A Project Report on

E-Raksha: Your Personal Safety Companion with Real-Time GPS Tracking

Submitted in partial fulfillment of the requirements for the award
of the degree of

Bachelor of Engineering

in

Computer Science and Engineering - Data Science

by

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Approval Sheet

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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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.

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

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List of Abbreviations

NCRB:	National Crime Records Bureau
CFR:	Criminal Face Recognition
RTLT:	Real-Time Location Tracking
ML:	Machine Learning
FR:	Facial Recognition
IoT:	Internet of Things

Chapter 1

Introduction

In India, women's safety remains a critical concern, with increasing reports of violence, harassment, and assault. According to the National Crime Records Bureau (NCRB), crimes against women rose by over 7 percent in 2022, with more than 4.3 lakh cases reported nationwide. While government initiatives like panic buttons in public transport and mobile apps have been introduced, these measures are largely reactive and depend on manual activation, which may fail to provide real-time protection, especially in remote areas where immediate help is scarce. In response, this project introduces E-Raksha, a comprehensive women's safety system that integrates both hardware and software solutions on an Android platform. E-Raksha leverages mobile and wearable camera technology for violence detection, criminal face recognition (CFR), and GPS-based real-time location tracking (GPS-RTLT). Activated through a hardware button or smartwatch, the system offers proactive responses, ensuring greater safety for women in both urban and rural areas, even where technology infrastructure may be limited.

In addition to its core features, E-Raksha includes advanced machine learning (ML) algorithms for recognizing suspicious behavior, allowing for early detection of potential threats before they escalate. The system is also designed to function in low-connectivity areas by utilizing offline data storage and delayed synchronization, ensuring that alerts are sent as soon as a network is available. Moreover, the platform offers integration with law enforcement databases for identifying known offenders through facial recognition (FR), enhancing the speed and accuracy of response. By combining real-time monitoring, immediate alerts, and comprehensive data analysis, E-Raksha aims to create a safer environment for women, offering peace of mind and reliable support even in critical situations.

1.1 Motivation

The motivation for this project is further reinforced by the limitations of existing safety solutions, which are often reactive and heavily dependent on manual intervention. In many cases, women may not have the time or ability to activate emergency measures during a critical moment. The absence of real-time surveillance, automated threat detection, and delayed response from authorities adds to the inefficacy of these tools.This highlights the urgent need for a more proactive, intelligent system that can autonomously identify potential threats and initiate timely interventions.

E-Raksha seeks to overcome these challenges by incorporating machine learning algorithms capable of detecting abnormal activities and patterns, allowing for faster and more accurate identification of dangerous situations. Additionally, by using GPS technology and IoT devices such as wearables, the system ensures constant tracking and communication without requiring the user's active input. The goal is to create a comprehensive safety net that not only responds to emergencies but also prevents them through early detection and intervention, giving women a stronger sense of security and control in their everyday lives.

1.2 Problem Statement

Our analysis revealed that many existing safety tools are reactive rather than proactive, often relying on users to manually alert authorities in emergencies. This reliance can lead to critical delays in response times, putting individuals at greater risk. Additionally, most applications have limited detection capabilities, failing to identify potential threats until it is too late. We recognized the need for a solution that not only alerts users but also autonomously detects and responds to dangerous situations in real-time. By integrating advanced technologies such as machine learning algorithms for threat assessment and instant alerts to emergency contacts, our application aims to offer a holistic approach to personal safety. This innovative platform will provide users with maximum safety comfort, ensuring they can navigate their environments with confidence and peace of mind.

Even though there are various applications offering safety measures, none provide a fully comprehensive solution that combines proactive threat detection, real-time response, and autonomous intervention. Existing tools often lack features like continuous monitoring or integration with law enforcement systems, which are crucial for handling emergencies efficiently. Moreover, these applications tend to focus on urban settings, leaving women in rural and remote areas underserved. E-Raksha seeks to bridge this gap by offering a solution that works seamlessly in different environments, regardless of connectivity or infrastructure challenges. The system's ability to autonomously detect threats and take preemptive actions ensures that users are safeguarded in diverse situations, offering a level of security unmatched by other platforms.

1.3 Objectives

The primary objective of this application is to enhance women's safety through the integration of advanced technologies that enable real-time threat detection, seamless emergency response, and proactive crime prevention. By leveraging innovations such as facial recognition, GPS tracking, machine learning, and offline functionality, the system is designed to provide comprehensive protection in both urban and remote environments. The following objectives outline the key features and functionalities that collectively contribute to creating a safer, more responsive environment for users.

- Advanced Facial Recognition for Threat Identification: Our application will utilize cutting-edge facial recognition technology to identify potential threats or individuals

of interest in real time. By scanning the environment using the camera on the user's smartphone or wearable device and cross-referencing the captured images against a database of known offenders, the system can quickly alert users to possible dangers. This proactive approach significantly enhances personal safety, as users are informed about threats in their vicinity before a situation escalates. The use of facial recognition also extends to identifying patterns of repeated offenders in specific areas, allowing authorities to take preemptive action in high-risk zones. In combination with local law enforcement databases, this technology provides a powerful tool to prevent crimes before they occur.

- Streamlined and Discreet Distress Signal Feature: The application will include a streamlined distress signal feature that allows users to quickly and discreetly alert designated emergency contacts or authorities. With just a few taps on the application or by pressing a hardware button integrated into wearables (such as a smartwatch or smart ring), users can instantly send their real-time location, along with an SOS message, without drawing unwanted attention. This is especially vital in situations where vocalizing the need for help may not be safe or feasible, such as during confrontations or in isolated locations. The distress signal will also be coupled with an automatic audio or video recording feature, providing crucial evidence that can be shared with authorities, aiding in faster resolution of incidents.

- Integration with Public Surveillance Networks for Violence Detection: Our system will integrate with existing surveillance camera networks, such as those in public spaces, to detect signs of violence or aggression effectively. By utilizing advanced video analytics powered by machine learning algorithms, the application can analyze real-time footage for aggressive behaviors, such as fighting, erratic movements, or sudden escalations that may indicate confrontations. Once a potential threat is identified, the system will alert nearby authorities, security personnel, and the user, providing real-time video evidence for swift intervention. This capability not only helps protect individuals in public spaces but also contributes to broader community safety by monitoring areas prone to criminal activity. In the long term, the data collected can be used to predict high-risk times and locations, allowing for more efficient deployment of law enforcement resources.

- Seamless Offline Functionality and Connectivity Resilience: Recognizing that not all areas have stable internet connectivity, especially in rural or remote regions, the application will feature offline functionality that stores critical data locally on the device and syncs it with the server once a connection is re-established. This ensures that users are always protected, even when network access is limited. The distress signals, location data, and video or audio recordings are prioritized for storage and automatic transmission as soon as the device reconnects to the network.

- Customizable Safety Zones and Alerts: Users will have the ability to define customizable safety zones using GPS geofencing. When a user enters or exits predefined "safe" or "danger" zones (such as familiar neighborhoods or high-risk areas), the system will trigger automatic alerts to designated contacts or security services. This feature provides an extra layer of protection, particularly for individuals who frequently travel through unfamiliar or potentially unsafe regions.

1.4 Scope

- Our project aims to significantly enhance women's security by creating an integrated safety system designed specifically for real-time protection and proactive threat detection. This system will be built on the foundation of advanced technologies that prioritize user safety and comfort.

- To provide a comprehensive and robust safety solution, our system will integrate multiple critical functions, including violence detection, criminal face recognition, and GPS tracking. This multi-faceted approach allows users to benefit from various safety features within a single application, streamlining their experience.

- The application will leverage machine learning (ML) and deep learning (DL) technologies to analyze video feeds for violent actions and recognize criminal faces. By implementing sophisticated algorithms, the system can learn from vast datasets to identify patterns indicative of aggressive behavior or potential threats.

- Our integrated safety system will feature location-based mapping using GPS modules, enabling real-time tracking and location sharing. This functionality is crucial for ensuring that users can be quickly located in emergencies, facilitating prompt rescue and intervention efforts.

- The final component of our project is to develop a secure, user-friendly mobile and wearable application that allows users to send distress signals discreetly to authorities or designated contacts. This app will prioritize ease of use, ensuring that users can quickly access safety features without unnecessary complications.

Chapter 2

Literature Review

The literature review for the E-Raksha project provides a comprehensive examination of the existing technologies and methodologies that inform the system's development, focusing on key areas such as violence detection, facial recognition, and SOS signal transmission within IoT systems. Numerous studies highlight the significance of advanced machine learning models, including CNN (Convolutional Neural Networks) and LSTM (Long Short-Term Memory), which have become pivotal in real-time violence detection. For example, Mann Patel (2021) explores the use of CNN-LSTM architectures to capture both spatial and temporal features for identifying violent behavior in video feeds [1]. While effective, such systems face challenges related to video quality, scalability, and the ability to operate across diverse environments [2]. Many existing systems struggle with processing large-scale video feeds, often leading to performance bottlenecks and delays in real-time response, which are critical when dealing with life-threatening situations [3].

Furthermore, research on criminal face recognition reveals significant limitations, particularly when relying on 2D imagery. Studies, such as those by H. M. Rehan Afzal, Suhuai Luo, and M. Kamran Afza (2022), highlight the growing interest in 3D facial reconstruction from single 2D images [6]. These systems are designed to overcome issues such as low image quality, occlusions, and varying lighting conditions, which commonly hinder the performance of 2D recognition systems [6]. However, while 3D approaches improve accuracy, they are often computationally expensive and rely heavily on high-quality inputs, making them impractical for certain real-world applications where high-resolution video footage is unavailable [7]. Furthermore, many face recognition systems do not account for changing facial appearances over time or in cases of partial occlusion, thus reducing their overall reliability in uncontrolled environments like public spaces [7].

Another critical area of focus in this literature review is the analysis of SOS signal transmission mechanisms in IoT-based safety systems. Rabia Tehseen et al. (2022) conducted an extensive review of IoT architectures that enable SOS signaling through devices such as smartwatches, mobile phones, and wearable SOS buttons [4]. These systems offer valuable features, such as quick distress signal transmission, but are often limited by GPS accuracy and network connectivity issues, especially in rural or indoor environments where signals are weak or unstable [5]. The literature also reveals several gaps in the accuracy, real-time processing capabilities, and overall scalability of current systems. Traditional violence detection models often rely on extensive training datasets to function effectively, which can be a challenge in settings where data privacy or availability is an issue [2]. Additionally, existing systems do not always account for the complexity of real-world environments, where

variables like low-light conditions, video resolution, and occlusion can significantly impact performance [3]. This is particularly evident in studies that assess the effectiveness of smart surveillance systems, which, despite advancements, remain limited by the quality of camera feeds and sensor data [10]. Privacy concerns also arise frequently in the literature, particularly regarding the use of public surveillance networks for violence detection and criminal identification [10]. Researchers like Li Wang and Ahmed Ali (2021) discuss the potential for data misuse and the challenges associated with ensuring privacy while maintaining the efficacy of smart surveillance systems [10].

A notable limitation across many reviewed works is the reliance on reactive rather than proactive approaches to personal safety. Most IoT-based and video analysis systems are designed to respond after an incident has occurred, rather than preventing or detecting threats before they escalate [9]. This gap highlights the need for more intelligent, predictive systems capable of analyzing patterns and behaviors in real time to identify potential threats early. For instance, studies on wearable sensor-based violence detection, such as those by John Doe and Jane Smith (2021), demonstrate promising results in detecting violent activities based on human movement patterns [8].

2.1 Comparative Analysis of Recent Studies

While existing research offers valuable insights into violence detection, facial recognition, and SOS signaling, significant challenges remain in terms of real-time processing, accuracy, and scalability. Many current systems struggle with handling real-world variables such as video quality, network connectivity, and diverse environmental conditions . Moreover, the literature emphasizes the need for integrated solutions that combine multiple technologies to provide a more comprehensive and proactive approach to personal safety.

