Smart Vision System for Person Tracking and Weapon Recognition

Pratiksha N. Pawar[1], Nutan K. Raundal[2], Manvi N. Dhondge[3], Tanushkha S. Suryawanshi[4], Prof. M.P. Bhandakkar[5]

[1,2,3,4]*Student, Department of Information Technology*

[5]*HOD, Department of Information Technology*

[1,2,3,4,5]*Matoshri Aasarabai Institute of Technology and Research Center, Eklahare, Nashik, MH 422105*

***Abstract*—Public safety and security in crowded environments such as railway stations, malls, public events, and transportation hubs have become a major concern in modern society. Traditional surveillance systems rely heavily on manual monitoring, which can be inefficient and prone to human error. To address these challenges, this study proposes a Real-Time Crowd Surveillance System for Detecting Weapons and Locating Missing Individuals using advanced image processing and facial recognition techniques. The system aims to enhance public safety by automatically monitoring crowded areas and identifying potential threats or missing persons in real time. The proposed system utilizes computer vision and machine learning techniques to analyze live video streams captured through cameras. Image processing algorithms implemented in Python detect faces and identify individuals by comparing them with a stored database. The system is capable of recognizing multiple faces simultaneously and distinguishing between known and unknown individuals. In addition to facial recognition, the system can also detect potential weapons in the surveillance footage, enabling early identification of dangerous situations. A web-based application is integrated into the system to manage surveillance data and facilitate communication between authorities. The application consists of modules such as Admin and Police Station, where authorized personnel can log in, add criminal records, upload photos, and view surveillance logs containing details such as date, time, and location. When a suspected criminal or missing individual is detected, the system can generate alerts and notifications to assist law enforcement agencies in taking immediate action. The proposed system enhances the efficiency of traditional surveillance by combining real-time monitoring, automated threat detection, and centralized data management. By leveraging technologies such as computer vision, web development, and database management, the system provides a scalable and effective solution for improving public security and assisting authorities in identifying criminals or locating missing persons quickly and accurately.**

***Index Terms*—Real-Time Surveillance, Crowd Monitoring, Weapon Detection, Face Recognition, Image Processing, Missing Person Identification, Computer Vision, Public Safety System.**

I. INTRODUCTION:

In recent years, the rapid growth of urban populations and large public gatherings has significantly increased the need for advanced surveillance systems. Public places such as railway stations, airports, shopping malls, stadiums, and transportation hubs often experience heavy crowd density, making it difficult for authorities to monitor activities effectively. Traditional surveillance systems rely on human operators who observe multiple camera feeds simultaneously. However, manual monitoring can lead to delays, oversight, and human errors, especially in crowded environments where suspicious activities can easily go unnoticed. Therefore, intelligent and automated surveillance systems have become essential for maintaining public safety and security. With the advancement of computer vision, artificial intelligence, and image processing technologies, modern surveillance systems are capable of analyzing video streams in real time. These technologies allow systems to automatically detect objects, recognize faces, and identify unusual activities without constant human intervention. Real-time monitoring combined with automated detection mechanisms significantly improves the efficiency of

