SOFTWARE SYSTEM TO PERFORM REAL TIME ANALYSIS FOR WOMEN'S SAFETY

Tanvi Bokade[1] , Prantik Kharmale[2] , Rahul Kulkarni[3] , Manthan Kadakane[4] , Ravi Ray Chaudhari[5]
[1]MIT ADT University , Pune , Maharashtra , India
tanvi.bokade@gmail.com
[2]MIT ADT University , Pune , Maharashtra , India
prantikkharmale@gmail.com
[3]MIT ADT University, Pune , Maharashtra , India
rahulkulkarni14204@gmail.com
[4]MIT ADT University , Pune , Maharashtra , India
manthankadakane992@gmail.com
[5]MIT ADT University , Pune , Maharashtra , India
ravi.chaudhari@mituniversity.edu.in

ABSTRACT

This paper gives insights on a software system that performs real-time analysis for women's safety, utilizing multiple algorithms (facial recognition, sentiment analysis, natural language processing, proximity analysis, audio analysis, reinforcement learning) to detect, monitor, and respond to potential threats against the safety of women. Key features include : automatic detection of threats based on location, movement patterns, and facial expressions, which trigger alerts to local authorities. Machine learning models are integrated to improve the system's predictive accuracy by learning patterns associated with risk scenarios over time. This solution offers an effective tool for real-time prevention of threats against women , making it a valuable addition to the ecosystem of women's safety technology.

Keywords

Women's Safety, Real-time Analysis, Facial Recognition, Sentiment Analysis, Natural Language Processing (NLP), Proximity Analysis, Audio Analysis, Reinforcement Learning

INTRODUCTION

Women around the world face various safety threats, ranging from physical violence and harassment to stalking and sexual assault. These threats are present in both public and private spaces, creating a concern when it comes to safety. Despite various efforts by governments, NGOs, and communities to address these issues, like Women's helpline and several schemes, incidents of violence and harassment remain at an all time high. The primary problem is the lack of effective, real-time mechanisms to predict, prevent, and respond to these threats.

Because of these increasing threats it has been observed that women have been suffering in silence leading to :

- Higher rate of Incidence
- Underreporting of incidences and fear

This has brought the need to make a change, a system that can provide Data-driven solution for this problem and have a social and economical impact. Women's safety issues not only affect individuals but also have broader social and economic implications. They can restrict women from freely walking around, limit their participation in the workforce, and reduce their overall contribution to society due to fear of being judged and put down. Traditional methods of addressing women's safety often lack the precision and effectiveness required in today's digital age. There is a pressing need for data-driven, analytics-based solutions to enhance the safety of women. There are some models available currently that help in prevention of threats against women and there are various machine learning algorithms that help us in that as well.

Algorithms such as Naive Bayes (NB) and XGBoost are used in the analysis of women's safety on various social media sites. The goal is to use classification techniques to categorize or forecast the Type based on dataset properties. Using categorization algorithms, we can determine whether social media content is positive, negative, or neutral. It has been substantiated that Naive Bayes algorithm has proved better accuracy compared to random forest and decision tree algorithms.[1] and there are various IoT-based women's safety devices that use technologies that activate various features and play an important role in sending the danger alert to the guardian of the woman under threat. Some of the main technologies used in women's safety devices are GPS (Global Positioning System), GSM (Global System for Mobile Communication) and Raspberry Pi. GPS is used to track and locate the location of the victim whereas GSM is used to send the alert of danger to the guardian. Raspberry pi is a small computer chip-based technology used in IoT-based devices, which has further extensions such as Raspberry pi zero and Raspberry pi 3.[2]

The increasing concern for women's safety and the rise in crimes against women in various cities highlight the need for advanced surveillance and analytical solutions. Women Safety Analytics provides real-time threat detection software to address these issues and enhance safety for women in public

spaces.Key functionalities include continuous monitoring of the scene to count the number of men and women present, providing insights into gender distribution at specific times and locations. The system identifies unusual patterns, such as a lone woman at night or gestures signaling distress, generating alerts to mitigate risks.[3] The software uses OpenCV for image processing, enabling detection of faces and gestures in real-time. A deep neural network (DNN) is employed for robust detection and classification tasks, ensuring the accuracy of the results.[3] By leveraging advanced analytics through real-time monitoring, Women Safety Analytics should create safer environments for women and assist law enforcement in effectively addressing and preventing crimes against women. The proactive approach of detecting anomalies and generating alerts can play a crucial role in enhancing public safety and fostering a secure atmosphere for women. Women safety analytics software should continuously monitor the scene to count the number of men and women present, offering insights into gender distribution in specific locations and times. It should identify unusual patterns, such as a lone woman at night, unusual gestures and generates alerts to pre-empt potential incidents [4].

