AURA (Adaptive Urban Risk Analyzer for Crowd Management)

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INTRODUCTION

AURA (Adaptive Urban Risk Analyzer) is an intelligent crowd-safety ecosystem designed to predict and prevent stampedes using real-time video analytics and adaptive risk modelling. It continuously tracks crowd density, movement, flow direction, and pressure to detect early danger signals such as congestion, surges, huddles, and overloaded exits.

Unlike traditional CCTV monitoring, AURA is a full-stack safety solution combining computer vision, predictive algorithms, a multi-zone command dashboard, and a citizen mobile app. It not only detects risk but anticipates it, provides safe-route guidance, delivers instant alerts, and helps authorities manage large crowds proactively and confidently.

OBJECTIVES

The objective of **AURA** is to revolutionize crowd safety by moving from reactive monitoring to predictive, data-driven prevention. AURA aims to continuously interpret live crowd behaviour, forecast dangerous pressure patterns before they form, and deliver life-saving guidance to both authorities and citizens in real time. Through the fusion of computer vision, intelligent risk analytics, and interactive interfaces, the system seeks to set a new benchmark in smart-city crowd management—making large gatherings safer, more coordinated, and fundamentally more resilient.

METHODOLOGY

1. Input Acquisition & Zone Mapping

Live video feeds are segmented into zones and exits. Each frame is processed to detect crowd presence, movement, and spatial spread.

2. Metric Extraction & Data Refinement

Computer vision converts raw detections into core metrics — density, speed, movement flow, surge intensity, and exit inflow/outflow. Noise filtering ensures stable, trustworthy data.

3. Multi-Parameter Risk Computation

AURA's adaptive engine integrates these metrics to generate real-time safety indicators like Risk Score, Crowd Pressure Index, and Exit Load Balance. It also flags micro-patterns such as huddles, stalls, or pressure buildup.

4. Predictive Analysis & Early Hazard Detection

Trend monitoring and anomaly modelling forecast upcoming risks — congestion spikes, exit overloads, and potential stampede triggers — before they escalate.

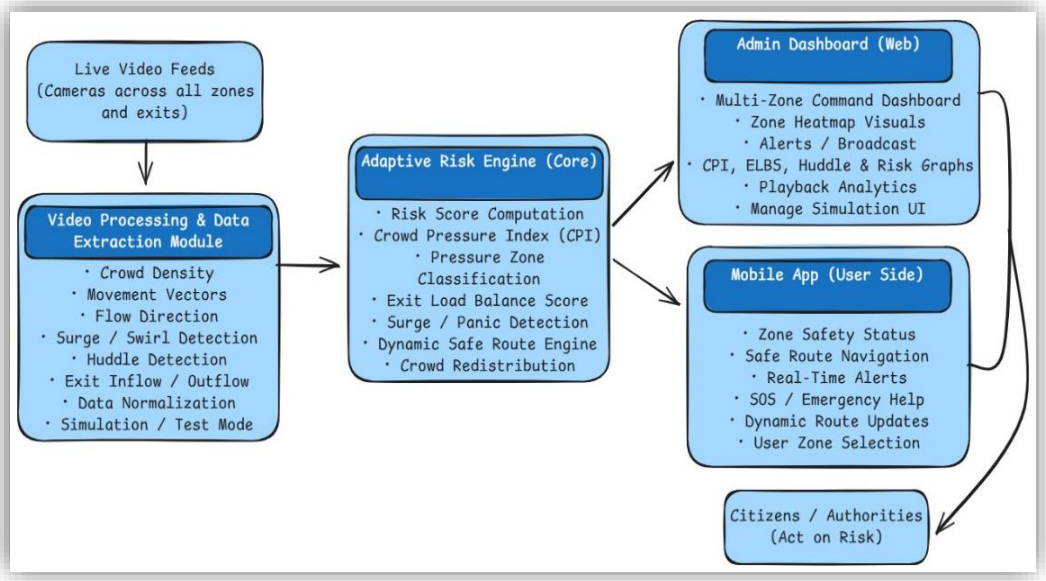
5. Visualization & Decision Support

Insights appear instantly on the command dashboard through heatmaps, alerts, and risk timelines, enabling quick, informed crowd-control decisions.

6. Public Guidance & Dynamic Routing

Citizens receive live zone safety updates and adaptive safe-route suggestions via the mobile app, ensuring smoother movement and coordinated evacuation during emergencies.

FLOWCHART



TECH TOOLS

Technology Used	Purpose
OpenCV (cv2)	Handles video processing & motion detection
NumPy	Vector math & computations
Farneback Optical Flow	Estimates crowd movement & speed
Contour Detection	Identifies crowd regions & density
Pandas	Storing & processing metrics
Risk Scoring Engine	Computes CPI & risk scores
Python 3	Core backend logic
React.js	Dashboard UI
Tailwind CSS	UI styling
React-Toastify	Real-time alert popups
Leaflet.js	Maps & heatmap visualization
Node.js + Express	Backend API & routing
Twilio	Sends SMS emergency alerts
Analytics Algorithms	Detects surge, swirl & risk patterns
Flutter	Builds cross-platform mobile UI
Dart	App logic & UI programming
Android Studio	Mobile app testing & deployment

OUTCOMES

CONCLUSION

AURA delivers proactive crowd safety by detecting high-pressure zones, predicting emerging risks, and guiding authorities and citizens with clear, real-time actions. It transforms chaotic crowd patterns into actionable intelligence, proving itself a reliable and adaptive platform for preventing dangerous situations before they escalate.