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Person Re-Identification for Public Safety in Indian Railways using deep learning

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Abstract—*Ensuring public safety in large-scale environments like Indian Railways requires robust surveillance mechanisms. Traditional systems relying on handcrafted features suffer from low accuracy due to sensitivity towards variations in lighting, pose, and camera angles. To address this limitation, a deep learning-based approach for person re-identification is proposed. The system employs Convolutional Neural Networks (CNNs) for automatic feature extraction from video feeds, followed by classification using machine learning algorithms such as Random Forest and Support Vector Machines (SVM). The architecture supports dual interfaces for administrators and railway employees, facilitating real-time monitoring and alert generation upon detecting matches with a database of suspicious individuals. Experimental evaluation indicates that Random Forest achieves higher accuracy compared to alternative classifiers, making it suitable for deployment. Comprehensive testing validates system functionality, while challenges related to manual surveillance and data acquisition are acknowledged. Future enhancements include integration with live CCTV feeds and scalability improvements.*

Keywords—*Person Re-Identification; Deep Learning; Public Safety; Indian Railways; Convolutional Neural Networks.*

I. INTRODUCTION

Public safety in densely populated transportation hubs such as Indian Railways demands advanced surveillance technologies. Current systems rely on manually crafted image features which are inadequate for accurate cross-camera person identification. These methods are prone to errors caused by environmental variability and lack automation in threat detection. This work proposes a deep learning-based solution to enhance person re-identification performance through automated feature extraction and intelligent classification.

The objective of this study is to design a surveillance framework that improves public safety by efficiently identifying and tracking suspicious individuals across multiple cameras within railway premises. By leveraging modern machine learning tools and architectures, the system aims to reduce reliance on manual oversight and increase response efficiency during security incidents.

II. LITERATURE SURVEY

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Several studies have explored person re-identification using both traditional and deep learning methodologies. Zheng et al. [1] introduced scalable benchmarks for evaluating re-ID systems under varying conditions. Sun et al. [2] proposed refined part pooling strategies combined with convolutional baselines to improve retrieval accuracy. Hermans et al. [3] defended the use of triplet loss functions in training deep models for better discrimination between similar identities.

Zhao et al. [4] developed SpindleNet, incorporating human body region guidance into feature decomposition processes. Szegedy et al. [5] emphasized architectural innovations in CNNs for enhanced visual recognition tasks. Dalal and Triggs [6] pioneered histogram-based gradient descriptors for pedestrian detection, laying groundwork for early re-ID approaches.

Liu et al. [7] applied deep relative distance learning to distinguish visually similar objects, offering insights applicable to fine-grained person matching. Pedregosa et al. [8] provided scikit-learn, a widely used toolkit supporting various ML implementations including those relevant to this domain. Krizhevsky et al. [9] demonstrated the power of CNNs via ImageNet classification, influencing many subsequent vision applications. Redmon and Farhadi [10] contributed YOLOv3, an efficient object detector adaptable for real-time video analysis scenarios.

III. EXISTING SYSTEM AND PROPOSED SYSTEM

A. Existing System

Current surveillance practices in Indian Railways utilize handcrafted image features for person identification across distributed camera networks. These techniques involve extracting basic visual characteristics such as color histograms or edge patterns. However, they exhibit poor generalization ability when faced with dynamic environmental factors like illumination shifts, occlusions, and viewpoint differences, resulting in unreliable identification outcomes.

