



A Multi-Source Surveillance System for Face Detection and Identity Matching Using Live and Pre-Recorded Video Streams

Rozina Chohan¹, Azhar Hussain Lashari², Muzamil Hussain³ & Shazia⁴

¹Associate Professor, Institute of Computer Science, Shah Abdul Latif University, Khairpur Mir's

²Lecturer, Department of Computer science, College Education Department Govt of Sindh

³Student, Institute of Computer Science, Shah Abdul Latif University, Khairpur Mir's

⁴Student, Institute of Computer Science, Shah Abdul Latif University, Khairpur Mir's

ARTICLE INFO

Article History:

Received: January 11, 2026
Revised: February 05, 2026
Accepted: February 18, 2026
Available Online: February 27, 2026

Keywords:

Video Streams, Surveillance System

Corresponding Author:

Azhar Hussain lashari

Email:

lashariahar@gmail.com



ABSTRACT

This research presents the design and implementation of a multi-source surveillance system for face detection and identity matching using both live CCTV feeds and pre-recorded video streams. The system aims to automate the monitoring process by detecting human faces in video inputs and matching them against a predefined database of known individuals. By integrating computer vision techniques with a user-friendly interface, the system provides real-time and offline analysis capabilities. The proposed system utilizes video processing techniques to extract frames from input sources, followed by face detection and feature encoding. Detected faces are compared with stored facial data to identify individuals and classify them into predefined categories such as authorized, watchlist, or unknown. The system is implemented using Python-based tools, enabling efficient processing and visualization through an interactive dashboard. Experimental results demonstrate that the system can accurately detect and recognize faces under varying conditions, although performance may be affected by lighting, resolution, and camera angles. This approach highlights the potential of intelligent surveillance systems in enhancing security monitoring while also emphasizing the importance of ethical considerations and data privacy. The system can be further improved by incorporating real-time alert mechanisms, larger datasets, and advanced deep learning models to increase accuracy and scalability.

Introduction

With the rapid advancement of technology, video surveillance systems have become an essential component in ensuring safety and security in public and private environments. Traditional

surveillance systems rely heavily on human operators to continuously monitor multiple camera feeds, which is both time-consuming and prone to human error. As the number of surveillance cameras increases, manual monitoring becomes inefficient and unreliable, creating a need for intelligent automated solutions.

Face detection and recognition technologies, powered by computer vision, have emerged as effective tools for enhancing surveillance systems. These technologies enable the automatic identification of individuals by analyzing facial features captured through cameras. Integrating such capabilities into surveillance systems can significantly improve monitoring efficiency, reduce response time, and assist in decision-making processes.

This research focuses on the development of a multi-source surveillance system capable of processing both live CCTV feeds and pre-recorded video streams. The system is designed to detect faces in video inputs and match them against a predefined database of known individuals. Based on the matching results, individuals are categorized into predefined classes such as authorized, watchlist, or unknown, enabling structured and prioritized monitoring.

The proposed system utilizes modern software tools and libraries to implement face detection and identity matching while providing a user-friendly interface for interaction and visualization. By supporting both real-time and offline video analysis, the system offers flexibility for continuous monitoring as well as post-event investigation.

The objective of this research is to design and implement an efficient, accurate, and scalable surveillance solution that reduces the dependency on manual observation while maintaining reliability. Additionally, this work highlights the importance of ethical considerations, including privacy and responsible use of facial recognition technologies.

Overall, this study contributes to the growing field of intelligent surveillance systems by presenting a practical and adaptable approach to automated face detection and recognition using multiple video sources.

Literature Review

The field of intelligent surveillance systems has gained significant attention in recent years due to the increasing demand for automated security solutions. Traditional video surveillance relies heavily on human monitoring, which is inefficient when dealing with large volumes of video data. As a result, researchers have explored computer vision techniques to automate the detection and recognition of individuals in video streams (see Musale, Singh, and Shirke, 2025).

One of the fundamental techniques used in early face detection systems is the Haar Cascade Classifier, which provides a fast and efficient method for detecting faces in images and videos. Although this method performs well in controlled environments, it has limitations in handling variations in lighting, pose, and occlusion (Krishnapriya and Shalini, 2025; Fikry, 2024). To address these challenges, more advanced approaches based on machine learning and deep learning have been developed, offering improved accuracy and robustness (e.g., see Yao, 2025; Fatih Ozdemir and Hanbay, 2024).

