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KAVACH: Automated Emergency Trigger-Based Women Safety App

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***Abstract*— Women safety in emergency situations requires rapid response mechanisms that function with minimal user interaction. This paper presents KAVACH, an automated emergency trigger-based Android application designed to provide instant distress communication and location sharing. The system introduces a dual activation mechanism combining shake-based detection and a floating SOS overlay that operates across all mobile screens. Unlike conventional safety applications that depend on manual interaction or continuous internet connectivity, the proposed system ensures reliable SMS-based alert transmission even in low-network environments. The application integrates real-time location tracking using the Location Provider API, secure backend management through Firebase, and a guardian PIN verification mechanism to prevent false alerts. Experimental evaluation demonstrates improved response time, reliable alert delivery, and enhanced usability under real-world conditions. The proposed system demonstrates strong potential for deployment in smart safety infrastructure and real-time emergency response frameworks.**

***Keywords*— Women Safety System, Android Application, Floating SOS, Shake Detection, Firebase, Location Provider API, SMS Manager, Emergency Alert System.**

I. Introduction

Smartphones are increasingly used as personal safety tools, yet in many critical situations users cannot reliably unlock the device, open an application, and manually trigger an SOS request. During harassment, assault, or sudden medical emergencies, even a few seconds of delay can affect the timeliness and effectiveness of any assistance. Conventional women's safety applications usually depend on explicit button presses and stable internet connectivity for tracking and alerting, which limits their reliability in real-world high-stress scenarios.

Many existing solutions require foreground interaction and active data connections for location sharing, so they may fail when the device is locked, the user's movement is restricted, or network coverage is weak. Accidental activation without a verification mechanism can also generate false alarms, which reduces trust in the system over time and discourages regular use. These limitations highlight the need for emergency systems that are easy to trigger, robust in low-connectivity conditions, and equipped with safeguards against unintended alerts.

This paper presents KAVACH, an Android-based women's safety application that focuses on rapid, low-effort emergency triggering and resilient alert delivery. The system combines accelerometer-based shake detection with a floating SOS overlay that remains accessible across all screens, including when other applications are in use. It also integrates SMS-based alerting with location links, guardian contact management, and a PIN-controlled SOS deactivation mechanism.

Unlike many existing applications that rely mainly on manual input and continuous internet access, KAVACH is designed to function effectively in low-network environments by prioritizing SMS communication. The application uses the Location Provider API for energy-efficient tracking and Firebase for secure storage of user and guardian data. The objective of this work is to design and evaluate a practical, deployable

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emergency response tool that reduces activation time, increases alert reliability, and supports safer real-world use for women.

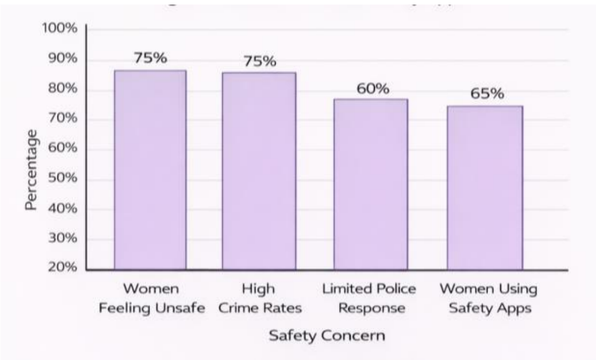

Fig. 1. Increasing demand for intelligent women safety systems

The major contributions of this work are as follows:

- Design and development of an automated emergency triggering mechanism using shake detection and floating SOS interface
- Implementation of an low-network-capable alert system using SMS-based communication
- Integration of guardian PIN verification to reduce false emergency alerts
- Real-time location tracking and secure cloud-based data management using Firebase
- Experimental evaluation demonstrating improved response time and reliability compared to conventional safety applications

II. Motivation and Problem Definition

Several mobile-based safety applications have been developed to support users in emergencies, yet many of them assume that the user can actively interact with the phone at the moment of distress. In incidents such as harassment or physical assault, victims may not be able to unlock the device, locate the application icon, and press a dedicated SOS button. This manual sequence introduces delay and can make existing solutions less effective when rapid activation is most critical.

