

PERSON RE-IDENTIFICATION FOR PUBLIC SAFETY IN INDIAN RAILWAYS USING DEEP LEARNING

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ABSTRACT

Person Re-Identification (Re-ID) is an important computer vision task used to recognize and match individuals across multiple surveillance cameras. In large public infrastructures such as Indian Railways, identifying suspicious persons across different locations is challenging due to variations in pose, illumination, camera angle, and background conditions. Traditional approaches relied on handcrafted image features, which produced low identification accuracy and were not suitable for real-time surveillance applications. To overcome these limitations, this project proposes a Deep Learning-based Person Re-Identification system using Convolutional Neural Networks (CNNs) to automatically extract discriminative facial and body features. The extracted features are then classified and matched against a database of known suspicious individuals using Machine Learning algorithms such as Support Vector Machine (SVM) and Random Forest. The model with the highest accuracy is selected for deployment in the monitoring system. The system allows railway administrators to upload datasets of suspicious persons, extract features, train identification models, and monitor surveillance videos. When a match is detected in uploaded video footage, the system generates alerts and logs them into the database for further investigation. This solution enhances railway security by enabling automated detection of suspicious individuals, reducing manual monitoring effort, and improving identification accuracy through deep learning-based feature extraction.

Keywords:

Person Re-Identification, Deep Learning, Convolutional Neural Network (CNN), Surveillance System, Indian Railways Security, Face Recognition, Feature Extraction, Machine Learning, Support Vector Machine (SVM), Random Forest, Video Monitoring, Suspicious Person Detection, Computer Vision, Public Safety, Automated Alert System.

I INTRODUCTION

In recent years, ensuring public safety in large transportation networks such as Indian Railways has become a major challenge due to the massive number of passengers, multiple entry points, and continuous movement across stations. Traditional surveillance

systems rely heavily on human operators to monitor CCTV footage, which is time-consuming, prone to fatigue, and often leads to missed detections. Identifying suspicious individuals manually across multiple cameras is extremely difficult, especially when a person appears in different locations with variations in appearance, pose, lighting, or camera angle.

Person Re-Identification (Re-ID) is an advanced computer vision technique that focuses on recognizing and matching individuals captured across different cameras or at different times. Earlier approaches to person identification used handcrafted features such as color histograms, texture descriptors, or shape-based methods. However, these traditional techniques suffered from low accuracy and were not robust against real-world challenges like occlusion, illumination changes, and background clutter.

With the advancement of Deep Learning, Convolutional Neural Networks (CNNs) have demonstrated remarkable performance in automatically learning discriminative features from images. Unlike manual feature extraction methods, CNNs can capture complex facial characteristics, body structure, and pose information directly from data. This makes them highly suitable for surveillance-based applications where reliability and scalability are critical.

The proposed system utilizes a CNN-based feature extraction model to analyze images of known suspicious individuals and create a feature database. Machine Learning classifiers such as Support Vector Machine (SVM) and Random Forest are then trained on these features to perform accurate identification. When surveillance video is uploaded, the system detects persons in the frames, extracts their features, and compares them with the stored database to determine whether the individual is suspicious or not.

This automated approach significantly reduces human effort in monitoring railway surveillance while increasing detection accuracy and response speed. The system also generates alerts and maintains logs for administrative review, enabling timely action by security personnel. By integrating Deep Learning with intelligent video monitoring, the proposed solution enhances security infrastructure and supports safer public transportation environments.

LITERATURE REVIEW

Person Re-Identification has gained significant attention in recent years due to its wide applications in surveillance, smart cities, and transportation security. Early research in this field primarily relied on handcrafted feature extraction techniques such as color histograms, Scale-Invariant Feature Transform (SIFT), and Histogram of Oriented Gradients (HOG). These methods attempted to describe a person's appearance using manually designed features, which were simple to implement but lacked robustness in real-world scenarios involving pose variation, illumination changes, and occlusions [1][2].

To improve identification performance, researchers introduced Machine Learning-based classification techniques such as Support Vector Machines (SVM), k-Nearest Neighbors (k-NN), and Random Forest. These algorithms learned patterns from extracted features and improved classification accuracy. However, their success was still dependent on manually engineered features, which limited scalability in complex environments such as railway surveillance systems [3].

