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A Location Based Safety Application for Enhancing Women's Safety

Prof. Rekha Sahare[1]

Assistant Professor, Department of Computer Science and Engineering, Government College of Engineering Chandrapur, Maharashtra, India

Manish Walurkar[2], Rohit Farkade[3], Mansi Bambode[4], Gaznavi Sheikh[5], Uzma Ali[6]

Final year student. Department of Computer Science & Engineering, Government College of Engineering, Chandrapur, India

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Abstract - Women's safety remains a critical and urgent concern, as evidenced by the increasing incidence of harassment and violence, necessitating the development of innovative, technology-driven solutions. Although numerous mobile applications have been designed to address this issue, many fails to deliver essential functionalities. These deficiencies include the lack of real-time emergency response mechanisms, seamless tracking capabilities, and proactive safety features that meaningfully enhance user protection. Often, these applications rely on outdated alert systems and exhibit delayed SOS notifications, undermining their effectiveness in critical situations. To address these shortcomings, 'Shield Sisters' was developed as a Flutter-based mobile application aimed at equipping women with reliable and practical safety tools. The application integrates instant SOS alerts, real-time location tracking, an intelligent geofencing system, and a community-driven safety reporting mechanism. Its robust technological infrastructure comprises MongoDB, Node.js, and Firebase Firestore for efficient backend operations, the Twilio API for immediate emergency SMS notifications, and the Google Maps API for precise, real-time geolocation services. Shield Sisters classifies locations into Safe Zones (e.g., police stations and hospitals), Red Zones (e.g., high-risk areas), and Neutral Zones, providing users with timely warnings before entering potentially dangerous areas. Furthermore, its live tracking feature updates the user's location every ten seconds, enabling trusted contacts to monitor movements with accuracy. To ensure security and privacy, Shield Sisters employs SHA-256 encryption for password protection, JWT-based authentication for user verification, and role-based access controls to restrict emergency contact privileges. The application's performance, scalability, and security were rigorously evaluated using Flutter's testing framework, Thunder Client for API validation, and stress testing to assess server load capacity. Designed for speed, scalability, and dependability, Shield Sisters offers a trustworthy solution that users can rely upon in moments of need.

***Key Words*:** women's safety application, real-time tracking, firebase, node.js, mongo DB, flutter Application

1.INTRODUCTION

Violence, harassment, and assault against women remain pervasive and persistent challenges. In India, the National Crime Records Bureau documented over 400,000 reported crimes against women in 2021, underscoring an urgent need for enhanced safety measures [National Crime Records Bureau, 2022]. While various mobile applications have been developed to address this issue, many fall short in delivering critical functionalities. These shortcomings include the absence of real-time emergency responses, effective geofencing, and reliable tracking systems, often resulting in delayed SOS alerts, inconsistent background performance, and failure to function without stable connectivity, as noted in reviews of existing safety applications [Hodes et al., 2021]. Moreover, most existing solutions do not provide warnings prior to users entering high-risk areas. Shield Sisters was developed to address these deficiencies. The application integrates instant SOS alerts, real-time location tracking, an intelligent zoning system, and a community-driven mechanism for reporting safety concerns. Its robust technological framework includes MongoDB for secure data storage, Node.js for efficient backend processing, Firebase Firestore for live tracking, Twilio for emergency SMS notifications, and the Google Maps API for precise geolocation services. The SOS functionality serves as a critical feature, enabling users to trigger a distress signal by pressing a button. This action promptly sends an alert to designated contacts, accompanied by the user's exact location, battery status, and a timestamp. Additionally, the system activates a 'loud siren' to attract immediate attention, facilitating rapid assistance. The real-time tracking capability updates the user's position every ten seconds and allows trusted contacts to monitor movements remotely via a shared link. A distinguishing aspect of Shield Sisters is its geofencing system, which categorizes locations into safe zones (e.g., police stations and hospitals), red zones (e.g., areas with high crime rates or liquor stores), and neutral zones. The application issues alert to users approaching red zones, offering the opportunity to alter their route or seek assistance. Users can also contribute to a collective safety database by reporting hazardous areas, enhancing the system's effectiveness over time. The application simplifies emergency contact management, allowing users to add, modify, or remove contacts with real-time synchronization across all features. It further includes a safety manual and helpline section, providing self-defense guidance, legal rights information, and direct access to law enforcement and medical services through a single tap. Data security is prioritized, with SHA-256 encryption safeguarding passwords, JWT-based authentication verifying user identity, and role-based access controls restricting emergency contact privileges. Rigorous testing—utilizing Flutter's testing framework, Thunder-Client for API validation, and stress tests