In an era where technology plays an ever-increasing role in our daily lives, the potential for IoT (Internet of Things) to address critical societal issues is profound. One such issue is women's safety, a concern that transcends geographic boundaries and affects women worldwide. In response to this pressing concern, the development of wearable IoT devices has emerged as a powerful tool to empower women and enhance their safety.[5] There might be a situation in which the person has to travel alone a long distance at an odd hour and perhaps even by public transport and may face some danger. At such a time, a personal safety app might not only be wise to have easy access to, it might also give you a lot of confidence. There might be a situation where women had an accident in the late night and there is no one to help and to take care of them. In such situations the person will not be able to tell the situation that he/she facing.[6]

These IoT-based technologies are used to minimize the difficulties, labor and time. But the majority of the devices associated with the above discussed technologies require full time internet connection and become expensive with the use of a wide range of technologies. Therefore, a simple and efficient system should be designed to develop communication between the women and guardians.[7].

LITERATURE SURVEY

Sr.no	Paper Title	Authors	Published Year	Technologies Used	Problem Type	Proposed Solution
[1]	A Novel Women Safety Analysis and Monitoring System over Social Media using Machine Learning	Ashok Kuruppath, B Rajalakshmi, Konapalli Sai Chaitanya Reddy, Geetha Priyanka Guggulla, Santhosh Krishna B V	2023	Machine Learning, Python, Naive Bayes Algorithm, XGBoost Algorithm, Natural Language Processing (NLP)	Women facing threats and harassment on social media platforms like Twitter, Facebook, and Instagram	Utilized classification algorithms (Naive Bayes and XGBoost) to categorize social media content into positive, negative, and neutral sentiments. Achieved better accuracy using the Naive Bayes algorithm.
[2]	The Role of IoT in Woman's Safety: A Systematic Literature Review	Muhammad Shoaib Farooq, Ayesha Masooma, Uzma Omer, Rabia Tehseen, S. A. M. Gilani, Zabihullah Atal	2023	IoT, Sensors (Pulse-rate, Temperature, Heartbeat), GPS, GSM, Bluetooth, Raspberry Pi, Machine Learning (Logistic Regression, Hidden Markov Model,	Women facing threats like harassment, molestation, and domestic violence; challenges in wearable IoT-based devices for women's safety	Systematic review of IoT-based women's safety devices; proposes a taxonomy of technologies, features, and sensors; emphasizes automation of alerts with minimal human interaction for

				Decision Tree)		enhanced effectiveness.
[3]	Women Safety Analytics: Real-Time Monitoring System	Divyanshu-RS	2022	OpenCV, Deep Learning	Real-time threat detection	Real-time detection of faces and gestures, gender distribution analysis.
[4]	Women Safety Analytics Using Machine Learning	Utkarsh Pushpankar	2023	Machine Learning, Computer Vision	Gender distribution and anomaly detection	Counting men and women in a scene using machine learning.
[5]	Implementation of IoT-based Real-time Women's Safety System	IJERT Researchers	2023	IoT, Real-time Analytics	Crowd monitoring and unsafe situations	IoT-based systems to monitor crowd compositions to identify threats.
[6]	A Mobile Based Women Safety Application (I Safe Apps)	IOSR Authors	2021	Mobile Apps, Real-time Analytics	Distress gesture recognition	Mobile apps to detect distress gestures and send alerts to authorities.
[7]	The Role of IoT in Woman's Safety	IEEE Researchers	2023	IoT, Data Analytics	High-risk area identificatio n	IoT-based analysis of past incidents for identifying high-risk zones.