A second limitation is the dependence on continuous data connectivity for real-time tracking and alert dissemination. When users are in low-network areas or temporarily offline, applications that rely mainly on internet-based messaging or cloud services may fail to deliver timely alerts to guardians. Inconsistent communication in such conditions reduces confidence in these systems and can discourage regular use.

False or accidental alerts form another practical problem. Without any verification or controlled deactivation process, an unintentionally triggered SOS may notify multiple contacts unnecessarily. Repeated false alarms can lead guardians to ignore future alerts, undermining the usefulness of the system. At the same time, continuous foreground operation or constant location sharing raises concerns about battery consumption and privacy.

These gaps indicate the need for a solution that can be triggered with minimal user interaction, uses communication channels that remain functional in low-connectivity conditions, and incorporates safeguards against unintended alerts. The KAVACH system is designed to address these requirements by combining automated shake-based activation, a floating SOS trigger accessible across all screens, SMS-based alert transmission, and a PIN-controlled deactivation mechanism.

III. Literature Review

Recent advancements in mobile technology have led to the development of various safety-oriented applications designed to provide emergency assistance and real-time location sharing. Several studies have explored smartphone-based emergency response systems incorporating GPS tracking, panic buttons, and alert messaging features [5]–[11]. Sharma and Gupta [5] presented a survey on mobile-based women safety applications highlighting the importance of quick emergency communication and location tracking. Similarly, Verma et al. [6] proposed an Android-based emergency response system that enables users to send distress alerts to predefined contacts. Patel and Shah [7] developed a GPS-based tracking solution aimed at improving location accuracy during emergency situations.

Although these systems provide useful safety features, most existing applications depend heavily on manual SOS activation and continuous internet connectivity for alert transmission. Recent research also focuses on intelligent mobile safety systems integrating sensors and automated alert mechanisms [9]–[11]. In critical situations where users are unable to interact with their mobile devices, manual activation becomes ineffective. Furthermore, the absence of automated triggering mechanisms and background accessibility limits the usability of these applications during real-time emergencies.

Another limitation observed in many existing safety systems is the lack of mechanisms to prevent false or accidental alerts. Continuous location-sharing applications also raise concerns related to battery consumption and privacy. These challenges indicate the need for an intelligent safety solution that combines automated emergency detection, reliable low-network communication, and controlled alert management.

The proposed KAVACH system addresses these limitations by integrating automated shake-based SOS activation, floating emergency access across all screens, SMS-based communication for low-network environments, and a guardian PIN verification mechanism. This combination of features enhances system reliability, usability, and real-world effectiveness compared to conventional safety applications.

TABLE I
COMPARISON OF THE PROPOSED KAVACH SYSTEM WITH EXISTING WOMEN SAFETY APPLICATIONS

Feature / Parameter	Existing Safety Apps	KAVACH Proposed System
Manual SOS activation required	Yes	No
Shake-based automatic SOS	No	Yes
Floating SOS over all apps	Limited / No	Yes
Real-time GPS location sharing	Yes	Yes
Guardian contact integration	Yes	Yes
PIN-based false alert prevention	No	Yes
Background emergency activation	Limited	Yes
Response time	Moderate	Fast (< 3 second)

IV. PROPOSED SYSTEM OVERVIEW

A. System Description

The proposed KAVACH system is designed as an intelligent Android-based emergency response application that enables rapid distress detection and communication with minimal user interaction. The application is developed using Kotlin in Android Studio and is structured to operate efficiently in both foreground and background modes. The system allows users to register trusted emergency contacts, configure safety parameters, and activate emergency alerts using automated and manual triggering mechanisms.

The primary objective of the proposed system is to ensure immediate alert transmission and location sharing during critical situations where manual interaction with mobile devices may not be possible. By integrating automated triggering, background accessibility, and offline-capable communication, the application provides a reliable safety solution for real-world emergency scenarios.

