AI Based Criminal Identification System

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***Abstract*— Criminal identification remains a crucial aspect of law enforcement, but existing face recognition techniques often struggle with accuracy due to variations in facial features, lighting conditions, and occlusions. Traditional approaches, such as Haar Cascade and Histogram of Oriented Gradients with K-Nearest Neighbors, exhibit limitations in precision and robustness. This paper proposes an enhanced AI-driven system that integrates HOG and Convolutional Neural Networks (CNNs) for feature extraction, combined with a hybrid KNN-Support Vector Machine (SVM) classification model. Additionally, Multi-task Cascaded Convolutional Neural Networks (MTCNNs) are used for facial alignment. The proposed system significantly out performs conventional approaches in terms of Classification Models, making it highly effective for law enforcement applications**

***Index Terms*— Face Recognition, Criminal Identification, HOG, CNNs, KNN, SVM, Biometric Security.**

I. INTRODUCTION

Face recognition technology is widely used in law enforcement for criminal identification, surveillance, and biometric security. It provides a contactless and automated method for identification, making it ideal for security applications. However, existing techniques struggle with pose variations, lighting inconsistencies, and occlusions, reducing accuracy. Traditional methods like Haar Cascade and HOG with KNN face limitations in handling complex facial variations and become computationally expensive with large datasets.

To address these issues, this research proposes an AI-driven facial recognition system integrating hybrid feature extraction and classification. HOG extracts structural features, while CNNs provide deep feature representation for improved accuracy. A hybrid KNN-SVM model enhances classification by combining similarity-based matching with refined decision boundaries. Additionally, MTCNN ensures precise face alignment, enables lightweight, real-time processing. This approach enhances accuracy, precision, and scalability, making it is a reliable solution for law enforcement applications.

II. LITERATURE REVIEW

Face detection and recognition have significantly evolved with Deep Learning models such as CNNs and transformer architectures.[1]. While these models enhance accuracy and robustness, they still face challenges like lighting variations, occlusion, and pose differences.[2]. Studies suggest solutions such as hybrid deep learning models and transfer learning techniques, evaluating performance metrics like accuracy, speed, and computational efficiency.[3]. Traditional face detection methods like Viola-Jones, though computationally efficient, are being out performed by deep learning-based approaches such as YOLO, SSD, and MTCNN.[4]. Additionally, Generative Adversarial Networks (GANs) are being explored for data augmentation and model generalization, improving recognition accuracy and adaptability.[5].

The integration of AI and IoT in real-time face recognition is gaining attention, especially for surveillance and access control applications.[6]. Adaptive learning techniques enable continuous model updates, enhancing recognition performance over time. However, security concerns, such as adversarial attacks, have led to research on blockchain-based identity verification for enhanced security.[7]. Hybrid approaches combining Viola-Jones with deep learning techniques have also been proposed to improve detection accuracy in challenging conditions like low light and partial occlusions.[3]. Furthermore, feature extraction methods such as Local Binary Patterns, Histogram of Oriented Gradients, and DL based embeddings are being compared, with Explainable AI (XAI) improving model transparency.[5]. Ongoing research continues to refine these methodologies, balancing accuracy, computational efficiency, and security in real-world applications.

III. METHODOLOGY

Facial recognition has improved by integrating traditional feature extraction with deep learning. Combining (HOG) with (CNNs) enhances feature extraction, while a hybrid (KNN) and (SVM) classifier improves accuracy and efficiency. HOG captures edge-based facial features but lacks depth in recognizing texture variations. CNNs complement this by learning deep facial representations, ensuring better accuracy by leveraging both handcrafted and learned features.

For classification, KNN efficiently finds similar matches but struggles with large datasets. SVM refines the classification by establishing precise decision boundaries, reducing misclassification. The system follows a sequential approach: HOG detects faces, features are extracted using both HOG and CNN, and classification is performed using KNN and SVM for enhanced precision. This hybrid model improves recognition across varying conditions, making it ideal for biometric security and criminal identification. Future advancements may include optimizing CNN architectures, self-supervised learning, and Vision Transformers (ViTs).

