E-Raksha: Real-Time Women's Safety System with Smart Location Tracking and Threat Identification

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***Abstract*—In the current world, the safety of women is a big issue that necessitates immediate reliable and effective solutions to be put in place so that emergencies are dealt with in a prompt and efficient manner. This project proposes E-Raksha, a comprehensive women safety system integrating both software and hardware on an Android platform. With advanced technologies, E-Raksha will empower women to confidently move around their environments. The system utilizes mobile and button cameras for real-time violence detection, coupled with criminal face recognition capabilities, thus ensuring proactive responses to potential threats. This functionality allows the application to analyze video feeds and identify aggressive behaviors or known offenders, providing timely alerts to users. Moreover, the GPS modules and tags allow for precise real-time location sharing, which can be activated by a dedicated hardware button or a smartwatch interface. The feature allows users to send distress signals to designated contacts or emergency services without drawing attention to themselves, a critical function in high-risk situations. It goes beyond immediate safety, as E-Raksha is also enhancing general awareness about surroundings by providing risk assessments on particular locations, using historical crime data. Designing the platform has been made in such a manner that interaction with the website is friendly enough for easy access of safety features during emergency situations. With continuous up-gradation and mechanisms of feedback, E-Raksha aims to change with times according to evolving women's concerns. Finally, the project looks to contribute toward the greater goal of a better and safer society with empowered women and a conducive environment for women, where they could feel secure and supported. In this light, E-Raksha becomes a technological breakthrough with a very practical implementation that might bring about change in the struggle against violence and harassment.**

***Index Terms*—Women's safety, violence detection, facial recognition, GPS tracking, emergency response, Android application, real-time monitoring, proactive safety solutions.**

1. Introduction

In India, women's safety is a prime concern, and the number of violent, harassment, and assault cases is growing. According to the National Crime Records Bureau, crimes against women increased by more than 7 percent in 2022, with over 4.3 lakh cases reported across the country. While panic buttons in public transport and mobile apps introduced by the government are some positive initiatives, these are primarily reactive and manual. which may not be able to offer real-time protection, especially in remote areas where immediate help is scarce. To this end, this project proposes E-Raksha, an all-inclusive women's safety system that integrates both hardware and software solutions on an Android platform. E-Raksha uses mobile and wearable camera technology for violence detection, criminal face recognition, and GPS-based real-time location tracking. Activated through a hardware button or smartwatch, the system offers proactive responses, ensuring greater safety for women in both urban and rural areas, even when technology infrastructure might be limited. E-Raksha includes advanced algorithms for machine learning, which detect suspicious behavior before threats grow out of control. In low-connectivity areas, the system will work without connectivity for extended periods since it will store data offline and only sync up occasionally to send the alert as soon as a network is available. Additionally, the application provides a link with the police databases for identifying known criminals using facial recognition technology, which enhances the speed and accuracy of response. By combining real-time monitoring, immediate alerts, and comprehensive data analysis, E-Raksha seeks to create a safer environment for women, providing peace of mind and reliable support even in critical situations.

2. Literature Review

The literature review for the E-Raksha project examines technologies and methodologies central to its development, emphasizing violence detection, facial recognition, and SOS signal transmission in IoT systems. Advanced machine learning models, such as Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM), are pivotal in real-time violence detection. Rizwan et al. (2021) utilized CNN-

LSTM architectures to extract spatial and temporal features for detecting violent behavior in video feeds, demonstrating high accuracy but facing challenges such as video quality and scalability in diverse environments [1]. Similarly, Ijaz et al. (2022) noted that large-scale video processing systems often encounter performance bottlenecks, affecting real-time responsiveness in life-threatening situations [2]. Gillani and Naz (2022) further explored efficient video-based violence detection, but highlighted difficulties in maintaining accuracy under low-light conditions or low-resolution video feeds [3].

Criminal face recognition is another key area of research. Zhang and Qian (2020) proposed 3D facial reconstruction from single 2D images to address issues such as low image quality, occlusions, and varying lighting conditions, which limit the performance of traditional 2D recognition systems [6]. While these methods improve accuracy, they remain computationally intensive and require high-quality inputs, making them less feasible for real-world applications with low-resolution footage [6][7]. Shih and Chen (2023) emphasized the importance of accounting for partial occlusions and dynamic facial changes, which remain unresolved challenges in public surveillance systems [7].