The emergence of Deep Learning significantly transformed the field of person identification. Convolutional Neural Networks (CNNs) enabled automatic feature learning from raw images, eliminating the need for handcrafted descriptors. Deep architectures such as AlexNet, VGGNet, and ResNet demonstrated the ability to learn hierarchical representations, capturing both low-level visual cues and high-level semantic information, resulting in substantial improvements in recognition accuracy [4][5].

Recent research has explored hybrid models that combine Deep Learning feature extraction with traditional Machine Learning classifiers. In such approaches, CNNs are used to generate discriminative embeddings, while classifiers like SVM or Random

Forest perform final matching. These hybrid techniques achieve a balance between computational efficiency and prediction accuracy, making them suitable for real-time surveillance applications [6].

In transportation environments such as airports, metro stations, and railway networks, intelligent video surveillance systems have been developed to automate monitoring and detect suspicious activities. These systems aim to enhance public safety by reducing reliance on manual observation and enabling faster response to threats. However, many existing solutions require expensive infrastructure or large datasets, limiting their adaptability in practical deployments [7].

The proposed system builds upon these advancements by integrating CNN-based deep feature extraction with Machine Learning classifiers to create an efficient and cost-effective Person Re-Identification system tailored for Indian Railway security applications.

III EXISTING SYSTEM

The existing surveillance systems used in public transportation environments, including railway stations, mainly rely on conventional CCTV monitoring and manual observation by security personnel. In these systems, cameras continuously capture video footage, which must be monitored by human operators to identify suspicious individuals or activities. This approach is highly dependent on human attention and experience, making it inefficient when dealing with large-scale environments that generate massive amounts of video data.

Earlier automated identification methods attempted to use handcrafted image processing techniques for recognizing individuals. These techniques extracted basic visual features such as color, texture, and shape from images and compared them with stored records. However, these manually designed features were not

robust enough to handle variations in lighting conditions, camera angles, occlusions, and changes in a person's appearance over time.

Some systems incorporated traditional Machine Learning algorithms like Support Vector Machine (SVM) and k-Nearest Neighbors (k-NN) for classification. Although these methods improved detection to some extent, their performance was still limited because they relied on low-level features that could not accurately represent complex human characteristics. As a result, the identification accuracy in real-world surveillance scenarios remained low.

Moreover, existing railway surveillance solutions often lack automation for real-time alerts and cross-camera tracking. Security staff must manually review recorded footage to verify whether a suspicious individual appeared in different locations, which is time-consuming and may delay necessary action.

Thus, the current systems are largely reactive rather than proactive, offering limited intelligence, low scalability, and insufficient accuracy for modern public safety requirements. These limitations highlight the need for an advanced, automated Person Re-Identification system based on Deep Learning techniques.

IV PROPOSED SYSTEM

To overcome the limitations of the existing surveillance methods, the proposed system introduces an intelligent Person Re-Identification framework using Deep Learning and Machine Learning techniques. The system is designed to automatically detect and identify suspicious individuals from surveillance videos by analyzing facial and body features, thereby reducing manual monitoring efforts and improving security efficiency in railway environments.

In this system, a Convolutional Neural Network (CNN) is used to extract high-level discriminative features from images of known suspicious persons. Unlike traditional handcrafted methods, the CNN automatically learns important patterns such as facial structure, posture, and appearance variations, making the identification process more accurate and reliable under different lighting conditions, camera angles, and backgrounds.

After feature extraction, the generated feature vectors are stored in a database and used to train Machine Learning classifiers such as Support Vector Machine (SVM) and Random Forest. These classifiers learn to distinguish between suspicious and non-suspicious individuals. The model that achieves the highest accuracy during training is selected for deployment in the monitoring system.

The system provides a web-based interface (implemented using Django) where the railway administrator can upload datasets, extract features, train models, and manage employees responsible for monitoring surveillance videos. Railway staff can upload video footage, and the system automatically analyzes each frame, detects persons, compares them with the trained database, and identifies matches through feature similarity.

Whenever a suspicious person is detected, the system generates real-time alerts and logs the detection details into the database for administrative review. This enables quick response from security authorities and ensures continuous monitoring without human fatigue.

Thus, the proposed system transforms traditional surveillance into an automated, intelligent, and scalable security solution that enhances public safety, improves identification accuracy, and enables proactive threat detection in Indian Railways.