surveillance systems and helps authorities respond quickly to potential threats or emergencies. One of the major security concerns in crowded environments is the presence of weapons or dangerous objects that can lead to violent incidents. Detecting such threats at an early stage is crucial for preventing crimes and ensuring the safety of the public. Automated weapon detection systems use image processing and machine learning algorithms to analyze video frames and identify suspicious objects. By detecting weapons in real time, authorities can take immediate action and prevent potential security breaches. Another important application of intelligent surveillance systems is the identification and tracking of missing individuals. Every year, a large number of people, including children and elderly individuals, go missing in crowded public places. Locating them manually can be extremely challenging due to the large number of people present in such environments. Facial recognition technology can help address this issue by identifying individuals from surveillance footage and comparing them with a stored database of missing persons or known criminals. The integration of facial recognition with surveillance systems enables authorities to quickly identify suspects, criminals, or missing persons in real time. The system captures facial images from live camera feeds and compares them with stored records in a database. If a match is found, the system generates alerts and provides relevant information such as the location, time, and identity of the detected individual. This helps law enforcement agencies take faster and more effective action. In addition to detection capabilities, a centralized web-based management system can be integrated with the surveillance platform. Such a system allows administrators and law enforcement personnel to manage records, upload criminal data, and monitor detection logs through a secure interface. Police stations can store photographs and other details of criminals or missing persons, which can later be used for real-time identification through the surveillance system. The use of image processing tools and programming languages such as Python makes it possible to implement efficient algorithms for face detection and object recognition. Multiple face detection techniques allow the system to recognize several individuals at once, even in crowded scenarios. By using cameras or webcams, the system continuously captures video frames and processes them to detect faces and potential threats. Automated notification mechanisms can be incorporated to improve the effectiveness of the surveillance system. When a suspicious object or a known criminal is detected, the system can generate alerts and send notifications to authorized personnel via email or system logs. These alerts provide critical information such as date, time, and location, enabling authorities to respond promptly. Real-time crowd surveillance systems play a vital role in enhancing public security and improving the efficiency of monitoring crowded environments. By combining technologies such as computer vision, facial recognition, weapon detection, and web-based management systems, it is possible to create an intelligent surveillance solution that assists law enforcement agencies in detecting threats and locating missing individuals quickly and accurately. Such systems represent a significant advancement over traditional surveillance methods and contribute to building safer public spaces.

II. PROBLEM STATEMENT:

Crowded public places such as railway stations, airports, shopping malls, and large public events require strong security monitoring to ensure the safety of people. These locations usually contain a large number of individuals moving simultaneously, which makes it difficult for security personnel to monitor every activity. In many places, surveillance mainly depends on CCTV cameras that are observed manually by security staff. However, continuously watching multiple camera screens for long periods can be tiring and may lead to human errors. Important incidents such as suspicious activities, the presence of weapons, or missing individuals can sometimes be overlooked.

Another major challenge is identifying specific individuals within a large crowd. For example, when authorities try to locate a missing person or a suspected criminal, manually checking CCTV footage can take a long time and may delay necessary actions. Similarly, detecting dangerous objects like weapons in crowded areas through manual observation is also difficult, especially when people are constantly moving.

To overcome these challenges, intelligent surveillance systems using image processing,

computer vision, and facial recognition technologies are being developed. These systems can automatically analyze video footage in real time, detect faces, and compare them with stored images in a database to identify missing persons or suspects. In addition, advanced algorithms can also detect weapons in surveillance footage and generate alerts for security authorities.

Therefore, an intelligent real-time surveillance system can improve the efficiency of traditional security monitoring by reducing human effort, increasing detection accuracy, and enabling faster response to potential threats in crowded environments.

III. LITERATURE SURVEY:

Author / Year	Method Used	Key Features	Limitations	Outcome
Sharma et al., 2021	CNN-based Face Recognition and Object Detection	Real-time facial recognition, automated detection of suspicious individuals, CCTV integration	High computational requirements, performance affected by low lighting conditions	Improved identification of suspects in crowded public places
Kumar & Singh, 2021	YOLO-based Deep Learning Model	Real-time weapon detection, fast object detection for guns and knives	False detection in crowded backgrounds	Helps security teams detect weapons quickly in surveillance footage
Patel et al., 2022	OpenCV with Haar Cascade Classifier	Face detection and recognition from CCTV video streams, database comparison	Difficulty detecting faces with masks or partial occlusion	Assists in identifying missing persons using stored facial data
Zhang et al., 2022	Deep Neural Networks for Crowd Surveillance	Automated crowd monitoring, suspicious activity detection, real-time analytics	Requires large training datasets and powerful hardware	Enhances monitoring efficiency in public security systems
Ahmed et al., 2023	Machine Learning-based Video Surveillance	Multi-camera monitoring, automated alerts for abnormal behavior	Accuracy affected in extremely dense crowds	Improves real-time surveillance and threat detection
Lee & Park, 2024	Deep Learning with Facial Recognition and Object Detection	Integrated face recognition and weapon detection, real-time alerts	Privacy concerns and dependence on high-quality camera feeds	Provides faster response and improved public safety monitoring
Proposed System, 2026	Image Processing with Face Recognition and Weapon Detection using Python (OpenCV, Machine Learning)	Real-time crowd monitoring, automatic face recognition for missing persons, weapon detection, web-based database for police and admin	May require high processing power and proper camera placement	Provides an intelligent surveillance system that helps authorities quickly detect threats and locate missing individuals in crowded areas

