

# Tracion Tech-Tracking People, Empowering Safety

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**Abstract** — Crowd management and public safety have become major challenges in urban areas due to increasing population density and large public gatherings. Traditional surveillance and manual monitoring methods are often inefficient and slow in emergency situations. This intelligent surveillance system enables lost person identification and real-time crowd density monitoring using AI-based computer vision techniques. By analyzing CCTV feeds, the system helps authorities locate missing individuals, prevent overcrowding, and generate timely alerts, thereby improving public safety and supporting smart city infrastructure.

**Keywords:** Lost Person, Crowd Monitoring, CCTV, Face Recognition, Safety

## I. INTRODUCTION

The TRACION TECH is an intelligent, real-time monitoring solution developed to enhance public safety and improve crowd management in densely populated environments. With the increasing number of large public gatherings such as festivals, transport hubs, shopping complexes, and events, ensuring safety and effective monitoring has become a major challenge. Traditional surveillance systems rely heavily on manual observation, which is often inefficient and slow in emergency situations. The proposed system addresses these limitations by integrating artificial intelligence and computer vision with CCTV camera feeds to provide automated and reliable monitoring. The system combines AI-based face recognition with real-time people counting techniques to support lost person identification and crowd density monitoring. The lost person detection module allows operators to upload a missing person's image and search across live and recorded CCTV footage to identify the last seen location, camera ID, and timestamp. Simultaneously, the crowd monitoring module tracks individuals entering and exiting predefined zones to calculate real-time occupancy levels and detect overcrowding. The system is further enhanced by integration with interactive visualization tools such as Google Maps and building floor plans, enabling authorities to monitor crowd distribution and take timely preventive actions. This scalable and technology-driven solution offers an effective approach for modern public safety and crowd management systems.

## II. SYSTEM OVERVIEW

The proposed TRACION TECH system consists of CCTV-based surveillance integrated with AI-powered face detection and crowd monitoring modules to analyze live and recorded video feeds in real time. The lost person detection module allows operators to upload an image and search across multiple camera feeds to identify the last seen location, camera ID, and timestamp. In parallel, the crowd monitoring module tracks entry and exit of individuals in predefined zones to calculate real-time occupancy levels and generate

visual alerts when capacity limits are exceeded. A centralized server processes and stores data, while a web-based dashboard with map integration enables authorities to monitor crowd distribution and manage public safety efficiently.

## III. LITERATURE SURVEY

- 1) The increasing use of intelligent video surveillance systems in public spaces has raised the need for automated methods to identify missing persons and manage crowd density effectively. Traditional manual monitoring and basic CCTV surveillance are insufficient to handle large-scale environments and real-time safety requirements. Recent research proposes the use of computer vision and artificial intelligence techniques, such as face detection and facial feature extraction, to automatically identify individuals from surveillance footage. These systems improve detection accuracy, reduce human intervention, and enable faster response in crowded environments. Experimental results show that AI-based face recognition systems significantly enhance reliability and efficiency in missing person identification and public safety applications. [1]
- 2) This research presents an integrated approach for crowd density monitoring and people counting in smart public spaces using real-time video analytics. By tracking individuals entering and exiting predefined zones, the system continuously updates occupancy levels and compares them with safe capacity thresholds. Machine learning-based detection models and vision-based tracking techniques enable accurate crowd estimation even in complex environments. Visual alert mechanisms and dashboard-based monitoring help authorities take timely preventive actions, thereby reducing the risk of overcrowding-related incidents and improving crowd management efficiency. [2]
- 3) The growing deployment of AI-powered surveillance systems in smart cities has encouraged the integration of face recognition and crowd analysis into unified monitoring frameworks. Advanced computer vision techniques, including frontal face detection, Haar cascade classifiers, and facial feature embedding methods, have been explored to improve identification accuracy under varying lighting conditions, camera angles, and crowded scenes. These techniques enable reliable identification of individuals from both live and recorded CCTV footage. In parallel, real-time crowd analytics and people counting methods provide continuous assessment of occupancy levels, supporting proactive crowd control and emergency management. Existing studies highlight challenges related to scalability, real-time processing, and privacy concerns, while also identifying future research directions focused on improving accuracy, computational efficiency, and

robustness of intelligent crowd management and lost person detection systems.[3]

#### IV. OBJECTIVES

- 1) To develop a real-time surveillance system for lost person detection using CCTV feeds.
- 2) To implement AI-based face recognition for identifying missing individuals.
- 3) To monitor crowd density by tracking entry and exit of people in defined zones.
- 4) To generate alerts when crowd occupancy exceeds safe limits.
- 5) To provide map and floor-plan based visualization for monitoring.
- 6) To improve public safety and crowd management efficiency.