VMETHODOLOGY

The proposed Person Re-Identification system follows a structured methodology that integrates Deep Learning-based feature extraction with Machine Learning-based classification to accurately identify suspicious individuals from surveillance videos. The workflow consists of several sequential stages, ensuring efficient data processing, model training, and real-time detection.

1. Data Collection and Preparation

A dataset containing images of suspicious individuals is collected and organized into folders. These images represent different variations in pose, lighting, and appearance to help the model generalize effectively. The collected data is preprocessed by resizing images, normalizing pixel values, and removing noise to ensure uniformity before training.

2. Feature Extraction using CNN

A Convolutional Neural Network (CNN) is used to automatically extract deep features from the input images. The CNN learns hierarchical patterns such as edges, textures, facial details, and body structure. These extracted features form a numerical representation (feature vector) of each individual, which is more robust than manually designed features.

3. Feature Database Creation

The generated feature vectors are stored in a structured database along with corresponding person labels. This database serves as the reference for identifying individuals during the re-identification process.

4. Model Training using Machine Learning Algorithms

The extracted CNN features are used to train classification algorithms such as:

- Support Vector Machine (SVM)
- Random Forest

Both models are trained and evaluated using performance metrics like accuracy, precision, and recall. The algorithm achieving the best performance is selected as the final detection model.

5. System Integration through Web Interface

The trained model is integrated into a Django-based web application. The system provides modules for:

- Admin login and dataset upload
- Feature extraction and model training
- Employee access for monitoring videos
- Alert management and result visualization

This interface allows easy operation without requiring technical expertise.

6. Video Monitoring and Person Re-Identification

When a surveillance video is uploaded, the system:

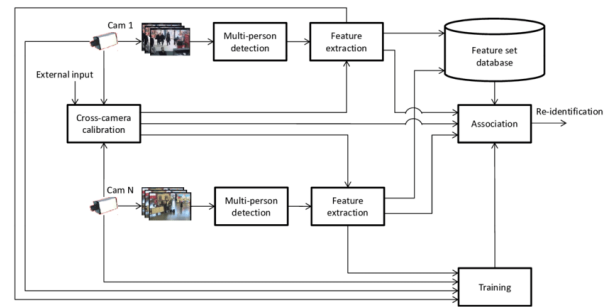
1. Extracts frames from the video.
2. Detects persons appearing in each frame.
3. Applies the CNN model to extract features.
4. Compares these features with the stored database using the trained classifier.
5. Identifies whether the detected person matches any suspicious individual.

7. Alert Generation and Logging

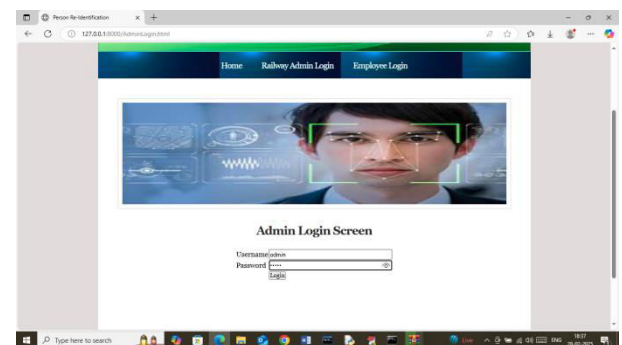
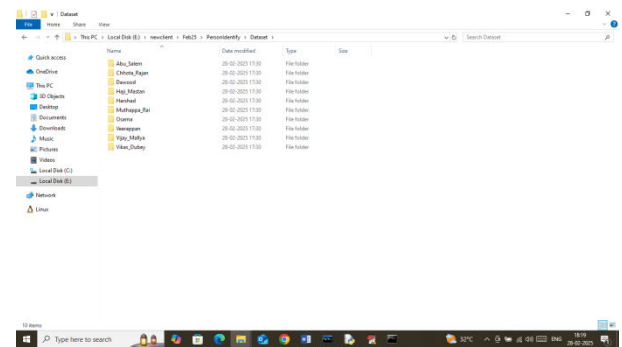
If a match is found, the system generates an alert and stores details such as detected person name, video source, and timestamp in the database. If no match is found, the individual is labeled as non-suspicious. This enables authorities to review alerts and take necessary action promptly.