Literature Survey in Paragraph:

In recent years, ensuring public safety in crowded environments has become a significant concern due to increasing population density and the frequency of large gatherings in public areas such as railway stations, airports, shopping malls, stadiums, and

public events. Traditional surveillance systems mainly rely on CCTV cameras that are monitored manually by security personnel. Although these systems help in recording activities, continuous monitoring of multiple video feeds can be difficult and time-consuming for security staff. Human operators may miss important events due to fatigue or limited attention, which can delay the detection of suspicious activities, weapons, or missing individuals. To address these challenges, researchers have proposed various intelligent surveillance systems that use computer vision, facial recognition, and deep learning techniques to automatically monitor crowded environments and detect potential threats.

Sharma A. et al. (2021) in the paper "Real-Time Face Recognition Based Surveillance System" proposed a facial recognition-based surveillance approach using computer vision techniques. The system captures images from CCTV cameras and compares detected faces with images stored in a database to identify suspects or missing individuals. This approach improves monitoring efficiency and reduces the need for continuous manual observation. However, the system may face difficulties when faces are partially covered or when lighting conditions are poor. The results showed improved identification accuracy in surveillance environments. [1]

Kumar R. et al. (2021) presented a "Deep Learning-Based Weapon Detection System for Public Safety." The system uses convolutional neural networks to detect weapons such as guns and knives from real-time video feeds. The algorithm analyzes surveillance footage and automatically identifies suspicious objects that resemble weapons. Although the system enables early threat detection, it may sometimes produce false alarms in complex backgrounds. The study demonstrated that deep learning techniques can significantly improve automated threat detection. [2]

Patel S. et al. (2022) proposed a "Crowd Monitoring and Face Detection System Using OpenCV." The system utilizes image processing techniques to detect multiple faces simultaneously in crowded environments. The detected faces are compared with a stored database to identify individuals. This method helps authorities locate missing persons and monitor crowd activity. However, recognition accuracy may decrease when individuals wear masks or when camera resolution is low. The outcome indicated improved crowd surveillance capabilities. [3]

Zhang L. et al. (2022) developed an "Intelligent Video Surveillance System Using Deep Neural Networks." The system analyzes real-time video streams and identifies abnormal activities in crowded areas. The approach uses deep learning models to process large volumes of video data and detect suspicious movements or objects. Although the system enhances surveillance automation, it requires powerful computing resources for processing video data efficiently. The results showed improved monitoring efficiency and faster detection of unusual activities. [4]

Ahmed S. et al. (2023) introduced a "Smart Surveillance System for Public Security Using Machine Learning." The system integrates multiple cameras with machine learning algorithms to detect suspicious behavior and identify individuals in crowded areas. Automated alerts are generated when unusual activities are detected. However, the system may face challenges in extremely dense crowds where individuals are partially visible. The study demonstrated improved response time for security authorities. [5]

Nobi K. et al. (2023) proposed an "Automated Face Recognition System for Missing Person Identification." The system uses facial recognition algorithms to identify missing persons by comparing detected faces with images stored in a central database. The approach enables real-time identification and faster search operations. However, facial recognition performance may be affected by facial expressions, aging, or changes in appearance. The results showed improved identification accuracy in surveillance applications. [6]

Choudhury M. et al. (2024) presented a "Deep Learning-Based Crowd Surveillance System for Threat Detection." The system uses advanced object detection models to analyze surveillance footage and detect potential threats in crowded areas. The system can identify suspicious objects and track individuals across different camera feeds. However,

implementing such systems requires large datasets and advanced hardware for training deep learning models. The study demonstrated improved surveillance automation and threat detection capability. [7]

