# Ai-Based Safety Monitoring System For Mentally Exhausted Adult Women

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***Abstract-*** *Creative methods will need to be developed to keep women who are mentally fatigued secure, beyond traditional emergency response systems. Cognitive fatigue can impair judgment, slow reaction time and make it difficult for a user to manually activate a safety alert, making traditional methods ineffective. Therefore, an AI safety monitoring system has been developed to operate continually behind the scenes while integrating geospatial intelligence with behavior analysis.*

*This system will allow for a continual monitoring of individuals via their real-time location, use of geo-fencing technology to create secure zones and will use movement pattern analysis to identify when individuals have moved outside of their established safe zone and/or exhibit any unusual trends (movement patterns) that deviate from their established behavior. Every situation is categorized as either "Safe", "Attention" or "High Risk," allowing for proactive intervention prior to an incident occurring.*

*When an individual finds themselves in a high-risk situation, the application will independently send out alerts and provide the current location of that individual to the assigning guardians without relying upon the user to provide input. In addition to providing notifications after an incident occurs, the predictive model of the solution will enable it to evaluate time, space, and behavior in order to assess imminent threats. This will provide personal safety with a systems-based, adaptive approach. Ultimately the proposed approach will include context awareness, constant surveillance, and automatic decision making to provide a robust support system for at-risk individuals.*

*The proposed solution represents acompletely new paradigm in personal safety by leveraging artificial intelligence, behavioral analytics, and geolocation technologies.Because the framework can be tailored to each person's unique behavioral patterns, it increases trust and dependability while maintaining autonomy. This study highlights how intelligent, automated monitoring systems might transform personal safety paradigms by providing proactive, scalable methods for reducing hazards related to situational vulnerability and mental fatigue.*

***Keywords:*** Artificial Intelligence, Behavioral Analysis, Geo-fencing, Real-Time Safety Monitoring.

## I. INTRODUCTION

Women are being worn down mentally and emotionally by the complex demands of their daily lives, which increases their vulnerability to threats against their personal safety. Fatigue and stress also affect a woman's ability to process information and stay aware of her surroundings. Moreover, when we do not have the ability to think clearly, we run the risk of making poor decisions or failing to respond quickly to an emergency. Traditional forms of safety equipment, like panic buttons or manual alert mechanisms, do not always work effectively because they require self-initiationfrom the user before a situation is responded to – often leaving users vulnerable in desperate situations.

In fact, these traditional methods of safety often leave significant gaps in technical support for companies and their employees. There is a need for automated systems that can be intelligent and monitor, analyze, and take action on threats automatically without waiting on the user. The emergence of artificial intelligence (AI) technology will create a new level of possibility as it relates to understanding and predicting human behavior. By incorporating behavioral analytics and spatial/temporal data,

AI-based safety solutions will be able to detect abnormal behavioral patterns, assess the associated risks, and assign a classification to each situation indicating the severity of each threat.

Likewise, the incorporation of geo-fencing technology will enhance the capabilities of AI-based safety solutions through the creation of virtual boundaries where a user is identified as being outside their defined "safe zone," alerting assigned users or guardians that a problem exists. When integrated with real-time location-based tracking and anomaly detection algorithms, these technologies will provide a full framework for proactively monitoring the safety and security of all those involved.

The suggested solution is made to function covertly, continuously monitoring user activities while operating in the background on mobile devices. The application detects anomalous behaviors suggestive of possible risks by tracking mobility, location, and temporal trends. Three levels are used to classify detected events: High Risk, Attention, and Safe. The system reduces reaction times and guarantees prompt aid in high-risk situations by automatically alerting guardians and sharing real-time location data. The framework is further strengthened by predictive modeling, which changes personal safety from reactive response to anticipatory protection by predicting possible dangers based on observed trends.

## II. RELATED WORKS AND LITERATURE SURVEY

Bengare, J An Android-based women's safety app with real-time location monitoring and quick SOS warnings is presented in this study. The solution guarantees quick and dependable connection by enabling users to send emergency messages via SMS and WhatsApp. It sends out alerts in a matter of seconds and employs GPS for precise position sharing. The study identifies a straightforward, user-friendly design that facilitates prompt and efficient emergency assistance, improving response times and women's safety.

