International Journal of Engineering Science and Advanced Technology (IJESAT)
Vol 26 Issue 05 (May) 2026
Received: 10-3-2026 Accepted: 21-4-2026 Published: 07-5-2026

AI-DRIVEN RAILWAY SECURITY USING HUMAN RE-IDENTIFICATION TECHNIQUES

[1] J.V. ANIL KUMAR, [2] KOPPULA ANJALI DEVI, [3] SHAIK AARJU, [4] THOMMANDRU GOWTHAMI,
[5] G. CHANDRIKA,[6] JYOTHI SHRIJA

[1] PROFESSOR & HOD, DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING, KRISHNA CHAITANYA INSTITUTE OF TECHNOLOGY & SCIENCES, DEVARAJUGATTU, MARKAPUR.

[2,3,4,5,6] STUDENT, DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING, KRISHNA CHAITANYA INSTITUTE OF TECHNOLOGY & SCIENCES, DEVARAJUGATTU, MARKAPUR.

ABSTRACT

Person Re-Identification (Re-ID) is a crucial task in computer vision that focuses on recognizing and matching individuals across multiple non-overlapping camera views. In the context of Indian Railways, which is one of the largest and busiest transportation networks in the world, ensuring public safety and effective surveillance is a significant challenge due to dense crowds, diverse environments, and real-time monitoring requirements. This project proposes a deep learning-based person re-identification system tailored for railway stations to enhance security, track suspicious activities, and assist in locating missing individuals. The system utilizes advanced Convolutional Neural Networks (CNNs) and feature extraction techniques to generate unique identity embeddings from person images. These embeddings are then compared across camera feeds to identify and track individuals across different locations and time instances. The model is trained on large-scale datasets with variations in pose, illumination, occlusion, and background, making it robust for real-world deployment. Additionally, the integration of real-time video analytics and database matching improves response time for security personnel.

Keywords: Person Re-Identification, Deep Learning, Convolutional Neural Networks (CNN), Computer Vision, Surveillance System, Public Safety, Indian Railways, Feature Extraction, Image Matching, Real-Time Monitoring, Video Analytics, Security Systems

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I. INTRODUCTION

The rapid growth of population and increasing dependency on public transportation systems have made safety and surveillance a critical concern, especially in large-scale networks like Indian Railways. Every day, millions of passengers travel across thousands of railway stations, making it one of the busiest transportation systems in the world. Managing security in such a dynamic and crowded environment is a challenging task for authorities. Traditional surveillance systems rely heavily on manual monitoring of CCTV footage, which is time-consuming, error-prone, and inefficient when dealing with large volumes of video data. Therefore, there is a strong need for intelligent, automated solutions that can assist in monitoring and identifying individuals in real time.

Person Re-Identification (Re-ID) is an emerging field in computer vision that aims to recognize and match individuals across different camera views without requiring continuous tracking. Unlike facial recognition, which may fail due to low resolution or occlusion, person re-identification focuses on extracting unique features such as clothing patterns, body shape, and gait. This makes it highly suitable for crowded environments like railway stations where faces are not always clearly visible. With advancements in deep learning, especially Convolutional Neural Networks (CNNs), Re-ID systems have achieved significant improvements in accuracy and robustness.

II. LITERATURE REVIEW

Person Re-Identification (Re-ID) has gained significant attention in recent years due to its wide applications in surveillance, security, and public safety. Numerous research works have explored deep learning techniques to improve identification accuracy under challenging real-world conditions such as occlusion, illumination variation, and viewpoint changes.

Early studies in person re-identification relied on traditional machine learning approaches that focused on handcrafted features such as color histograms, texture descriptors, and local binary patterns. These methods, although computationally simple, struggled to perform effectively in complex environments like crowded public spaces. With the emergence of deep learning, especially Convolutional Neural Networks (CNNs), researchers began developing more robust feature extraction techniques that automatically learn discriminative representations from large datasets.

One of the foundational works in deep learning-based Re-ID introduced CNN architectures trained on large-scale datasets

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such as Market-1501 and CUHK03. These models demonstrated significant improvements in accuracy by learning identity-specific features. Further advancements were made with the introduction of Siamese networks, which learn similarity metrics between image pairs, and triplet loss-based models that optimize the distance between anchor, positive, and negative samples. These approaches enhanced the system's ability to distinguish between different individuals.