Face recognition systems typically involve feature extraction and matching processes (Ihsan, et al., 2025). Modern approaches use facial encoding techniques to convert facial features into numerical representations, which can then be compared with stored data (Singh et al., 2024). These methods have been widely adopted in various applications, including access control, attendance systems, and law enforcement.

In addition to detection and recognition, recent research has focused on integrating surveillance systems with real-time processing capabilities. The use of libraries such as OpenCV has enabled efficient video processing, while frameworks like Streamlit have simplified the development of interactive user interfaces for monitoring and control.

Another important aspect explored in existing studies is the use of multi-camera systems. These systems allow for broader coverage and improved tracking of individuals across different locations. However, managing and processing data from multiple sources remains a challenge, particularly when combined with the need for real-time analysis and accurate recognition.

Despite these advancements, several limitations still exist in current surveillance systems. These include sensitivity to environmental conditions, dependence on high-quality datasets, and concerns related to privacy and ethical use. Many systems also lack support for analyzing pre-recorded video efficiently, which is essential for post-event investigations.

This research builds upon existing work by proposing a system that integrates face detection and recognition across both live and pre-recorded video sources. By combining multiple input streams with a user-friendly interface, the proposed approach aims to provide a practical and flexible solution for modern surveillance challenges.

Methodology

This section describes the overall approach and techniques used to design and implement the proposed multi-source surveillance system. The system integrates face detection and identity matching capabilities to process both live CCTV feeds and pre-recorded video streams efficiently.

Data Collection

The system requires a dataset of facial images representing known individuals. These images are organized and labeled according to predefined categories such as authorized, watchlist, and unknown. The dataset is stored locally in a structured format, where each individual has a separate folder containing multiple facial images to improve recognition accuracy.

Tools and Technologies

The implementation of the system is based on Python due to its extensive support for computer vision and machine learning libraries. The OpenCV library is used for video processing, including capturing frames from live camera feeds and reading pre-recorded video files. For face detection and encoding, a face recognition library is utilized to extract unique facial features and convert them into numerical representations.

The user interface is developed using Streamlit, which provides an interactive platform for uploading videos, displaying results, and monitoring system outputs in real time.

System Workflow

The system follows a structured pipeline for processing video inputs. First, video data is obtained either from live CCTV cameras or uploaded recorded files. The video is then divided into individual frames, which are processed sequentially.

Each frame undergoes face detection to locate human faces within the image. Once detected, facial features are extracted and encoded into a numerical format. These encodings are compared with the stored database of known individuals using similarity measures. If a match is found within a

defined threshold, the identity of the individual is recognized; otherwise, the person is labeled as unknown.

Based on the matching results, individuals are categorized into predefined classes, enabling structured monitoring and prioritization. The system then displays the results through the interface, including the identified name, category, and relevant timestamps.

Handling Multiple Input Sources

The system is designed to support both real-time and offline processing. For live CCTV feeds, frames are continuously captured and processed in real time. For pre-recorded videos, users can upload files through the interface, and the system processes the video frame by frame. This dual capability enhances the flexibility of the system by supporting both active monitoring and post-event analysis.

Output Generation

The processed results are displayed through the Streamlit interface, providing a clear and user-friendly dashboard. The system shows the detected individual's identity, classification category, and the time of detection. Additionally, snapshots of detected faces can be generated for further analysis and record-keeping.

Overall, the methodology ensures an efficient and scalable approach to face detection and recognition across multiple video sources while maintaining ease of use and adaptability.

System Architecture

The architecture of the proposed surveillance system is designed to handle multiple video inputs and perform real-time as well as offline analysis. The system consists of four main components: input layer, processing layer, database, and output interface.

The input layer includes live CCTV camera feeds and pre-recorded video files uploaded by the user. These inputs are passed to the processing layer, where video frames are extracted and analyzed using face detection and recognition algorithms.

The processing layer is responsible for detecting faces, extracting features, and performing identity matching. This layer interacts with the database, which stores facial encodings and associated identity information of known individuals.

The output interface, developed using Streamlit, displays the processed results in an interactive format. It provides real-time updates for live feeds and detailed analysis for recorded videos, including identity labels, categories, and timestamps.

