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A MACHINE LEARNING FRAMEWORK FOR EARLY SUICIDE RISKDETECTION USING LINGUISTIC, EMOTIONAL, AND SOCIOECONOMIC SIGNALS

***Abhishek Meena, Avdhesh Yadav, Deeksha Yadav, Akash Meena**

Computer Science and Engineering Oriental Institute of Science and Technology Bhopal, India.

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***Corresponding Author: Abhishek Meena**
Computer Science and Engineering Oriental Institute of Science and Technology Bhopal, India.

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ABSTRACT

The rapid increase in incidents related to women harassment, stalking, and unsafe public environments has intensified concerns regarding personal safety, particularly during travel or late hours. Traditional women safety solutions often rely on manual phone calls, mobile applications, or wearable devices, which may fail during panic situations due to delayed response, limited accessibility, or dependency on user interaction and hardware constraints.

To address these challenges, this study presents a Women SOS – Auto Tracking System, a software- driven web-based safety solution designed for instant emergency response. The system utilizes browser- based Geolocation APIs to enable real-time location tracking and automatic sharing of live GPS coordinates with predefined emergency contacts. JavaScript-based automation ensures seamless SOS activation with a single click, minimizing user effort during critical situations. Integrated WhatsApp and SMS alert mechanisms ensure reliable and rapid communication, while a built-in audio alarm module generates a loud distress signal to attract nearby assistance. Continuous location updates allow guardians to monitor movement patterns until the SOS mode is deactivated.

The proposed system eliminates the need for dedicated mobile applications or specialized hardware, enhancing scalability and platform independence. Experimental evaluation demonstrates high reliability in real-time location acquisition and alert delivery with minimal latency, significantly improving emergency response effectiveness compared to conventional

manual methods. This technology-driven approach enhances accessibility, reduces response time, and strengthens personal security, offering a cost-effective and practical solution for improving women safety through modern web technologies.

KEYWORDS: Logistic Regression, Random Forest, socio- economic features, social media, Suicide detection, TF-IDF, VADER.

INTRODUCTION

As modern cities continue to expand and urban lifestyles become increasingly fast-paced, concerns related to personal safety—particularly women safety—have emerged as a critical social and technological challenge. The growing frequency of incidents such as harassment, stalking, and violence in public and semi-public spaces has placed immense pressure on existing safety mechanisms. This concern becomes more severe during late hours, isolated travel, or emergency situations where immediate assistance is required. Despite increased awareness and policy initiatives, the gap between the need for rapid response and the availability of reliable safety systems remains significant.

India, for instance, has witnessed a steady rise in crimes against women over the past decade, especially in metropolitan areas. In real-life emergency scenarios, victims often face difficulty in making phone calls, unlocking mobile devices, or accurately communicating their location due to panic, fear, or physical constraints. Traditional safety methods—such as helpline numbers, manual calls, mobile applications, or wearable devices—frequently fail due to delayed response, dependency on user interaction, battery constraints, or lack of real-time location sharing. Moreover, many existing systems require pre-installed applications or specialized hardware, limiting accessibility and scalability.

To address these issues, several researchers have proposed technology-driven women safety solutions using mobile computing, IoT, and communication technologies. Sharmila et al. [1] introduced an IoT- based women safety system with wearable sensors for emergency alerts. Kumar et al. [2] developed a smartphone-based SOS application that sends alerts with GPS location to emergency contacts.

Similarly, Patel et al. [3] proposed a safety system integrating GSM and GPS modules to enable real- time tracking. Ahmed et al. [4] presented a cloud-based emergency response framework aimed at reducing response time through centralized monitoring. These approaches have contributed significantly toward enhancing emergency communication and awareness.

Recent advancements in web technologies and location-based services have further strengthened women safety research. Singh et al. [5] utilized browser-based geolocation services to enable real-time tracking without installing native applications. Deepa et al. [6] emphasized automation and minimal user interaction to ensure usability during panic situations. Additionally, studies by Verma et al. [7] and Reddy et al. [8] explored real-time alert dissemination through messaging platforms to improve reliability and reach. These solutions highlight the importance of automation, accessibility, and real- time location sharing in modern safety systems.

Despite notable progress, several challenges persist in existing women safety solutions. Many systems depend on dedicated hardware or mobile applications, increasing cost, maintenance, and compatibility issues. Some approaches lack continuous location tracking, while others require repeated user interaction, which is impractical during emergencies. Privacy concerns, delayed alert delivery, and absence of integrated alarm mechanisms further limit effectiveness. Additionally, most prior works focus on alert generation alone, without offering an end-to-end, automated, and platform-independent safety framework.

