AI-DRIVEN SURVEILLANCE: ADVANCED THREAT DETECTION, REAL-TIME BEHAVIOUR ANALYSIS FOR CITIZEN, AND PREDICTIVE SAFETY SOLUTIONS FOR WOMEN.

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Keywords:

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Introduction:

In recent years, urban areas have witnessed a surge in public safety concerns, particularly around the safety of women in public spaces. Traditional surveillance systems are reactive in nature and heavily dependent on human intervention, which often results in delayed responses to emergencies.To address these limitations, this project introduces an AI-powered **Advanced CCTV Analytics System** that performs **real-time threat detection**, **gender-based analysis**, and **automated alert generation**. By leveraging cutting-edge technologies such as **YOLOv8 for object detection**, and **One-Class SVM for anomaly detection**, and **OpenPose for gesture recognition**, this system provides **proactive threat identification** and **swift communication with law enforcement agencies**.The solution integrates **Women Safety Analytics**, enabling monitoring of gender-based crowd compositions and situations where women may be at risk. The system ensures timely intervention through real-time alerts via **TeleBot integration**, enhancing urban safety and fostering public trust.

Objectives:

The primary goal of this project is to create an intelligent surveillance system capable of identifying and responding to potential safety threats in real time. The solution also aims to reduce incidents against women through anomaly detection, gesture recognition, gender-based analysis, scream detection and emotion detection

Key objectives:

1. Design a robust AI-powered system for analysing live CCTV feeds.
2. Automate crime detection using advanced object and gesture recognition models.
3. Provide real-time alerts to law enforcement to enable swift action.
4. Develop a scalable cloud-based architecture for multi-agency accessibility.
5. We can predict and prevent crimes before they occur by analysing behavioural patterns and environmental cues in real-time.