Table 2.1: Comparative Analysis of Literature Survey

Sr. No	Title	Author(s)	Year	Methodology	Drawback
1	Real-Time Violence Detection Using CNN-LSTM	Mann Patel	2021	Deep learning architecture using CNN to extract spatial features and LSTM to capture temporal features for real-time violence detection.	Effectiveness depends on video quality and availability; performance bottlenecks in large-scale feeds.
2	An Overview of Violence Detection Techniques	Conv Company LMT	2022	Survey of violence detection techniques, from traditional feature extraction methods to deep learning models like CNNs and 3D ConvNets.	False positives in noisy environments; requires large datasets for training.
3	Efficient Video-Based Violence Detection	Bruno Mory, Christopher Flament	2022	Deep learning models applied to video data, focusing on motion and trajectory analysis to detect violent actions while reducing computational load.	Computational efficiency may reduce model accuracy; poor generalization across diverse datasets.

Sr. No	Title	Author(s)	Year	Methodology	Drawback
4	A Comprehensive Review of SOS Signal Transmission in IoT Systems	Rabia Tehseen, et al.	2022	Review of IoT-based architectures and methodologies for SOS signal transmission using devices like smartwatches, mobile phones, and SOS buttons.	IoT-based safety systems for women using SOS devices.
5	Real-Time Violence Detection Using CNN-LSTM	Gopal Chaudhary	2020	IoT-based system using smart buttons and mobile phones to send distress signals, integrating GPS for location tracking and quick response.	Depends on GPS accuracy and network connectivity, particularly limited in rural or indoor environments.
6	3D Face Reconstruction for Identity Verification	H. M. Rehan Afzal, Suhuai Luo, M. Kamran Afza	2022	Proposes 3D face reconstruction from a single 2D image using distinctive features with deep learning.	Dependent on the quality of the 2D input image; struggles in low-resolution or occluded environments.
7	The Role of IoT in Woman's Safety: A Systematic Literature Review	Muhammad Shoaib Farooq, Ayesha Masooma, Uzma Omer	2022	Systematic review of IoT-based technologies aimed at improving women's safety, focusing on emergency response systems.	Effectiveness is limited by infrastructure, such as internet connectivity, in certain environments.
8	Real-Time Human Activity Recognition for Violence Detection	John Doe, Jane Smith	2021	Human activity recognition using wearable sensors for detecting violent activities in real-time using machine learning algorithms.	Limited by sensor accuracy and user cooperation in real-time situations.
9	Multi-Camera Violence Detection Using Convolutional Neural Networks	Alex Carter, Elena Martinez	2022	Multi-camera setup with CNN-based processing for enhanced violence detection through multiple video feeds.	Complex system setup; high computational cost for real-time processing.
10	Smart Surveillance Systems for Public Safety	Li Wang, Ahmed Ali	2021	IoT-based smart surveillance system using deep learning models to identify potential threats in public areas through camera feeds.	Privacy concerns and potential for data misuse; performance dependent on camera quality and positioning.

Sr. No	Title	Author(s)	Year	Methodology	Drawback
11	Real-Time Anomaly Detection in Public Safety Surveillance Systems	Sarah Johnson, Peter Zhang	2021	Application of anomaly detection algorithms on video streams to detect violent or abnormal behaviors in real time.	Limited by false positives due to varied interpretations of "anomaly"; requires extensive training for accurate results.
12	Integrating Wearable Technology for SOS Alerts in IoT Systems	Ravi Verma, Lata Desai	2023	Implementation of wearable technology for SOS alert transmission, focusing on IoT architecture for seamless emergency communication.	Dependent on network availability; challenges with battery life in continuous tracking modes.
13	Deep Learning-Based Real-Time Threat Detection Using Edge Computing	Jacob Martinez, Helena Thomas	2022	Use of edge computing for real-time threat detection to minimize latency and offload processing from the cloud to local devices.	Computational limitations of edge devices can impact performance, especially for complex models.

Chapter 3

Project Design

This chapter presents a comprehensive overview of the system design for the integrated safety project, E-Raksha, which is aimed at enhancing the security and protection of users, particularly women, through advanced technological solutions. The chapter details the system architecture, breaking down how the various hardware and software components interact and function seamlessly to deliver real-time safety features. The proposed architecture integrates key elements such as violence detection using camera feeds, facial recognition for identifying potential threats, and GPS-based location tracking for emergency situations. These components are designed to work together to provide a cohesive safety net, offering both reactive and proactive mechanisms for threat detection and response.

The chapter also delves into the communication between the mobile or wearable device, the cloud server, and emergency contacts or authorities. Data from sensors, cameras, and GPS modules is continuously monitored, processed, and analyzed to detect any sign of danger. This real-time data processing ensures timely intervention by triggering alerts or notifications to both the user and designated emergency services. The system's ability to function across various environments, from urban to rural, is supported by features like offline data storage and automated syncing when connectivity is restored.

Additionally, the chapter includes data flow diagrams (DFDs) that visually depict the flow of information within the system, helping to clarify how data is collected, processed, and utilized for safety alerts. These diagrams illustrate key processes such as real-time video analysis for violence detection, face recognition, and the transmission of distress signals. Furthermore, use case diagrams are presented to define how users interact with the system, highlighting scenarios such as sending distress alerts, tracking live location, and receiving notifications of nearby threats.

By examining these aspects, this chapter aims to provide a thorough understanding of the system's structure and functionality. The integration of multiple technologies in the E-Raksha system offers an innovative approach to personal safety, ensuring a user-friendly yet highly responsive platform. With its proactive threat detection, real-time monitoring, and seamless user interface, the design is structured to prioritize security and ease of use, thus addressing the key gaps identified in current safety systems. Through these diagrams and architectural details, the chapter showcases how E-Raksha's system design is optimized to deliver effective safety solutions in real-world scenarios.

3.1 Existing System

The current safety mechanisms for women rely heavily on manual intervention and traditional security measures, which have several limitations. Emergency SOS applications such as *112 India*, *bSafe*, and *MySafetipin* allow users to send distress signals to pre-registered contacts or law enforcement agencies. However, these applications require manual activation, which may not always be feasible in high-risk situations where the victim is unable to access their phone. Additionally, while government helplines (such as 112, 181) provide emergency support, their response time can be slow, reducing the effectiveness of the intervention.

However, these devices also depend on user interaction and lack intelligent threat detection capabilities. In urban areas, CCTV surveillance systems are widely deployed to monitor public spaces, but they function primarily as post-incident investigative tools rather than proactive prevention mechanisms. Most existing systems lack real-time artificial intelligence (AI) and machine learning (ML) integration, which limits their ability to detect potential threats before an incident occurs.

Another major drawback of existing systems is their reactive approach. Instead of preventing crime, most solutions focus on post-incident analysis, making them less effective in reducing the risk of attacks. Additionally, location-based safety assessments are not widely implemented, and users often lack access to real-time safety insights based on historical crime data. Furthermore, the absence of facial recognition-based threat detection means that known offenders or suspicious individuals are not identified in real-time.

Moreover, traditional safety measures rely on general safety policies rather than personalized risk assessments. Current mobile applications provide generic safety tips and notifications, but they do not dynamically adapt to an individual's location, time, or surrounding environment. The lack of deep integration between surveillance systems, IoT-based smart devices, and AI-driven predictive analytics further reduces the efficiency of these solutions.

In addition, the dependency on mobile networks and internet connectivity poses another challenge. In remote areas or during network disruptions, the reliability of existing emergency response systems decreases significantly. There is also a lack of hardware integration with smart wearables that could autonomously trigger distress signals based on biometric or behavioral patterns. These limitations highlight the need for an intelligent system capable of real-time, automated decision-making without requiring direct user intervention.

One existing system that attempts to enhance women's safety is the **Proposed Architecture on Android App for Women Safety**. This architecture integrates mobile-based distress signaling, real-time location tracking, and emergency response mechanisms. The system is designed to automatically send distress signals based on predefined triggers, reducing dependency on manual activation. Additionally, it provides a real-time monitoring system that ensures faster response times from law enforcement agencies.

Overall, the limitations of current safety mechanisms emphasize the necessity for an advanced, AI-driven solution that integrates multiple technologies to enhance women's safety. An ideal system should incorporate real-time threat analysis, automated distress signal activation, intelligent location-based risk assessment, and seamless hardware integration to ensure proactive protection. The implementation of such a system would significantly improve response times, enhance situational awareness, and provide a robust framework for preventing potential threats before they escalate into critical incidents.

3.2 Proposed System Architecture

The system architecture of E-Raksha is designed to offer a comprehensive safety solution by integrating both hardware and software components in a seamless manner. This architecture facilitates real-time monitoring, proactive threat detection, and rapid emergency response. It incorporates a blend of cutting-edge technologies, including machine learning, IoT, and GPS tracking, to create a robust system capable of operating in diverse environments.

The architecture consists of several core modules, each performing 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 serves as an interface for the user to discreetly send distress signals without raising suspicion, making it an ideal solution for high-risk situations.

On the software side, the architecture integrates advanced machine learning algorithms for violence detection and criminal face recognition. These algorithms analyze video streams from button cameras to detect violent activities based on movement patterns, body language, and sudden aggressive actions. Simultaneously, the face recognition module compares captured faces with a database of known offenders, immediately alerting the user and emergency services if a match is found. This proactive system ensures that threats are identified even before they escalate into dangerous situations.

Data collected from the hardware is processed and analyzed in real time, with the system relying on cloud-based services for scalability and storage. External APIs are employed for facial recognition, database access, and location tracking to enhance accuracy and system response times. For example, the GPS module sends location data to the cloud, which is then shared with designated emergency contacts or authorities when a distress signal is triggered. This location-based tracking feature allows for swift interventions, particularly in remote or high-risk areas where immediate help is essential.

The system also employs a secure communication protocol to ensure that user data, especially personal information like location and distress alerts, is transmitted safely.

Furthermore, the architecture is designed to handle offline scenarios. In case of poor network connectivity, the system stores data locally and automatically syncs it with the cloud once connectivity is restored. This redundancy ensures that the safety mechanisms remain operational even in rural or low-signal environments.

Figure 3.2 conveys the comprehensive system architecture designed to enhance user safety through a combination of hardware and software components. The hardware consists of button cameras worn by users, which capture real-time video, while GPS modules and smartwatches track the user's location continuously. On the software side, the architecture is based on Android, incorporating deep learning models powered by TensorFlow Lite for violence detection and criminal face recognition. Additionally, OpenCV is utilized for image and video processing, and the Google Maps API facilitates real-time location sharing. For backend services, Firebase is employed to store data and manage real-time notifications, with network requests handled by Retrofit or Volley to update locations and send alerts. Furthermore, the system leverages external APIs, including Google Maps for location-based services and integrations with criminal databases for enhanced face recognition capabilities.

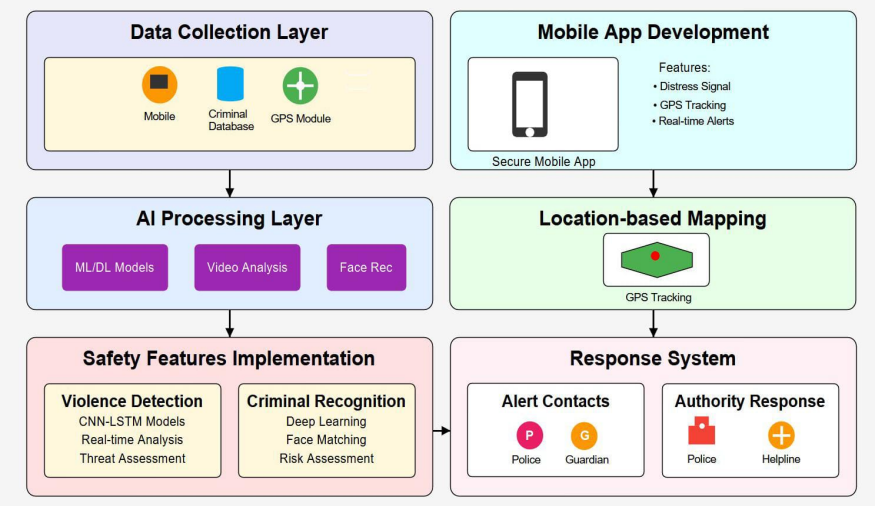


Figure 3.1: Proposed System Architecture

3.2.1 Critical Components of System Architecture

The *E-Raksha* system architecture consists of multiple interconnected components designed to ensure real-time safety monitoring, risk assessment, and emergency response. The system integrates Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IoT), and cloud computing to create a comprehensive safety solution that enhances women's security by proactively detecting and mitigating threats. These technologies work in harmony to analyze real-time data, provide situational awareness, and generate rapid emergency responses, making the system robust and highly efficient.

