations along the route. These reports include factors such as incident type, severity, time, and proximity to the user's path.

The safety level of different segments along the route is represented using color-coded indicators, allowing users to visually identify safer and risk-prone areas. This information is dynamically updated as new reports are added, ensuring that the system reflects current conditions. All data is stored in Firebase and synchronized across clients in real time, while also supporting offline persistence for continued accessibility.

E. Design of Mobile Application

The user logs into the application using secure authentication, and emergency contacts are added for communication during critical situations. The interface of the Raksha application is designed to be user-friendly and responsive. Kotlin programming language is used for development, and Android Studio IDE is used to implement the following functionalities:

- The user logs into the application using Google Sign-In or authentication services.
- The user adds and manages emergency contacts for SOS alerts.
- The user enters the source and destination locations.
- The system retrieves and displays the route using the Google Directions API.
- Safety information is overlaid on the route using color-coded indicators.
- The user is provided with navigation details such as estimated time of arrival.
- During the journey, real-time alerts such as proximity warnings and safety timer monitoring are active.
- In case of an emergency, the user can trigger an SOS alert, which sends live location information to emergency contacts.

F. User Authentication and Verification

Raksha implements a secure authentication mechanism to ensure controlled access to the application. Users sign in using authentication services such as Google Sign-In, which is integrated with Firebase Authentication. This approach provides a reliable and seamless login experience without requiring manual identity verification through documents.

User information is securely stored and managed using cloud-based services, allowing access to personalized features such as emergency contacts and safety preferences. Additional verification steps, such as phone number authentication using OTP, can be optionally enabled to enhance account security.

The authentication system is designed to be efficient, privacy-aware, and scalable, ensuring that users can quickly access safety features without complex onboarding procedures while maintaining data integrity and security.

G. Route Suggestion Algorithm

Google Maps Platform provides a set of APIs and SDKs that enable integration of mapping and navigation features into mobile applications. Using the Google Maps Android API and Location Services API, the user's current location is displayed and updated in real time. The Google Directions API is used to retrieve and render routes between the selected source and destination on the map interface.

Instead of suggesting an alternative safest route, Raksha overlays safety information along the retrieved path using color-coded indicators based on crowd-sourced reports. These visual markers highlight varying risk levels across different segments of the route. The user can then interpret this information and choose how to proceed, ensuring both awareness and autonomy during navigation.

H. Visualization of the Safest Route

The retrieved route is displayed to the user along with navigation details such as the estimated time of arrival. Safety information is overlaid on the route using color-coded indicators, allowing the user to identify safe, moderate, and high-risk areas along their path.

I. Feedback of Zonal Safety

Safety data is continuously updated through crowd-sourced reports submitted by users. These reports contribute to refining the safety representation of different areas in real time. The system dynamically reflects recent conditions based on incoming data, ensuring that users receive updated safety information.

In addition, Raksha integrates emergency features such as SOS alerts and proximity warnings to handle critical situations during travel. The overall functionality of the application is achieved through the coordination of multiple interconnected modules, enabling both situational awareness and emergency response while maintaining a user-friendly experience.

IV. RESULT AND ANALYSIS

A. Design of Mobile Application

Figure 3 depicts the Raksha mobile application interface developed for the Android platform. The application provides an intuitive onboarding experience, introducing key features such as safety-aware navigation, community-based reporting, and proactive safety mechanisms.

Figure 4 highlights key screens of the application, including onboarding modules, permission setup, and core safety features. The application supports functionalities such as route visualization with safety indicators, safety timer for automated alerts, user reporting of unsafe locations, and SOS alerts to emergency contacts. Additionally, the app requests essential permissions like location and notifications to enable real-time alerts and tracking features.