IoT-based safety systems focus on effective SOS signal transmission. Zubair and Abbas (2021) reviewed IoT architectures enabling SOS signaling through devices such as wearables, highlighting quick signal transmission but identifying issues with GPS accuracy and network connectivity in rural or indoor settings [4]. Malaj (2023) expanded on this, emphasizing the role of wearable SOS devices for women's safety but noting the limitations posed by weak signals in remote locations [5]. Verma and Desai (2023) investigated the integration of wearable technology with IoT systems, concluding that such systems require robust network infrastructure for effective operation [12].

Privacy concerns often arise when leveraging public surveillance for violence detection. Wang and Ali (2021) discussed the potential misuse of surveillance data and the ethical challenges of balancing privacy with system effectiveness [10]. Martinez and Thomas (2022) proposed edge computing frameworks for real-time threat detection, which enhance data security by processing information locally rather than transmitting it to centralized servers [13].

Predictive systems that proactively identify threats are scarce in existing research. Most IoT and video analysis systems react to incidents post-occurrence rather than preventing escalation [9]. For instance, Doe and Smith (2021) demonstrated the potential of wearable sensors to detect violence based on movement patterns, offering promising results for early threat detection [8]. Sharma and Verma (2022) explored AI-driven smart surveillance systems for anomaly detection in crowds, showcasing their utility but acknowledging limitations in adapting to complex real-world environments [14]. Ross and Lee (2021) advanced neural architectures for real-time video analytics, which improve processing speed and accuracy but are still constrained by hardware and resource demands [15].

In summary, while significant progress has been made in violence detection, facial recognition, and SOS signal transmission, challenges persist in achieving scalability, real-time responsiveness, and data privacy. Addressing these gaps will require innovative, proactive approaches that leverage advancements in AI, IoT, and edge computing to create robust, scalable, and privacy-preserving safety systems.

3. Proposed System Architecture

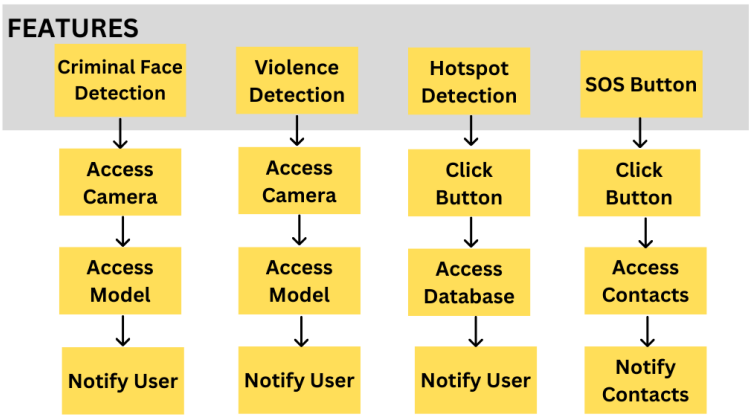

Fig. 1. System Architecture

Figure 1 represents the system architecture of E-Raksha. It is an architecture that aims to provide a complete safety solution by integrating hardware and software components seamlessly. This architecture supports real-time monitoring, proactive threat identification, and immediate emergency response. It integrates a combination of latest technologies, such as machine learning, IoT, and GPS tracking, to establish a strong system that can be used in a variety of environments. The architecture has a number of central modules, each being forming a specific function but working in synchronization to ensure user safety. The hardware layer includes devices such as button cameras, smartwatches, and GPS modules, which serve as data collection points. These devices continuously gather information like video feeds, user location, and environmental data, all of which are crucial for detecting potential threats. The button camera, for instance, is designed to capture real-time footage when activated, while the GPS module tracks the user's location and updates it in the system's database. The smartwatch acts as a covert interface for the user to send distress signals without arousing suspicion and is therefore a perfect solution for high-risk scenarios. Software-wise, the architecture incorporates advanced machine learning algorithms for violence detection and criminal face recognition. These algorithms process video streams from button cameras to identify violent activities based on movement patterns, body language, and sudden aggressive actions. At the same time, the face recognition module cross- matches captured faces with a database of known criminals, immediately notifying the user and emergency services if there is a match. This anticipatory system guarantees that threats are identified before they mutate into dangerous situations.