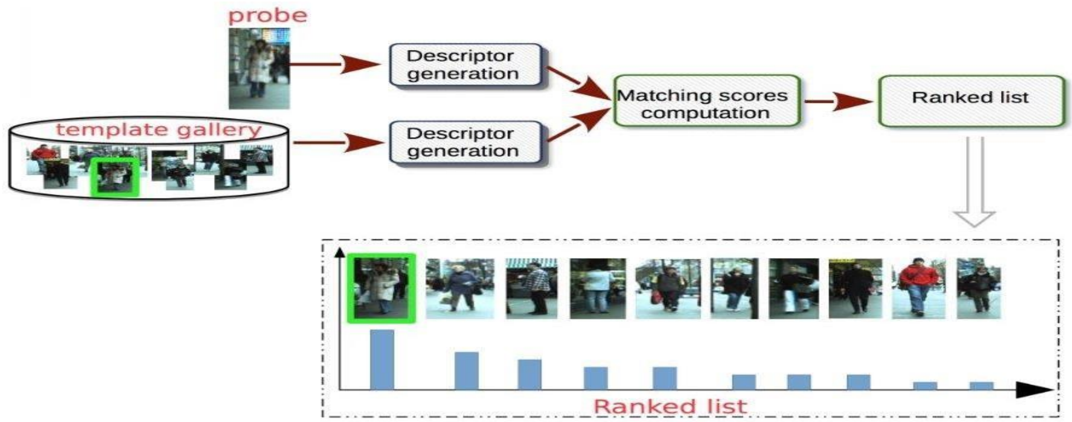
B. Proposed System

This research introduces a novel approach based on deep learning to overcome limitations inherent in conventional systems. It integrates Convolutional Neural Networks (CNNs) for robust feature representation alongside classical machine learning classifiers such as Random Forest and Support Vector Machines (SVM). Additionally, components like MTCNN and Facenet assist in preprocessing stages involving face detection and embedding normalization respectively.

IV. SYSTEM DESIGN AND ARCHITECTURE

The overall system architecture comprises two distinct user roles: administrators and railway employees. Administrators handle critical backend operations including uploading datasets, executing feature extraction routines, and conducting model training sessions. Employees access front-end functionalities enabling live video feed observation and instant alert notifications whenever potential matches occur against stored suspect profiles.

At its core, the system utilizes a Python-driven web server interfaced with a MySQL database for persistent data storage and retrieval. Key modules encompass preprocessing pipelines, CNN-based encoders, classifier engines, and alert logging subsystems designed for seamless interaction and operational continuity.



V. SYSTEM IMPLEMENTATION

Implementation was carried out using Python 3.7.2 along with libraries such as TensorFlow, Keras, OpenCV, NumPy, and scikit-learn. Feature extraction involved applying MTCNN for facial localization followed by Facenet embeddings normalized through dedicated processing layers. Classification phase incorporated comparative assessments among Random Forest and SVM models before final selection.

Database management relied on MySQL for organizing metadata associated with enrolled subjects and recorded events. Administrative controls were implemented via secure login portals allowing authorized personnel to perform administrative duties effectively. Employee dashboards facilitated continuous monitoring capabilities integrated directly with backend analytics engine outputs.

VI. RESULTS AND DISCUSSION

Performance evaluations revealed that Random Forest consistently outperformed other evaluated classifiers in terms of accuracy metrics. As a result, it was chosen as the primary algorithm for deployment within the production environment. Various forms of testing including unit, integration, functional, system, white box, and black box procedures ensured comprehensive validation coverage spanning key application modules.

Test cases specifically targeted essential UI elements such as login forms, registration pages, and password modification workflows. All conducted tests confirmed adherence to specified requirements and acceptable usability standards without encountering significant failures.

VII. CHALLENGES AND LIMITATIONS

Multiple obstacles were encountered throughout development lifecycle phases. Notably, achieving consistent identification accuracy remained challenging due to complexities arising from unconstrained imaging conditions typical in railway settings. Manual intervention still plays a role despite automation efforts indicating room for further refinement.

- Low Accuracy in Person Identification
- Manual Surveillance Requirements
- Absence of Automated Alert Mechanisms
- Difficulties in Data Acquisition
- Resource Constraints During Development
- Complexity in Interpreting Model Outputs
- Susceptibility to High Error Rates Under Adverse Conditions

VIII. CONCLUSION AND FUTURE SCOPE

This project successfully demonstrates how integrating deep learning techniques can significantly advance person re-identification capabilities beyond what traditional methods offer. Through empirical comparisons, Random Forest emerged as the optimal choice for classification purposes, thereby validating the efficacy of the proposed methodology.