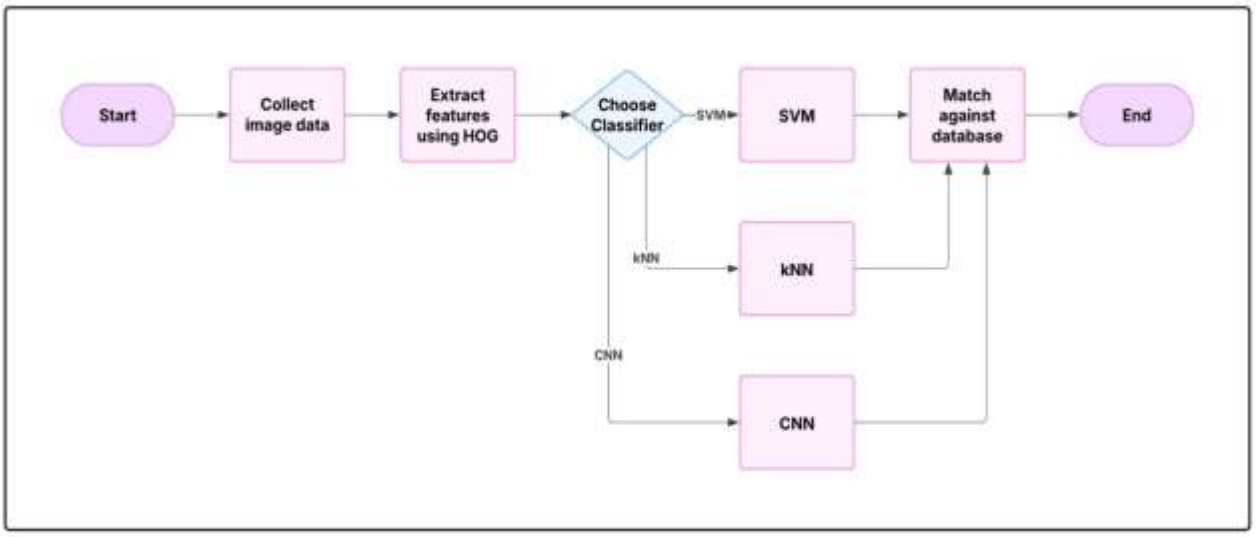

Fig1. Flow Chart of Criminal Identification System.

IV. SYSTEM ANALYSIS:

The system architecture for the AI-driven criminal identification system begins with image acquisition. MTCNN is used for face detection and alignment to ensure accurate facial feature extraction. Features are then extracted using a combination of HOG and CNNs, capturing both basic and advanced facial traits. The extracted features are classified using a hybrid KNN-SVM model, which identifies the individual or verifies their identity. Finally, the system compares the features against a stored database for verification. The result is displayed in the user interface, providing identity confirmation or rejection.

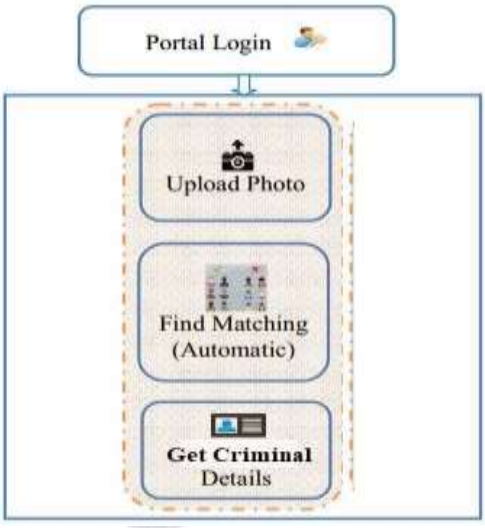

Fig2. System architecture

V. IMPLEMENTATION

In this system, a police officer can carry out two key functions. First, they log in to check if an individual has a criminal record. By uploading a person's photo, the system employs a smart technique called Histogram of Oriented Gradients (HOG) to detect and isolate the face in the image. Then, the K-Nearest Neighbors (KNN) algorithm is used to compare the detected face against a database of known criminals.