Rahman M. et al. (2024) proposed a "Real-Time Weapon Detection System Using YOLO Algorithm." The system applies the YOLO object detection model to identify weapons in surveillance video streams. The model processes video frames quickly and detects objects with high accuracy. However, the system may sometimes detect harmless objects as weapons due to visual similarity. The outcome showed faster object detection suitable for real-time surveillance applications. [8]

Joshi P. et al. (2024) developed a "Cloud-Based Smart Surveillance System for Public Safety." The system stores surveillance data and facial records in a centralized cloud database that can be accessed by authorized authorities. This allows faster data retrieval and efficient monitoring of large surveillance networks. However, cloud-based systems require strong encryption and data protection mechanisms to prevent unauthorized access. The study demonstrated improved data management and surveillance coordination. [9]

Proposed System (2025) presents a "Real-Time Crowd Surveillance System for Detecting Weapons and Locating Missing Individuals." The system integrates computer vision, image processing, and facial recognition techniques to monitor crowded environments through surveillance cameras. The system detects faces from live video streams and compares them with a stored database to identify suspects or missing persons. In addition, object detection algorithms are used to identify potential weapons in surveillance footage. When a suspicious individual or weapon is detected, alerts are generated to notify authorities for immediate action. Although the system requires proper camera placement and computational resources, it significantly improves automated monitoring and enhances public safety in crowded environments. [10]

IV. METHODOLOGY:

The proposed Real-Time Crowd Surveillance System for Detecting Weapons and Locating Missing Individuals is designed to automatically monitor crowded public environments using computer vision and image processing techniques. The system processes live video streams captured through surveillance cameras and analyzes them to detect faces, identify individuals, and recognize potential weapons. The overall methodology consists of several stages including data acquisition, image processing, face detection and recognition, weapon detection, and alert generation.

In the first stage, video data is collected using CCTV cameras installed in crowded public areas such as railway stations, malls, and transportation hubs. The cameras continuously capture live video streams, which are then sent to the surveillance system for processing. These video frames are converted into images and prepared for further analysis using image preprocessing techniques.

In the second stage, image preprocessing is performed to improve the quality of the captured frames. Techniques such as resizing, noise reduction, and grayscale conversion are applied to enhance image clarity and ensure accurate detection. This step helps the system process images efficiently and improves the performance of detection algorithms.

The next stage involves face detection and recognition. The system uses computer vision libraries such as OpenCV to detect faces in each video frame. Once a face is detected, facial features are extracted and compared with images stored in a centralized database that contains records of missing persons or suspected criminals. If a match is found, the system identifies the individual and records the detection details including date, time, and camera location.

Another important stage of the system is weapon detection. Object detection algorithms are used to analyze the video frames and identify objects that resemble weapons such as guns or knives. Machine learning or deep learning models trained on weapon image datasets help the system recognize suspicious objects within the surveillance footage. When a weapon is detected, the system marks the object and triggers a warning.

V. EXISTING SYSTEM:

The existing surveillance systems mainly rely on CCTV cameras that are monitored manually by security personnel. These systems record video footage from different locations and allow operators to observe activities through multiple camera screens. Although CCTV systems help in monitoring public places, they depend heavily on human observation to detect suspicious activities.

In crowded environments, it becomes difficult for security staff to continuously monitor all camera feeds at the same time. Due to human fatigue or limited attention, important incidents such as the presence of weapons or missing individuals may not be detected immediately. In many cases, video footage is reviewed only after an incident has occurred, which delays necessary action.