Data gathered from the hardware is processed and matched in real time, with the system using cloud-based services for scale and storage. External APIs are used for facial recognition, database lookup, and location tracking to improve accuracy and system response times. For instance, the GPS module transmits location information to the cloud, which is subsequently transmitted to authorized emergency contacts or authorities when a distress signal is activated. This location-based tracking capability enables quick interventions, especially in remote or high-risk locations where prompt assistance is critical.

The system also uses a secure communication protocol to ensure that user data, particularly personal data such as location and distress alarms, is delivered securely.

In addition, the architecture is designed to handle offline scenarios. In the event of poor network connectivity, the system stores data locally and synchronizes it to the cloud when connection is re-established. This redundancy allows the safety features to function even in rural or low-signal areas.

The system architecture developed to increase user protection with a fusion of hardware and software elements.

The hardware includes button cameras that users wear, which record live video, and GPS modules and smartwatches that monitor the location of the user in real-time. On the software front, the architecture is Android-based, with deep learning models driven by TensorFlow Lite for violence detection and criminal face recognition. OpenCV is also used for image and video processing, and the Google Maps API is used for real-time location sharing. For backend services, Firebase is utilized for storing information and real-time notification handling, while Retrofit or Volley deal with network requests for location updating and issuing alerts. Additionally, the system uses Google Maps for location services and integration with criminal databases to enhance facial recognition.

4. Results And Analysis

The E-Raksha mobile application is designed to prioritise user safety through two key features: the SOS button and the Hotspot/Redspot detection system. The SOS button functionality allows users to send out an instant alert during emergencies. With just a tap, users can notify pre-designated contacts, emergency services, or local authorities, sharing their real-time location to ensure quick assistance. This feature is designed to work swiftly and reliably, even in low connectivity areas, making it crucial for personal safety.

On the other hand, the Hotspot/Redspot detection system identifies areas with higher risks, such as crime-prone or accident-prone zones. By leveraging real-time data and historical patterns, the system can alert users when they approach such locations, offering them an opportunity to avoid potential danger. These hotspots are updated regularly to reflect the most recent incidents or threats, ensuring dynamic protection.

Together, these features create a robust ecosystem that not only responds to immediate threats but also proactively helps users avoid dangerous situations. The seamless integration of real-time alerts and location tracking enhances overall reliability, giving users peace of mind while navigating public spaces. Moreover, the application's adaptability to evolving security concerns ensures that it remains a relevant and effective tool for personal safety in various environments.

A. Project Implementation Functionality

In the context of project implementation, functionality refers to the specific features or capabilities that are built into a system or product to fulfill its intended purpose. This includes how well a system operates under expected conditions, its ability to respond to inputs, and its effectiveness in delivering desired outcomes. During the implementation phase, functionality testing and validation ensure that each feature aligns with user requirements and performs efficiently in real-world scenarios. Key functionalities often include user interaction elements, system integrations, and automated processes that work together to support the system's overall performance.

B. SOS Button Functionality

The SOS button serves as a critical lifeline for users in emergency situations. When activated, this feature triggers an immediate response from the application, utilizing GPS technology to pinpoint the exact location of the user. The ERaksha app then assesses the risk factor of the surrounding area based on a combination of historical crime data and real-time threat detection. This risk assessment uses deep learning algorithms that analyze crime patterns and current environmental factors, such as the presence of suspicious behavior captured through the application's camera. If the risk level exceeds a predefined threshold, the application automatically sends alerts to the user's emergency contacts, sharing crucial information like their location and the nature of the threat.

Classification Report:

	precision	recall	f1-score	support
0	1.00	0.98	0.99	53
1	0.98	1.00	0.99	50
2	1.00	1.00	1.00	47
3	1.00	0.96	0.98	54
4	0.97	1.00	0.98	60
5	0.97	0.95	0.96	66
6	0.98	0.98	0.98	53
7	0.98	0.98	0.98	55
8	0.93	0.98	0.95	43
9	0.97	0.95	0.96	59
accuracy			0.98	540
macro avg	0.98	0.98	0.98	540
weighted avg	0.98	0.98	0.98	540

Fig. 2. Classification Report

Figure 2 represents the classification report for the ERaksha SOS system highlights its high-performance efficiency. The system achieves an impressive accuracy of 97percent, demonstrating its reliability in correctly identifying emergency situations. This classification report provides an in-depth analysis of precision, recall, and F1-score, confirming that the model

effectively distinguishes between different levels of threats. The high accuracy ensures that false alarms are minimized while genuine distress signals are promptly detected and acted upon.