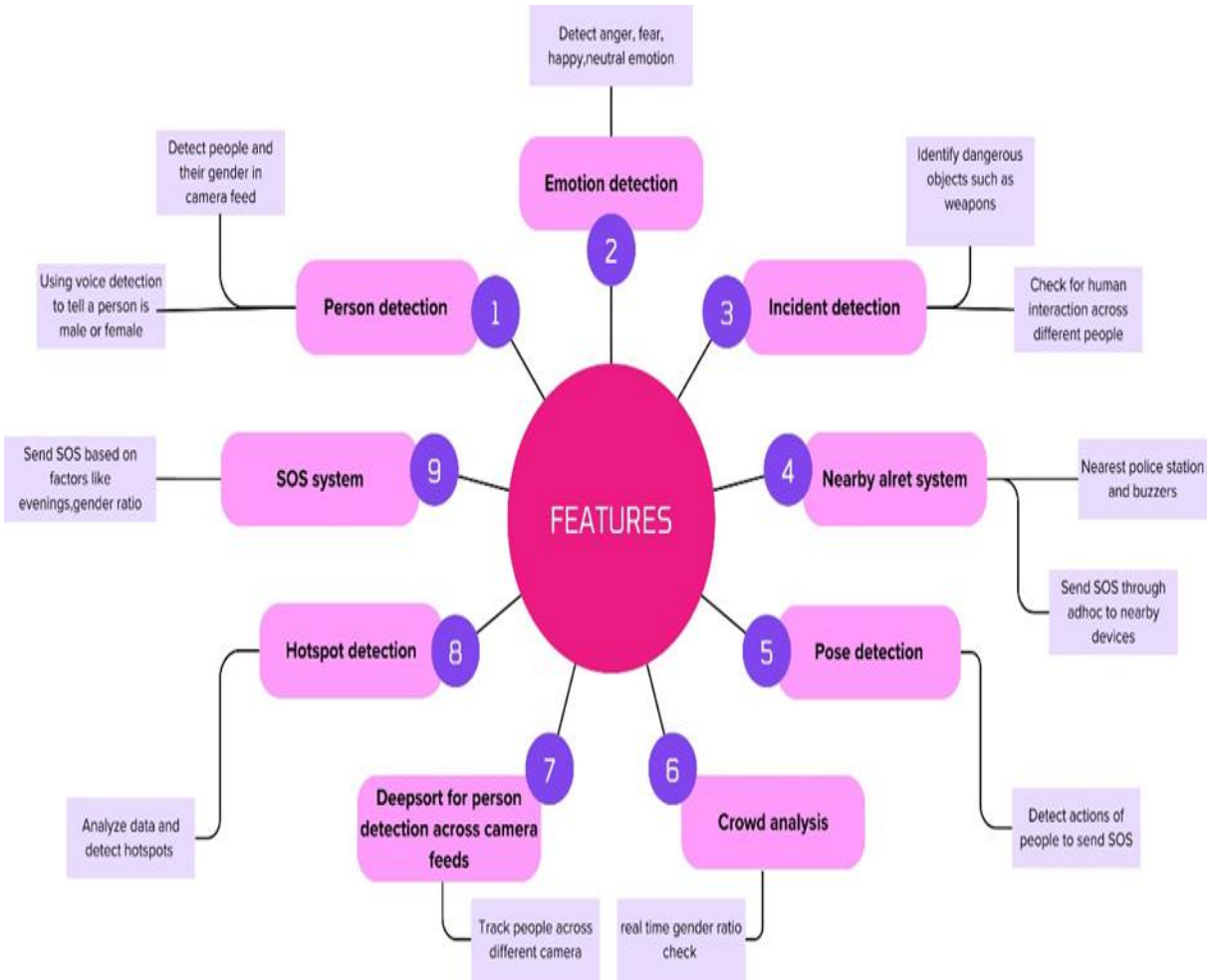

Figure 1: Features of Project.

Methodology:

1. Data Collection and Pre-processing

- Integrate live CCTV feeds and extract video frames in real time.
- Apply pre-processing techniques like resizing, noise reduction, and background subtraction to optimize frames for analysis.

2. Object Detection and Gender Classification

- Utilize YOLOv8 to detect individuals in monitored areas.
- Classify individuals by gender to analyze demographic distributions and identify specific situations, such as lone women in isolated areas or male-dominated crowds.

3. Anomaly Detection

- Implement models like LSTM Autoencoder and One-Class SVM for identifying unusual behaviors.
- Detect scenarios such as loitering, crowd surges, or abnormal movements indicating potential threats or distress.

4. Gesture Recognition for SOS Signals

- Use 3D Convolutional Neural Networks (3D-CNNs) and Recurrent Neural Networks (RNNs) for identifying predefined distress gestures (e.g., waving or forming SOS symbols).
- Ensure low-latency real-time analysis for immediate response.

5. Emotion Detection

- Leverage MediaPipe for analyzing facial expressions indicative of distress, fear, or anger.
- Integrate CNN models trained on datasets like FER2013 to improve accuracy under varied conditions, including occlusions and poor lighting.

6. Audio-Based Scream Detection

- Analyze audio spectrograms using Convolutional Recurrent Neural Networks (CRNNs) to detect screams.
- Train models to differentiate distress sounds from regular loud noises for accurate detection.

7. Weapon Detection

- Employ object detection algorithms such as YOLOv8 and Faster R-CNN to identify weapons in video streams.
- Train the models on diverse weapon datasets to improve precision in complex environments.

8. Alert Generation and Reporting

- Automate the generation of alerts containing incident details like time, location, and captured images.
- Forward alerts to local law enforcement agencies for prompt intervention.

9. Cloud-Based Deployment and Scalability

- Host the system on a cloud platform like AWS to enable real-time, city-wide monitoring.
- Design architecture for scalability to accommodate future expansion across multiple locations.

10. Database Management and Analytics

- Maintain a centralized database to store incident reports, video footage, and historical data.
- Perform long-term analytics to identify high-risk areas, assisting law enforcement in strategic resource deployment.

11. Predictive Analytics and Hotspot Detection

- Use clustering techniques like K-Means and heatmap visualizations to identify crime-prone areas.
- Integrate predictive models for optimizing law enforcement resource allocation and improving public safety.