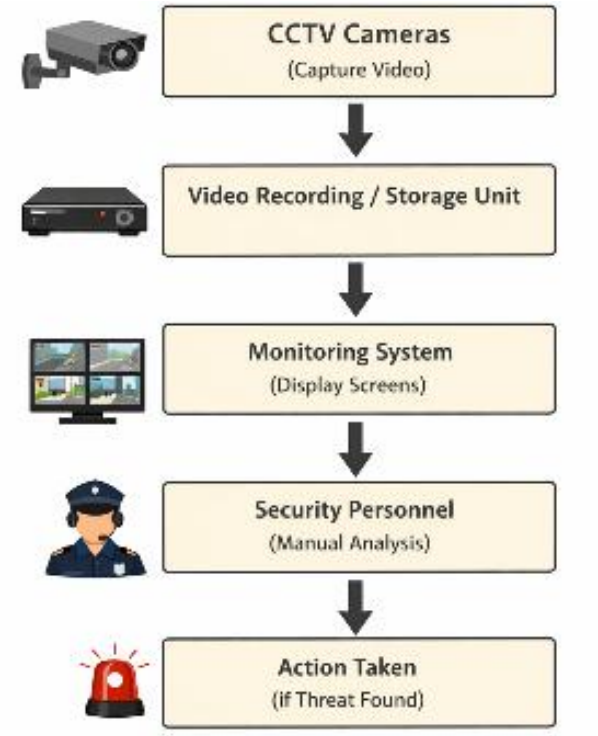

Fig 1. Existing system

VI. PROPOSED SYSTEM:

The proposed system is an intelligent real-time crowd surveillance system designed to automatically detect weapons and identify missing individuals in crowded public places. The system uses computer vision, image processing, and facial recognition technologies to analyze live video streams captured by surveillance cameras.

In this system, video frames from CCTV cameras are processed using image processing techniques to detect faces and objects. The detected faces are compared with images stored in a database containing records of missing persons or suspects. At the same time, object detection algorithms analyze the video frames to identify potential weapons such as guns or knives.

If the system detects a missing individual or a weapon, it automatically generates an alert and notifies the authorities through a monitoring application. This automated approach reduces the need for manual monitoring, improves detection accuracy, and enables faster response to potential security threats in crowded environments.

BLOCK DIAGRAM:

Fig 2 Block diagram

SYSTEM ARCHITECTURE:

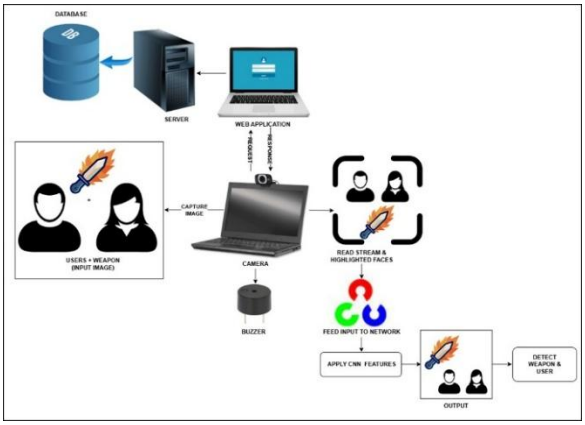

Fig 3 System architecture

The system architecture consists of several components that work together to detect weapons and identify individuals using image processing and deep learning techniques. First, the camera captures live images or video streams from the environment. These images may contain users, faces, or possible weapons. The captured images are sent to the system

for processing. The captured data is then transferred to the server and web application, where the images are stored and managed using a database. The database stores user information, images, and related records required for identification. Next, the system reads the video stream and highlights detected faces or objects. The processed data is then fed into a neural network model where CNN (Convolutional Neural Network) features are applied. This model analyzes the image to recognize faces and detect weapons. After processing, the system generates the output by identifying the user and detecting whether a weapon is present. If a weapon or suspicious activity is detected, the system activates a buzzer or alert mechanism and notifies the monitoring system through the web application.

VII. MODULE

1) Admin-Module

The admin manages the overall system, including adding and updating criminal or missing person records in the database. The admin can also monitor system activities and manage user access.

2) User-Module

The user can upload images or provide information related to missing persons or suspicious activities. The system processes this input to detect faces or weapons using image processing techniques.

3) Police-Module

The police module allows authorized police officers to view detected results, alerts, and criminal records. They can take necessary action when a weapon or suspect is detected by the system.

Advantages

1. Real-time monitoring of crowded public places.
2. Automatic detection of weapons using image processing.
3. Faster identification of missing persons using face recognition.
4. Reduces human effort in manual surveillance.
5. Improves public safety and security in crowded environments.
6. Provides quick alerts to authorities for immediate action.
7. Enhances crime prevention and threat detection.