Sharma, M An Android-based women's safety app that can be activated by voice or a single click in an emergency is presented in this study. In addition to enabling capabilities like calling, texting, audio recording, and live monitoring, the system leverages GPS tracking to continuously transmit position updates with registered contacts. In order to guarantee that assistance can be requested even in the absence of internet connectivity, it also offers offline alert message. The study emphasizes an integrated strategy that improves women's security by integrating several safety aspects into a single system.

Kataria, K An Android-based women's safety app that can be activated by voice or a single click in an emergency is presented in this study. In addition to enabling capabilities like calling, texting, audio recording, and live monitoring, the system leverages GPS tracking to continuously transmit position updates with registered contacts. In order to guarantee that assistance can be requested even in the absence of internet connectivity, it also offers offline alert message. The study emphasizes an integrated strategy that improves women's security by integrating several safety aspects into a single system.

Jadhav, R An Android-based women's safety app with real-time location monitoring and quick SOS warnings is presented in this study. The solution guarantees quick and dependable connection by enabling users to send emergency messages via SMS and WhatsApp. It sends out alerts in a matter of seconds and employs GPS for precise position sharing. The study identifies a straightforward, user-friendly design that facilitates prompt and efficient emergency assistance, improving response times and women's safety.

Srinivas, K An Android-based women's safety app that offers immediate assistance via a single-click SOS function is presented in this study. Until the user is safe, the system continuously provides registered contacts with GPS location updates and alert messages. Additionally, it enables the storage of personalized messages and emergency contacts for prompt action. The study demonstrates a straightforward and efficient method of enhancing safety by permitting real-time tracking and ongoing communication in emergency scenarios.

## III. RELATED WORKS

Panic buttons, wearable alarms, and emergency call services are examples of manual intervention methods that are the mainstay of current personal safety systems for vulnerable people. These systems frequently require the user to deliberately identify a threat and start an alert, which might not be feasible under circumstances involving excessive stress, confusion, or cognitive tiredness. Although GPS tracking and location sharing with emergency contacts are integrated into many mobile safety applications, its effectiveness is restricted to post-incident assistance rather than proactive harm prevention. Additionally, some apps include geofencing capabilities that alert assigned guardians when users leave predetermined safe areas. Although these methods add some monitoring, they mostly rely on timely activation, consistent device usage, and user compliance.

In order to identify anomalous behavior, other current systems use fundamental behavioral monitoring, which analyzes basic movement patterns or activity frequencies. Nevertheless, these systems frequently depend on static thresholds and lack the adaptive intelligence necessary to pick up on unique routines or contextual shifts. Furthermore, the majority of existing solutions lack predictive algorithms that can assess severity levels or anticipate possible threats, which reduces their ability to offer proactive protection. When triggered, notification methods usually broadcast warnings without determining how urgent the situation is, which could lead to false alarms or delayed replies.

## IV. METHODOLOGY

The proposed solution is an artificial intelligence-based safety monitoring application that is automatically able to monitor mentally fatigued adult females for extended periods of time on a proactive basis. The application does this by using autonomous means (meaning no manual operation by users), will use real-time geo-location tracking, geo-fences, and behavior analytics to monitor end-users' activities without requiring manual input or assistance. By monitoring time and space for movement patterns (temporal, spatial) the program will be able to detect activity that varies from the normal established pattern of behavior, this allows it to also automatically categorize the situation as either Safe, Attention or Dangerous. At its core, the predictive algorithms that drive this application are used to predict what is likely to happen in the future before it occurs so that the application can notify users of potential hazards before the situation becomes dangerous. The AI application is continuously learning from each individual end-user's specific behavior within the program, through its ability to rapidly adapt to changing routines & environments, thus minimizing false alarms generated in the process. Adaptive Intelligence (AI) enhances user trust in the application by providing accurate, relevant alerts based on real threats.