Table 1. Literature Survey

PROBLEM STATEMENT

Women around the world continue to face safety threats, despite there being preventive measures in the market, since none of them are as effective as one needs them to be. This gap in proactive safety solutions leaves women vulnerable and underscores an urgent need for technologies that can provide timely intervention to enhance their security and well-being.

PROPOSED SOLUTION

System that performs real time analysis of public areas by using sentiment analysis, gender detection, facial recognition, audio analysis, natural language processing and reinforcement learning, which would be integrated with the CCTV camera present in that area can help in detecting early signs of harassment or threats. This can be particularly useful in identifying perpetrators or understanding the dynamics of harassment.

Analytics can be used to optimize the response times of law enforcement agencies and public services to safety incidents. Data-driven insights can guide policy-making and resource allocation to areas with the highest need.

WORKFLOW DIAGRAM

Fig 1. Workflow diagram for Proposed solution

BLOCK DIAGRAM

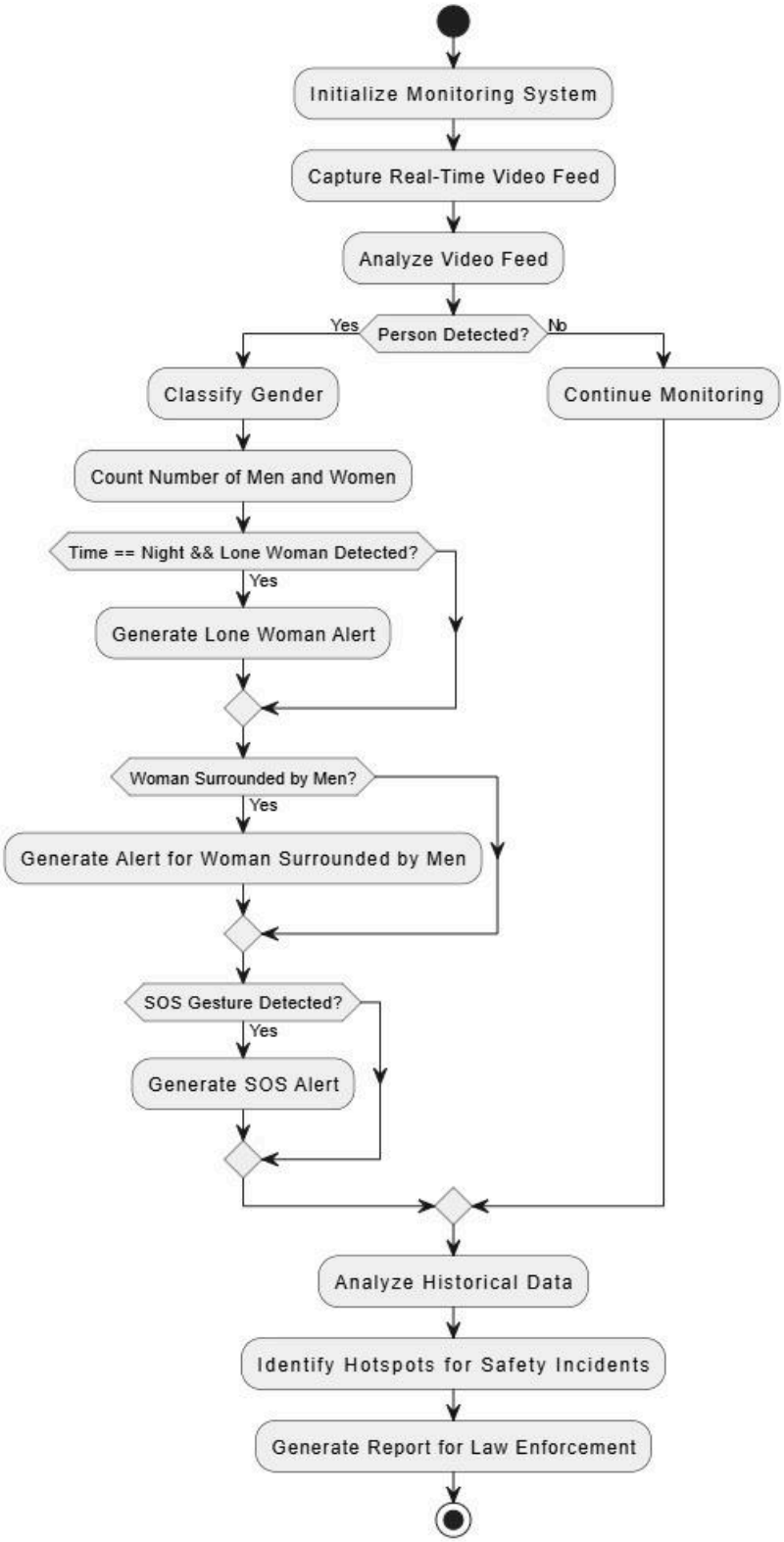

Fig 2 . Block diagram for Proposed solution

Proposed Methodology Solution

1. Facial Recognition and Gender Detection

- **Objective:** the main aim of our system is to identify and classify the individuals based on facial recognition which would help us in monitoring the gender distribution within the targeted area.
- **Process and Models:** The system uses the DeepFace model for facial recognition. Gender classification will be done using the convolutional neural networks (CNNs) which are trained on very large, labeled datasets resulting in an accurate gender detection. These models will help us in counting male and female individuals, identifying lone women at night, and determining the crowd composition.

2. Facial Expression Detection

- **Objective:** To detect facial expressions and other emotional cues like fear, anger, or distress, which will help us in identifying a potential threat.
- **Process and Models:** The system will use facial expression recognition (FER) models. These models are often based on CNNs or multimodal approaches. Multimodal Deep Learning techniques help us in enhancing the accuracy by analyzing both the facial features as well as other contextual cues. Models like OpenFace or EmotionNet are commonly used in FER to categorize emotions like happiness, sadness, anger, and fear.

3. Behavioral and Proximity Analysis

- **Objective**: To recognize the body language, gestures, and spatial relationships (proximity analysis) which will help us in identifying dangerous situations, such as a woman being closely followed or surrounded.