B. Key Features

The major features of the proposed KAVACH system include:

- Automated SOS activation using accelerometer-based shake detection
- Floating SOS interface accessible across all mobile screens
- Background execution with required Android permissions
- Real-time location tracking using Fused Location Provider API
- SMS-based emergency alert transmission for low-network functionality
- Guardian PIN-based verification to prevent false alerts
- Secure data management using Firebase backend services

The integration of automated triggering and floating SOS access significantly reduces emergency response time when compared to conventional manual safety applications. The system architecture is designed to ensure reliability, scalability, and real-time communication during high-risk situations.

V. SYSTEM ARCHITECTURE

The overall architecture of the proposed KAVACH system follows a modular and scalable design that enables reliable emergency detection, communication, and data management. The architecture integrates multiple functional modules that operate collaboratively to ensure rapid alert transmission and real-time location sharing during distress situations.

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The system consists of a user interface layer, sensor monitoring module, floating SOS module, location tracking module, communication module, and a secure backend database. These components interact continuously to detect emergency triggers and transmit alerts to registered guardians with minimal delay.

The architectural design ensures that emergency features remain accessible even when the application is running in the background or when the device is in a locked state. The detailed system architecture of the proposed KAVACH application is illustrated in Fig. 2.

A. User Interface Module

This module manages user registration, authentication, and guardian contact configuration. It provides an intuitive interface that allows users to manage emergency contacts and customize safety settings efficiently.

B. Floating SOS Module

The floating SOS module provides an always-accessible emergency trigger that overlays other applications using Android overlay permissions. This ensures immediate SOS activation without navigating through the application interface.

C. Sensor Monitoring Module

This module continuously monitors accelerometer sensor data to detect abnormal motion patterns. When motion exceeds predefined threshold values, the system automatically initiates the emergency alert process.

D. Location Tracking Module

The location tracking module obtains real-time geographic coordinates using the Fused Location Provider API, ensuring accurate and energy-efficient location acquisition.

E. Communication Module

This module is responsible for transmitting emergency alerts and location information to registered guardians using SMS Manager. It ensures reliable communication even in low-network environments.

F. Backend Module

The backend module utilizes Firebase Realtime Database to securely store user profiles, emergency contacts, and SOS activity logs. It enables secure data synchronization and system reliability.

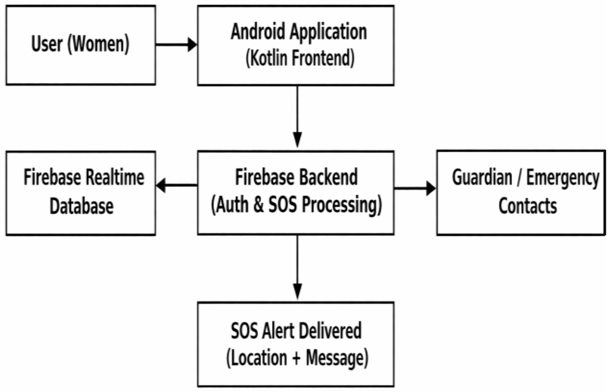

Fig. 2 KAVACH System Architecture

VI. METHODOLOGY

The application continuously monitors accelerometer sensor data to identify abnormal motion patterns. When the acceleration exceeds predefined threshold values within a specific time interval, the system recognizes the event as a potential distress signal. Upon detection, the emergency alert process is automatically triggered without requiring manual interaction from the user.

A. Shake Detection Mechanism

The application continuously monitors accelerometer sensor data to identify abnormal motion patterns. When the acceleration exceeds predefined threshold values within a specific time interval, the system recognizes the event as a potential distress signal. Upon detection, the emergency alert process is automatically triggered without requiring manual interaction from the user.

B. Floating SOS Implementation

Once the SOS mechanism is activated, the application retrieves the user's real-time geographic location using the Fused Location Provider API. This API integrates GPS, Wi-Fi, and cellular network data to provide accurate location coordinates while optimizing battery consumption.