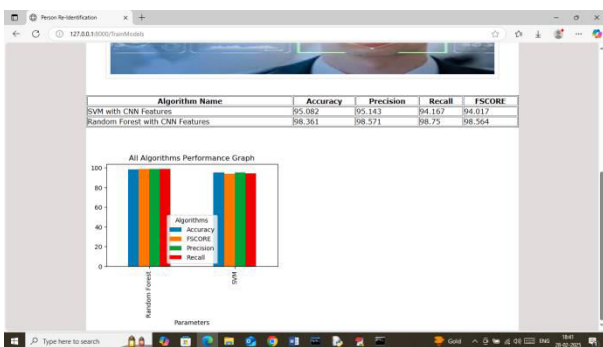
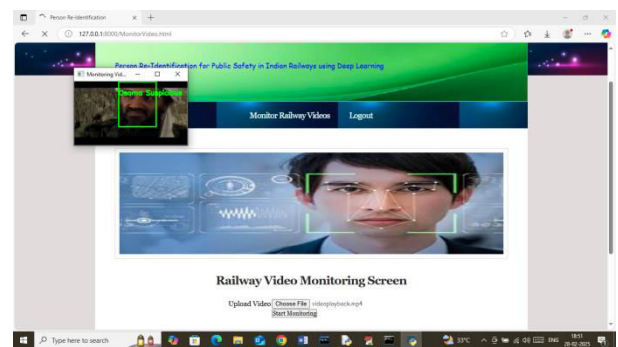
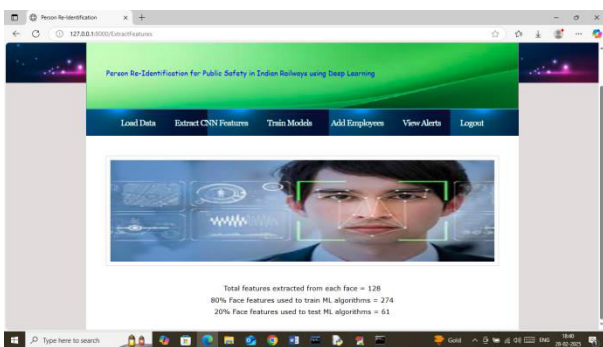
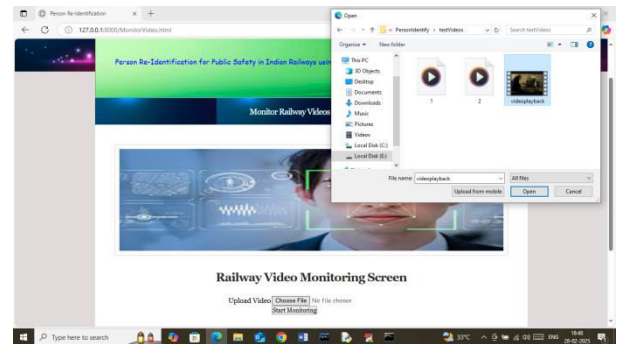
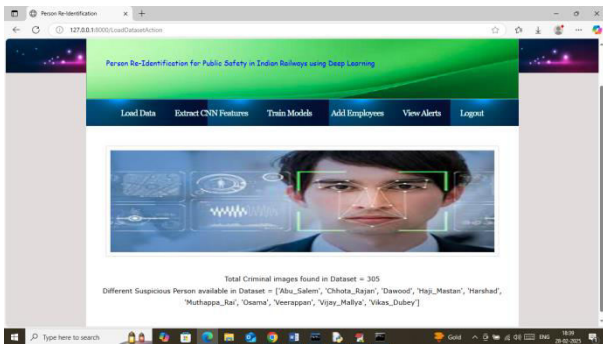
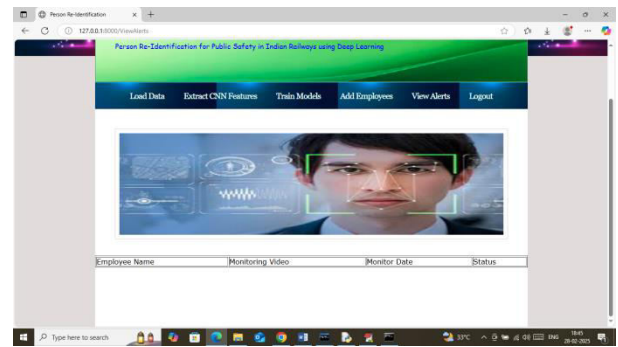
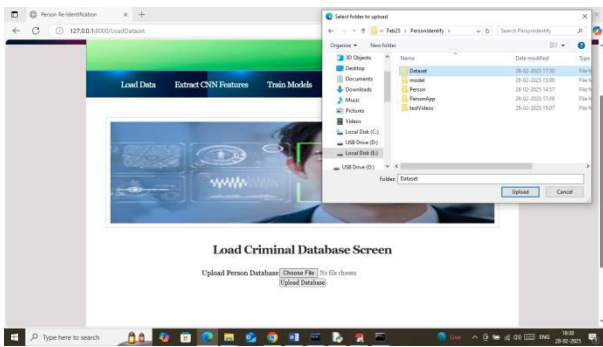
VISYSTEM MODEL