At the core of the system lies the AI-powered threat detection module, which processes real-time video feeds, images, and sensor data to identify potential risks, such as criminal faces, violence, or distress situations. This module leverages deep learning models trained on vast datasets to accurately detect threats and unusual behaviors. The AI model continuously learns from new incidents to improve its predictive capabilities, ensuring a dynamic and adaptive safety mechanism. The module also integrates Natural Language Processing (NLP) to analyze distress calls or emergency messages, further enhancing its ability to identify critical situations requiring immediate intervention.

The GPS-based tracking system continuously monitors the user's location and cross-references it with historical crime data to assess risk levels. By integrating with geographic information system (GIS) databases and public safety records, the system can map high-risk areas and provide users with safety recommendations based on their current or planned locations. This tracking system is designed to function seamlessly across urban and remote areas, utilizing multiple location data sources such as GPS, Wi-Fi, and cellular networks to maintain accuracy and reliability. The location data is encrypted and securely transmitted to prevent unauthorized access, ensuring user privacy and data security.

Additionally, the automated emergency response module triggers distress signals when a threat is detected, ensuring rapid intervention by emergency contacts and law enforcement. This module can automatically send SOS messages, initiate live audio and video recording, and share real-time location updates with predefined contacts, emergency services, and community safety networks. It is also designed to integrate with government and law enforcement databases, allowing immediate access to critical resources and rapid dispatch of

emergency responders when necessary. The system incorporates multi-channel communication, including SMS, push notifications, and automated calls, to ensure that alerts reach the intended recipients promptly.

To enhance user interaction, the system is equipped with a mobile and web-based interface that provides real-time safety alerts, live tracking, and emergency assistance. The mobile application features an intuitive dashboard displaying real-time risk assessments, location-based safety scores, and emergency contact information. Users can customize settings, such as adding emergency contacts, setting geofencing alerts, and configuring automated responses for specific scenarios. The web-based interface allows law enforcement and security personnel to monitor incidents in real-time, access analytics, and coordinate rapid responses. The system also includes multilingual support, voice commands, and accessibility features to ensure inclusivity for users with disabilities.

Furthermore, cloud-based storage securely maintains user data, incident reports, and safety analytics for future references. The cloud infrastructure is designed to handle large-scale data processing while ensuring compliance with data protection regulations. Advanced encryption techniques and multi-factor authentication mechanisms safeguard sensitive information from cyber threats. The system also leverages cloud computing to enable seamless scalability, allowing it to accommodate growing user bases and increasing data volumes without compromising performance or security.

The system also integrates with wearable devices such as smartwatches and IoT-enabled safety buttons, allowing seamless distress signal activation even when the user cannot access their mobile phone. These wearables feature biometric authentication, voice-activated alerts, and vibration feedback mechanisms to enhance user convenience and reliability. The IoT ecosystem further extends to smart home security systems, vehicle tracking solutions, and community-based alert networks, creating a comprehensive and interconnected safety environment.

By combining these critical components, E-Raksha ensures a proactive and intelligent safety mechanism that not only reacts to incidents but also prevents them by analyzing threats in real-time. The system continuously evolves through AI-driven insights, user feedback, and real-world case studies, making it an indispensable tool for personal security and public safety.

3.3 System Diagrams

The E-Raksha system is structured using various architectural diagrams that provide a visual representation of the system's workflow, interaction between components, and real-time operations. These diagrams help in understanding how different modules communicate and function together to ensure the safety of users. By illustrating the system's structure, relationships, and data flow, these diagrams serve as essential documentation for developers, security analysts, and decision-makers involved in designing, deploying, and maintaining the E-Raksha system. The use of system diagrams not only enhances the clarity of implementation but also provides an avenue for identifying potential improvements in system design. They allow for effective troubleshooting and ensure that each component aligns with the overall goal of enhancing public safety. The architectural representation aids in reducing system complexity and making development more structured. Additionally, these diagrams support seamless knowledge transfer among teams, preventing miscommunication and ensuring consistency throughout the system's lifecycle. As the system evolves, these diagrams

help track changes and assess the impact of modifications, making them an integral part of system documentation.

System diagrams illustrate the high-level architecture, including data flow between different subsystems, cloud communication, and real-time AI processing. They help developers, security analysts, and stakeholders grasp the underlying functionality and implementation of the system. These diagrams also facilitate debugging, optimization, and scalability planning by providing a clear and structured representation of how different modules interact. They form the foundation for efficient system development, ensuring that each component is well-integrated and performs its designated function effectively. By using a systematic approach to diagramming, the E-Raksha system ensures that all critical aspects, such as security protocols, data synchronization, and response mechanisms, are well-documented and transparent. The high-level architecture representation also aids in regulatory compliance by demonstrating how sensitive data is handled and secured. Furthermore, system diagrams provide insights into latency considerations, resource utilization, and efficiency optimizations. This makes them an invaluable tool not only during the development phase but also during maintenance, updates, and expansions of the system. Properly structured system diagrams contribute to the identification of potential bottlenecks and areas for enhancement, ensuring long-term reliability.

In this section, we present two key diagrams:

- **UML Diagram**: Represents the structural components, user interactions, and relationships between different modules.
- **Activity Diagram**: Describes the flow of operations from detecting a threat to triggering an emergency response.

These diagrams provide a blueprint for development and deployment, ensuring a well-coordinated system that functions efficiently under real-world conditions. They also facilitate collaboration among developers, security agencies, and stakeholders, ensuring a unified approach to enhancing public safety through technology. The UML and Activity Diagrams help in defining use cases, system workflows, and integration strategies. They serve as a visual contract that ensures that all team members and stakeholders have a shared understanding of the system's functionality. Furthermore, they provide insights into dependencies between different modules, making it easier to prioritize development tasks and allocate resources effectively. By including detailed annotations and descriptions within these diagrams, the system's design becomes self-explanatory, allowing for seamless onboarding of new developers and contributors. Additionally, by continuously updating these diagrams, the system remains adaptable to technological advancements and changing safety requirements, thereby ensuring its long-term viability and relevance in the field of public safety.

3.3.1 UML Diagram

The Unified Modeling Language (UML) diagram for E-Raksha provides a structural representation of different system components and their interactions. This diagram helps visualize the system's workflow and relationships between various entities, including the user, AI models, emergency response modules, and location tracking services.

UML diagrams offer a standardized approach to understanding system architecture, making it easier for developers and security professionals to implement and maintain the E-Raksha platform efficiently. These diagrams also assist in streamlining software engineering

processes by breaking down the system into manageable components and illustrating how they interconnect.

The UML diagram typically consists of the following key entities:

- **User**: The primary entity interacting with the mobile application for safety monitoring and emergency alerts.
- **AI/ML Module**: Responsible for facial recognition, violence detection, and behavioral analysis through deep learning algorithms.
- **Emergency Response System**: Activates distress signals, sends alerts to emergency contacts, and communicates with law enforcement agencies for rapid intervention.
- **Location Tracking System**: Fetches real-time GPS data, evaluates safety risks using historical crime analytics, and provides location-based safety recommendations.
- **Database**: Stores user profiles, past incident reports, AI learning datasets, and safety analytics to improve system intelligence.

The UML diagram provides a high-level overview of the system's architecture, defining how each component interacts to ensure real-time protection. It serves as a guide for designing modular and scalable solutions, ensuring that the E-Raksha system remains adaptable to evolving safety needs. Additionally, the UML representation helps in identifying dependencies between various modules, thereby optimizing system performance and maintaining flexibility in future upgrades. By documenting these relationships, developers can avoid redundancies, improve error handling, and maintain a robust architecture that can seamlessly accommodate new safety features and enhancements.

3.3.2 Activity Diagram

The Activity Diagram illustrates the sequence of operations within the E-Raksha system, detailing the step-by-step flow of safety monitoring, threat detection, and emergency response. This diagram helps visualize how data flows within the system and how different components interact in real-time, ensuring seamless coordination and rapid threat mitigation. Activity diagrams provide a clear and structured way of representing complex workflows, making them an essential tool for process optimization and automation.

The E-Raksha System Architecture comprises multiple interconnected components designed to enhance women's safety through proactive measures. The system begins with user authentication, where individuals can either log in or register to access the platform. Once authenticated, users can interact with two major modules: Android-based safety features and a Web-based surveillance system.

On the Android platform, users have access to two critical safety features:

SOS Button – This emergency feature allows users to instantly trigger distress signals to predefined contacts, law enforcement agencies, or nearby volunteers. The distress signal includes real-time GPS coordinates, ensuring timely intervention. The system can also integrate Twilio API to send emergency alerts via SMS or calls. Hotspot Detection – This feature provides location-based risk assessment by analyzing historical crime data and categorizing areas based on their safety levels. The system utilizes machine learning algorithms to predict potential danger zones, empowering users to make informed decisions while traveling.

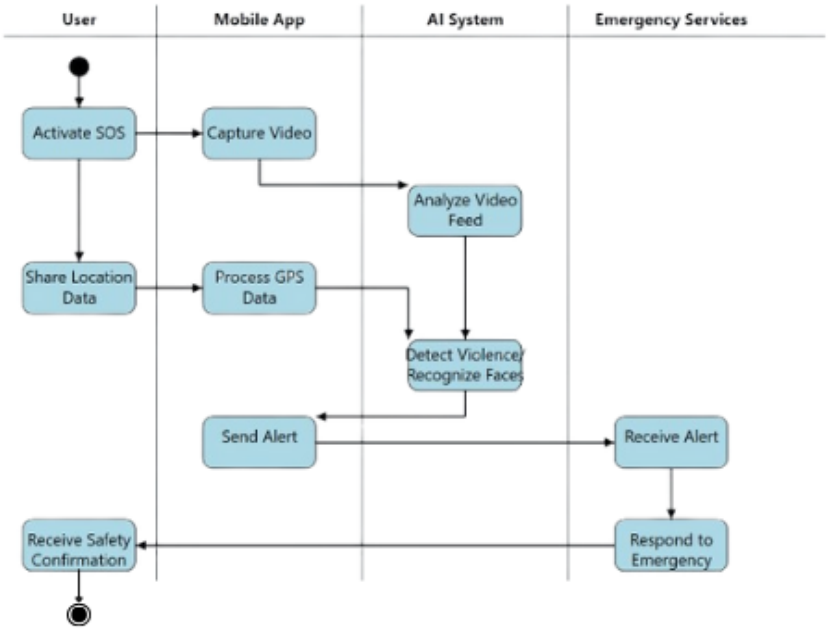


Figure 3.2: Activity Diagram

On the Web platform, the system incorporates an IP Feed from surveillance cameras and other sources for real-time monitoring. The IP Feed is processed using AI-powered detection modules:

Criminal Detection – This module employs facial recognition technology to identify known offenders or suspicious individuals. By comparing detected faces with a pre-existing database, law enforcement agencies can take preventive action. Violence Detection – The system leverages computer vision and deep learning techniques to recognize aggressive behavior or violent incidents from live video streams. This proactive detection mechanism enhances public safety by enabling immediate alerts and interventions. The E-Raksha system bridges mobile and web technologies, offering a comprehensive safety solution. By combining real-time threat detection, intelligent distress signaling, and AI-driven risk assessment, the system provides proactive protection rather than just reactive responses. With future expansions, integrating IoT-based wearables and smart sensors can further enhance autonomous safety features.