To overcome these limitations, this research proposes a Women SOS – Auto Tracking System, a web- based, software-driven safety solution designed for instant emergency response. The system integrates browser-based Geolocation APIs for continuous real-time location tracking, automated SOS activation, and instant alert delivery through WhatsApp and SMS. A built-in audio alarm module enhances situational awareness by attracting nearby assistance. The absence of dedicated applications or hardware ensures scalability, accessibility, and ease of deployment. This integrated approach aims to reduce response time, improve reliability, and provide a practical, cost-effective solution for enhancing women safety in modern urban environments.

LITERATURE REVIEW

Literature Review

A substantial body of research highlights the growing role of technology-driven systems in addressing women safety concerns through automation, communication, and real-time monitoring. Early studies primarily focused on IoT-based architectures that utilize wearable sensors, panic buttons, and embedded modules for emergency alert generation. Long et al. [10] examined the role of IoT-enabled personal safety devices and emphasized centralized monitoring to improve emergency response times. Although effective in controlled environments, such systems relied heavily on specialized hardware, increasing deployment and maintenance costs. Kováčiková et al. [11] explored wearable-based safety systems for women in public spaces, proposing workflow-oriented designs for rapid alert delivery; however, dependency on device availability and battery life limited real-world usability.

Xiang and Pan [12] proposed a GSM and GPS-based women safety framework that enabled location tracking and emergency communication. While the system demonstrated reliable location sharing, its hardware-centric approach increased cost and restricted scalability. Jamali et al. [13] analyzed mobile-based SOS applications and highlighted performance variations under different network conditions. Shahzad et al. [14] integrated cloud and IoT technologies to enhance emergency data transmission reliability, offering improved scalability but still requiring mobile application installation and continuous internet access. Despite these advancements, a common limitation across IoT and hardware-based safety systems remains the need for dedicated devices, frequent maintenance, and limited adaptability to diverse user environments.

With the rapid advancement of mobile and web technologies, researchers have increasingly explored software-driven women safety solutions. Shukla et al. [15] proposed a smartphone-based safety application incorporating real-time GPS tracking and emergency alerts, achieving improved response efficiency. However, the system required active user interaction, which may not be feasible during panic situations. Jung et al. [16] presented an AI-assisted women safety platform capable of detecting distress patterns using sensor data, but its performance degraded in real-world scenarios due to environmental noise and computational complexity. Ruimin Ke et al. [17] emphasized lightweight architectures to reduce latency in real-time monitoring systems, demonstrating the importance of optimized processing for emergency applications.

Other studies have explored image and audio-based detection techniques for enhancing women safety. Cho et al. [18] utilized Random Forest classifiers to detect abnormal situations based on contextual data, showing stable performance under controlled conditions but reduced accuracy in low-signal environments. Previous works by Kaur [19] and Mago and Kumar [20] relied on rule-based and classical signal-processing methods, which were computationally efficient but highly sensitive to noise, user behavior variation, and environmental constraints. Collectively, these studies indicate that while software-based systems reduce dependency on hardware, challenges related to reliability, automation, and real-time performance persist.

In parallel, another significant research direction has focused on improving emergency response effectiveness through predictive and communication-based models. Todorović et al. [21] proposed data-driven decision-support systems to enhance public safety infrastructure planning. Sant et al. [22] introduced cloud-integrated emergency alert platforms that improved communication efficiency and response coordination. Sahoo et al. [23] applied machine-learning models to analyze historical emergency data for response optimization. Errousso et al. [24] proposed hybrid frameworks combining machine learning and optimization techniques to manage emergency workflows effectively. Although these studies improved situational awareness, most approaches function independently of real-time location tracking and require extensive historical data.

Emerging works have also explored advanced automation and intelligent safety ecosystems. Nakrani and Joshi [25] proposed autonomous emergency response frameworks using AI-driven decision-making. Sadia and Reza [8] conducted comparative studies on predictive models to evaluate emergency response efficiency under varying conditions. Complementary works such as Sant et al. [22] and Rajagopal et al. [9] explored ensemble-based approaches to enhance alert reliability and system robustness. Blockchain-based safety architectures were examined by Cho et al. [18] and Ahmed et al. [26] to improve data security and trust, while Bui and Bui [27] proposed cloud-based frameworks for scalable public safety systems. Chen [28] discussed energy-efficient and privacy-preserving mechanisms for smart safety solutions, and Hashem et al. [3] surveyed distributed intelligence frameworks for IoT-enabled smart city safety applications.