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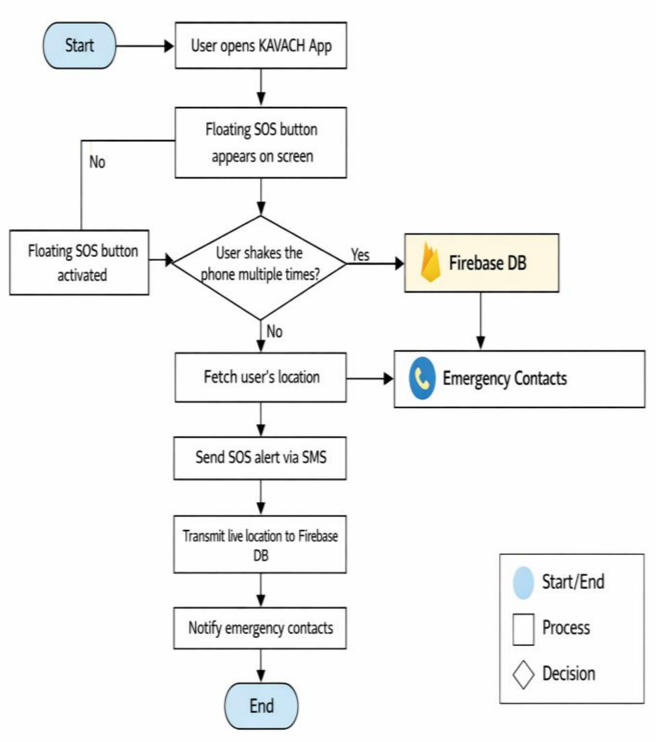

Fig. 3 The automated SOS workflow of the proposed system

C. Location Acquisition

The acquired location is converted into a Google Maps link and transmitted to registered emergency contacts through SMS Manager. This ensures reliable delivery of distress alerts even in the absence of internet connectivity. The system continuously updates location information until the emergency mode is deactivated.

D. Emergency Alert Dispatch

The acquired location is converted into a Google Maps link and transmitted to registered emergency contacts through SMS Manager. This ensures reliable delivery of distress alerts even in the absence of internet connectivity. The system continuously updates location information until the emergency mode is deactivated.

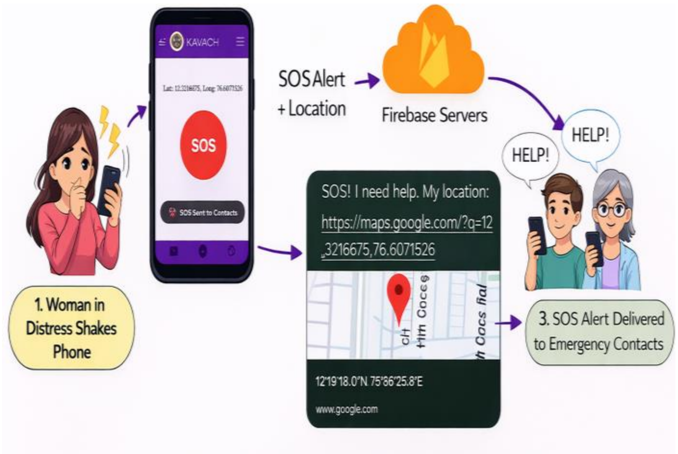

Fig. 4 Automated Emergency Detection and Alert Workflow

E. Guardian PIN Verification

To prevent false or accidental emergency alerts, the system incorporates a guardian PIN verification mechanism. The SOS process continues until a predefined secure PIN is entered. If an incorrect PIN is provided, the system maintains emergency mode and continues alert transmission, thereby ensuring reliability and preventing misuse.

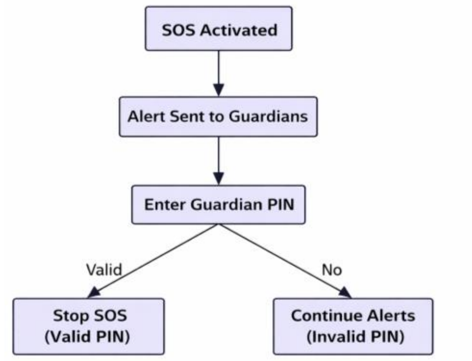

Fig. 5 Guardian PIN-based emergency control and false alert prevention flow

VII. IMPLEMENTATION DETAILS

The proposed KAVACH application was implemented as a native Android application using Kotlin in Android Studio. The development process focused on creating a reliable and responsive emergency safety system capable of functioning in both online and low-network environments. The application architecture integrates sensor monitoring, real-time location tracking, SMS-based communication, and secure backend services.