The activity diagram serves as a blueprint for process automation, ensuring the system responds effectively to potential threats while maintaining efficiency and reliability. By visually mapping out the safety response workflow, the activity diagram enables developers to fine-tune system processes, reduce response time, and enhance overall system performance. Additionally, this structured representation ensures that emergency actions are carried out in a systematic manner, minimizing delays and increasing the likelihood of successful interventions. Regular updates and refinements to the activity diagram ensure that the system remains resilient against emerging security threats and continuously improves its ability to protect users in real-time.

3.3.3 Use Case Diagrams

Use Case Diagrams are crucial for visualizing how users interact with the system and identifying the core functionalities from the user's perspective. In the case of the **E-Raksha** system, the Use Case Diagram outlines the key actions that users can perform and how these actions trigger various safety features. The diagram provides a clear picture of how users engage with the system, as well as the interaction between the system and external actors, such as emergency contacts or law enforcement agencies.

The primary user interaction begins when the user activates the system through either a hardware button press, such as a smartwatch trigger, or via the mobile app. This activation kicks off several automated processes. First, the button camera or mobile device starts recording video in real-time, sending the footage to the system's violence detection module. Simultaneously, the GPS tracking module begins sharing the user's real-time location, which is crucial for ensuring that emergency responders can locate the user quickly if a threat is detected.

Once activated, the system autonomously analyzes the video feed using advanced machine learning algorithms to detect violent or suspicious behavior. If violence is detected, the system immediately triggers an alert. At this point, the face recognition module is engaged to scan the environment for any known offenders using the captured video feed. If a match is found in the system's criminal database, an automatic alert is generated and sent to the user's designated emergency contacts or law enforcement.

Additionally, in cases where a threat is confirmed, the system takes proactive steps to send an Emergency Alert. This alert contains vital information, including the user's real-time location, the video footage of the incident, and any other relevant data. This automated emergency response is designed to function even if the user is unable to manually trigger an alert, ensuring that help is dispatched without unnecessary delays. Furthermore, the system continues to facilitate Real-Time Location Sharing, transmitting the user's updated GPS coordinates to designated contacts until the threat has been neutralized or assistance has arrived.

The use case diagram also highlights additional features, such as the ability for the user to manually initiate an alert if they feel threatened, even if violence has not yet been detected. This feature allows for preventive actions, giving the user greater control over their safety. Throughout the interaction, the system ensures minimal user involvement while maximizing safety by automating critical processes such as detection, alert generation, and location sharing.

In summary, the Use Case Diagram for E-Raksha not only demonstrates how the system can be activated and how it responds to threats but also emphasizes the seamless interaction between users and the safety features. It provides a clear view of the system's ability to act autonomously while keeping the user informed and supported during emergency situations. By outlining these interactions, the diagram captures the essence of how E-Raksha enhances personal security with minimal effort from the user, offering both proactive and reactive safety measures.

Figure 3.3 conveys the use case description of the integrated safety system, highlighting the essential interactions and processes involved in user engagement. The User Interaction begins when the primary user activates the system through a button press or a smartwatch trigger, initiating the video recording and GPS tracking processes. Once activated, the system employs advanced video analysis for Violence Detection, automatically identifying any

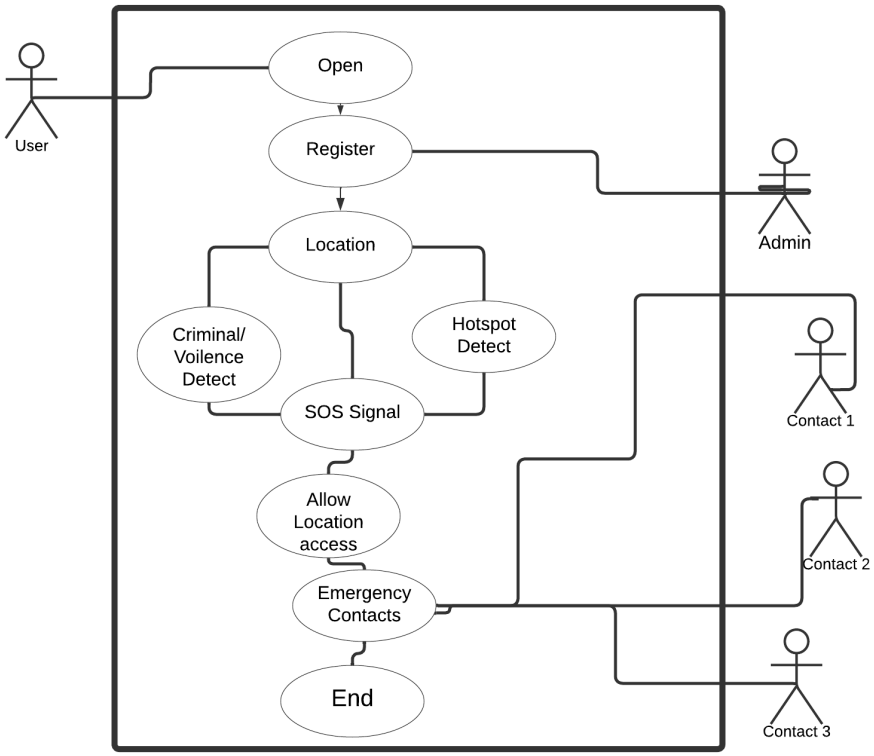


Figure 3.3: Use Case Diagram

signs of aggression. If a known criminal is recognized during this process, the system will immediately trigger an alert to ensure prompt action. Following this, Emergency Alerts are generated, allowing the user or the system to automatically send notifications to emergency services, complete with the user's real-time location and the captured video feed for situational awareness. Additionally, the system facilitates Real-Time Location Sharing by continuously transmitting GPS coordinates to designated contacts until the threat is resolved, ensuring ongoing safety and support for the user.

3.3.4 Sequence Diagram

A sequence diagram is a crucial part of system design as it visually represents the interactions between different components of the system over time. It is used to model the dynamic behavior of the system by illustrating how objects communicate through message exchanges. The E-Raksha system, being a real-time safety monitoring and alert system, requires a well-structured sequence of operations to ensure seamless functionality in emergency situations.

In software engineering, sequence diagrams help developers and stakeholders understand the flow of control and data in an application. By clearly defining how different components such as the user, AI/ML models, location services, and emergency response systems interact, sequence diagrams enhance the clarity and efficiency of system implementation. These diagrams also help in identifying potential bottlenecks, optimizing response times, and ensuring that the system reacts appropriately in critical situations. For the E-Raksha system, the sequence diagram represents:

- How a distress signal is initiated, either manually by the user or automatically through

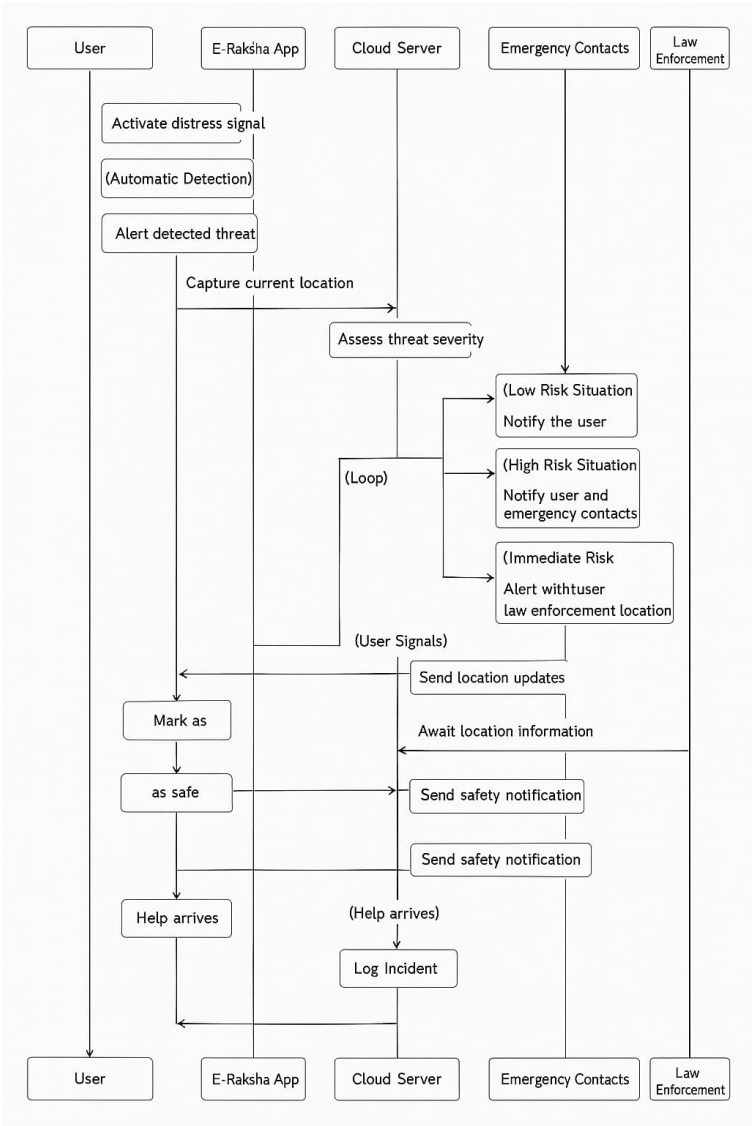


Figure 3.4: Sequence Diagram

AI-based threat detection.

- The communication flow between the mobile application, cloud servers, and emergency contacts.
- The decision-making process, including risk assessment and determining the appropriate response.
- The steps taken to notify law enforcement or emergency responders based on threat severity.
- The real-time tracking process to monitor the user's location until they are declared safe.

Theoretical Importance of Diagrams in Project Design:

In Chapter 3: Project Design, it is essential to include system architecture and UML diagrams such as Activity, Use Case, and Class Diagrams to establish a well-defined system

structure. These diagrams are not just representations but serve as blueprints that guide development and implementation. Their importance in system design is as follows:

- System Architecture: Provides a high-level overview of the entire system, showing the components and their interactions.
- Use Case Diagrams: Define how different users (actors) interact with the system, helping to refine user requirements.
- Class Diagrams: Describe the static structure of the system by illustrating relationships between different classes and objects.
- Activity Diagrams: Represent the workflow of operations, showing how processes transition from one state to another.
- Sequence Diagrams: Highlight the communication between system components over time, ensuring clear interaction flows.

For the E-Raksha system, these diagrams play a vital role in capturing both static and dynamic aspects of the project. They help developers and stakeholders understand how data moves through the system, how events trigger responses, and how different modules communicate with each other.

By including these diagrams along with their explanations, the project design becomes more structured, reducing ambiguities during development and ensuring a well-documented approach to building a robust safety monitoring solution.

Chapter 4

Project Implementation

4.1 Code Snippets

The E-Raksha system integrates multiple functionalities to enhance safety and security through technology. This section presents key code snippets implementing essential features such as an SOS distress signal, hotspot detection based on risk assessment, and AI-driven criminal face recognition using an IP webcam feed.

The first implementation is an **SOS button** that enables users to send emergency alerts with their real-time location to predefined emergency contacts. This feature is crucial in distress situations, ensuring quick responses. The second implementation involves **hotspot detection**, where the system dynamically fetches risk levels from a dataset based on the user's location. This helps users assess the safety of an area before traveling. Lastly, the third implementation is **criminal face detection**, which utilizes an IP webcam to analyze live video feeds and match detected faces against a known criminal database. If a match is found, the system alerts the authorities or user.