System Architecture



VIRESULTS AND DISCUSSIONS

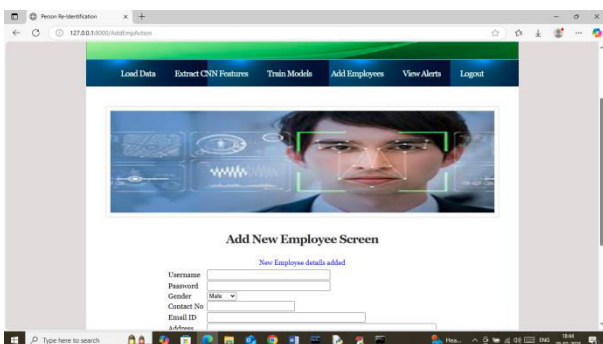




VIII CONCLUSION

The proposed **Person Re-Identification for Public Safety in Indian Railways using Deep Learning** system provides an intelligent and automated solution to enhance surveillance and security in large transportation environments. Traditional monitoring methods relied heavily on manual observation and handcrafted feature extraction techniques, which were inefficient and prone to errors in real-time scenarios. These limitations made it difficult to accurately identify suspicious individuals across multiple cameras and locations.

By integrating Convolutional Neural Networks (CNNs) for deep feature extraction with Machine Learning classifiers such as Support Vector Machine (SVM) and Random Forest, the developed system is capable of



learning complex visual patterns and accurately matching individuals with a stored database. The automation of feature extraction, training, and identification significantly reduces human effort while improving detection accuracy and response time.

The Django-based web interface enables administrators and railway staff to easily manage datasets, monitor videos, and receive alerts when suspicious persons are detected. The system ensures scalable, reliable, and efficient surveillance by transforming traditional CCTV monitoring into an intelligent video analytics platform.

Overall, the proposed solution enhances public safety, enables proactive threat detection, and demonstrates how Deep Learning can be effectively applied to real-world railway security applications.

IX. FUTURE WORK

Although the proposed Person Re-Identification system provides an effective solution for detecting suspicious individuals, several enhancements can be implemented in the future to further improve performance, scalability, and real-time usability.

In future developments, the system can be integrated with **live CCTV camera feeds** instead of manual video uploads, enabling real-time monitoring and instant alert generation. This would allow security personnel to respond immediately to potential threats without waiting for offline analysis.

The accuracy of identification can be further improved by training the model on **larger and more diverse datasets** that include variations in clothing, aging, occlusions, and crowd density. Advanced deep learning architectures such as ResNet, EfficientNet, or transformer-based vision models can also be incorporated to enhance feature learning capabilities.

Another possible extension is the implementation of **multi-camera tracking**, where the system can follow

an individual across different railway stations and camera networks. This would help authorities understand movement patterns and detect suspicious behavior over time.

The system can also be enhanced with **edge computing and GPU acceleration** to reduce processing latency and support deployment in real-time environments with high video throughput. Additionally, integrating cloud storage would allow centralized monitoring and large-scale data management.

Future versions may include **behavior analysis and anomaly detection**, enabling the system not only to identify known suspicious persons but also to detect unusual activities automatically using AI-based pattern recognition.

Finally, the application can be extended into a **mobile or alert notification system** that sends instant alerts to security personnel through smartphones or dashboards, improving response coordination and operational efficiency.

These improvements will make the system more robust, scalable, and suitable for deployment in real-world smart surveillance infrastructures.

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