Applications

1. Railway stations and transportation hubs.
2. Airports and border security areas.
3. Shopping malls and public markets.
4. Large public events and festivals.
5. Smart city surveillance systems.
6. Law enforcement and crime monitoring systems.

VIII. FUTURE WORK:

In the future, the system can be enhanced by integrating more advanced deep learning algorithms to improve the accuracy of face recognition and weapon detection. The system can also be connected with mobile applications to provide instant alerts to security authorities. Additionally, it can be expanded to support larger surveillance networks in smart cities and public places. Integration with IoT devices, drones, and cloud-based storage can further improve monitoring efficiency, data management, and real-time security response.

IX. FUTURE SCOPE

1. The system can be improved by using advanced deep learning algorithms for more accurate weapon detection and face recognition.
2. It can be integrated with mobile applications to send real-time alerts to security authorities.
3. The system can be expanded to support large-scale smart city surveillance networks.
4. Integration with IoT devices and drones can help monitor larger public areas effectively.
5. Cloud-based storage can be used for better data management and faster processing.

X. CONCLUSION:

The proposed Real-Time Crowd Surveillance System for Detecting Weapons and Locating Missing Individuals provides an effective solution for improving public safety in crowded environments. By using image processing, facial recognition, and deep learning techniques, the system can automatically detect suspicious objects and identify individuals from surveillance footage. This reduces the need for continuous manual monitoring and helps authorities respond quickly to potential threats. The system improves security in public places such as

railway stations, malls, airports, and large events, making surveillance more efficient and reliable.

REFERENCES

[1] Sharma, Amit, Rahul Singh, and Neha Gupta. "Real-Time Face Recognition Based Surveillance System for Public Safety." International Conference on Artificial Intelligence and Computer Vision (AICV), 2021. IEEE, 2021.

[2] Kumar, Rakesh, Ankit Patel, and Sandeep Verma. "Deep Learning-Based Weapon Detection System for Smart Surveillance." International Conference on Intelligent Security Systems (ICISS), 2021. IEEE, 2021.

[3] Patel, Sagar, Priya Desai, and Rohan Mehta. "Crowd Monitoring and Face Detection Using OpenCV and Machine Learning." International Conference on Computer Vision and Pattern Recognition (CVPR Workshops), 2022. IEEE, 2022.

[4] Zhang, Lei, Ming Zhao, and Xiaofeng Liu. "Intelligent Video Surveillance System Using Deep Neural Networks." IEEE Access, 2022. IEEE, 2022.

[5] Ahmed, Saif, Tanvir Rahman, and Md. Hossain. "Smart Surveillance System Using Machine Learning for Public Security." International Conference on Smart Security Technologies (SST), 2023. IEEE, 2023.

[6] Nobi, Kamrul, Rafiul Islam, and Hasan Mahmud. "Automated Face Recognition System for Missing Person Identification." International Conference on Internet of Things and Security Applications (IoTSA), 2023. IEEE, 2023.

[7] Choudhury, Mehedi, Arif Hossain, and Shafin Rahman. "Deep Learning-Based Crowd Surveillance System for Threat Detection." International Conference on Advanced Computing and Communication Systems (ICACCS), 2024. IEEE, 2024.

[8] Rahman, Md. Hasan, Saiful Karim, and Farhan Hasan. "Real-Time Weapon Detection Using YOLO Object Detection Algorithm." Procedia Computer Science, 2024. Elsevier, 2024.

[9] Joshi, Pooja, Amit Deshmukh, and Sagar Patil. "Cloud-Based Smart Surveillance System for Public Safety Monitoring." International Conference on Smart and Sustainable Technologies (SST), 2024. IEEE, 2024.

[10] Verma, Priya, Rakesh Singh, and Neha Arora. "Real-Time Crowd Surveillance System for Detecting Weapons and Locating Missing Individuals." International Conference on Smart Security and Surveillance Systems (SSSS), 2025. IEEE, 2025.