for server capacity—has confirmed the application's scalability and resilience. This paper provides an in-depth examination of Shield Sisters, detailing its design, system architecture, development process, and testing methodologies. It also outlines prospective enhancements, including AI-driven threat prediction, offline emergency capabilities, and integration with law enforcement for expedited response times, aligning with emerging trends in safety technology research [Hodes et al., 2021]. By combining real-time tracking, proactive alerts, and community collaboration, Shield Sisters transcends conventional safety applications, offering a dependable and contemporary solution to improve women's security in daily life.

2. LITERATURE REVIEW

Numerous mobile applications have been developed to support women's safety, incorporating features such as emergency alerts, location tracking, and incident reporting. However, many of these applications exhibit significant limitations, including delayed SOS alerts, inconsistent tracking reliability, excessive battery consumption, and a dependency on continuous internet connectivity. For instance, Stree-Raksha provides SOS alerts and an audible siren but fails to operate effectively in the background, limiting its utility when the device is locked or in power-saving mode [Kolte et al., 2023]. Abhaya integrates GPS tracking with law enforcement connectivity, yet its functionality is contingent upon uninterrupted internet access, rendering it less reliable in areas with poor network coverage [Singh et al., 2017]. Safetipin enables users to report unsafe locations and provides safety scores based on crowd-sourced data but lacks real-time tracking capabilities, reducing its effectiveness in dynamic emergencies [Ratnam & Sen, 2015]. Similarly, Safe Naari offers location tracking and audio/video recording functionalities, though it is hindered by inaccurate GPS performance and substantial battery usage, compromising its practicality over extended periods [Hodes et al., 2021]. A common drawback among these applications is the requirement of multiple steps to activate an SOS alert, resulting in delays during time-sensitive emergencies. Furthermore, most do not provide advance notifications to users approaching high-risk areas, limiting their proactive potential. Shield Sisters addresses these deficiencies by implementing an instantaneous SOS system that transmits alerts via SMS, ensuring operational reliability even in areas with limited network coverage, as evidenced by its design to overcome the connectivity issues seen in applications like Abhaya [Singh et al., 2017]. The application updates the user's location every ten seconds, delivering precise real-time tracking, and employs a geofencing system that classifies regions into safe, red, and neutral zones, thereby offering proactive safety notifications—features that address the tracking and alert gaps noted in Safeti-pin and Safe Naari [Hodes et al., 2021; Ratnam & Sen, 2015]. Additionally, users can contribute to a community-driven safety network by reporting hazardous areas, enhancing collective security. Shield Sisters is designed to function efficiently in the background, maintaining its effectiveness even when the device is locked or operating in power-saving mode, thus resolving the operational challenges observed in Stree-Raksha [Kolte et al., 2023]. This approach aligns with broader research highlighting the need for reliable, low-connectivity solutions, positioning Shield Sisters as a comprehensive response to the safety challenges underscored by the National Crime Records Bureau's report of over 400,000 crimes against women in India in 2021 [National Crime Records Bureau, 2022].

3. SYSTEM ARCHITECTURE

The system architecture of Shield Sisters is engineered to deliver real-time safety assistance, robust data management, and effective communication among users, emergency contacts, and backend services. It adheres to a client-server model, wherein the mobile application interfaces with a backend server, a database, and third-party APIs to provide core functionalities, including SOS alerts, real-time tracking, geofencing-based warnings, and secure authentication.

System Components:

Shield Sisters comprises multiple integrated components, each tasked with distinct responsibilities to ensure a cohesive and reliable safety solution.

- ✓ Mobile Application (Front-end): Developed using Flutter, the application offers cross-platform compatibility for Android and iOS devices. The front-end manages user interactions, facilitates SOS alert activation, enables location tracking, and provides map-based geofencing notifications.
- ✓ Backend Server: Built with Node.js, the backend oversees user authentication, data processing, and API coordination. It ensures secure data transmission and efficiently handles user requests.
- ✓ Database Management: MongoDB serves as the database, storing user credentials, emergency contact details, SOS alert records, reported locations, and geofencing data. It supports rapid data retrieval while upholding stringent security and privacy standards.
- ✓ Real-Time Tracking and Notifications: Firebase Firestore enables real-time updates for location tracking, allowing designated contacts to monitor a user's movements. Firebase Cloud Messaging (FCM) delivers timely push notifications to keep users and contacts informed.