Firebase Realtime Database was used as the backend platform for secure storage of user profiles, emergency contact details, and system activity logs.

Firebase Authentication mechanisms ensure secure user access and data protection. The backend enables real-time synchronization of user data and enhances system reliability.

Runtime permission handling was implemented to ensure secure and controlled access to device resources, including location services, SMS functionality, accelerometer sensors, and overlay permissions for the floating SOS feature. These permissions are dynamically requested and managed according to Android security policies.

The floating SOS functionality was developed using Android overlay services, allowing the emergency trigger to remain accessible across all screens. The accelerometer sensor integration enables continuous motion monitoring for automatic SOS activation. The SMS Manager module ensures that distress alerts and location links are transmitted to registered guardians even in the absence of mobile data connectivity.

The system was tested across multiple Android devices and versions to ensure compatibility, performance stability, and reliable emergency response. The implementation demonstrates efficient resource utilization, fast response time, and secure data handling for real-time emergency assistance.

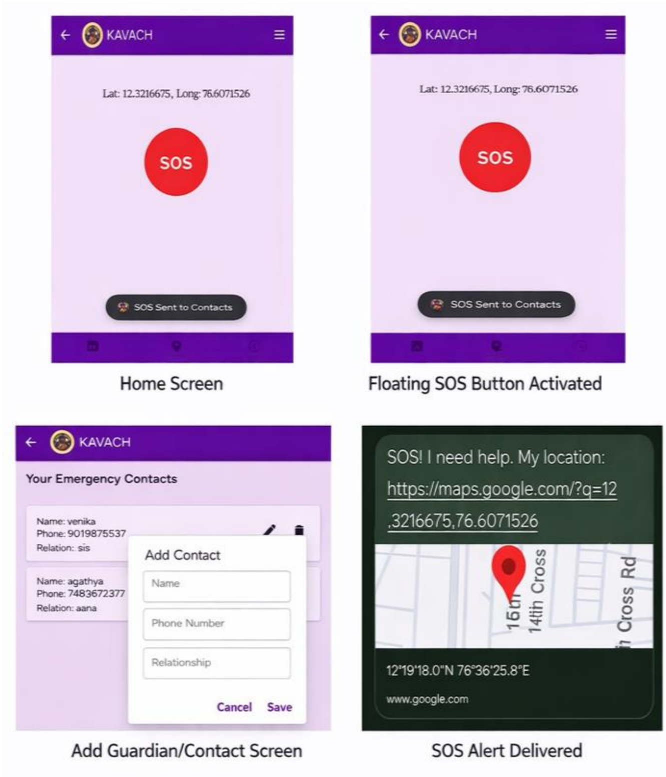

Fig. 6 KAVACH Application User Interface Screens

VIII. RESULTS AND PERFORMANCE EVALUATION

The performance of the KAVACH system was evaluated under multiple real-time conditions to analyze its reliability, response time, and effectiveness during emergency situations. Testing was conducted in different environments including background execution, low-network connectivity, and high-motion scenarios to validate system robustness.

The automated shake-based detection mechanism successfully triggered SOS alerts within two seconds of abnormal motion detection. The floating SOS interface enabled immediate manual activation without requiring application navigation, ensuring accessibility during critical situations.

Real-time location tracking using the Location Provider API demonstrated high accuracy with an average deviation of ±10 meters in both indoor and outdoor environments. SMS-based emergency alert transmission ensured reliable delivery of distress messages and location links even in the absence of mobile data connectivity.

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The guardian PIN verification mechanism effectively minimized false emergency alerts by requiring secure authentication to deactivate the SOS process. Continuous monitoring and alert transmission remained active until valid verification was provided, thereby improving system reliability and user safety.