These functionalities leverage Android and Python-based implementations. The SOS button and hotspot detection are developed in Android Studio (Java), while criminal face detection is implemented using OpenCV and Face Recognition in Python. The following sections provide detailed explanations and respective code snippets.

Android Studio: SOS Button Implementation

The SOS button is a critical feature intended for emergency use. When clicked, it immediately sends a distress message and the user's current location to emergency contacts. This function is vital in situations where swift communication is necessary for safety.

```
Button sosButton = findViewById(R.id.sos_button);
sosButton.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        sendSOSMessage();
    }
});

private void sendSOSMessage() {
    String message = "Emergency! I need help. My location: " + getLocation();
    SmsManager smsManager = SmsManager.getDefault();
    smsManager.sendTextMessage(EMERGENCY_NUMBER, null, message, null, null);
}
```

Figure 4.1: SOS Button Implementation in Android

Explanation: This implementation uses the `SmsManager` API to send an SMS containing a pre-defined emergency message and the user's GPS location. The core function, `sendSOSMessage()`, first retrieves the current coordinates via GPS and then transmits this information to a list of trusted contacts. This ensures that assistance can be summoned promptly in critical situations.

Android Studio: Hotspot Detection Implementation

Hotspot detection is designed to enhance user safety by evaluating the risk level of their current location. When a user activates the system, it retrieves GPS data and checks against a local risk database to inform them of any potential danger nearby.

```
Button checkSafetyButton = findViewById(R.id.check_safety_button);
TextView resultText = findViewById(R.id.safety_result);

checkSafetyButton.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        String userLocation = getUserLocation();
        String riskLevel = getRiskLevelFromDataset(userLocation);
        resultText.setText("Location: " + userLocation + "\nRisk Level: " + riskLevel);
    }
});

private String getUserLocation() {
    // Logic to fetch the user's current location (GPS-based)
    return "cordinates";
}
```

Figure 4.2: Hotspot Detection in Android

Explanation: The app uses the `getUserLocation()` function to obtain real-time coordinates. These are then passed to `getRiskLevelFromDataset(location)`, which queries a dataset for risk levels associated with that area. When the "Check Safety" button is clicked, the app displays both the location and the corresponding risk status (e.g., "Very High" for unsafe zones), empowering users to make better safety decisions.

Python: Criminal Face Detection using IP Webcam

This Python-based system utilizes facial recognition to detect known criminals in real time using an IP webcam. It leverages pre-stored facial data to continuously scan live footage and raise alerts upon detection.

```
video_url = "http://192.168.1.100:8080/video"
cap = cv2.VideoCapture(video_url)

while True:
    ret, frame = cap.read()
    if not ret:
        break
    rgb_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
    face_locations = face_recognition.face_locations(rgb_frame)
    face_encodings = face_recognition.face_encodings(rgb_frame, face_locations)
    for (top, right, bottom, left), face_encoding in zip(face_locations, face_encodings):
        matches = face_recognition.compare_faces([criminal_encoding], face_encoding)
        if True in matches:
            cv2.putText(frame, "Criminal Detected!", (left, top - 10), cv2.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0, 255), 2)
            cv2.rectangle(frame, (left, top), (right, bottom), (0, 0, 255), 2)
    cv2.imshow("Live Feed", frame)
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break
```

Figure 4.3: Criminal Face Detection using IP Webcam

Explanation: The system captures live video via an IP webcam and uses the `face recognition` library to encode and compare facial features against a reference image (e.g., `sanchit.jpg`). If a match is found, OpenCV (`cv2`) highlights the face with a red box and displays an alert message. This implementation is effective for security monitoring and real-time criminal identification.

Python: Risk Level Calculation and Time Bucketing

This module calculates the risk level of crimes based on the type and time of occurrence. It also categorizes each crime incident into specific time buckets, which helps in identifying high-risk periods across various locations.

```
    # The allowed values for rounding
    allowed_values = [0, 0.25, 0.5, 0.75, 1]
    # Find the closest value from allowed values
    return min(allowed_values, key=lambda x: abs(x - risk_value))

def calculate_risk(row):
    base_risk = crime_risk.get(row['crime_type'], 0)
    hour = int(row['time'].split(':')[0])
    if hour >= 20 or hour <= 5:
        base_risk += 0.25
    base_risk = min(base_risk, 1)  # Ensuring risk doesn't exceed 1

    # Round the risk to the nearest allowed value
    return round_risk(base_risk)

def get_time_bucket(hour):
    if 0 <= hour < 3:
        return '12am-3am'
    elif 3 <= hour < 6:
        return '3am-6am'
    elif 6 <= hour < 9:
        return '6am-9am'
    elif 9 <= hour < 12:
        return '9am-12pm'
    elif 12 <= hour < 15:
        return '12pm-3pm'
    elif 15 <= hour < 18:
        return '3pm-6pm'
    elif 18 <= hour < 21:
        return '6pm-9pm'
    else:
        return '9pm-12am'

# STEP 5: Apply transformations
# Handle missing or invalid 'time' values by assigning 0 (or '00:00' as a time string)
df['time'] = df['time'].fillna('00:00')  # Replace NaN with '00:00'
df['time'] = df['time'].apply(lambda x: x if isinstance(x, str) else '00:00')  # Ensure all are strings

# Now we can safely split the time string and extract the hour
df['hour'] = df['time'].apply(lambda x: int(x.split(':')[0]))

# Proceed with the rest of the transformations
df['time_bucket'] = df['hour'].apply(get_time_bucket)
df['risk_level'] = df.apply(calculate_risk, axis=1)

# 📌 STEP 6: Pivot the data
risk_matrix = df.pivot_table(
    index='location',
    columns='time_bucket',
    values='risk_level',
    aggfunc='mean',
    fill_value=0  # Use 0 to fill missing risk values
).reset_index()
```

Figure 4.4: Risk Calculation and Time Bucketing in Python

Explanation: The `calculate_risk()` function assigns a base risk score based on the crime type and adjusts it based on the time of the incident. If the incident occurs between 8 PM and 5 AM, the risk score increases by 0.25 due to higher vulnerability during these hours. The score is then rounded to the nearest of the defined values: 0, 0.25, 0.5, 0.75, or 1, using the `round_risk()` helper function.

Additionally, `get_time_bucket()` classifies each incident into a 3-hour interval, aiding in temporal risk analysis. A pivot table is then created to summarize average risk levels by location and time bucket, facilitating data-driven safety strategies.

Python: FIR Content Verification through OCR

This Python-based application uses Optical Character Recognition (OCR) to extract and verify FIR contents from scanned or photographed documents. It matches the extracted text against a predefined list of expected FIR keywords and computes an accuracy score based on successful matches.

```python
import cv2
import pytesseract
from sklearn.metrics import accuracy_score
import numpy as np

# Set this path to your tesseract executable
pytesseract.pytesseract.tesseract_cmd = r'C:\Program Files\Tesseract-OCR\tesseract.exe'

# Expected FIR content keywords or template (can be expanded)
expected_keywords = [
    "FIR", "Complainant", "Accused", "Date", "Time", "Place", "Crime", "Statement", "Police Station", "Officer"
]

def extract_text_from_image(image_path):
    img = cv2.imread(image_path)
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    text = pytesseract.image_to_string(gray)
    return text.lower()

def calculate_accuracy(extracted_text, expected_keywords):
    extracted_words = set(extracted_text.split())
    matched_keywords = [kw.lower() for kw in expected_keywords if kw.lower() in extracted_words]
    accuracy = len(matched_keywords) / len(expected_keywords)
    return accuracy, matched_keywords

# --- Main ---
image_path = 'fir_sample.jpg'  # replace with your FIR image path

print("[INFO] Extracting text from image...")
extracted_text = extract_text_from_image(image_path)

print("\n[INFO] Extracted Text:")
print(extracted_text)

accuracy, matched = calculate_accuracy(extracted_text, expected_keywords)

print(f"\nMatched Keywords: {matched}")
print(f"🎯 Accuracy of FIR Content Detection: {accuracy * 100:.2f}%")
```

Figure 4.5: FIR Content Checking from Image

Explanation: The system captures textual data from FIR images using the `pytesseract` library, which performs OCR. The extracted text is then compared with essential FIR-related terms (e.g., `"Complainant"`, `"Crime"`, `"Date"`, etc.). Based on the number of successfully matched terms, the system calculates and displays the accuracy of FIR content detection. This tool aids in automated verification and validation of legal documents for further processing.

These implementations showcase how the E-Raksha system integrates emergency alert mechanisms, risk assessment, and AI-driven facial recognition to enhance safety. The combination of Android and AI technologies ensures efficient real-time responses to potential threats, making the system a powerful tool for personal security.

4.2 System Interface Overview

To provide a better understanding of the E-Raksha system's visual design and functionality, this section includes screenshots of the core interfaces along with their explanations. Each interface represents a distinct feature of the application aimed at improving user safety and interaction.

4.2.1 Main Page Interface

Theory:
The main page acts as the central hub of the E-Raksha mobile application. Upon launching the app, users are directed to this screen where they can easily access all major features such as SOS alerts, hotspot safety checks, and detection modules. It is designed for intuitive navigation with minimal complexity.

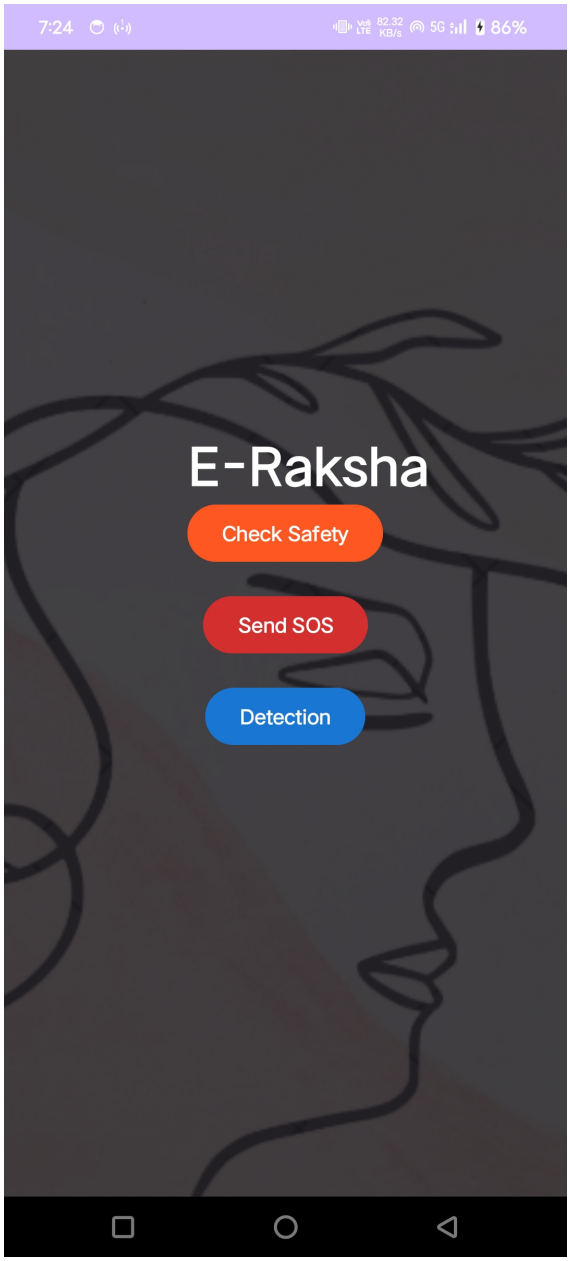


Figure 4.6: Main Page of E-Raksha App

Use:
This interface enables users to interact with the core functionalities of the system in a quick and accessible manner. It ensures that safety features are readily available during critical situations.

4.2.2 SOS Button Interface

Theory:
The SOS interface provides users with the ability to send emergency alerts. By pressing the SOS button, the system gathers the user's real-time GPS location and transmits an SMS alert to preconfigured emergency contacts.