Looking ahead, several avenues exist for extending current functionalities. Planned enhancements include direct interfacing with live CCTV infrastructure, expanding dataset diversity to cover broader demographic ranges, exploring multimodal biometric inputs, optimizing for edge computing deployments, addressing privacy concerns proactively, and refining graphical user experiences for improved operator engagement.

Representative figures from the system are listed below:

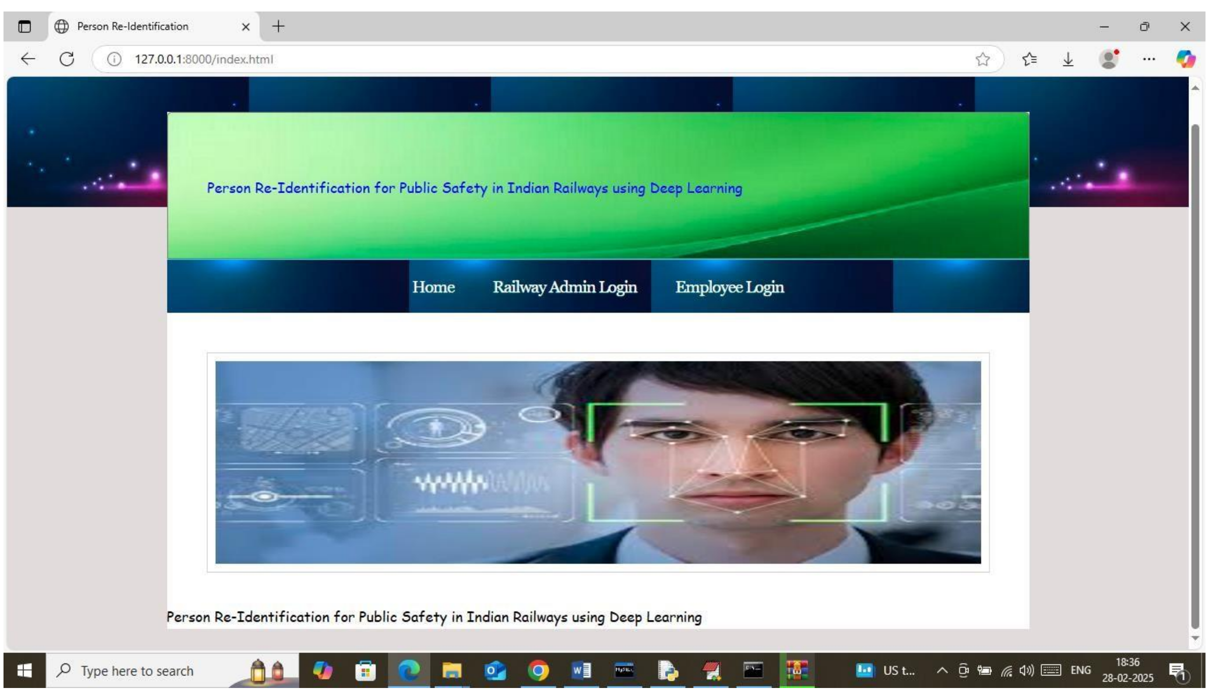