- **Process and Models:** The system uses Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) models for sequential analysis.It helps in capturing movement patterns over time. Reinforcement learning is also applied to better the proximity-based threat detection by learning what the optimal alert thresholds are from real-world interactions. YOLO (You Only Look Once) model can also help in recognizing specific postures or gestures.

4. Object and Scene Recognition

- **Objective:** to identify any potentially dangerous objects (e.g., weapons) or classifying environments (e.g., crowded vs. isolated areas).
- **Process and Models:** The system will be using Object Detection Models like YOLO, Faster R-CNN, or MobileNet to identify objects in real-time. Scene recognition can be done using ResNe or other CNN architectures which will help us in identifying locations based on threat level.

5. Audio Sentiment and Keyword Detection

- **Objective:** To detect any audio signals for distress indicators which are in the form of raised voices, or specific distress words, or aggressive tones that might signal a threat.

- **Process and Models:** The system will be using RNN or LSTM based models to analyse audio recordings. Audio-based CNN models are also effective for detecting keywords and sounds associated with distress. NLP-based Sentiment Analysis can be used to interpret voice signals, flagging distress terms like “help” or “stop”.

6. Multimodal Fusion Analysis

- **Objective:** Integrating data from visual (image/video) and audio sources for a better situational understanding.
- **Process and Models:** Our system will be using Multimodal Deep Learning which aims to combine visual cues, body language, facial expressions, and audio data, which allows for a more accurate context-based alerts. This integration helps in improving the detection accuracy, especially in complex situations like identifying a distressed woman based on both body language and verbal cues.

7. Alert and Response Mechanism

- **Objective:** Automatically alerting and notifying authorities when a distress signal is sent.
- **Process:** The system will be using a rule-based system which has been informed by reinforcement learning. Alerts are generated when combined visual and audio recordings exceed thresholds for threat classification. Reinforcement learning optimizes the alert thresholds over time to reduce false positives and improve response times.

8. Continuous Learning and Model Adaptation

- **Objective:** To ensure that the model improves over time and adapt to evolving patterns and behaviors.
- **Process:** The system will make use of Continuous Training Pipelines where the feedback from false positives and new incidents retrains models over time. Techniques like Active Learning also allow the system to improve by using new data, while reinforcement learning optimizes the response protocols based on real-world effectiveness.