This modular architecture ensures scalability and flexibility, allowing the system to be extended with additional features such as real-time alerts, cloud integration, and advanced recognition models in the future.

The architecture of the proposed surveillance system is designed to handle multiple video inputs and perform real-time as well as offline analysis. The system consists of four main components: input layer, processing layer, database, and output interface.

The input layer includes live CCTV camera feeds and pre-recorded video files uploaded by the user. These inputs are passed to the processing layer, where video frames are extracted and analyzed using face detection and recognition algorithms.

The processing layer is responsible for detecting faces, extracting features, and performing identity matching. This layer interacts with the database, which stores facial encodings and associated identity information of known individuals.

The output interface, developed using Streamlit, displays the processed results in an interactive format. It provides real-time updates for live feeds and detailed analysis for recorded videos, including identity labels, categories, and timestamps.

This modular architecture ensures scalability and flexibility, allowing the system to be extended with additional features such as real-time alerts, cloud integration, and advanced recognition models in the future.

Results

The proposed surveillance system was tested using both live CCTV camera feeds and pre-recorded video datasets to evaluate its performance in face detection and identity matching. The system demonstrated reliable functionality in detecting human faces and matching them against the stored database under standard conditions.

In live video streams, the system was able to process frames in near real-time, successfully identifying individuals present in the database. Similarly, for pre-recorded video inputs, the system efficiently processed video files frame by frame and generated consistent detection and recognition results along with corresponding timestamps.

The overall recognition accuracy of the system was observed to be moderate to high under controlled conditions, particularly when the input video had good lighting and clear facial visibility. The system performed best when faces were directly visible and of sufficient resolution. However, performance declined in scenarios involving poor lighting, occlusions, or extreme camera angles.

Additionally, the system successfully categorized detected individuals into predefined groups such as authorized, watchlist, and unknown. The Streamlit-based interface effectively displayed results, including detected identities, categories, and visual outputs, making it easy for users to interpret the results.

These results indicate that the proposed system is capable of performing efficient face detection and recognition across multiple video sources while maintaining usability and consistency.

Discussion

The results of the proposed system highlight its effectiveness in automating surveillance tasks that traditionally require continuous human monitoring. By integrating face detection and recognition into a unified platform, the system reduces manual effort and improves the efficiency of monitoring multiple video sources.

One of the key strengths of the system is its ability to process both live and pre-recorded video streams, providing flexibility for real-time monitoring as well as post-event analysis. The use of an interactive interface further enhances usability, allowing users to easily upload videos and view results without requiring advanced technical knowledge.

Despite these advantages, the system has several limitations. The accuracy of face recognition is highly dependent on environmental conditions such as lighting, camera quality, and the angle of the face. In cases of low resolution or partial occlusion, the system may produce incorrect or

missed detections. Additionally, the system relies on a limited dataset, which may affect its ability to generalize to new or unseen individuals.

Another important consideration is the ethical use of facial recognition technology. Issues related to privacy, data security, and potential misuse must be carefully addressed. The system should be deployed responsibly, with proper safeguards to ensure that personal data is protected and used only for legitimate purposes.

Overall, while the system demonstrates strong potential, further improvements are necessary to enhance accuracy, scalability, and ethical compliance.

Conclusion

This research presented the design and implementation of a multi-source surveillance system for face detection and identity matching using both live CCTV feeds and pre-recorded video streams. The system successfully integrates computer vision techniques with an interactive interface to automate the process of monitoring and identifying individuals.

The proposed approach demonstrates the ability to detect faces, extract meaningful features, and match them against a predefined database with reasonable accuracy. The inclusion of both real-time and offline processing capabilities enhances the versatility of the system, making it suitable for various surveillance applications.

Although the system performs effectively under favorable conditions, challenges such as environmental variability and dataset limitations impact its overall performance. Addressing these challenges through improved models and larger datasets can significantly enhance system reliability.

In conclusion, the developed system provides a practical and scalable solution for intelligent surveillance, contributing to the advancement of automated monitoring technologies. Future enhancements can further improve its accuracy, efficiency, and applicability in real-world scenarios while ensuring adherence to ethical standards and data privacy regulations.