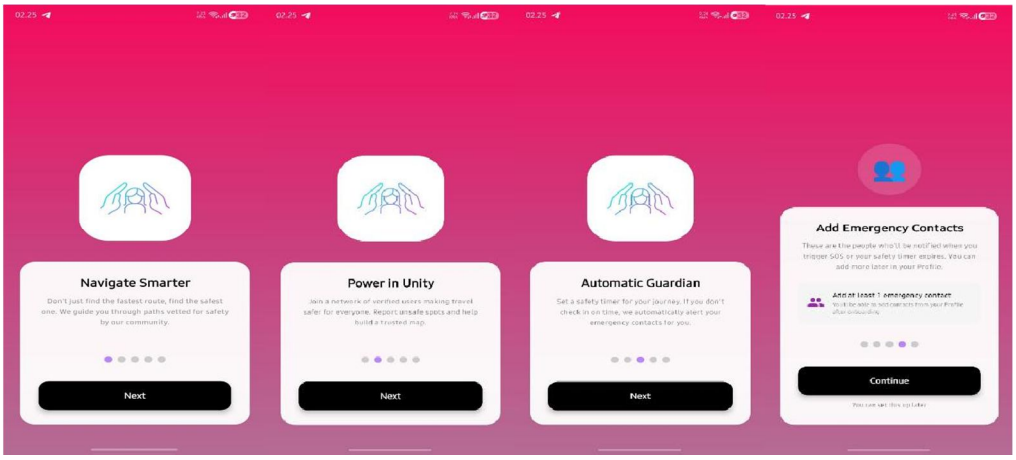

FIGURE 3 FIGURE 4 FIGURE 5 FIGURE 6

FIGURE 7

B. Home Screen Overview

The home screen (FIGURE 8 and 9) of Raksha serves as the central interface, integrating navigation, safety awareness, and emergency features into a single view. It is designed to provide quick access to essential functionalities while maintaining a simple and intuitive layout.

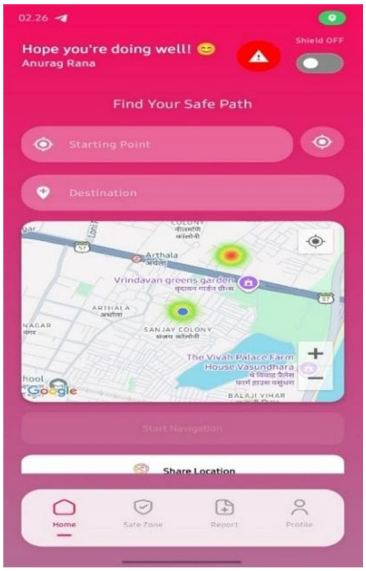

FIGURE 8

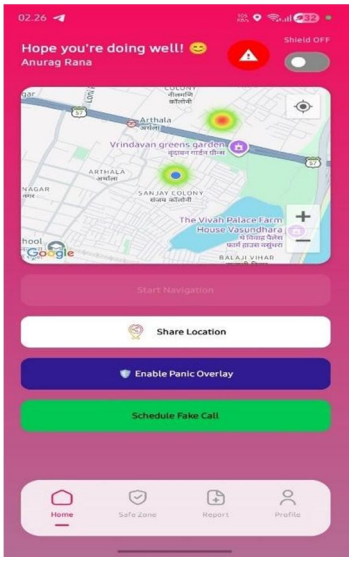

FIGURE 9

C. Route Input and Safety Visualization

The user can enter the starting point and destination directly from the home screen. Once selected, the route is displayed on the map using Google Maps integration. Safety conditions along the route are visualized using color-coded indicators, highlighting safe, moderate, and high-risk areas to enhance situational awareness.

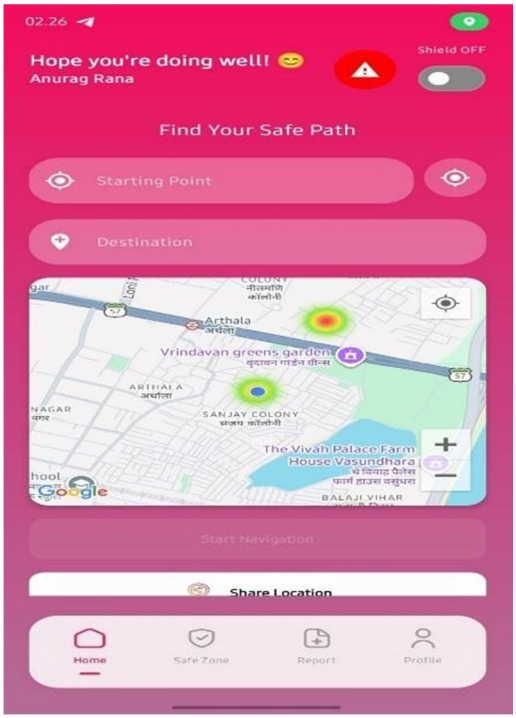

FIGURE 10

D. Location Sharing Module

The application provides a location sharing feature, allowing users to share either their current location or live location with trusted contacts. Live location sharing enables real-time tracking, while static sharing provides a quick snapshot of the user's position.