FUTURE SCOPE AND BENEFITS

1. Value Proposition.

- **Real-Time Safety notifications:** Provides proactive safety notifications to help women avoid potential risks, particularly in public locations.
- **Data-Driven City Planning:** Provides valuable information to law enforcement and city planners for identifying hotspots and analyzing crime trends.
- **Enhanced Surveillance**: Adds advanced analytics to traditional surveillance systems to track gender distribution, detect anomalies, and evaluate crowd behavior.
- **Prevention-Oriented Technology:** Allows for proactive action by identifying potentially dangerous circumstances based on behavioral patterns and time of day.

2. Customer Segments.

- Municipalities, police departments, and public safety organizations can employ data-driven insights to plan strategic deployments and prevent crime.
- Public and private security organizations monitor huge complexes, malls, universities, hospitals, and corporate campuses.
- **Smart Cities Initiatives:** Projects that aim to integrate sophisticated technologies for citizen protection.
- **Transportation Authorities:** Public transportation agencies are working to make stations, trains, and bus terminals safer.
- **Businesses and Property Managers:** Owners of large properties and event sites that want to secure the safety of visitors.

3. Sources of Income

- **Subscription-Based Model:** Smart city initiatives, the government, and security agencies charge monthly or yearly subscription fees.
- **One-time licensing fees:** For law enforcement and government organizations buying the program for extended use.
- **Pay-Per-Use:** For special events, event-based monitoring, or temporary installations in prominent locations.
- **Services for Data Analytics and Reporting:** For better strategic planning, premium data analysis reports are provided on a monthly or quarterly basis.
- **Custom Integrations:** At an additional cost, we provide private organizations and major venues with custom integrations into pre-existing surveillance systems.

4. Channels Direct Sales:

- The sales staff focuses on private security companies, government agencies, and transportation authorities.
- **Partnerships with Security businesses:** Working together to provide bundled solutions with security and surveillance businesses.
- **Online and In-Person Events:** Technology demonstrations at public safety conferences, smart city expos, and industry-specific events.
- **Digital marketing:** Content marketing and targeted efforts directed at public safety and security decision-makers.

5. Relationships with Customers

- **Dedicated Customer Support:** round-the-clock customer service for clients in essential infrastructure, including transportation and law enforcement.
- **Training Programs:** To help law enforcement and security teams use the system efficiently, onboarding and training sessions are provided.

- **Community Engagement:** Demonstrating a dedication to public safety by working with NGOs and advocacy groups to collect input and enhance the system.
- **Constant Improvements:** Frequent releases featuring enhanced analytics and

6. Cost Structure : Research and Development Costs:

- The software's development, testing, and refinement will incur the highest costs.
- Infrastructure Costs: Expenses related to cloud storage and data processing for extensive video data analysis.
- Costs associated with marketing, customer acquisition, and collaborations are included in marketing and sales costs.
- Legal and Compliance Expenses: Making sure that data security and privacy regulations are followed consistently.
- Support and Maintenance: Ongoing training expenses, system upgrades, and customer service.

CONCLUSION

An encouraging answer to the growing worries about women's safety in urban settings is the Women Safety Analytics system. This technology helps with crime prevention and response by enabling proactive threat detection through the use of real-time surveillance and powerful analytics. In addition to monitoring and alerting, the system recognizes risk patterns that can direct law enforcement actions through features including person detection, gender classification, and gesture recognition.

Authorities are able to react quickly and maybe prevent events before they worsen because of the system's capacity to identify odd circumstances, such as a woman alone at night, a woman surrounded by men, or distress signs through gesture analysis. Furthermore, ongoing data analysis provides essential information for strategic city planning and resource allocation to the public by revealing high-risk areas and periods.

This study demonstrates how advanced analytics in women's safety can greatly improve monitoring capacities and make public spaces safer. The suggested model illustrates how technology may provide a safe environment for women in metropolitan environments, supporting the idea of smart, safe cities, even though more research and testing are necessary to improve the system's accuracy and responsiveness. Law enforcement, urban planners, and security agencies can all benefit greatly from the Women Safety Analytics system, which provides a scalable and practical way to improve women's safety in a range of public areas.

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