Fig. 1. Admin Login

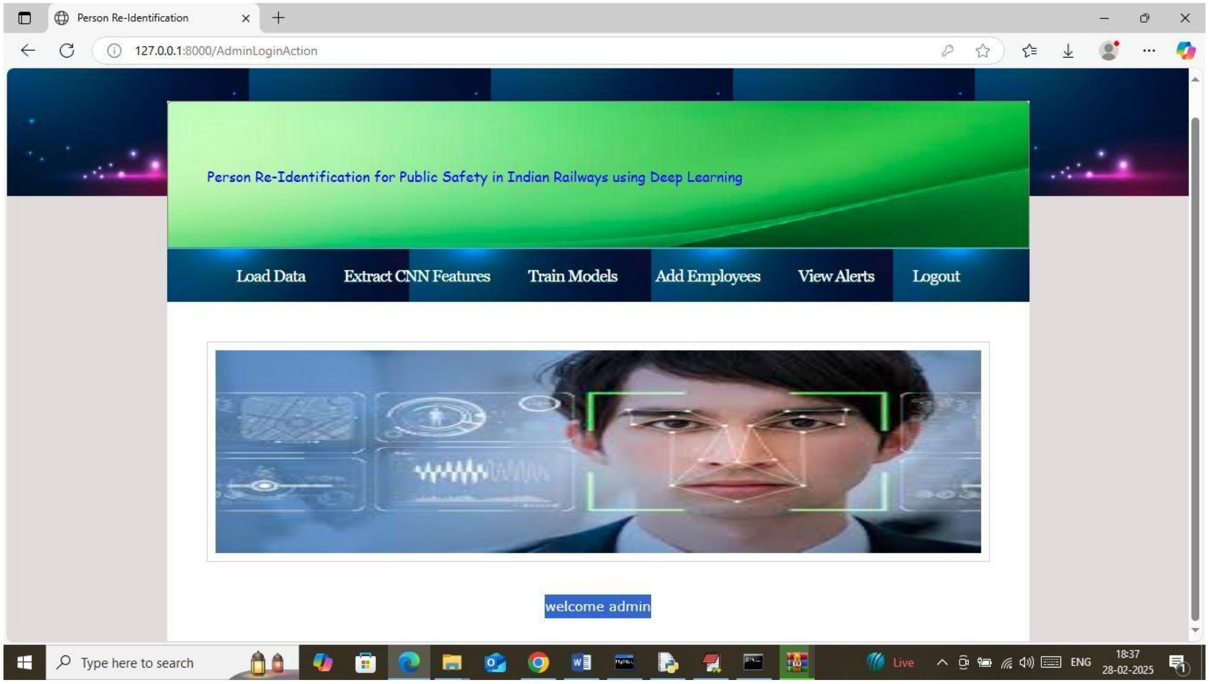


Fig. 2. Admin Dash Board

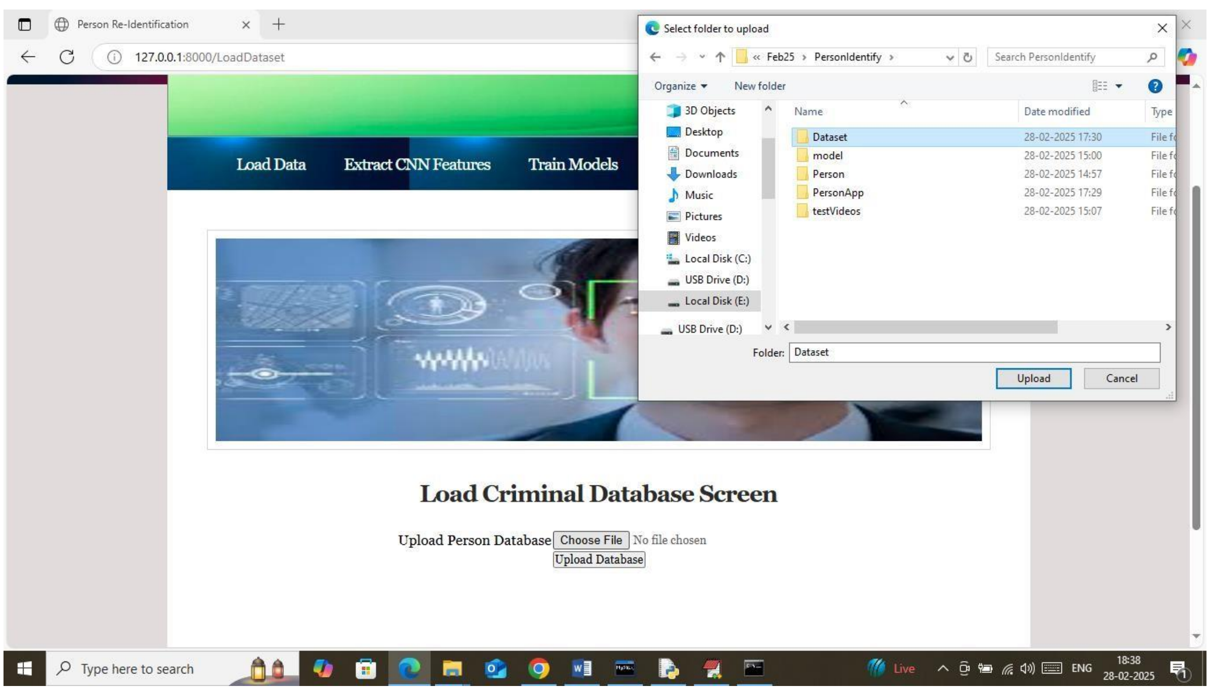


Fig. 3. Training Machine Learning

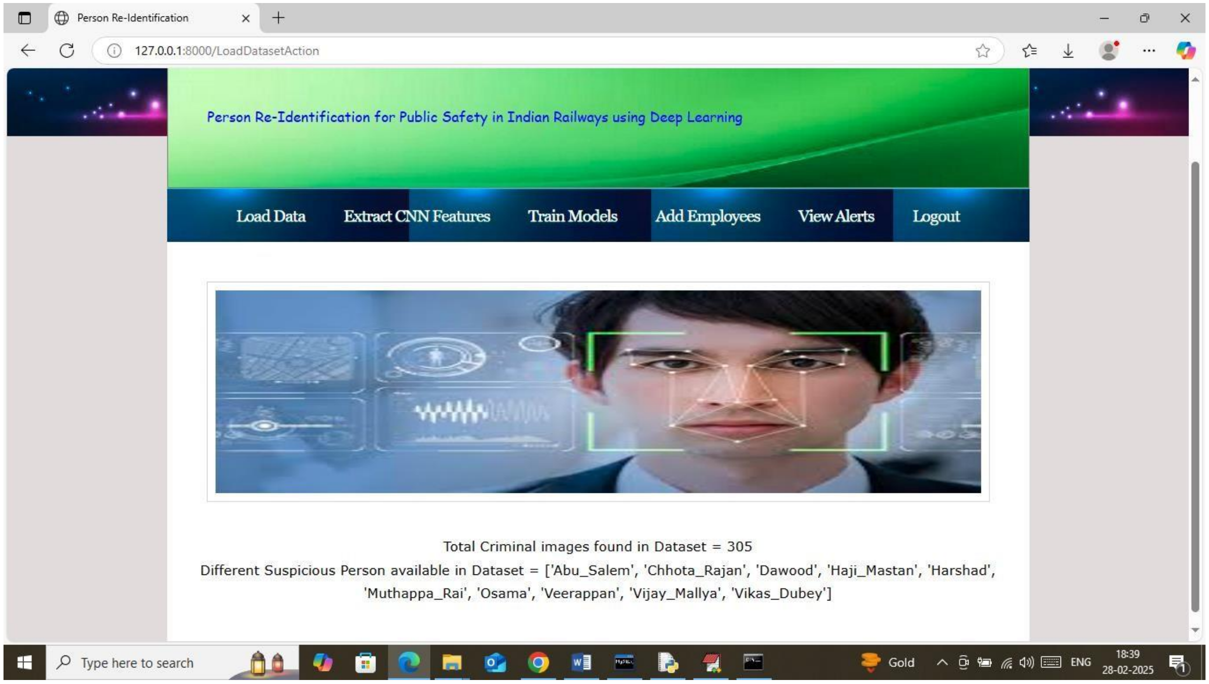


Fig. 4. Extract Features of Images