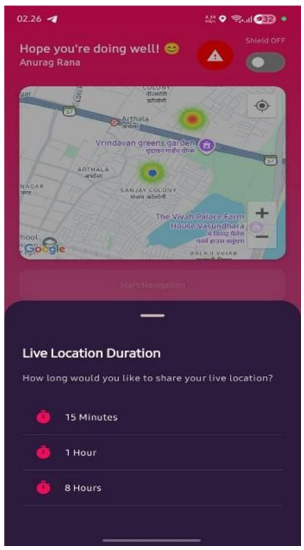

FIGURE 11

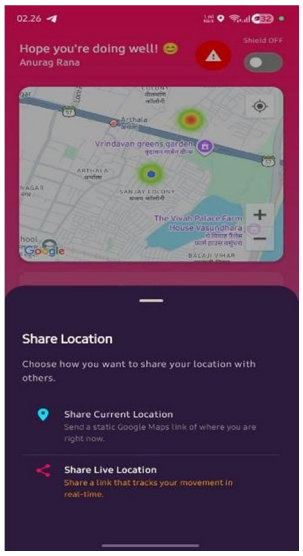

FIGURE 12

E. Emergency and Quick-Access Features

Raksha provides multiple quick-access safety features directly from the home screen. The panic overlay enables users to trigger emergency actions instantly, even while using other applications. The fake call scheduling feature allows users to simulate an incoming call by selecting a contact and setting a delay, helping them exit uncomfortable situations discreetly.

FIGURE 13

F. Proactive Safety Monitoring

The application includes a timed safety check feature that allows users to set a duration for their journey. If the user does not confirm their safety within the specified time, an automatic alert is triggered, sending the last known location to emergency contacts. This proactive mechanism ensures user safety even when manual intervention is not possible.

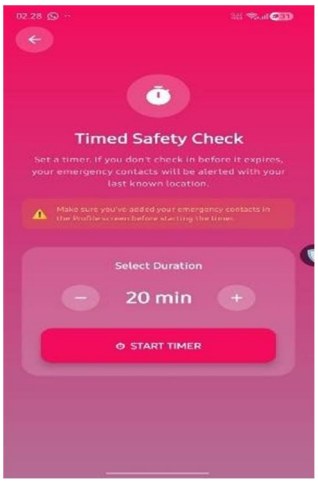

FIGURE 14

G. Route Analysis and Navigation Modules

Raksha provides route-related insights such as estimated time, distance, travel modes, and detected incidents along the selected path. This helps users make informed decisions before starting navigation.

A bottom navigation bar enables seamless access to additional modules such as Safe Zone, Report, and Profile, ensuring smooth interaction across different features of the application.

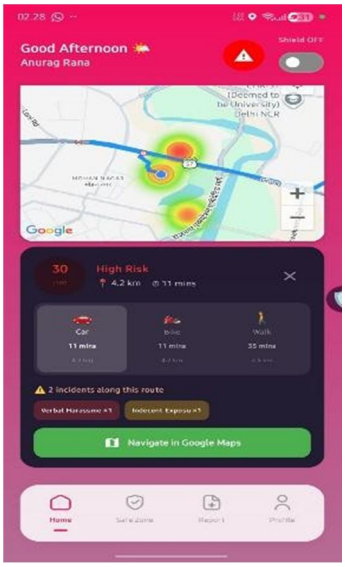

FIGURE 15

H. Safe Zone Module

The Safe Zone module provides users with access to nearby safety resources and essential services based on their current location. This screen is designed to enhance situational awareness by combining safety tips, emergency services, and location-based safe zones in a single interface.

