Women's Safety App: A Multimodal Strategy for Automated SOS Notifications

Asst. Prof. Devesh Singh Som[1], Rohit Kumar[2]
[1]Professor, Department of Computer Science and Engineering, R.D. Engineering College Duhai, Ghaziabad, Uttar Pradesh
[2]Student, Department of Computer Science and Engineering, R.D. Engineering College Duhai, Ghaziabad, Uttar Pradesh

Abstract*—A strong global problem—women not feeling secure and minor advancements in technology society knowledge Nevertheless, there is a pressing need on the international level especially in non-segregated space where the accessibility of emergency support or tools to employ conventional self-defense might be restricted. This work describes the intelligent design and development of the Women's Safety a Mobile Application that unlike prior systems can detect dangerous situations without requiring pre-defined threat models leveraging multi-modal data inputs from mobile devices. The inputs are motion trajectories voice signals live video images and several sensor data open from now on. The system then relies on machine learning models to accomplish in-the-loop analysis and detect turns of potential threat based on behavioral counter indicators and contextual hints.If the user is incapacitated or unable to manually raise an alert, the system triggers an automated SOS notification (GPS locational data included) to the closest police and emergency contacts. In terms of mitigating connectivity problemes, particularly in remote or low network areas the application opts for mesh networking technology to maintain a decentralized peer-to-peer connectivity and reliable communication.These are stages in the architecture of application: sensor data acquisitio,n signal processing; feature ex.Also metrics like detection accuracy, system reliability and real-time responsiveness are used for a system performance evaluation.Results of the experimental validation study suggest that the application is associated with women having improved personal safety due to rapid, autonomous and reliable emergency response capabilities. The survey also validates the utility of a multi-modal data fusion and machine learning approach towards safe proactive interventions in real-world situations.

I. INTRODUCTION

A. Research Issue and Importance

An age-old problem that has persisted as a major cause for concern in society continues to be the safety of women especially in public where one never knows and when help is needed — at times not immediately available. Even with the advent of many emergency support systems, and the endorsement of self-defense articulation many women still face significant hurdles in getting help quickly when in a severe or life-threatening position. Manual activation of existing safety mechanisms is one of the main bottlenecks, and for the methods in which the victims are incapacitated, restrained or subjected to extreme psychological duress it becomes theoretically obsolete (emergency numbers, panic buttons etc.) At this point, strong and intelligent safety solution that can inherently identify potential threats and deliver an action in a timely manner is very much needed for proactive context. The result has resulted in the creation of an advanced Women's Safety App that uses multi-modal data streams from smartphones and wearables to sense the environment and user behavior in real-time.These data streams can be motion (from accelerometer and gyroscope measurements), images, voice, ambient sound recordings in the environment, video captures and sensor-driven data such as heart rate, light exposure or sudden force impact detection. The application uses the real-time machine learning and signal processing to look for abnormal patterns —for instance quick jerks, sounds of scream or sudden scream/crieslike verbal behavior or exuberance to running to sharp voice tones that might be indicative of an incoming threat. Recognizing this kind of patterns, the system automatically triggers an SOS plan which means it alerts registered emergency contacts with GPS location data, time stamp and contextual information and in case relevant even small dose to local law enforcement or safety authorities. One of the key aspects of the system runs due to non-constant internet connectivity, where it can work without visible changes. The app uses mesh networking to keep in contact with other devices, providing peer-to-peer relays where standard cell signal is bad and using them as connected devices.These are especially competent in remote, rural or isolated locations where traditional methods for communication may be nonfunctional.This solution aims to close the loop of the manual safety system by providing an autonomous but intelligized and real-time threat detection, emergency response platform. By fusing heterogeneous requirements. sensor data withdeep machine learning algorithms, the proposed application has promising promise to substantially improve the individual security level and lowering response time for incidents involving women in distress.Please let me know if you want to have a literature review part, system architecture breakdown or model training dataset

B. The Study's Motivation

The necessity for technology-driven safety solutions has been brought to light by the rise in incidents of harassment and violence against women in both public and private settings. Existing apps depend on human intervention or manual

Fig. 1. Increasing incidents of harassment highlight the need for autonomous safety solutions, which can detect threats and trigger alerts without user intervention.

activation, but these approaches don't take into consideration scenarios in which the user can be incapacitated. By using real-time monitoring and sophisticated danger identification to automate the safety procedure, this research seeks to close the gap and provide a more accessible and responsive safety solution.