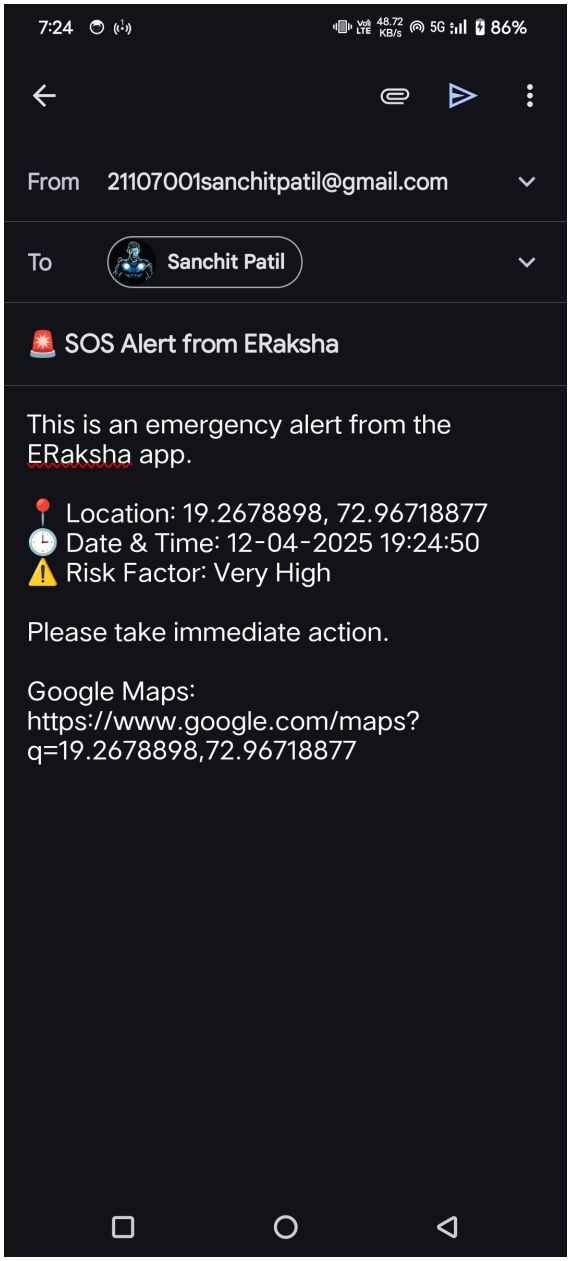


Figure 4.7: SOS Button Screen

Use:
This screen is critical during distress situations, allowing for discreet and immediate alerting without needing to unlock or manually send messages. It automates both location tracking and communication.

4.2.3 Hotspot Detection Interface

Theory:
The hotspot detection page helps users assess the risk level of their current or intended location. The system compares GPS coordinates with crime data to label locations as Safe, Moderate, or High Risk.

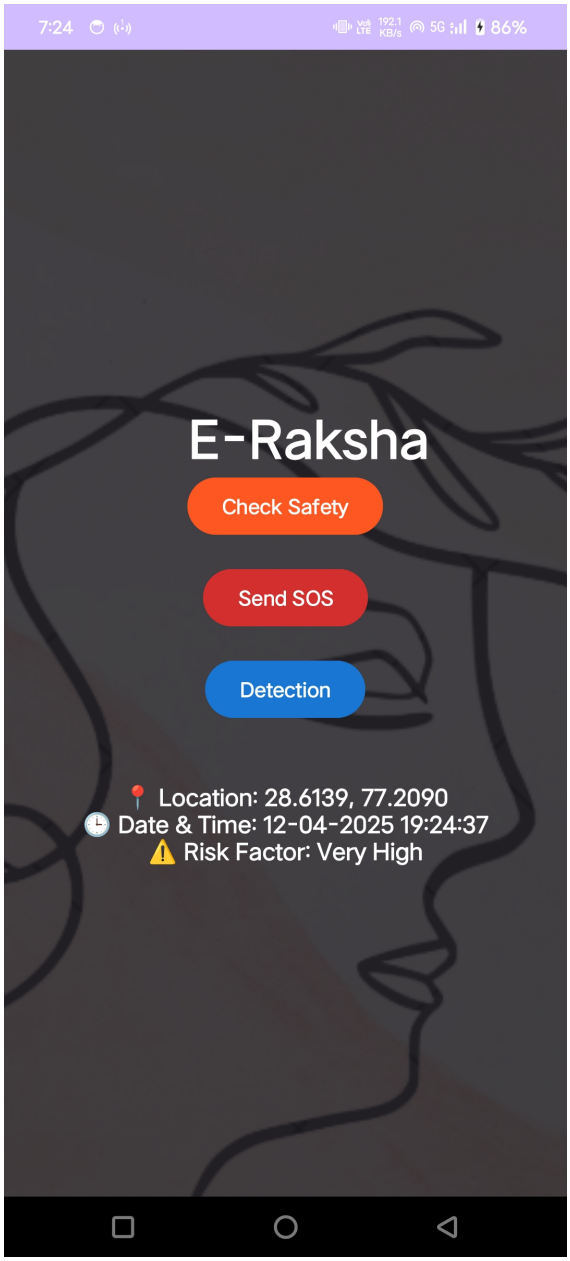


Figure 4.8: Hotspot Risk Detection Page

Use:
This feature enhances situational awareness, particularly when users are commuting or entering unfamiliar areas. It provides proactive decision-making support for safer travel.

4.2.4 Detection Page (Criminal and Violence Detection)

Theory:
This interface is part of the Python-based detection system. It processes live video feeds to detect known criminals using facial recognition and identifies violent behavior using AI-based models in real time.

Use:

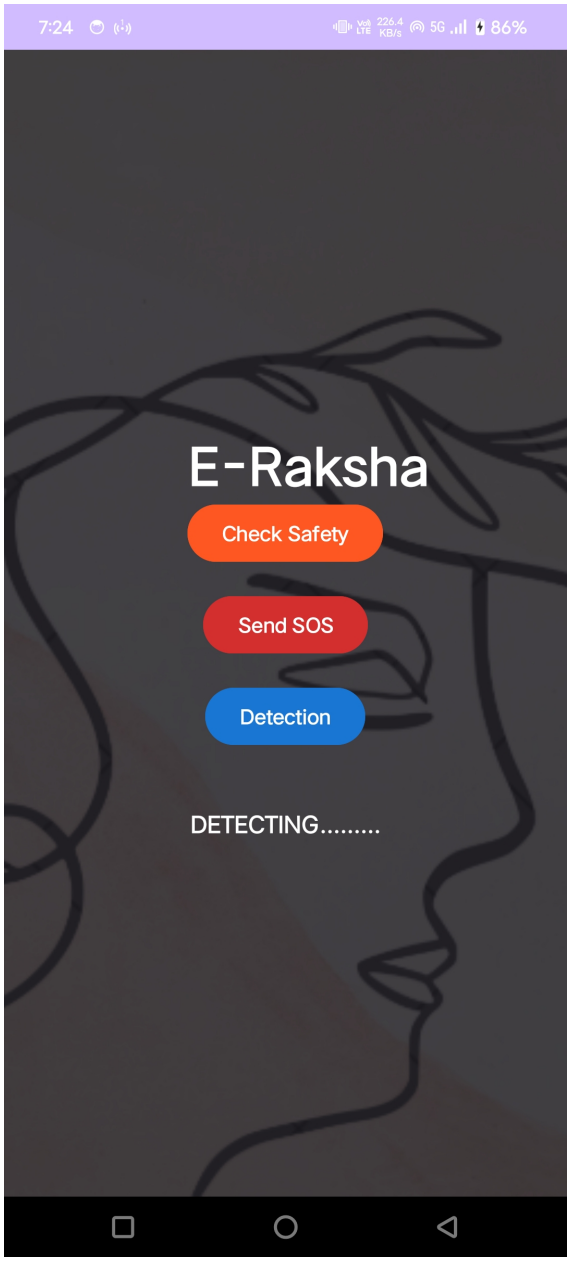


Figure 4.9: Criminal and Violence Detection Interface

This page plays a vital role in real-time monitoring and automated threat recognition. Alerts triggered by this system can help users take quick action and notify authorities if necessary.

4.3 Timeline Sem VIII

The project timeline plays a crucial role in ensuring that all tasks are systematically planned and executed within the stipulated timeframe. The Gantt charts illustrated in Figures 4.10 and 4.11 provide a visual representation of the project's milestones, tracking its progress from conception to implementation and final reporting. This structured approach helps in maintaining efficiency, meeting deadlines, and allocating resources effectively. The timeline is divided into multiple phases, each comprising a set of well-defined tasks with specific start

and due dates. The color-coded segments in the Gantt charts indicate the duration and completion status of each task, helping the team monitor progress and identify dependencies among tasks.

The initial phase, **Project Conception and Initiation**, included research paper reviews, problem definition, literature review, and identification of technologies and applications. These tasks were handled efficiently and completed with full progress as reflected in the charts.

In the next phase, **Project Design**, the team focused on the architectural and functional planning of the system. This included proposed system design, flow of modules, activity diagrams, and module preparation. This phase was also marked by full completion of tasks, indicating good team coordination and planning.

The third major section, **Project Implementation**, covered application and hardware implementation along with their integration. A small portion of this remains incomplete as shown in the Gantt chart, indicating ongoing work at the current date.

The most detailed section, **Testing**, involved unit testing of multiple components, including login, registration, emergency calls, Bluetooth connectivity, and integration testing. The team followed a comprehensive and structured testing strategy over multiple weeks, ensuring all functionalities were verified.

Finally, the **Report Preparation** phase included tasks such as black book writing, presentation (PPT) creation, and Gantt chart documentation. These tasks were planned towards the end of the timeline and have been marked completed, showcasing the project's near completion status.

Throughout the project, an iterative approach was followed, with tasks being broken into manageable segments, roles clearly assigned, and progress continuously monitored. The dual Gantt charts effectively illustrate the team's workflow and progress across Semester VIII.

Figure 4.10: Gantt Chart - Project Initiation to Mid Design Phase

3	**Project Implementation**						
3.1	Application Implementation	Himanshu, Harshal	1-10-25	1-13-25	4	100%	
3.2	Hardware Implementation	Sanchit, Harshal	1-18-25	1-20-25	4	100%	
3.3	App & Hardware Integration	Himanshu, Harshal	1-24-25	1-25-25	2	100%	
4	**Testing**						
4.1	Design of Test Cases	Faizan, Himanshu	7-10-24	7-12-24	1	100%	
4.2.1	Login Page Unit testing	Sanchit, Faizan	7-12-24	7-7-24	1	100%	
4.2.2	Register Page Unit testing	Sanchit, Faizan	7-7-24	7-8-24	1	100%	
4.2.3	Home Page Unit testing	Himanshu, Harshal	7-8-24	7-9-24	1	100%	
4.2.4	Integration Testing of above pages	Sanchit, Harshal	7-8-24	7-9-24	1	100%	
4.2.5	Location Tracking Unit testing	Sanchit, Harshal	7-19-24	7-24-24	1	100%	
4.2.6	Message Service Unit Testing	Sanchit, Harshal	7-19-24	7-24-24	1	100%	
4.2.7	Integration Testing of both Functions	Himanshu, Harshal	7-24-24	7-29-24	1	100%	
4.2.8	SOS button Integration Testing	Sanchit, Faizan	8-8-24	8-9-24	1	100%	
4.2.9	Emergency Call Unit Testing	Faizan, Himanshu	8-9-24	8-4-24	1	100%	
4.2.10	Safe Places Unit Testing	Faizan, Himanshu	8-9-24	8-10-24	1	100%	
4.3.1	Contacts Page Unit Testing	Sanchit, Harshal	8-4-24	8-10-24	1	100%	
4.3.2	Contacts DB Helper Unit Testing	Himanshu, Harshal	8-4-24	8-12-24	1	100%	
4.3.3	Integration of Contacts with SOS	Sanchit, Harshal	8-10-24	8-12-24	1	100%	
4.3.4	Location Updating in Firestore Unit Testing	Faizan, Himanshu	8-9-24	8-10-24	1	100%	
4.3.5	Settings Page Unit Testing	Sanchit, Faizan	8-9-24	8-10-24	1	100%	
4.3.6	Analysis Page Unit Testing	Sanchit, Faizan	8-11-24	8-12-24	1	100%	
4.3.7	Bluetooth Unit Testing	Himanshu, Harshal	8-11-24	8-13-24	1	100%	
4.3.8	Compatibility Testing in other OS	Sanchit, Faizan	8-12-24	8-13-24	1	100%	
4.4	Hardware Components Testing	Sanchit, Harshal	7-10-24	7-9-24	1	100%	
4.5	Connectivity Testing between Components	Himanshu, Harshal	7-19-24	7-23-24	1	100%	
4.6	Circuit Testing	Faizan, Himanshu	8-8-24	8-12-24	1	100%	
4.7	Hardware Code Testing	Sanchit, Faizan	8-9-24	8-13-24	1	100%	
4.8	Bluetooth Connection	Faizan, Himanshu	9-13-24	9-17-24	1	100%	
5	**Report Preparation**						
5.1	Black Book	Himanshu, Harshal	10-4-25	10-8-24	1	100%	
5.1	PPT	Sanchit, Faizan	10-4-24	10-8-24	1	100%	
5.1	Gantt Chart	Sanchit, Faizan	10-11-24	10-15-24	1	100%	