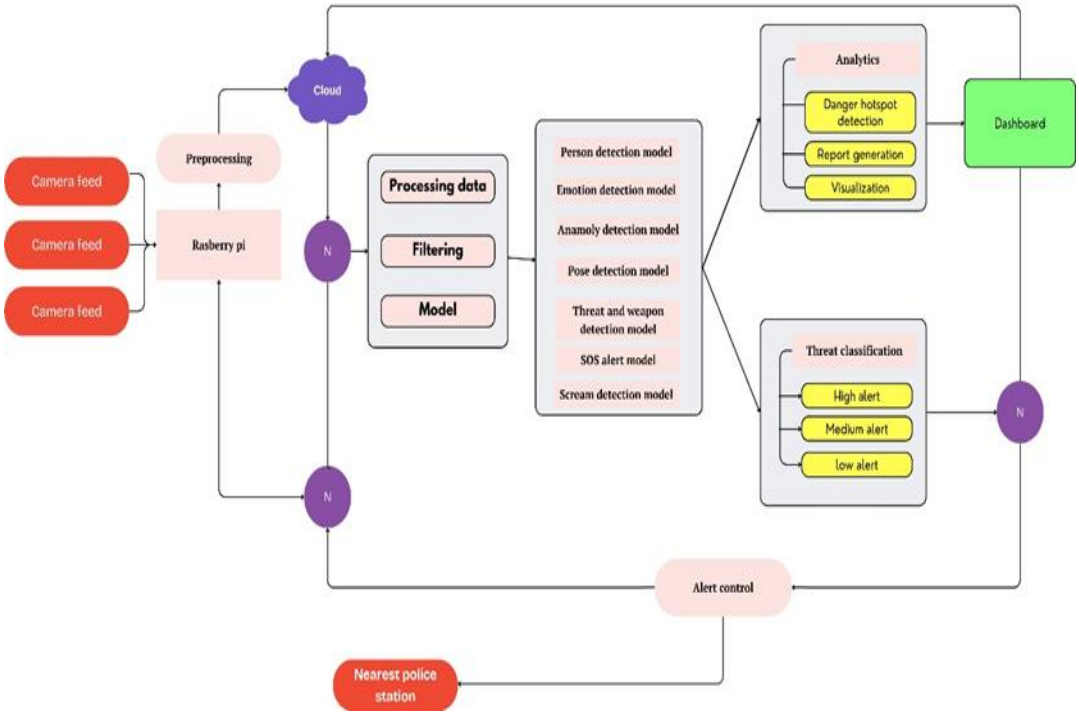

Figure 2: Architecture Diagram

Results and Conclusion:

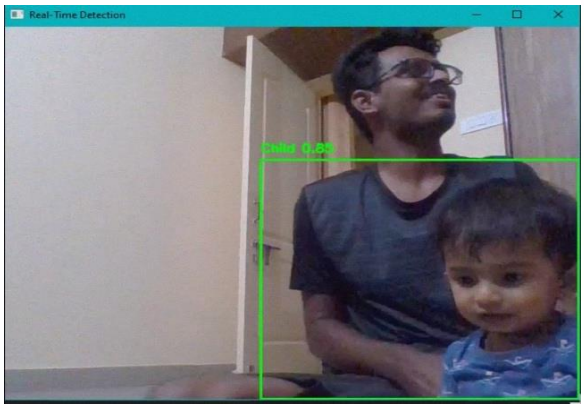

Figure 3: Child detection result

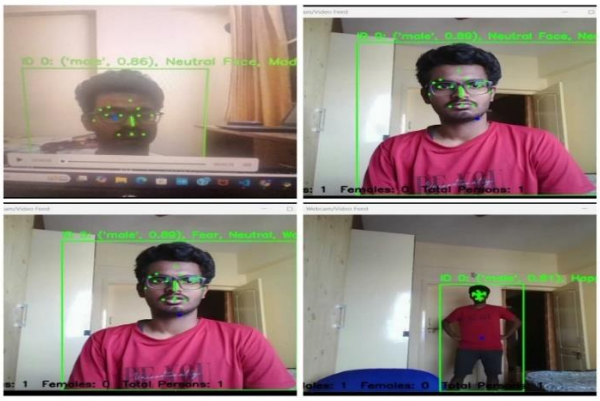

Figure 4: Emotion Detection Results

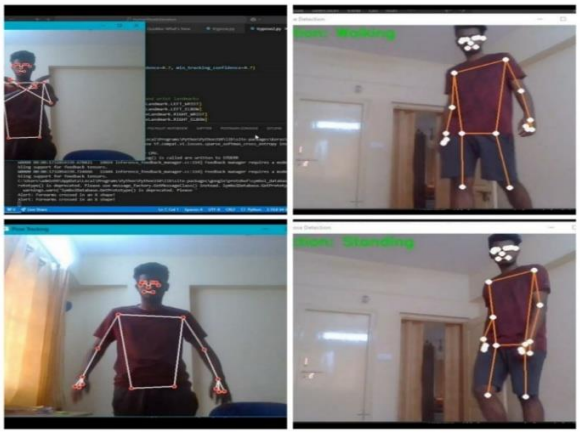

Figure 5: Results on Pose Detection

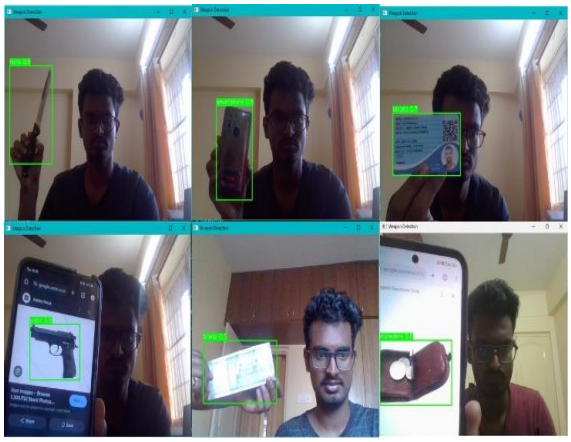

Figure 6: Results of Weapon Detection

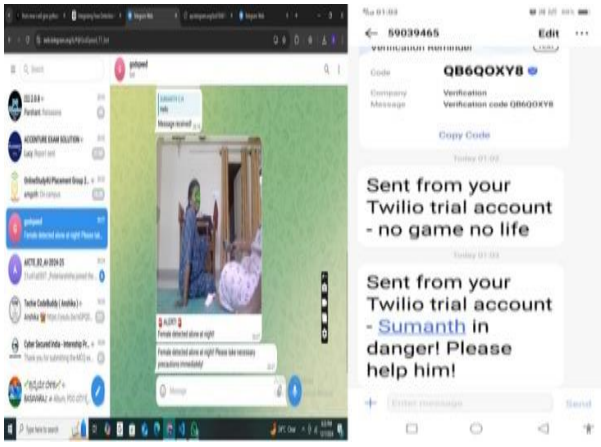

Figure 7: SOS on both Twilio and telegram

Figure 8: Showcasing gender and person detection with confusion matrix for validation set

The prototype system was rigorously tested across multiple modules and real-world scenarios. It showed:

- **High accuracy** in gender detection and emotion recognition (AUC-ROC ≈ 0.95).
- **Effective identification** of scream audio clips with over 90% recall.
- **Reliable object detection** including weapons and persons with precision exceeding 85%.
- **Real-time alerting** with negligible delays via TeleBot integration.
- **Smooth performance** under varying light and crowd conditions with low false positives.

This system bridges the gap between passive monitoring and proactive response, empowering law enforcement with actionable insights. The architecture supports modular upgrades and future scalability, making it a practical solution for smart cities focused on public safety.

Future Scope:

- **Predictive Crime Analytics:** Leverage historical data to predict and prevent future incidents.
- **Mobile App Integration:** Alert citizens in real-time and allow them to report incidents.
- **Multilingual Voice Interfaces:** For better accessibility and communication in diverse populations.
- **Integration with Law Enforcement Databases:** Auto-fill criminal records and aid investigation.
- **Facial Recognition with Privacy-by-Design:** For repeat offender identification.
- **Real-time 3D Mapping:** Using LiDAR or drone feeds for better crowd control.