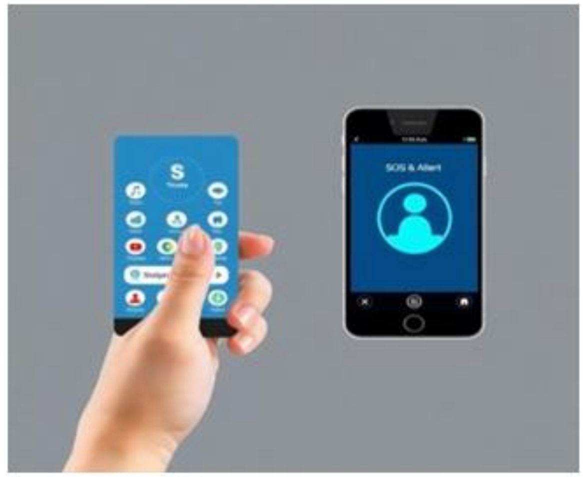

Fig. 2. Previous studies on women's safety apps highlight the limitations of manual trigger-based systems and explore the potential of audio, video, and sensor data for automatic threat detection.

C. Research Goals

Developing a system that gathers and examines multimodal data in order to identify risks instantly is the main goal of this work.

- Creating algorithms that leverage user location information and detected risks to automatically send out SOS notifications.
- Assessing the accuracy and dependability of the system under various real-world scenarios.

D. Hypothesis or Research Question

Can a mobile application efficiently identify hazardous circumstances and automatically broadcast SOS notifications without user participation by utilizing machine learning algorithms and real-time sensor data from smartphones?

II. LITERATURE REVIEW

A. Prior Investigations

The usage of mobile devices for women's safety has been the subject of numerous studies. Some apps concentrate on manually triggering SOS notifications by shaking the device or pushing a button. These systems, however, mostly depend on user input, which presents challenges in emergency situations where users can be physically challenged. Other studies have investigated the use of audio and video analysis for automatic threat identification. For instance, machine learning models are trained to assess sounds linked to risk (such as fighting or shouting), while computer vision algorithms are used to identify face expressions that indicate distress or aggression. Additionally, several current solutions try to use gyroscope and accelerometer data to identify unusual movements, although these approaches are frequently constrained by device capabilities or environmental factors.

- Analysis of images and videos: Convolution al Neural Networks (CNNs) learning methods. Furthermore, the application's mesh networking ensures connectivity in isolated locations where conventional networks are not available so networks may fail.

B. Gaps in Existing Studies

Few safety apps and systems combine many data sources, including motion detection, audio, video, and sensors, into a single threat detection system, despite the fact that there are many. Furthermore, the majority of apps still require human intervention, which reduces their usefulness in some emergency situations. Mesh networking, which is essential for preserving connectivity in places with inadequate network coverage, has also received little attention.

C. The Current Study's Contribution

To automatically identify danger and sound an SOS alarm, the suggested program combines a variety of sensor inputs, such as motion, audio, video, and smartphone sensors. More precise and prompt threat detection is ensured by processing these various data sources using machine Pre-processed data will be used to feed several machine learning models, such as:

• Audio analysis: To identify distress noises, a mix of feature extraction methods and classification algorithms (such as SVM and Random Forest) will be applied.

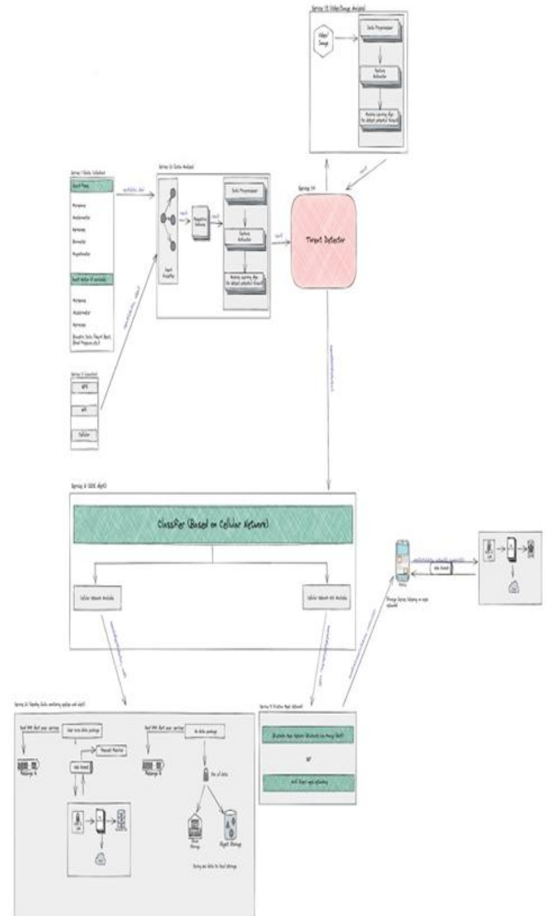

Fig. 3. Flow of the solution

III. METHODOLOGY

A. Research Design and Approach

In order to create and evaluate a Women Safety App that handles multi-modal data in real-time, this study uses an experimental methodology. The method blends mobile app development approaches for smooth integration and user engagement with machine learning algorithms for data analysis.