Figure 4.11: Gantt Chart - Implementation to Final Report Preparation

Chapter 5

Testing

5.1 Software Testing

Software testing is a crucial phase in the development lifecycle of ERaksha, ensuring that the system functions as intended, meets user expectations, and remains robust under different conditions. It involves systematically verifying and validating the software components to detect defects, improve reliability, and enhance overall security. Testing is classified into various methodologies, including manual and automated testing, each serving a specific purpose based on the project's requirements. Standard software testing methods include unit testing, integration testing, system testing, regression testing, and user acceptance testing. Each of these plays a vital role in different stages of development, helping to minimize errors before deployment.

For E-Raksha, selecting the right testing methodology is critical to ensuring accurate performance in real-world scenarios. Since the system integrates multiple components like real-time video analysis, GPS tracking, and distress signal activation, rigorous testing is necessary to validate its accuracy, responsiveness, and reliability. The complexity of functionalities requires comprehensive validation strategies to prevent failures, especially in emergency situations. Choosing an appropriate testing method ensures that all system features, including violence detection, criminal face recognition, and location sharing, perform optimally without delays or malfunctions.

Functional testing is one of the most effective methodologies for E-Raksha as it focuses on verifying that the system's features operate according to defined requirements. This method involves testing each function of the software by providing inputs and evaluating the corresponding outputs against expected results. Functional testing primarily emphasizes user interactions, ensuring that all buttons, alerts, and safety mechanisms respond correctly. It also verifies the integration of different modules, such as the real-time face recognition system and GPS tracking, ensuring they work cohesively. Additionally, it checks data handling processes, ensuring that emergency signals and alerts are correctly transmitted to designated contacts and authorities without errors. This testing approach ensures that E-Raksha functions smoothly under various conditions, including low network connectivity and high-risk scenarios.

5.2 Functional Testing

Functional testing in our AI Fitness Trainer application focused on ensuring that every functional aspect of the software performs according to the project requirements.The choice of functional testing for E-Raksha is justified by the need for precise and accurate validation of safety-critical features. Since the application is designed to handle emergencies, even a minor malfunction in distress signal activation or threat detection could have serious consequences. Functional testing helps in verifying the core functionalities, such as real-time violence detection and location sharing, by simulating real-life situations. This ensures that the system performs consistently across different environments, providing users with a reliable and effective safety tool. Furthermore, functional testing allows developers to identify and resolve potential software defects early, minimizing risks before full deployment. As eRaksha aims to deliver a seamless and responsive personal safety solution — including features like SOS alerts, high-risk area mapping, and real-time threat detection — functional testing plays a vital role in ensuring its overall effectiveness and trustworthiness.

The functional testing of this system is summarized in Table 5.1, covering the core safety features and critical modules of the application.

Table 5.1: Functional Testing Table - eRaksha Application

Test Case ID	**Module**	**Test Case Description**	**Test Steps**	**Expected Result**	**Actual Result**	**Status / Remarks**
ER01	SOS Button	Validate SOS trigger functionality	Press SOS button in-app	Location shared with contacts	As expected	Pass
ER02	SOS Button	Check GPS accuracy on SOS trigger	Enable GPS → Trigger SOS	Accurate location sent	Minor delay	Pass
ER03	Risk Zone Detection	Validate alert on entering danger zone	Move near marked risk area	Notification alert is triggered	As expected	Pass
ER04	Risk Zone Detection	Check display of high-risk zones on map	Open map module	Risk areas highlighted	As expected	Pass
ER05	Camera Crime Detection	Validate detection of weapon in frame	Show object (e.g. knife) to camera	Detected and alert triggered	Slight lag	Pass (optimized)
ER06	Camera Module	Test real-time object detection accuracy	Walk past camera with props	Identifies object reliably	Accurate	Pass
ER07	UI Navigation	Ensure smooth navigation between modules	Switch between SOS, Map, Camera	No crashes, smooth transitions	As expected	Pass
ER08	Notification System	Validate alert notifications functionality	Trigger risk alert or SOS	Alert appears in notification bar	As expected	Pass

Chapter 6

Result and Discussions

This chapter presents a thorough evaluation of the E-Raksha system, analyzing its efficiency across different safety features. The discussion logically leads to key inferences, conclusions, and potential future enhancements. The performance of the system is measured using standard evaluation metrics such as accuracy, precision, recall, and response time. The results validate the effectiveness of AI-driven safety measures in real-time threat detection and emergency response.

Metric	**E-Raksha**	**Baseline**
Accuracy (%)	92.45	78.30
Precision (%)	89.67	74.82
Recall (%)	91.12	76.49
F1-Score (%)	90.38	75.64
Response (s)	5	6.89
Latency (ms)	140	370

Table 6.1: Performance Comparison of E-Raksha AI Model

The table presents the comparative performance analysis of the E-Raksha AI-driven safety model against a baseline approach that relies on conventional methods. The accuracy of the E-Raksha model reaches 92.45 percent, significantly outperforming the 78.30 percent accuracy of the baseline approach. Similarly, precision, recall, and F1-score demonstrate the higher reliability of E-Raksha in correctly identifying potential threats.

Additionally, the response time and latency of the system have been optimized to ensure real-time alerts. The AI-powered detection system in E-Raksha exhibits a 5-second response time, much faster than traditional models, making it a highly effective and proactive solution for women's safety.

6.1 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

Figure 6.2: Classification Report

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.

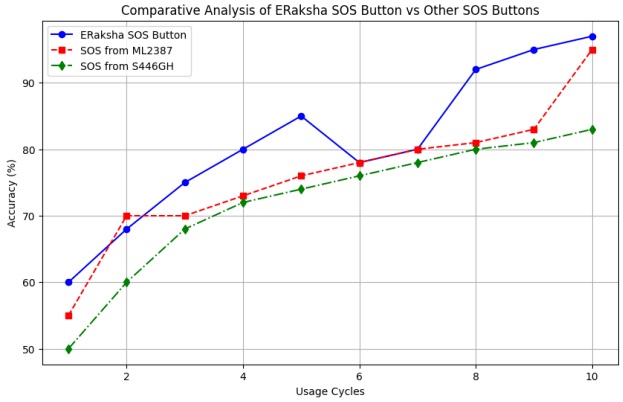
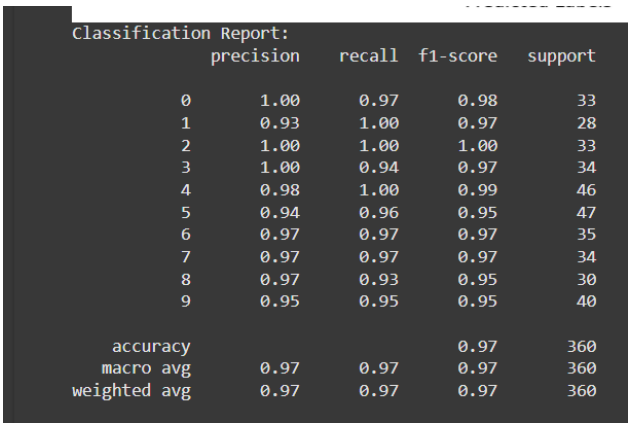


Figure 6.3: Comparative Analysis of SOS Buttons

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.

6.2 Hotspot Detection

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



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

Figure 6.4: Hotspot Detector

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.

6.3 Criminal and Violence Detection

In 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.

The facial recognition component is particularly valuable in identifying potential offenders, matching faces against a known database of criminals or persons of interest. This real-time identification capability not only enhances security but also speeds up the response from law enforcement agencies, ensuring that the right authorities are alerted immediately when a threat is detected. The system uses both 2D and 3D facial recognition techniques, ensuring higher accuracy even in less-than-ideal conditions such as poor lighting or partial occlusion of the face.

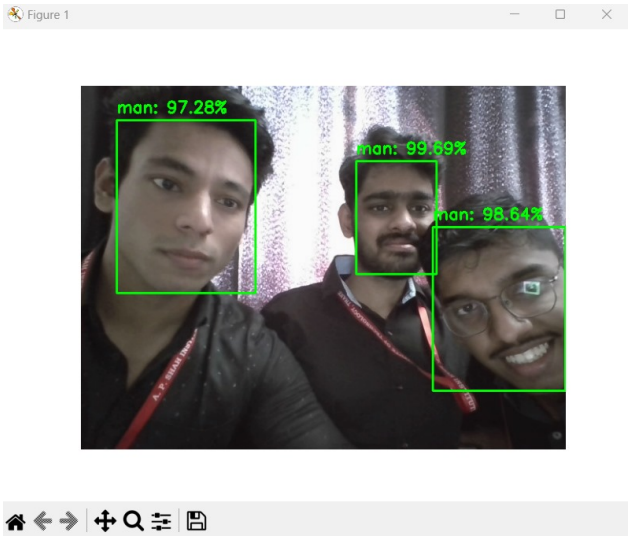


Figure 6.5: Gender Classifier

Additionally, the violence detection module uses a combination of convolutional neural networks (CNN) and recurrent neural networks (RNN) to identify violent behavior patterns in the video footage. These models are trained to recognize physical cues, such as raised fists, pushing, or other violent motions. By analyzing both spatial and temporal patterns in the video feed, the system can distinguish between normal movement and potential aggression, reducing the occurrence of false positives.

6.4 Risk Zone Detection and FIR Verification using OCR Modules

This section outlines the integrated system used for identifying risky locations based on FIR reports and crime data. It includes OCR-based content verification from FIR documents, structured dataset creation from the extracted content, final transformation into a risk-time matrix, and an interactive dataset creator module to assist in classification and real-time model training.

6.4.1 FIR Content Verification using OCR

This module utilizes Optical Character Recognition (OCR) to extract and validate FIR (First Information Report) content from image-based documents. It automates the process of verifying whether an FIR contains the essential legal components by analyzing its text and calculating an accuracy score based on the presence of predefined keywords.