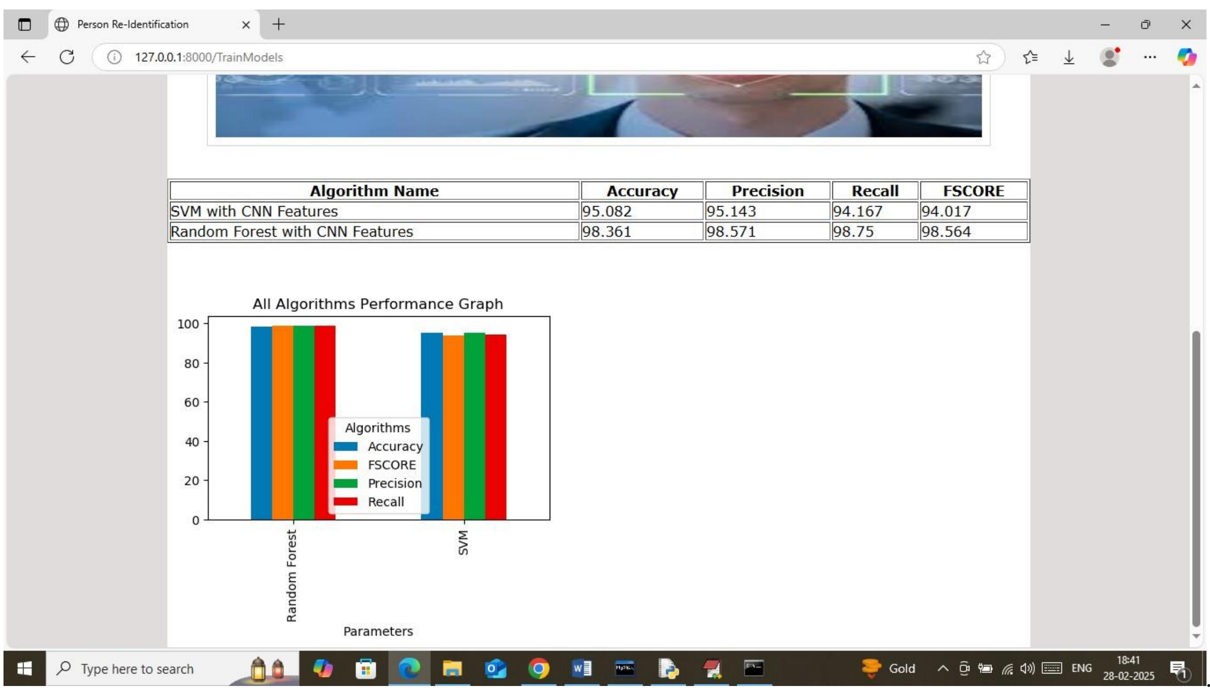


Fig. 6. Comparison graph demonstrating superior accuracy achieved by Random Forest classifier.

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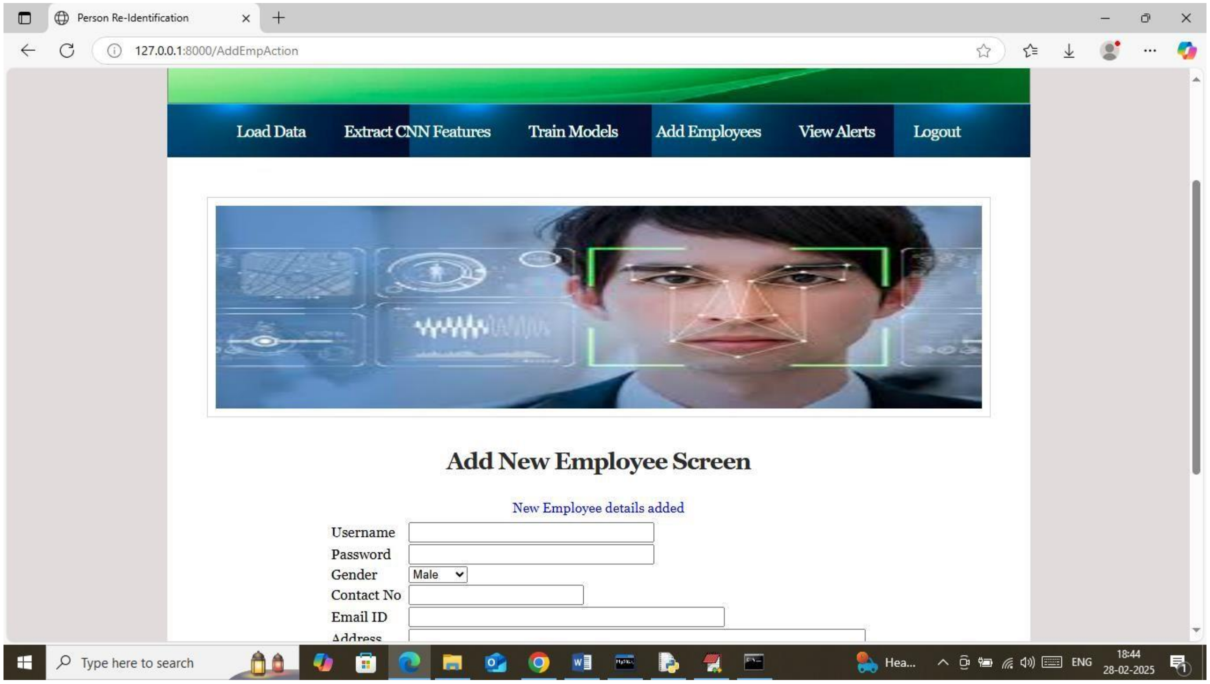