The module displays nearby emergency services such as police stations, hospitals, and fire stations, along with their relative proximity. Users can quickly access directions to these locations, enabling faster response during critical situations. In addition, the application highlights nearby safe zones, including verified locations such as police outposts and medical facilities, along with distance information for easy navigation. The interface also includes safety tips to promote awareness and encourage preventive actions during travel. By integrating real-time location data with essential services, the Safe Zone module acts as a support system that helps users identify and reach safer locations when needed.

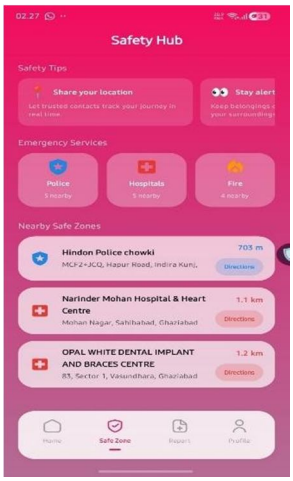

FIGURE 16

I. Incident Reporting Module

The Report module allows users to submit safety-related incidents, contributing to the crowd-sourced data used for risk visualization. Users can report incidents by selecting the incident type, specifying the location, providing an optional description, and assigning a severity level using a slider-based input.

To ensure data reliability and prevent misuse, the application restricts report submission to verified users only. This verification mechanism helps maintain the authenticity of reports and reduces the likelihood of false or misleading information being added to the system.

Submitted reports are stored in a real-time database and are used to update safety indicators across different locations. These reports directly influence the visualization of risk levels on the map, enabling dynamic and up-to-date safety awareness for all users.

FIGURE 17

J. User Profile and Configuration Module

The Profile module manages user information, verification status, and personalized safety settings within the Raksha application. It serves as a centralized space where users can configure preferences and manage emergency-related data.

The profile screen displays basic user details such as name, email, and phone number, along with a verification indicator. Only verified users are allowed to submit incident reports, ensuring the reliability and authenticity of crowd-sourced data within the system.

The module also includes a Medical ID section, allowing users to store critical health-related information that can be useful during emergencies. In addition, users can configure safety settings such as default timer duration and customizable SOS messages, enabling a more personalized emergency response experience.

Emergency contacts can be added, edited, or removed directly from the profile section. These contacts are used for features such as SOS alerts, live location sharing, and timed safety checks.

Overall, the Profile module enhances both usability and data integrity by combining user management, verification, and safety customization in a single interface.

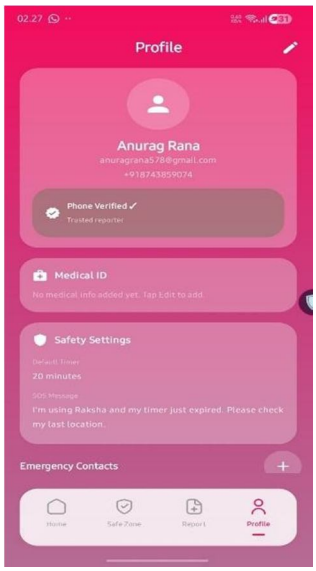

FIGURE 18

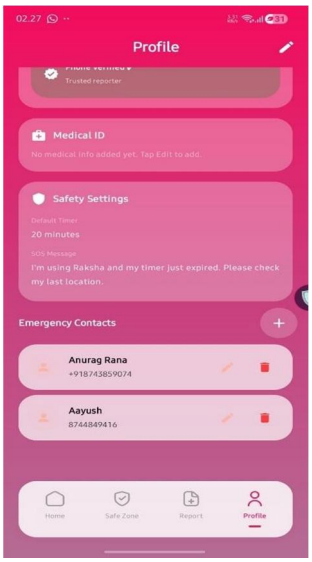

FIGURE 19

V. CONCLUSION

This paper presented Raksha, a real-time mobile safety application designed to enhance situational awareness and emergency response. The system integrates crowd-sourced safety data with location-based services to provide users with risk visualization along their navigation routes, allowing informed decision-making without enforcing route changes.

The application combines multiple safety mechanisms, including real-time alerts, location sharing, timed safety checks, and an emergency SOS system, creating a layered approach to personal safety. The use of verified users for incident reporting improves data reliability, while continuous updates ensure that safety information remains relevant to current conditions.