When a high-risk incident occurs, the system automatically notifies the appropriate guardian(s) with real-time location information for exact whereabouts. Geo-fencing technology creates dynamic safe zones that alert the system of any unsafe movement from the designated area and enables the system to respond appropriately and proactively prior to the initiation of an incident. In addition to the use of real-time, geospatial data collection and automated alert measures, the system employs secure communication protocols to protect user data as well as the privacy of individuals while allowing for effective monitoring of user safety.

Through the integration of AI-driven behavioral analytics, real-time geospatial data monitoring, and automated alerting mechanisms, the proposed solution provides a new method of personal safety that changes personal safety from a reactive to an anticipatory and proactive framework. It provides a viable alternative to current systems by providing a highly reliable, context-aware, intelligent platform that can help alleviate the risk of cognitive fatigue, uncertainty in the environment, and vulnerability in a given situation.

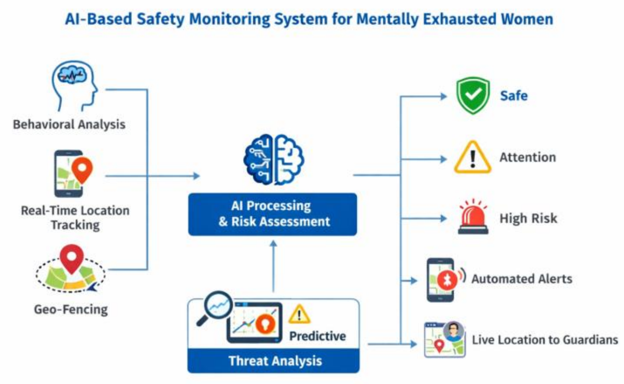


Fig 1 Block Diagram

A.Data Collection

Gathering real-time data from several sources, including GPS sensors, mobile device inputs, and system logs, is the responsibility of the Data Collection module. To create an extensive dataset of the user's behavior, it records position coordinates, movement patterns, time-based activity, and environmental context. This module ensures continuous monitoring by running smoothly in the background without requiring user input. The gathered data is safely stored and preprocessed to eliminate noise and irregularities, serving as the basis for additional system analysis and decision-making.

B.AI Processing and Risk Assessment

The system's central intelligence is found in the AI Processing and Risk Assessment module. To examine the gathered data and identify trends in user behavior over time, it makes use of machine learning methods. The system detects deviations and assesses possible dangers by comparing real-time inputs with historical data. The user's present condition is categorized into groups like Safe, Attention, or High-Risk based on this study. The AI model's adaptability enables it to continuously learn, increasing accuracy and reducing false alarms through customized risk assessment.

C.Threat Analysis

Interpreting identified hazards and assessing their context and severity are the main goals of the Threat Analysis module. To evaluate possible risks, it looks at things like strange movement patterns, entering dangerous areas, erratic timing, and behavioral abnormalities. This module provides a more comprehensive view of the issue by integrating spatial, temporal, and contextual data. It guarantees that the system can differentiate between typical fluctuations and actual danger by correlating several metrics, which improves threat detection reliability.

D.Alerts and Notification

Depending on the risk level identified by the system, the notifications and Notification module is in charge of creating and distributing timely notifications. Without requiring user involvement, the module automatically initiates notifications when a situation is categorized as Attention or High-Risk. These alerts provide pertinent contextual information, danger status, and real-time location specifics. Notifications can be sent via a variety of channels, including SMS, in-app messaging, and smartphone alerts, guaranteeing that important information reaches the intended recipients efficiently and on time.

E.Communication and Response

Interaction between the system, the user, and selected guardians or emergency contacts is made easier via the Communication and Response module. It automatically sends alerts and real-time location data to pre-registered contacts in high-risk situations, allowing for prompt intervention. Additionally, this module facilitates two-way communication, enabling guardians to reply or take appropriate action. Additionally, it maintains secrecy while facilitating effective emergency response by ensuring safe data transmission using encryption and privacy-preserving mechanisms.