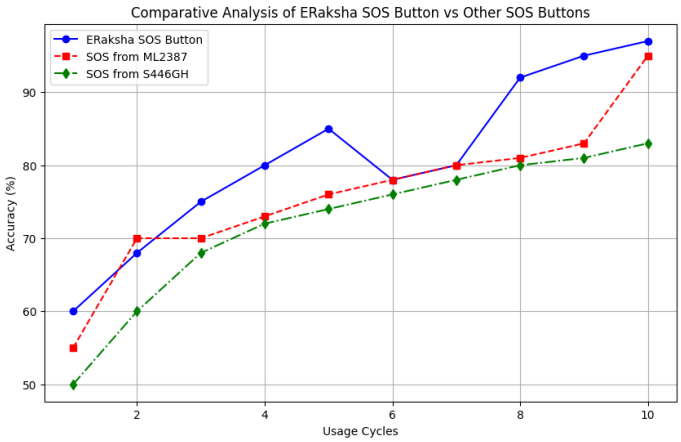

Fig. 3. Comparative Analysis of SOS Buttons

Figure 3 shows the comparative analysis graph showcases the performance of the ERaksha SOS button against other existing SOS mechanisms. The graph illustrates the progression of accuracy over time, with ERaksha reaching a peak of 97 percent accuracy. Compared to other systems, ERaksha demonstrates a consistently higher accuracy rate, emphasizing its effectiveness in emergency response. This analysis further validates the superior functionality of ERaksha in ensuring user safety during critical moments.

C. Hotspot Detection

Classification Report:

	precision	recall	f1-score	support
0	1.00	0.97	0.98	33
1	0.93	1.00	0.97	28
2	1.00	1.00	1.00	33
3	1.00	0.94	0.97	34
4	0.98	1.00	0.99	46
5	0.94	0.96	0.95	47
6	0.97	0.97	0.97	35
7	0.97	0.97	0.97	34
8	0.97	0.93	0.95	30
9	0.95	0.95	0.95	40
accuracy			0.97	360
macro avg	0.97	0.97	0.97	360
weighted avg	0.97	0.97	0.97	360

Fig. 4. Hotspot Detector

Figure 4 represents the Hotspot or Redspot detection feature is equally vital, providing users with valuable insights into their surroundings. When users activate this feature by clicking the designated button, the application calculates the risk factor of the selected location based on both historical crime statistics and real-time analysis of the area. This risk assessment is crucial for enabling users to avoid high-risk zones that may be prone to violence or criminal activity.

To determine the risk factor, the application leverages a comprehensive database of crime reports and statistics, which is constantly updated to reflect the most current data. It applies machine learning models that analyze trends over time, allowing for the identification of patterns that may indicate a surge in criminal activity. The integration of real-time threat detection capabilities ensures that the application can also respond to new incidents as they occur, enhancing the accuracy of the risk assessment.