Although the system depends on user participation and network availability, it demonstrates a practical and scalable solution for improving personal safety through real-time data and integrated mobile technologies. Overall, Raksha provides a balanced approach between user autonomy and safety awareness, making it a useful tool for everyday travel scenarios.

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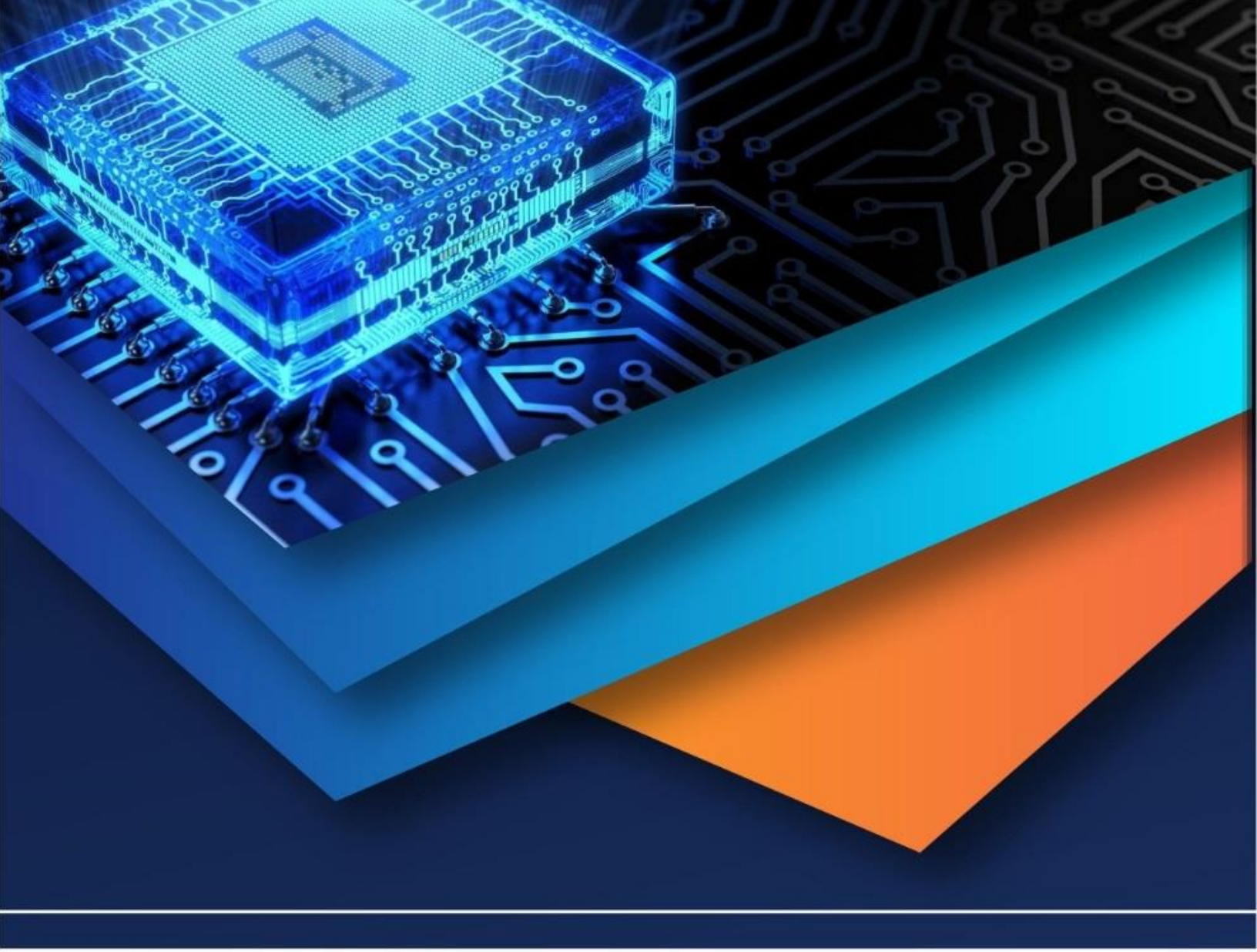

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