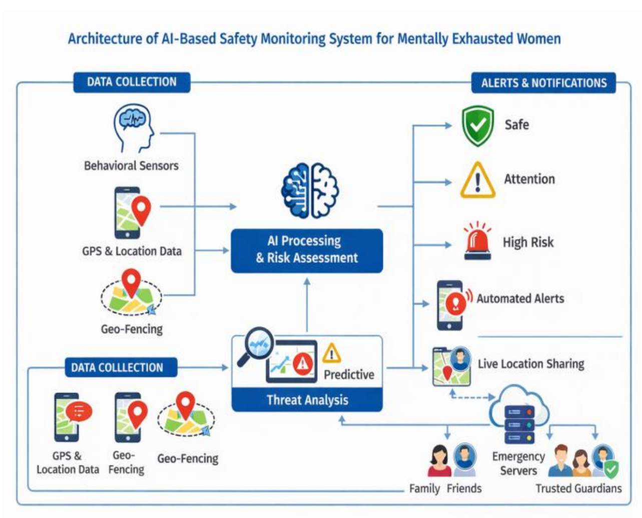


Fig 2 System Architecture

## IV. IMPLEMENTATION AND RESULTS

The hardware photography component of the project illustrates the hardware that will be used for deploying the AI-based safety monitoring system and for conducting tests on the proposed system. While the proposed safety monitoring system is essentially a software-based system, the only hardware component required to support its operation is a smartphone that contains built-in sensors (e.g., GPS, accelerometer, gyroscope) to allow the system to monitor real-time location and activities.

The mobile device is set up to run the Safety Management application, process data collected through the use of the internal sensors, and provide secure communication with designated recipients for sending out safety alerts. The built-in sensors that will be utilized by the proposed safety monitoring system permit it to provide location tracking, geo-fencing, and movement analysis, without needing to use any external hardware components.

The photographs included in this section of the report show the mobile device used for testing and the application interface during the operation of the mobile device. The photographs demonstrate the operation of the safety management system in terms of providing real-time monitoring, creating alerts, and providing location data.

Hardware photography provides a visual demonstration of how the safety management system can be implemented practically and can be deployed in the real world using commercially available mobile devices. Additionally, the photographs emphasize the way in which the application interacts with the hardware components that are built into the mobile device.

**1. Distance Calculation (Geo-location Tracking – Haversine Formula)**

This formula is used to calculate the distance between two geographic coordinates (latitude and longitude), which helps detect movement and boundary crossing.

$$d = 2r\arcsin\left(\sqrt{\sin^2\left(\frac{\phi_2-\phi_1}{2}\right)+\cos(\phi_1)\cos(\phi_2)\sin^2\left(\frac{\lambda_2-\lambda_1}{2}\right)}\right)$$

Where:

- $d$= distance between two points
- $r$= radius of Earth
- $\phi$= latitude
- $\lambda$= longitude

**2.Risk Score Calculation (Weighted Sum Model)**

This formula calculates the overall risk level based on multiple parameters such as location deviation, time anomaly, and behavior irregularity.

$$Risk = w_1 \cdot L + w_2 \cdot T + w_3 \cdot B$$

*Where:*

- $L$ = *Location deviation score*
- $T$ = *Time anomaly score*
- $B$ = *Behavior anomaly score*
- $w_1, w_2, w_3$ = *weights assigned to each factor*

**3.Logistic Regression (Risk Classification)**

Used to classify the situation into Safe, Attention, or High-Risk categories.

$$P(y = 1) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)}}$$

Where:

- $P(y = 1)$= probability of high risk
- $x_1, x_2, \ldots, x_n$= input features
- $\beta$= model coefficients

4. Z-Score (Anomaly Detection)

Used to detect abnormal behavior compared to normal patterns.

$$Z = \frac{X - \mu}{\sigma}$$

**Evaluation Metrics**

**Precision**

The precision metric quantifies the proportion of expected positives that are true.

$$Precision = \frac{TP}{TP + FP}$$

Recall

Recall quantifies the proportion of true positives that were accurately detected.

$$Recall = \frac{TP}{TP + FN}$$

Accuracy

Accuracy gauges how accurate the model is overall across all classes.