III. EXISTING SYSTEM

The existing surveillance system in Indian Railways primarily relies on Closed-Circuit Television (CCTV) cameras installed across railway stations, platforms, entry/exit points, and inside trains. These cameras continuously record video footage, which is monitored by security personnel in control rooms. The system is designed to observe activities, detect suspicious behavior, and provide recorded evidence when required. However, the monitoring process is largely manual, requiring human operators to watch multiple video feeds simultaneously, which becomes highly challenging in crowded environments.

In the current system, identifying a specific individual across multiple cameras is a difficult and time-consuming task. If a person needs to be tracked, security personnel must manually scan through hours of video footage from different cameras, often without any automated assistance. Traditional methods such as facial recognition are sometimes used, but they are not always reliable due to factors like low image quality, poor lighting conditions, occlusions (e.g., masks, scarves), and varying camera angles. As a result, consistent identification across different locations becomes inefficient.

Moreover, the existing system lacks integration and intelligent analytics. Most CCTV setups function as standalone units without advanced data processing capabilities. There is minimal use of artificial intelligence or machine learning to analyze patterns, detect anomalies, or automatically match individuals across different camera views. This limits the system's ability to respond quickly to real-time threats or incidents such as theft, missing persons, or suspicious movements.

Another limitation is scalability. With thousands of cameras deployed across the railway network, managing and analyzing such a massive amount of video data manually is impractical. Storage and retrieval of relevant footage also pose challenges, as there is no efficient indexing or search mechanism based on person identity. Overall, the existing system provides basic surveillance capabilities but lacks automation, intelligence, and efficiency.

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PROPOSED SYSTEM

The proposed system introduces a deep learning-based Person Re-Identification (Re-ID) framework designed specifically to enhance public safety in Indian Railways. Unlike traditional surveillance systems, this approach integrates intelligent video analytics with advanced Convolutional Neural Networks (CNNs) to automatically detect, extract, and match unique features of individuals across multiple non-overlapping camera views. The system processes live CCTV feeds in real time, identifies persons of interest, and generates distinctive feature embeddings based on attributes such as clothing patterns, body structure, and movement characteristics. These embeddings are stored in a centralized database and continuously compared with incoming video streams to track individuals across different locations within railway stations. The proposed system also incorporates modules for alert generation, enabling security personnel to receive instant notifications when a match is found or suspicious activity is detected. Additionally, it supports scalability through cloud or edge-based deployment, ensuring efficient handling of large-scale video data across the railway network.

METHODOLOGY

The proposed Person Re-Identification (Re-ID) system for public safety in Indian Railways follows a structured methodology that integrates deep learning, computer vision, and real-time video analytics to ensure accurate identification and tracking of individuals across multiple camera views.

Initially, the system collects video data from CCTV cameras installed at various locations such as platforms, entry/exit gates, and waiting areas. These video streams are processed frame by frame, where a person detection algorithm (such as YOLO or Faster R-CNN) is applied to identify and isolate human figures from the background. The detected person images are then preprocessed through resizing, normalization, and noise reduction to ensure consistency and improve model performance.

In the next stage, feature extraction is performed using a deep Convolutional Neural Network (CNN) model, such as ResNet or DenseNet. The model is trained on large-scale person re-identification datasets to learn discriminative features like clothing color, texture, body shape, and spatial patterns. Each detected individual is converted into a unique feature vector or embedding that represents their identity in a high-dimensional space.

These feature embeddings are stored in a centralized database. When a new person is detected, the system compares the extracted features with those stored in the database

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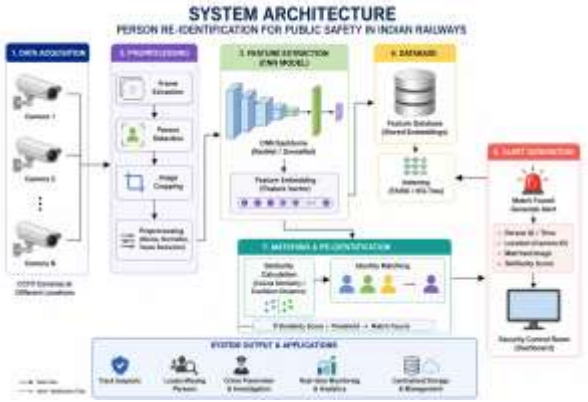
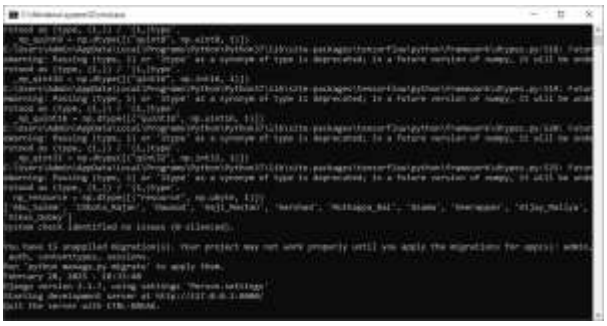
using similarity measures such as cosine similarity or Euclidean distance. If a match is found above a predefined threshold, the system identifies the individual and tracks their movement across different camera feeds.