B. Data Gathering Techniques

Information will be gathered from multiple sources, such as:

- Audio: Recorded using the microphone on a smartphone to detect distressing noises like yelling or hostile speech. • and Video: Taken using the smartphone's camera to identify distressing facial expressions or violent behavior.
- Motion: To detect unusual movement patterns, the smartphone's sensors—accelerometer, gyroscope,

and magnetometer—provide acceleration and orientation data.
- Position: GPS and Wi-Fi triangulation are used to determine the position

IV. ALGORITHMS AND MODELS

Will be used to extract distress indicators and violent interactions from visual data.
- Motion analysis: Using sensor data, a decision treebased algorithm will categorize anomalous movement patterns.
- Location-based threat detection: Mesh networking will guarantee communication in remote locations, while geo fencing will notify users when they enter high-risk zones.

Fig. 4.Diagrammatical representation of the process of Women's Safety
App

V. JUSTIFICATION OF METHODS

The selected techniques stem from the requirement for autonomous, real-time threat identification with little dependence on human involvement. The system can detect and react to a wide range of hazardous circumstances thanks to machine learning, which enables constant adaptation and learning from many sensor inputs. Even in places with spotty mobile network coverage, mesh networking guarantees that the system will continue to function.
- Software Framework: TensorFlow Lite or Core ML will manage on-device machine learning for real-time processing, while React Native will be utilized to create the cross-platform mobile application.
- Back-end: Web Sockets for instantaneous communication, MongoDB for database storage, and BLE for mesh networking.

VI.PARAMETER SETTINGS AND EVALUATION METRICS

- Parameters: Bluetooth range for mesh network connection; geo fencing parameters for location-based threats; and sensitivity thresholds for audio, motion, and video data.
- Evaluation Metrics: Threat detection algorithms' accuracy, precision, recall, and F1-score; app performance (battery usage, response time) will also be evaluated.

VII.STEPS IN PROCESSIONING

Prepossessing the data will entail:
- Audio: Chroma, MFCC, noise reduction, and feature extraction.
- Images and videos: resizing, adjusting, and enhancing.
- Motion: feature extraction and normalization (e.g., movement patterns based on accelerometers).

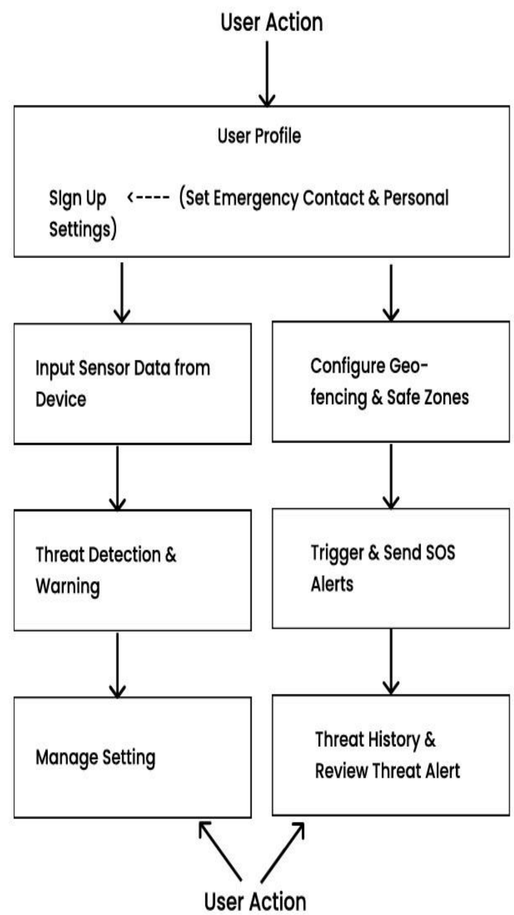

Fig. 5.Use case diagram for the Women's Safety App

A. *Findings and Conversation*

Even in difficult environmental circumstances, we expect the app to demonstrate excellent accuracy in threat detection and quick SOS alerts during testing. When compared to manual activation techniques, we anticipate a notable improvement in both detection and response time. The application's capacity to operate with spotty network coverage by mesh networking will also be validated. Limitations and Future Work

- Battery Life: The smartphone's battery may quickly run out if it is continuously monitored.
- Device Restrictions: Processing power for real-time analysis may be a problem for older devices.
- Environmental Factors: Lighting and noise levels can have an impact on the accuracy of video and audio analysis. Upcoming Projects
- Improving machine learning models to increase the precision of threat detection in a range of scenarios.
- Using wearable technology, such smartwatches, to collect extra data, like skin temperature and heart rate.

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