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN}$$

F1-score

By balancing Precision and Recall, the F1-score provides a single statistic that takes false positives and false negatives into consideration.

$$F1\text{-}score = 2 \cdot \frac{Precision * Recall}{Precision + Recall}$$

## V. CONCLUSION

The development of an AI-driven safety monitoring system for women adults suffering from mental fatigue has been substantially developed to enhance their safety through the integration of behavioural analytics, real-time geo-location services, and predictive intelligence to provide this proactively. The use of geo-fences to identify geographic locations where users are located, combined with adaptive algorithms that continually evaluate user's behavior, provide early detection of safety anomalies by generating an alert, and placing that anomaly into one of three categories: Safe; Attention, or High Risk. This provides timely alerts compared to previous systems which require human intervention to provide a timely response.

The implementation phase of the system verified the system's ability to function in the field using a mobile device (i.e., the iPhone) through the seamless interface between the different system modules for authentication, data storage/management, behaviour analysis, and notification of alerts. Additionally, the predictive algorithms verify their ability to anticipate deviations from established routine behaviours, thus validating the system's ability to provide anticipatory alerts. Furthermore, the integration of all system components (including mobile devices and wearable sensors) adds to the reliability of real-time monitoring of users and intervention based on context.

The system mitigates vulnerabilities related to cognitive fatigue, emotional stress, and environmental unpredictability by focusing on ongoing assessment, adaptive intelligence, and proactive risk assessment. In addition to improving physical safety, it also provides users with a sense of psychological security by enabling them to continue receiving protection while maintaining their autonomy.

In summary, this study highlights the potential for intelligent automated safety systems to change how personal safety is traditionally defined and understood. It describes a scalable, contextually-aware solution to reduce human reliance during emergency situations while anticipating risks and delivering timely intervention. Through the combination of artificial intelligence-driven analysis, secure communications, and behavioural adaptations, this work represents a strong platform for future safety technologies and offers a comprehensive approach to protecting vulnerable individuals in unpredictable and chaotic environments.

## VI. FUTURE WORK

Future enhancements to the AI-based safety-monitoring system should include increased predictive accuracy, customization of features for individual users, and adding new types of sensing equipment. One example of this would be incorporating advanced machine learning techniques such as deep learning and reinforcement learning into the system to improve behavior predictions and help predict difficult-to-forecast scenarios. Using continuously collected data from many different users and the environments they engage in will allow the AI to adapt to new behaviors, leading to fewer false alarms and improved reaction time for when an incident does occur.

Physiological monitoring equipment, such as heart rate monitors, stress indicators, and biometric sensors worn by users, will provide additional information about users’ mental and physical states. This additional information can be used, along with existing behavioral analytics, to help identify users who exhibit signs of fatigue, stress, or confusion, thereby improving prediction rates. Finally, using multiple devices where the AI could sync data from smartphones, wearable devices, and smart home devices would ensure the AI could monitor activities across multiple environments.

Possible future enhancements may also include reducing communication gaps through the introduction of integrated cloud-based notification systems (i.e., alerts) as well as implementing geospatial technology for analytics and coordination with emergency services for quick and effective response times. In order to ensure continued use among different groups of people, building such features as customizable risk thresholds, context-based alerts/notifications, and user- centered user interface design can help to support more widespread use of the system. Lastly, if privacy-enhancing AI, encryption standards, and decentralized data management are incorporated into the system, user confidence will be improved, thus allowing the system to remain compliant with applicable regulations. By enhancing adaptability, intelligence, and ethical compliance, the system can now be developed into a comprehensive, scalable, anticipatory safety solution. If these improvements occur, then the safety solutions can revolutionize personal safety models, and even provide proactive protection, and independence, and relieve mental fatigue for vulnerable adults, especially mentally fatigued adult women.

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