References

1. . C. Musale, A. K. Singh, and S. Shirke, "Effective face recognition from video using enhanced social collie optimization-based deep convolutional neural network technique," *J. Vis. Commun. Image Represent.*, 2025, doi:10.1016/j.jvcir.2025.104639. [Online]. Available: <https://www.sciencedirect.com/science/article/abs/pii/S1047320325002536> **ScienceDirect**
2. U. Ihsan, N. Z. Jhanjhi, H. Ashraf, F. Ashfaq, and F. A. Wicaksana, "A real-time intelligent surveillance system for suspicious behavior and facial emotion analysis using YOLOv8 and DeepFace," *Eng. Proc.*, vol. 107, no. 1, p. 59, 2025, doi:10.3390/engproc2025107059. [Online]. Available: <https://www.mdpi.com/2673-4591/107/1/59> **MDPI**
3. G. Krishnapriya and M. Shalini, "Enhanced security through real-time face recognition: A DeepFaceNet approach for video surveillance systems," *Int. J. Res. Appl. Sci. Eng. Technol. (IJRASET)*, vol. 13, no. II, Feb. 2025, doi:10.22214/ijraset.2025.67045. [Online]. Available: <https://www.ijraset.com/research-paper/enhanced-security-through-realtime-face-recognition-a-deepfacenet-approach-for-video-surveillance-systems> **IJRASET**
4. Ananthi and M. M. Faisal, "Hybrid motion vector and deep learning approach for crime event detection and face identification in CCTV feeds," *Int. J. Innov. Res. Sci. Eng. Technol.*, vol. 14, no. 5, May 2025, doi:10.15680/IJRSET.2025.1405257. ijrset.com

5. M. Fikry, "Performance analysis of smart technology with face detection using YOLOv3 and InsightFace for student attendance monitoring," *Int. J. Intell. Syst. Appl. Eng.*, vol. 12, no. 4, pp. 3490–3497, Jun. 2024. [Online]. Available: <https://ijisae.org/index.php/IJISAE/article/view/6865> **IJISAE**
6. Imran et al., "FaceEngine: A tracking-based framework for real-time face recognition in video surveillance system," *SN Comput. Sci.*, 2024, doi:10.1007/s42979-024-02922-1. **OUCI**
7. "A Comprehensive Review of Face Detection/Recognition Algorithms and Competitive Datasets to Optimize Machine Vision," *Comput. Mater. Contin.*, 2025, doi:10.32604/cmc.2025.063341. [Online]. Available: <https://www.sciencedirect.com/org/science/article/pii/S1546221825005326> **ScienceDirect**
8. S. S. Singh, V. Singh, S. Singh, and B. Hazela, "Face detection and counting: Recent advances and future research directions," *J. Appl. Sci. Educ.*, vol. 4, no. 1, pp. 1–8, Apr. 2024, doi:10.54060/a2zjournals.jase.69. [Online]. Available: <https://jase.a2zjournals.com/index.php/ase/article/view/69> **jase.a2zjournals.com**
9. Y. Yao, "Research on facial recognition system based on deep learning," *Appl. Comput. Eng.*, 2024, doi:10.54254/2755-2721/34/20230332. **Ewa Direct**
10. "A survey on masked face recognition based on deep learning," *Sensors & Transducers J.*, 2025, doi:10.1016/j.s2405959525002061. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S2405959525002061> **ScienceDirect**
11. M. Zhalgas, B. Amirgaliyev, and A. Sovet, "Robust face recognition under challenging conditions: A comprehensive review of deep learning methods and challenges," *Appl. Sci.*, 2024. [Online]. Available: <https://www.mdpi.com/2076-3417/15/17/9390> **MDPI**
12. P. V. S. Charan, "Face recognition-based criminal detection: Integrating image databases with live video surveillance," in *Proc. 4th Int. Conf. Info. Tech., Civ. Innov. Sci. & Manag. (ICITSM)*, 2025. **ResearchGate**
13. M. Fatih Ozdemir and D. Hanbay, "Real-time scalable system for face tracking in multi-camera surveillance," *J. Polytechnic*, vol. 27, no. 6, pp. 2215–2224, Dec. 2024, doi:10.2339/politeknik.1332952. **DergiPark**
14. (Review) "A comprehensive review of face detection techniques and deep learning advancements," *Int. J. Appl. Res.*, vol. 11, no. 6, pp. 270–275, 2025. **All Research Journal**
15. (Survey) "A survey on video face recognition using deep learning," ResearchGate, 2024. **ResearchGate**