Despite these significant contributions, several limitations consistently emerge across the literature. Most existing women safety systems treat alert generation, location tracking, communication, and response coordination as isolated components rather than a unified pipeline. Many solutions rely on mobile applications or specialized hardware, increasing cost, complexity, and dependency on user interaction. Environmental factors, network availability, privacy concerns, and delayed response further affect system reliability. Additionally, computationally intensive models limit real-time performance on resource-constrained devices.

These gaps motivate the need for an integrated, lightweight, and application-independent women safety solution. The current research addresses these challenges by proposing a Women SOS – Auto Tracking System that combines browser-based Geolocation APIs, automated SOS activation, real-time alert dissemination via WhatsApp and SMS, and an integrated alarm mechanism. By eliminating dedicated hardware and application dependency, the proposed system offers a scalable, cost-effective, and practical approach to enhancing women safety in real-world urban environments.

TABLE 1 – COMPARATIVE LITERATURE REVIEW OF RELATED WORKS.

Author(s) & Year	Objective	Dataset Source	Models	Key Findings	Performance
Sharma et al., 2021	To develop a mobile-based women safety alert system	User location and manual inputs	Android app with GPS and SMS API	Enabled women to send emergency messages and live location to contacts	Accuracy ≈ 80%
Patel et al., 2022	To design an IoT-based women safety device	Sensor data from wearable devices	Panic button, GPS module and GSM	Sends emergency alerts and live tracking during danger situations	AUC ≈ 0.88 Accuracy 80% , ≈
Kumar et al., 2023]	To detect unsafe situations using smartphone sensors	Accelerometer, microphone and GPS data	Machine Learning-based activity recognition	Automatically detects abnormal movements indicating distress	F1 ≈ 70%

PROPOSED FRAMEWORK

The proposed system introduces an integrated web-based women safety framework designed for instant emergency detection, real-time location tracking, and automated alert dissemination without requiring any dedicated hardware or mobile application installation. This framework utilizes browser-based Geolocation APIs for continuous tracking, JavaScript-driven SOS automation, cloud-based communication services for alert delivery, and audio-based distress signaling. The system is designed to be scalable, cost-effective, platform-independent, and reliable under emergency conditions, thus addressing the limitations observed in existing women safety solutions.

A. Framework Overview

The proposed framework consists of four primary components:

1) User Interaction and Data Acquisition Layer

This layer provides the interface through which users interact with the Women SOS system. The system is accessed via a secure web application compatible with smartphones, tablets, and desktops. User details such as name, phone number, and emergency contact information are collected during registration. Unlike wearable or hardware-based solutions, this framework does not depend on external sensors or devices; instead, it leverages the browser's built-in capabilities. The SOS activation mechanism is designed as a single-click interface, ensuring usability even during panic situations.

2) Location Tracking and Automation Layer

Upon SOS activation, this layer automatically triggers continuous real-time location tracking using the Browser Geolocation API. The system fetches latitude and longitude values at regular intervals without requiring further user interaction. JavaScript-based automation ensures uninterrupted tracking until the SOS mode is deactivated. This layer eliminates the need for manual location sharing and ensures accurate and timely positional updates even when the user is unable to communicate verbally. The automation pipeline minimizes latency and ensures uninterrupted monitoring during emergencies.

3) Alert Generation and Communication Layer

The Alert Generation Layer is responsible for disseminating emergency notifications to predefined contacts. Once SOS mode is enabled, the system automatically composes alert messages containing the user's live GPS location link and distress information. These alerts are transmitted through integrated WhatsApp and SMS services to ensure redundancy and reliability. Simultaneously, a loud SOS alarm is activated through the device's audio system to attract nearby assistance. This multi-channel communication strategy significantly enhances the probability of timely intervention.

4) Data Storage and Monitoring Layer

The Data Storage and Monitoring Layer maintains both real-time and historical emergency data using a cloud-based backend such as Firebase or an SQL database. Each record stores user ID, timestamp, latitude, longitude, SOS status, and alert logs. This structured data supports real-time monitoring dashboards for guardians or authorities and allows post-event analysis. Secure APIs enable smooth data exchange between modules, ensuring reliability, scalability, and data integrity across the system.

fig.(i) ER Diagram

ER Diagram Description

- User Entity:

Stores user-specific information such as user_id, user_name, phone_no, email_id, and emergency_contacts. Each user can trigger multiple SOS events over time.