If a match is found, the system confirms the person as a criminal. If the face is not recognized, the officer has the option to add the individual's details to the database. Additionally, officers can review a log of all users who have conducted searches within the system.

Similarly, general users also play a role in this system. They can verify a criminal's details by uploading a photo for identification. This dual-access functionality ensures that both police officers and users can efficiently perform criminal record checks.

VI. TEST CASES

SN0	TESTCASE	INPUT	EXPECTED Output	RESULT	PASS/FAIL
1	Register	Details to be entered	Registered Successful		PASS
2	Input Image For Criminal Identification		Match Found	Match Found	PASS
3	Input Image For Criminal Identification		Match Found	Match Found	PASS

VII. RESULTS

Fig3. Add Criminal data

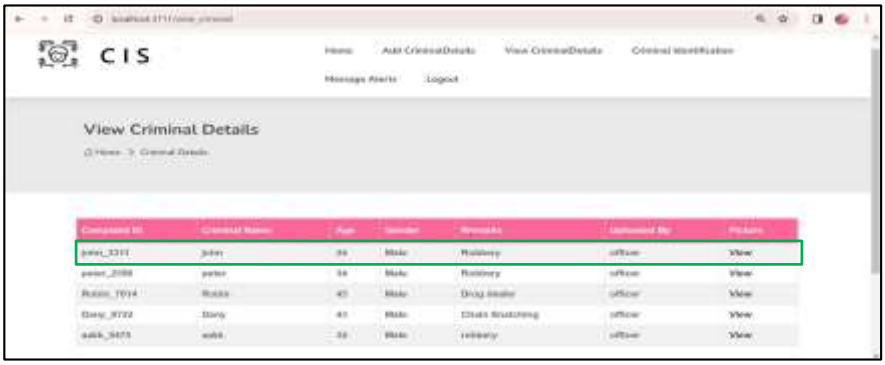

Fig4. View Criminal Data

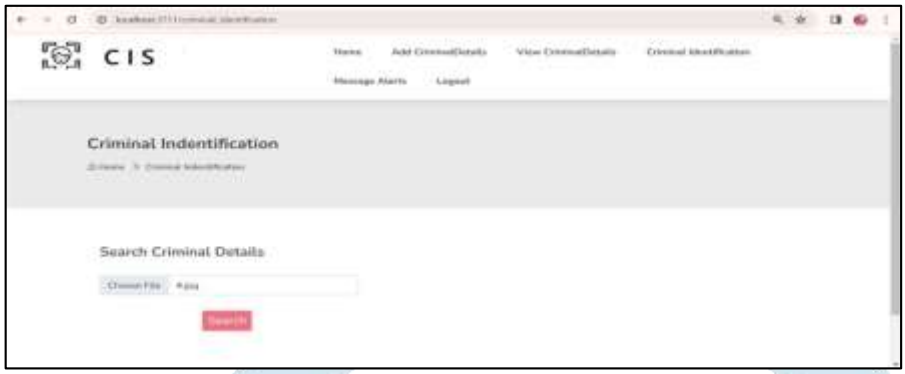

Fig5. Image Upload

Fig6. Image Matched

VIII. CONCLUSION

This AI-driven facial recognition system enhances accuracy, efficiency, and adaptability by integrating hybrid feature extraction and classification techniques. The combination of HOG and CNN ensures a comprehensive representation of facial features, while the hybrid KNN-SVM model improves classification accuracy. MTCNN enhances face detection and alignment. This system provides a robust and scalable solution for law enforcement and biometric security applications, addressing challenges such as pose variations, lighting inconsistencies, and occlusions. Future work can explore the integration of Vision Transformers (ViTs) and self-supervised learning for further improvements in recognition performance

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