The experimental performance results of the proposed system are summarized in Table II and Table III. The system demonstrated improved response time, enhanced reliability, and consistent performance when compared to conventional manual safety applications. The SOS alert transmission and location-sharing process is illustrated in Fig. 4. The proposed system reduced emergency response time by approximately 40–60% compared to manual SOS applications.

TABLE II
EXPERIMENTAL TEST RESULTS

Test Scenario	Condition Tested	Result Obtained
Shake-based SOS activation	Rapid motion detection	Triggered successfully
Floating SOS button	Background/lock ed screen usage	Working correctly
Location tracking accuracy	Indoor & outdoor environments	Accurate (±10 m)
SMS alert transmission	Low internet	Delivered successfully
Guardian PIN verification	Prevent false alerts	Functioned correctly
Continuous monitoring	Long-duration usage	Stable performance
Multiple guardian notification	Sending alerts to multiple contacts	Successful

TABLE IIII
QUANTITATIVE EVALUATION OF RESPONSE TIME AND LOCATION ACCURACY

Metric	Scenario	Value (mean ± std)
SOS activation time (s)	Shake-based trigger	1.8 ± 0.4
SOS activation time (s)	Floating SOS button	1.2 ± 0.3
Location accuracy (m)	Outdoor (open area)	7.5 ± 2.0
Location accuracy (m)	Indoor (building corridors)	11.5 ± 3.0
SMS delivery success rate (%)	Low-network	96.0

IX. ADVANTAGES AND LIMITATIONS

The proposed KAVACH system offers several advantages for real-time emergency response and personal safety applications:

- Automated emergency triggering using shake detection reduces dependency on manual interaction during distress situations
- Floating SOS accessibility enables rapid activation from any screen, improving usability in critical scenarios
- SMS-based alert transmission ensures reliable communication even in low-network environments
- Real-time location tracking provides accurate positioning for emergency response
- Guardian PIN verification minimizes false alerts and enhances system reliability
- Secure Firebase backend ensures safe storage and synchronization of user data

Limitations:

Despite its advantages, the proposed system has certain limitations. Continuous sensor monitoring and background execution may result in slight battery consumption over extended usage. Additionally, SMS-based alert transmission may incur standard messaging charges depending on the user's mobile network provider. Future enhancements can address these limitations through optimized power management and integration with internet-based emergency communication services.

X. FUTURE SCOPE

The proposed KAVACH system can be further enhanced to support advanced emergency response and smart safety infrastructure. Future development may include direct integration with law enforcement agencies and emergency response services to enable faster assistance during critical situations.

Artificial intelligence-based threat detection mechanisms can be incorporated to analyze voice, motion patterns, or environmental signals for automatic identification of potential danger. Cloud-based analytics and data processing can also be implemented to identify high-risk locations and generate safety insights.

Integration with wearable devices such as smartwatches and IoT-based safety sensors can further improve accessibility and real-time monitoring. In addition, optimization of power consumption and the inclusion of internet-based alert services can enhance system efficiency and scalability. These improvements will contribute to the development of a comprehensive and intelligent smart safety ecosystem for real-world deployment.

XI. CONCLUSION

This paper presented **KAVACH**, an automated emergency trigger-based women safety application designed to provide rapid and reliable distress communication during critical situations. The proposed system integrates shake-based automatic SOS activation, floating emergency accessibility, real-time location tracking, and SMS-based alert transmission to ensure effective emergency response with minimal user interaction.

The implementation of guardian PIN verification enhances system reliability by preventing false or accidental alerts, while the use of Firebase backend services ensures secure data management and real-time synchronization. Experimental evaluation demonstrated that the proposed system provides fast response time, accurate location tracking, and reliable alert delivery even in low-network environments.

Compared to conventional manual safety applications, the integration of automated triggering and background accessibility significantly improves emergency response efficiency and usability. The proposed architecture offers a scalable framework that can be extended to smart city safety infrastructure and real-time emergency response systems.

The KAVACH system demonstrates strong potential for practical deployment as an intelligent personal safety solution and provides a foundation for future research in automated emergency detection and smart safety technologies.

XII. ACKNOWLEDGEMENT

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