#### V. IMPLEMENTATION DETAILS

##### A. Java

Java is a class-based, general-purpose, object-oriented programming language used for developing the backend and server-side components of the TRACION TECH system. It is a high-level and strongly typed language that ensures platform independence, security, and robustness. Java is used to manage data processing, handle user requests, and support communication between the surveillance system and the centralized server. Its support for multithreading and networking makes it suitable for real-time data handling and scalable surveillance applications.

##### B. CCTV Camera System

The CCTV camera system serves as the primary data source for the TRACION TECH project. It captures live and recorded video streams from public spaces such as corridors, halls, and open areas. These video feeds are continuously analyzed by the system to detect individuals, track movement, and monitor crowd density. The cameras provide visual data required for face detection, lost person identification, and real-time crowd monitoring, forming the foundation of the intelligent surveillance system.

##### C. Face Detection and Recognition Module

The face detection and recognition module is a core component of the system, responsible for identifying individuals from CCTV footage. It uses computer vision techniques such as Haar Cascade and frontal face detection to locate faces in video frames. Once detected, facial features are extracted and converted into embeddings for matching with uploaded images of missing persons. This module enables accurate identification and supports rapid location tracking of lost individuals in crowded environments.

##### D. Crowd Density Monitoring Module

The crowd density monitoring module tracks individuals entering and exiting predefined rooms or zones to calculate real-time occupancy levels. By continuously analyzing video feeds, the system determines crowd density and compares it with predefined capacity thresholds. When the occupancy exceeds safe limits, the system generates alerts to notify

authorities. This module plays a critical role in preventing overcrowding and ensuring public safety.

##### E. Web-Based Dashboard

The web-based dashboard provides an interactive interface for operators and authorities to monitor system activity. It displays information such as detected individuals, last seen locations, crowd density levels, and alert notifications. The dashboard also integrates map views and building floor plans, allowing users to visualize crowd distribution and access detailed zone-level information for effective decision-making.

##### F. Alert and Notification System

The alert and notification system provides real-time warnings when critical events occur, such as detection of a missing person or overcrowding in a specific area. Alerts are generated using visual indicators and system notifications to ensure timely response by authorities. This component enhances situational awareness and enables quick preventive action, improving overall safety and system effectiveness.

#### VI. ADVANTAGES

- Quick Identification: Enables fast detection and location of missing individuals using AI-based face recognition.
- Real-Time Monitoring: Continuously tracks crowd density to prevent overcrowding in public spaces.
- Improved Safety: Generates timely alerts to reduce risks of stampedes and emergency situations.
- Efficient Management: Supports authorities with accurate data for effective crowd control and decision-making

#### VII. APPLICATIONS

- Public Safety Monitoring: Enhance safety in crowded public spaces through real-time surveillance and alerts.
- Missing Person Identification: Assist authorities in locating lost individuals using face recognition technology.
- Crowd Management: Monitor and control crowd density to prevent overcrowding and accidents.
- Event Management: Support efficient monitoring and safety control during large public events and gatherings.
- Smart City Surveillance: Enable intelligent monitoring and decision-making for smart city infrastructure.

#### VIII. CONCLUSION

In conclusion, the TRACION TECH intelligent surveillance system is an advanced solution that enhances public safety by providing real-time monitoring, accuracy, and operational efficiency. By enabling lost person identification and continuous crowd density monitoring, the system helps authorities manage public spaces more effectively and respond quickly to emergencies. The technology offers significant benefits, including improved situational awareness, reduced response time, and prevention of overcrowding-related incidents. As surveillance and AI technologies continue to evolve, such intelligent systems are

expected to play a vital role in shaping the future of smart cities and public safety management.

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