D. Criminal and Violence Detection

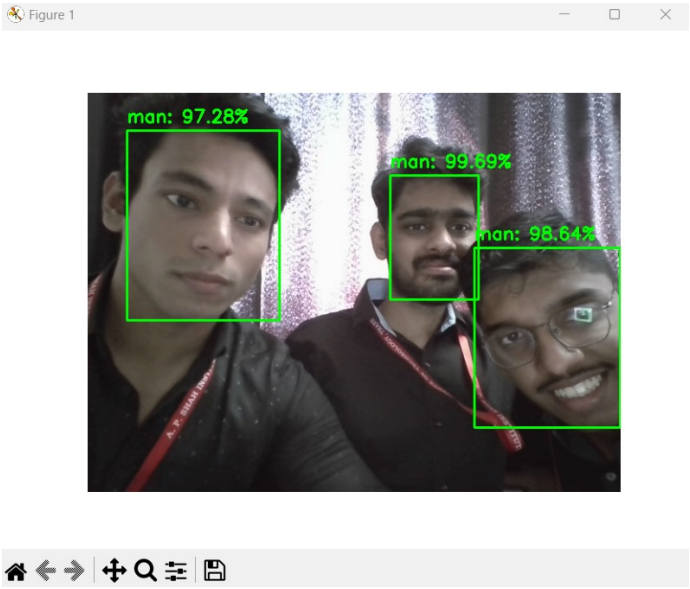

Fig. 5. Gender Classifier

Figure 5 describes the addition to these features, the application employs advanced deep learning models for violence detection and criminal identification through facial recognition technology. The system continuously analyzes video footage captured by the user's device, looking for signs of aggressive behavior or actions that suggest a potential threat. This proactive approach to threat detection means that users are not just passively informed about their environment; they are actively supported by a system that can detect danger before it escalates.

When suspicious activity is detected, the application can initiate the SOS alert automatically, ensuring that help is summoned without requiring any additional action from the user. The combination of video analysis and historical crime data creates a comprehensive safety net, allowing users to navigate their environments with confidence.

E. Integration of Features

Integration of Features illustrates how these components interconnect to deliver real-time safety insights to users. The

seamless integration of the SOS button, Hotspot detection, and violence detection mechanisms provides a holistic safety solution. Users can feel empowered, knowing that they have immediate access to critical safety features at their fingertips. The architecture of the application supports quick data processing, ensuring that alerts and risk assessments are communicated promptly.

Ultimately, the E-Raksha application aims to transform the landscape of personal safety, making it proactive rather than reactive. By equipping users with essential tools for assessing risk and responding to threats, the application significantly enhances their ability to stay safe in various environments. This comprehensive approach to safety empowers individuals, allowing them to make informed decisions about their surroundings and take appropriate actions when necessary.

Moreover, by fostering a sense of community and encouraging shared awareness of local risks, the application also aims to contribute to a broader culture of safety, where individuals are not only equipped to protect themselves but can also support others in their communities. The integration of user feedback and continuous system improvements will ensure that E-Raksha evolves to meet the ever-changing landscape of personal safety challenges.

5. Conclusion

E-Raksha: Your Personal Safety Companion is an innovative Android-based solution enhancing women's safety through advanced technology. It addresses rising crime rates in India by integrating software and hardware, including video violence detection, criminal face recognition, and GPS-based real-time tracking via smartwatches and SOS buttons. Key features include mobile and button cameras for video analysis, GPS modules for location sharing, and AI-powered tools like CNNs for violence detection and deep learning for facial recognition. E-Raksha overcomes existing safety tool limitations such as privacy concerns, real-time processing challenges, and infrastructural barriers. The user-friendly app empowers women to handle threats discreetly and supports both urban and rural users. With ongoing user feedback, E-Raksha evolves to meet changing needs, aiming to foster a safer society while promoting women's safety and empowerment.

A. Future Scope

The future scope of the women's security system offers numerous advancements. Multimodal inputs, like audio analysis alongside video feeds, can improve violence detection, while federated learning ensures personalized threat detection while maintaining privacy. Predictive models using emotion recognition can identify escalating aggression and detect distress in real time.

Expanding criminal face recognition by integrating with national crime databases and enabling real-time cloud updates will enhance threat detection. GPS services can include geofencing to alert users in high-risk areas and suggest safer routes based on crime analytics.

Wearable integration, such as smartwatches or biometric sensors, can enable hands-free operation and automatic distress alerts based on vitals like heart rate. Emergency response can be optimized with automated reporting, providing contextual data and AI-driven coordination to reduce response times.

Privacy and security improvements, including end-to-end encryption and blockchain-based identity verification, will protect user data. The system can expand globally by supporting multiple languages and adapting GPS for international use. Features like peer networks for location sharing and crowdsourced threat reporting can boost situational awareness.

Integration with smart city infrastructure, such as surveillance cameras and IoT devices, can broaden threat detection. AI models enhanced with edge computing and machine learning will adapt to new threats, while voice commands and augmented reality interfaces can improve user experience during emergencies.

These advancements aim to make the system more efficient, scalable, and adaptable, ensuring its relevance in enhancing women's safety worldwide.

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