Fig. 5. Adding New Employee

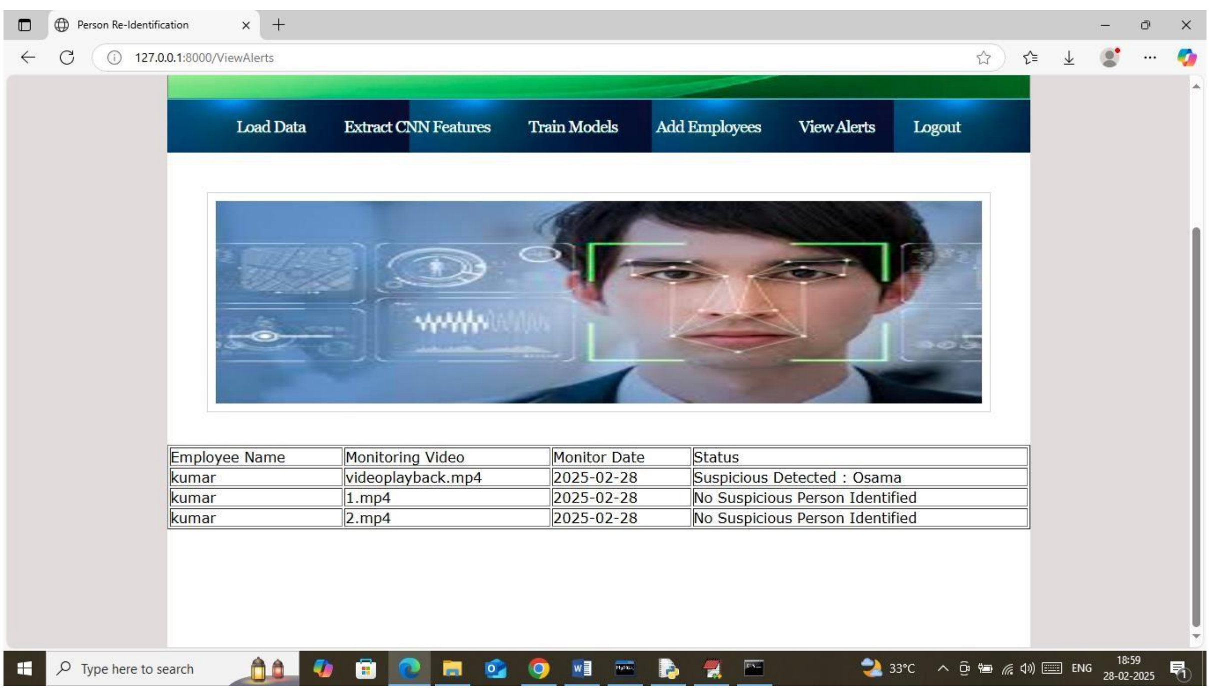

Fig. 6. Alerts check

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