Emergency Communication Services: The Twilio API supports instantaneous SMS alerts for SOS notifications, ensuring that emergency messages are transmitted to trusted contacts, even in areas with limited network connectivity.

4. FEATURE & IMPLEMENTATION

4.1. Secure Login System

The application includes a secure login system where users register using an email and password. Authentication is managed through JSON Web Tokens (JWT), and passwords are stored securely in MongoDB with SHA-256 encryption. This ensures data protection and prevents unauthorized access.

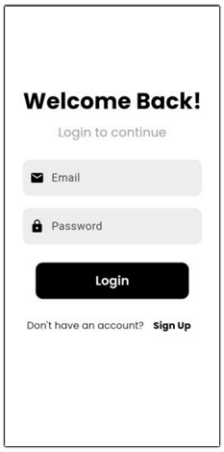

Fig-4.1a: Login Page

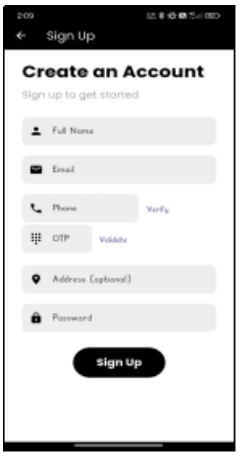

Fig-4.1b: Register Page

Fig-4.3: Map Page

4.2. SOS Alert System

The SOS alert system allows users to trigger an emergency alert with a single tap. The system collects and sends the user's live location, battery percentage, and timestamp to registered emergency contacts via Twilio SMS services. Additionally, the application triggers a loud alarm to alert nearby people even if the phone is on silent mode.

Fig-4.2: SOS Homepage

4.3. Map and Zoning System

Shield Sister integrates a geofencing-based zoning system using Google Maps API. Locations are categorized into safe zones such as hospitals and police stations, red zones such as crime-prone areas and liquor stores, and neutral zones. The application alerts users before entering red zones and allows them to navigate toward safe zones. Users can also report unsafe locations, contributing to a community-driven safety network.

4.4. Real-Time Location Tracking

Users can share their live location with trusted contacts through a generated tracking link. Location updates occur every ten seconds using Firebase Firestore. The tracking system is optimized for minimal battery consumption while maintaining accuracy.

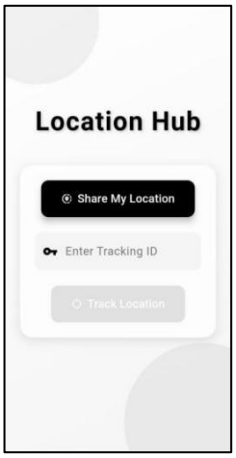

Fig-4.4a: Send Location

Fig-4.4b: Track Location

4.5. Contact Management System

The application allows users to add, update, and remove emergency contacts. These contacts receive SOS alerts and tracking links when the user is in distress. Contact information is stored securely in MongoDB and updated in real time.

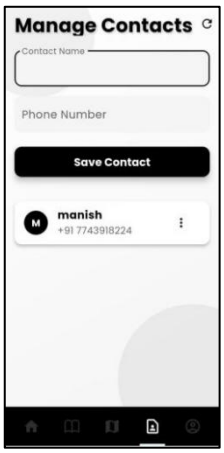

Fig-4.5: Contact Page

Fig-4.7a: Manual Page

Fig-4.7b: Helpline Page

4.6. User-Reported Safety System

Users can mark and report unsafe locations, which are then displayed to other users. Reports include details such as timestamps, location, and optional descriptions. This feature enhances community-driven safety awareness.

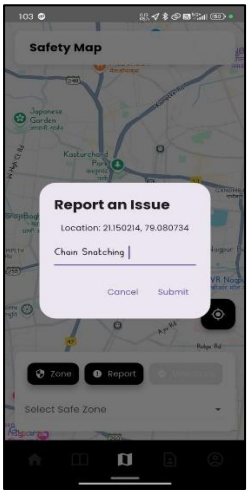

Fig-4.6: Reporting System

4.7. Manuals and Helplines

Shield Sister provides in-app manuals containing self-defense tips, emergency response guides, and instructions on using the application's features. The helpline section includes emergency contact numbers, allowing users to call for help directly from the app.