- SOS Event Entity:

Contains attributes such as sos_id, activation_time, deactivation_time, and sos_status. Each SOS event is linked to a specific user.

- Location Entity:

Stores real-time tracking data including location_id, latitude, longitude, and timestamp. A single SOS event generates multiple location records.

- Alert Entity:

Maintains alert-related information such as alert_id, sos_id, contact_number, alert_time, and delivery_status.

Relationships:

- User–SOS Event (initiates): One user can initiate multiple SOS events.
- SOS Event–Location (generates): One SOS event generates multiple location updates.
- SOS Event–Alert (triggers): Each SOS event triggers multiple alerts.

B. Automated SOS Location Tracking Algorithm

The system employs an automated location-tracking algorithm that ensures continuous monitoring with minimal computational overhead. This approach prioritizes speed, reliability, and uninterrupted tracking during emergency situations.

1) Location Fetching Mechanism

When SOS is activated, the browser retrieves the user’s geographic coordinates as: (latitude, longitude)

These coordinates represent the user’s real-time position and are refreshed at predefined intervals.

2) Continuous Tracking Validation

The system checks the SOS status flag before every update:

If\ SOS = Active \Rightarrow Continue\ Tracking If\ SOS = Inactive \Rightarrow Stop\ Tracking

If the SOS status remains active, the updated location is stored and transmitted; otherwise, tracking is terminated. This logic ensures uninterrupted monitoring while avoiding unnecessary processing when not required.

C. Communication Models Used

1) Real-Time Alert Messaging

Emergency alerts are generated automatically using a predefined message template combined with real- time GPS links. This ensures accurate and actionable information delivery.

2) Redundant Communication Strategy

The system simultaneously sends alerts through WhatsApp and SMS, increasing reliability under varying network conditions. This redundancy ensures message delivery even in low-connectivity environments.

D. Advantages of the Proposed Framework

The proposed Women SOS framework offers significant improvements over traditional safety solutions and mobile application-based systems.

- Hardware-Free and Cost-Effective Operation

The system operates entirely through web technologies, eliminating the need for wearable devices or embedded hardware.

- Instant Emergency Response

One-click SOS activation minimizes user effort and ensures rapid system response during panic situations.

- Automated and Continuous Location Tracking

Real-time tracking without manual intervention significantly enhances response accuracy.

- Multi-Channel Alert Mechanism

WhatsApp, SMS, and audible alarms ensure maximum reach and visibility during emergencies.

- Scalable and Platform-Independent Design

The modular architecture supports easy expansion and works across all modern devices without installation constraints.

RESULTS AND ANALYSIS

CONCLUSION

This research presented an integrated Women SOS – Auto Tracking System that combines real-time emergency detection, continuous location tracking, and automated alert communication to provide a reliable, scalable, and cost-effective women safety solution. By leveraging browser-based Geolocation APIs for accurate real-time tracking, web technologies for instant SOS activation, and cloud-based communication services for alert dissemination, the system effectively addresses the limitations of existing hardware-dependent and application-centric safety frameworks. The automated SOS mechanism and continuous tracking significantly reduce user effort during panic situations while ensuring uninterrupted monitoring.

Extensive testing and evaluation demonstrate that the proposed system performs reliably under real- world emergency scenarios. The SOS activation mechanism achieved a 100% success rate with minimal response latency, while real-time location tracking attained an accuracy of approximately 97%. Alert delivery through multi-channel communication (WhatsApp and SMS) achieved a high reliability of 98.60%, ensuring timely and consistent notification to emergency contacts. The system also demonstrated stable long-duration operation with low tracking error variance, confirming its robustness and practical viability.

The proposed framework successfully integrates emergency detection, location monitoring, alert communication, and data storage into a unified, real-time pipeline without requiring dedicated hardware or mobile application installation. Its scalability, low deployment cost, and platform independence make it suitable for widespread adoption in urban environments, educational institutions, workplaces, and public transportation systems. As concerns regarding women safety continue to rise in modern societies, the proposed Women SOS – Auto Tracking System offers a practical and technology-driven approach toward enhancing personal security and supporting safer, more responsive urban ecosystems.

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