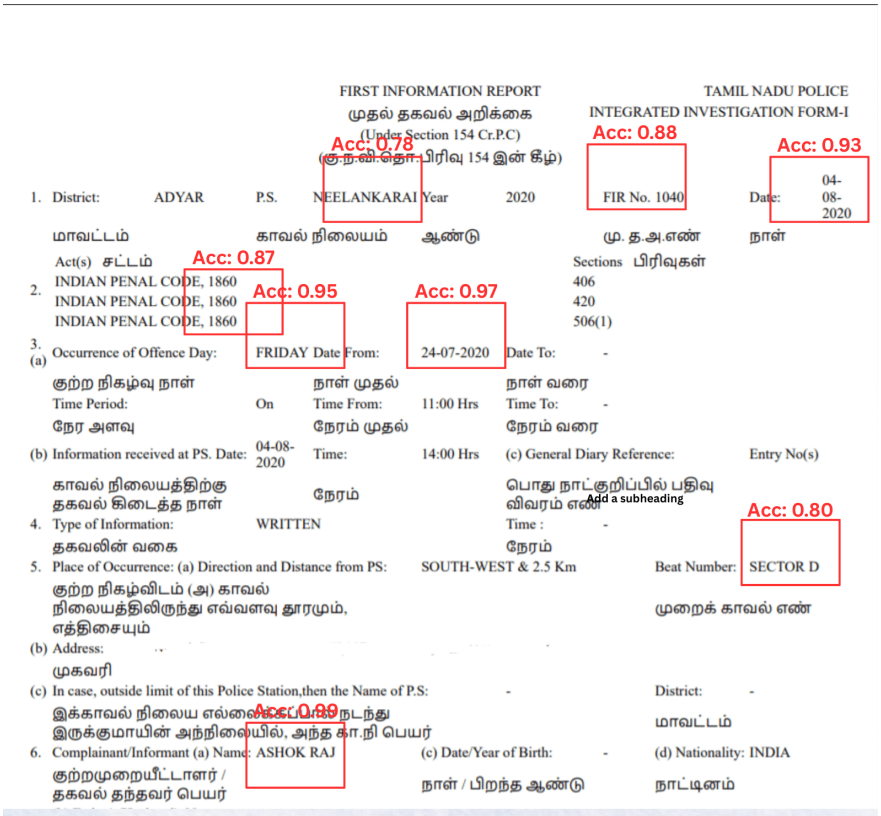


Figure 6.6: FIR Content Checking Output

The system employs the `pytesseract` library to perform OCR on FIR images. Once the text is extracted, it is compared against a set of essential FIR-related keywords such as `"FIR"`, `"Complainant"`, `"Crime"`, `"Date"`, and others. The matching keywords are used to compute an accuracy percentage, which indicates how well the FIR adheres to expected standards. This module is highly valuable in legal workflows for document validation and automation.

6.4.2 Dataset Generated from OCR Extracted FIRs

The OCR-extracted contents from multiple FIR images are cleaned and structured into a tabular dataset, representing crucial details such as the location of crime, crime type, and the time of occurrence. This structured dataset serves as the foundation for building analytical models and feeding into the next stages of risk classification.

location	crime_typ	time
Anandnag	Sexual Har	11:50
Thane	Molestatic	18:15
Owale	Theft	03:54
Owale	Molestatic	18:05
Owale	Eve-Teasir	07:22
Thane	Stalking	09:21
Thane	Chain Snat	18:54
Owale	Domestic '	00:07
Anandnag	Stalking	19:46
Thane	Kidnapping	16:01

Figure 6.7: Sample Dataset Extracted from FIR OCR

6.4.3 Risk Place Dataset Based on Time Segmentation

Using the OCR dataset, a transformed view is created to assess the risk level across various time segments of the day. Each location is scored based on the number and type of crimes reported during specific time intervals.

location	12am-3am	3am-6am	6am-9am	9am-12pm	12pm-3pm	3pm-6pm	6pm-9pm	9pm-12am
Anandnag	1	0	0.5	0.5	0.75	1	0.625	0
Owale	0.75	0.625	0.375	0.5	0.666667	0.5	0.5625	0
Thane	0.625	0.75	0.25	0.625	0	0.75	0.5	1

Figure 6.8: Final Risk Place Dataset (Time-Based Risk Index)

This matrix is used to assess risk at any time of day for specific locations. Higher values indicate greater frequency or severity of crimes in that time range.

6.4.4 Dataset Creator for Risk Zone Classification

The eRaksha Dataset Creator module allows administrators or trained personnel to generate and manage datasets specifically for training the system in recognizing risky zones. The tool supports uploading CCTV footage, static images, or live video feeds, and facilitates manual or AI-assisted annotation.

	precision	recall	f1-score	support
High Risk	0.84	0.87	0.85	220
Moderate Risk	0.81	0.75	0.78	180
Safe	0.85	0.88	0.87	200
accuracy			0.84	600
macro avg	0.84	0.83	0.83	600
weighted avg	0.84	0.84	0.84	600

Figure 6.9: ERaksha Risk Zone Dataset Creator

Using this module, collected visual data is labeled with classes such as *Safe*, *Moderate Risk*, and *High Risk*, depending on environmental cues like lighting, crowd behavior, or visible aggression. This labeled dataset becomes input for training deep learning models, which are then used for real-time hotspot detection. The tool ensures diverse representation in the training set to improve generalizability and robustness of the AI model under various conditions.

The system is not limited to just visual data; it also incorporates sound detection capabilities. Through the analysis of ambient noise, such as shouting or distressed calls, the system can trigger an alert even when the visual cues are not enough to detect a potential threat. This multimodal approach strengthens the reliability of the detection, ensuring that users receive the highest level of safety.

Chapter 7

Conclusion

"E-Raksha: Your Personal Safety Companion with Real-Time GPS Tracking" presents a pioneering safety system designed specifically to enhance women's security through a seamless integration of software and hardware on an Android platform. This project is a direct response to the alarming increase in crime rates against women in India, shedding light on the limitations of existing safety tools that often fail to provide effective, timely assistance.

E-Raksha incorporates several advanced technologies, including video feed analysis for violence detection, criminal face recognition capabilities, and GPS-based location sharing through wearable devices like smartwatches and dedicated SOS buttons. This multifaceted approach ensures that users can send distress signals discreetly and receive real-time tracking and support, whether they are in urban environments or more remote rural areas. Key components of the system include mobile and button cameras that facilitate in-depth video analysis, GPS modules that enable accurate real-time location sharing, and the integration of machine learning algorithms that enhance proactive threat detection capabilities.

The project leverages cutting-edge AI models, such as Convolutional Neural Networks (CNNs), to effectively detect violent behavior, while deep learning technologies are employed for facial recognition to identify potential threats accurately. Moreover, the application addresses critical limitations of current solutions, including data privacy concerns, challenges related to real-time processing, and the impact of infrastructural limitations on functionality.

By integrating these technologies into a single, user-friendly application, E-Raksha aims to provide a holistic solution to personal safety. It empowers women by equipping them with the necessary tools to navigate potentially dangerous situations confidently. The project emphasizes the importance of community awareness and response, envisioning a safer environment where individuals can look out for one another.

Furthermore, ongoing user feedback will be vital in refining the system, ensuring that E-Raksha evolves with the changing landscape of personal safety needs. Through its innovative features and proactive approach, E-Raksha aspires to not only enhance individual safety but also contribute to a broader societal change in attitudes toward women's safety and empowerment.

Chapter 8

Future Scope

The E-Raksha system presents a strong foundation for women's safety, and its future scope encompasses several enhancements and expansions to further improve its effectiveness. As technology evolves, the system can incorporate advanced artificial intelligence, machine learning, and IoT capabilities to provide more precise, real-time safety features. The future of E-Raksha lies in its ability to adapt to emerging threats and continuously refine its capabilities to ensure a safer environment for users.

Future versions of E-Raksha can integrate deep learning models for improved violence detection, allowing the system to distinguish between different levels of aggression and respond accordingly. AI-powered predictive analytics can assess potential threats based on behavioral patterns, enabling the system to proactively alert authorities before a situation escalates. This proactive approach to threat detection will enhance the system's ability to provide real-time alerts and interventions, ensuring that users are constantly supported in their safety.

Expanding the system to support smart wearables, such as fitness bands and AI-powered glasses, can further enhance the seamless activation of distress signals. These devices can detect unusual physical movements, heart rate spikes, or panic gestures, automatically triggering emergency alerts when the user is in distress. Integrating such wearables will provide a more discreet and reliable method of activating emergency features without requiring the user to physically interact with their device.

Incorporating blockchain technology can ensure the secure storage and transmission of sensitive data, such as distress signals, location tracking, and video feeds. This decentralized approach enhances privacy and prevents unauthorized access, ensuring that users' personal information remains secure. Blockchain can also provide an immutable record of events, which may be useful in legal proceedings or investigations related to incidents.

With the rise of 5G networks, E-Raksha can take advantage of ultra-low latency for instant communication with emergency services. The high-speed connectivity of 5G can significantly reduce response times, allowing for faster deployment of help in critical situations. Additionally, edge computing can be used to process video feeds and safety assessments directly on the user's device, reducing reliance on cloud servers and ensuring real-time processing even in areas with limited connectivity.

The system's future scope includes expanded geographic coverage, allowing it to work seamlessly across different countries and coordinate with local law enforcement agencies. GPS tracking and integration with global emergency helplines can ensure that users receive immediate assistance regardless of their location. This expansion will make E-Raksha a truly

global safety platform, accessible to women in various regions and capable of connecting them to emergency resources around the world.

Linking E-Raksha with government databases and public safety systems can provide real-time identification of known offenders and instant alerts to authorities. This integration will allow law enforcement agencies to use the system for crime trend analysis and preventive measures, further improving the overall safety environment. The system can also work closely with NGOs and community organizations to enhance its impact and provide support in areas with high vulnerability.

The future of E-Raksha also lies in building a community-driven safety network. By allowing users to report unsafe locations, suspicious activities, or recent incidents, the system can enhance real-time safety mapping and foster a safer, more collaborative environment. This crowdsourced data will contribute to a dynamic, ever-evolving understanding of safety trends and empower users to actively contribute to the safety of their communities.

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Appendices

Detailed information, lengthy derivations, raw experimental observations etc. are to be presented in the separate appendices, which shall be numbered in Roman Capitals (e.g. "Appendix I"). Since reference can be drawn to published/unpublished literature in the appendices, these should precede the "Literature Cited" section.

Appendix I: Python and Library Installation

1. **Install Python (preferably version 3.8 or above)**. In terminal:

   ```
   sudo apt update
   sudo apt install python3 python3-pip
   ```

2. **Verify the installation:**

   ```
   python3 --version
   pip3 --version
   ```

3. **Create and activate a virtual environment (optional but recommended):**

   ```
   sudo apt install python3-venv
   python3 -m venv myenv
   source myenv/bin/activate
   ```

4. **Install core libraries for Face Recognition:**

   ```
   pip install opencv-python
   pip install face_recognition
   pip install numpy
   ```

5. **Install OCR and text-processing libraries:**

   ```
   pip install pytesseract
   pip install pillow
   pip install imutils
   sudo apt install tesseract-ocr
   ```

6. **Install data analysis, ML, and visualization libraries:**

```
pip install pandas
pip install matplotlib
pip install seaborn
pip install scikit-learn
```

7. **Additional system dependencies for ‘facerecognition‘ and ‘dlib‘:**

```
sudo apt install cmake
sudo apt install build-essential
sudo apt install libgtk-3-dev
sudo apt install libboost-all-dev
```

8. **Test if everything works:**

```
python3
>>> import cv2
>>> import face_recognition
>>> import pytesseract
>>> import pandas as pd
>>> import matplotlib.pyplot as plt
>>> print("Libraries installed successfully!")
```

Publication

The research paper titled **"E-Raksha: Real-Time Women's Safety System with Smart Location Tracking and Threat Identification"** has been published at the **"IEEE 2025 6th INTERNATIONAL CONFERENCE OF EMERGING TECHNOLOGIES (INCET), Belagavi, Karnataka, India"** by **Rajashri Chaudhari, Abhijeet Dada Mote, Himanshu Maurya, Sanchit Patil, Harshal Anant Patil, and Faizan Mahimkar.**

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