5. FUTURE SCOPE

The Shield Sisters application holds significant potential for further enhancement through the adoption of emerging technologies. Future research and development efforts can target the following areas to strengthen its efficacy:

- **Artificial Intelligence-Based Threat Detection:** Subsequent iterations could leverage machine learning models to analyze user movement patterns alongside historical crime data. Such an approach would enable the system to anticipate potential risks, issue proactive safety notifications, and recommend safer routes in real time.
- **Wearable Device Integration:** Research could explore integrating the application with smartwatches and dedicated panic buttons, enabling users to activate SOS alerts instantaneously without needing to access their smartphones. This enhancement would accelerate response times and provide a more fluid mechanism for emergency assistance.
- **Offline Emergency Support:** To mitigate reliance on network connectivity, future versions could incorporate SMS-based distress signals and Bluetooth-enabled location sharing. These capabilities would allow users to transmit emergency alerts even in areas with limited network availability, ensuring functionality during critical situations.
- **Real-Time Law Enforcement Connectivity:** Additional development could prioritize direct integration with law enforcement agencies. Real-time distress signals could be relayed to police control centers, and automated crime reporting features could be introduced to facilitate incident documentation and enhance emergency response efficiency.

By integrating these advancements, Shield Sisters can transform into a more sophisticated, accessible, and effective safety solution. Ongoing contributions from researchers, developers, and policymakers will be instrumental in refining these enhancements, thereby fortifying the system's capacity to address women's safety challenges comprehensively.

6. DIAGRAMS AND FLOWCHARTS

Application Flowchart:

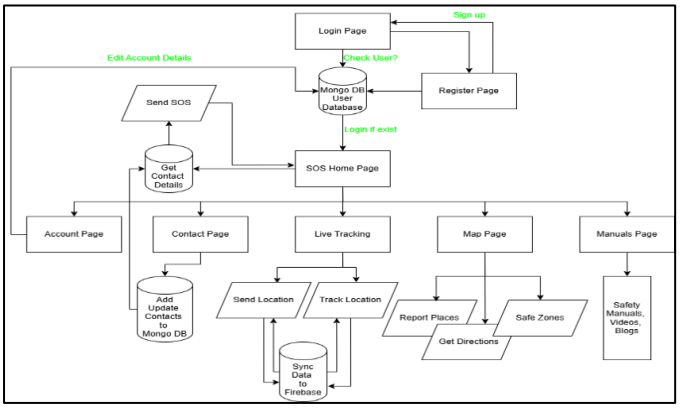

Fig-6.1: Flowchart of Application

4. RESULT & ANALYSIS

Shield Sister stands out from existing safety apps with its fast emergency response and user-friendly interface. The SOS feature instantly notifies emergency contacts and nearby authorities, triggering a loud siren for immediate attention. Users can also report incidents in real-time, contributing to a dynamic Safe Area Score that helps assess location safety. The app's live tracking ensures accurate location sharing with minimal battery consumption, making it reliable for travel.

By combining instant alerts, community-driven safety insights, and real-time tracking, Shield Sister empowers

3. CONCLUSIONS

Shield Sisters is a robust mobile application engineered to support women's safety through real-time tracking, emergency alerts, geofencing-based security protocols, and a community-driven safety reporting framework. The application overcomes the shortcomings of existing safety tools by incorporating dependable SOS activation, real-time location sharing, and preemptive safety notifications. It harnesses technologies such as Flutter for cross-platform functionality, MongoDB for secure data management, Twilio for immediate emergency communication, and the Google Maps API for sophisticated geofencing, delivering a cohesive and efficient safety solution.

Experimental evaluations and testing validated the application's performance in practical settings. SOS alerts were transmitted within seconds, live tracking operated with negligible latency, and geofencing notifications effectively warned users prior to entering high-risk zones. The application was fine-tuned to optimize battery usage and enhance security, ensuring consistent performance even in areas with limited network connectivity.

Looking ahead, the incorporation of advancements such as AI-driven threat detection, wearable device compatibility, offline emergency functionalities, and direct law enforcement integration will position Shield Sisters as a more advanced and accessible safety platform. This initiative underscores the transformative role of technology in mitigating security risks and equipping individuals with immediate protective measures. Through ongoing refinement and the expansion of its feature set, Shield Sisters offers a scalable and forward-thinking strategy for enhancing women's safety, contributing to the creation of safer public and private environments.

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