VI. SYSTEM MODEL

System Architecture



IV. RESULTS AND DISCUSSIONS



In above screen python server started and now open browser and enter URL as http://127.0.0.1:8000/index.html and then press enter key to get below page

In above screen click on 'Railway Admin Login' link to get below page

In above screen admin is login and after login will get below page

In above screen admin can click on 'Load Data' link to load dataset and then will get below page

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In above screen browse and upload 'Dataset' folder with criminal or suspicious person and then click Upload buttons to load dataset and then will get below page

In above screen can number of images loaded from different criminal database and now click on 'Extract CNN Features' link to extract features and then will get below page

In above screen can see number of features extracted from each image and now click on 'Train Models' link to train algorithms on extracted features and then will get below page

In above screen Random Forest and SVM trained on CNN extracted features and then in table format can see both algorithm performance where Random Forest got high accuracy. In above comparison graph x-axis represents algorithm names and y-axis represents accuracy and other metrics in different colour bars and in both algorithms Random Forest got high accuracy. In above screen Admin has trained all algorithms and make ready for employees to monitor videos. Now click on 'Add employee' link to get below page

In above screen admin adding new employee details and press button to get below page

In above screen new employee details added and now click on 'View Alerts' link to view alerts from different monitored videos

In above screen no alerts are available and now logout and login as employee to monitor videos and detect alerts

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In above screen employee user is login and after login will get below page

In above screen click on 'Monitor Railway Video' link to get below page

In above screen selecting and uploading video and then press buttons to get below page. Note model loading will take some time so please wait till video start playing

In above screen in playing Video system detected face matching with database suspicious person called 'OSAMA' and logged this alert to database

In above screen all detected persons will be displayed as 'suspicious or non-suspicious'. You can continue video playing till end or press 'q' key from keyboard to quit playing and can upload another video.

In above screen uploading another video and then press buttons to get below output

In above screen uploaded new video detected as "no Suspicious person" and similarly you can upload and test any other videos.

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Above videos also detected as 'No suspicious' and now logout and login as amdin to view alerts

In above screen admin view list of videos with and without suspicious 'Re-identified' persons.

So by following above screens you can run complete project by detecting suspicious criminals and send alerts to admin

VIII. CONCLUSION

In conclusion, the proposed Person Re-Identification system using deep learning provides an effective and intelligent solution for enhancing public safety in Indian Railways. By leveraging advanced computer vision techniques and Convolutional Neural Networks (CNNs), the system is capable of accurately identifying and tracking individuals across multiple camera views in real time. This significantly reduces the dependency on manual surveillance and improves the efficiency of monitoring large and crowded railway environments.

The integration of automated detection, feature extraction, and identity matching enables faster response to security threats, helps in locating missing persons, and supports law enforcement in criminal investigations. Additionally, the system's scalability and adaptability make it suitable for deployment across extensive railway networks with high passenger density.

Overall, the implementation of this deep learning-based Re-ID system contributes to building a smarter, safer, and more secure surveillance infrastructure. It not only enhances operational efficiency but also ensures a proactive approach to public safety management in Indian Railways.

IX. FUTURE WORK: Future work for this

The proposed Person Re-Identification system provides a strong foundation for intelligent surveillance in Indian Railways; however, several enhancements can be explored in future to further improve its performance, scalability, and real-world applicability. One important direction is the integration of

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advanced deep learning architectures such as Vision Transformers (ViTs) and hybrid CNN-transformer models, which can capture both local and global features more effectively, thereby improving identification accuracy in complex environments.

Another area of improvement is the incorporation of multi-modal biometric data such as facial recognition, gait analysis, and thermal imaging. Combining these modalities with person re-identification can create a more robust and reliable system, especially in cases where visual features like clothing change frequently. Additionally, improving the system's performance under extreme conditions such as heavy crowd density, poor lighting, and occlusions remains a key research challenge.

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