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Revolutionizing Criminal Identification : A Deep Learning-Based Application For Forensic Face Sketching And Matching

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Abstract: *The rapid growth of digital forensics and surveillance systems demands intelligent and automated criminal identification techniques. This paper presents an enhanced deep learning-based forensic system for face sketch generation and matching to improve suspect identification accuracy and efficiency. The proposed platform integrates Generative Adversarial Networks (GANs) for generating realistic facial sketches from descriptive inputs and Convolutional Neural Networks (CNNs) for extracting facial features and performing identity matching. The system analyzes facial data using deep learning techniques to provide accurate similarity results and improve forensic decision-making. The platform aims to reduce identification time, enhance accuracy, and support law enforcement agencies in a secure and efficient manner within a web-based environment.*

Keywords: *digital forensics*.

I. INTRODUCTION

The The rapid growth of digital technologies and surveillance systems has significantly transformed the field of forensic science and criminal identification. With increasing crime rates and the need for faster investigations, law enforcement agencies heavily rely on facial recognition and forensic sketching techniques to identify suspects. However, traditional methods of forensic sketching depend on eyewitness memory and manual drawing by forensic artists, which are often time-consuming, subjective, and prone to human error.

In addition, existing facial recognition systems face challenges in handling low-quality images, sketch-photo mismatches, and variations in lighting, pose, and expression. The absence of an integrated system that combines sketch generation and automatic facial matching limits the efficiency of criminal identification processes. Traditional approaches also require significant manual intervention, making them less suitable for real-time investigation scenarios.

To address these challenges, this paper proposes a deep learning-based forensic system for face sketch generation and matching. The proposed system integrates Generative Adversarial Networks (GANs) for converting facial descriptions into realistic sketches and Convolutional Neural Networks (CNNs) for extracting facial features and performing identity matching against criminal databases. The system analyzes facial data to generate accurate sketches and provides similarity-based matching results in real time.

The main contribution of this work includes the integration of deep learning-based sketch generation and facial recognition into a unified forensic platform, improved identification accuracy through automated feature extraction, and enhanced system efficiency and reliability.

II. LITERATURE REVIEW

Several traditional forensic identification systems such as FACES, IdentiKit, and composite sketch software are widely used by law enforcement agencies for suspect identification. However, these systems mainly depend on manual feature

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selection and eyewitness descriptions, which makes them time-consuming and less reliable in real-world forensic investigations. Existing facial recognition systems are also used in surveillance and
security applications, but they often face challenges such as variations in lighting, pose, expression, and low-quality images, which reduce their accuracy in practical scenarios.

III. METHODOLOGY

The proposed system follows a structured deep learning–based methodology for forensic face sketching and matching to improve criminal identification accuracy and speed. Initially, facial data is collected from publicly available face image datasets and forensic sketch datasets, which include both real photographs and corresponding sketch images.

In the preprocessing stage, the collected images are resized, normalized, and enhanced to improve quality and consistency. Face alignment techniques are applied to ensure that facial features such as eyes, nose, and mouth are properly positioned. Data augmentation methods like rotation, flipping, and scaling are used to increase dataset diversity and improve model robustness.

In the next stage, a deep learning model is developed for sketch generation and face feature extraction. Convolutional Neural Networks (CNN) are used to extract important facial features from images, while Generative Adversarial Networks (GANs) are used to convert facial photographs into realistic forensic-style sketches. The model learns the relationship between sketches and real face images for better representation.

After feature extraction, a matching algorithm is applied to compare the generated or input sketch with stored facial images in the database. Similarity measures such as cosine similarity or Euclidean distance are used to identify the closest match.

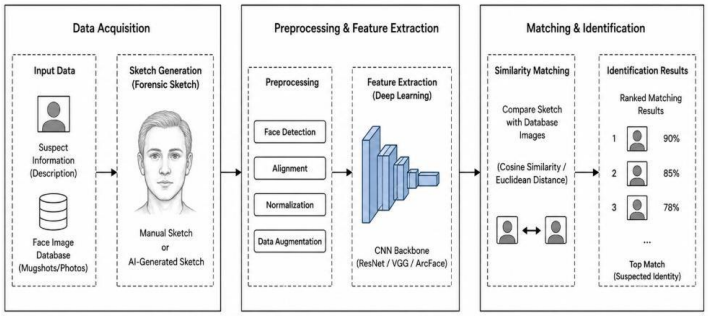

Fig. 1. Proposed Methodology of Deep Learning-Based Application for Forensic Face Sketching and Matching.

IV. SYSTEM DESIGN

The The proposed system, "Revolutionizing Criminal Identification: A Deep Learning-Based Application for Forensic Face Sketching and Matching," is designed as an intelligent, scalable, and secure AI-based platform that assists in criminal identification using witness descriptions and automated face sketch generation. The system integrates deep learning models, image processing techniques, and face recognition algorithms within a unified forensic framework to improve accuracy and speed in suspect identification.

The system architecture follows a modular design approach and consists of several interconnected components, including the user interface module, input processing module, sketch generation module, face recognition and matching engine, dataset management module, and security and access control module.

The user interface module provides a user-friendly web-based interface for law enforcement officers and forensic analysts to input witness descriptions, upload reference images, and view generated sketches and matching results. The input processing module captures textual descriptions of facial features such as eyes, nose, hair, facial structure, and other identifying attributes, and converts them into structured feature representations for further processing.

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The sketch generation module is the core component of the system. It utilizes deep learning techniques such as generative adversarial networks (GANs) or diffusion-based models to generate realistic facial sketches from textual or feature-based inputs.

It uses deep feature extraction models such as convolutional neural networks (CNNs) to extract facial embeddings and performs similarity matching to identify potential suspects with high accuracy.

The dataset management module is responsible for maintaining structured forensic datasets, including mugshots, previous criminal records, and training datasets used for model improvement. It ensures efficient data retrieval and supports continuous model training for improved performance.

The security and access control module ensures that sensitive criminal data is protected using encryption techniques, role-based access control, and secure authentication mechanisms. This prevents unauthorized access and maintains data confidentiality within the forensic system.

Overall, the system design ensures high accuracy, fast processing, and secure handling of forensic data. The integration of deep learning-based sketch generation with facial recognition technology makes the proposed system an efficient and intelligent solution for modern criminal identification challenges.

The proposed architecture follows a layered and modular approach to ensure efficient processing, secure data handling, and accurate facial matching. Initially, the system collects witness descriptions or partial facial inputs through the interface module. These inputs are then processed by the feature extraction layer, which converts textual or structured facial attributes into numerical representations.

Next, the deep learning-based sketch generation model transforms these features into realistic facial sketches. The generated sketch is then passed to the recognition module, where it is compared against the criminal database using feature embedding and similarity scoring techniques.

The database layer stores facial images, extracted embeddings, and criminal records in an optimized structure for fast retrieval.

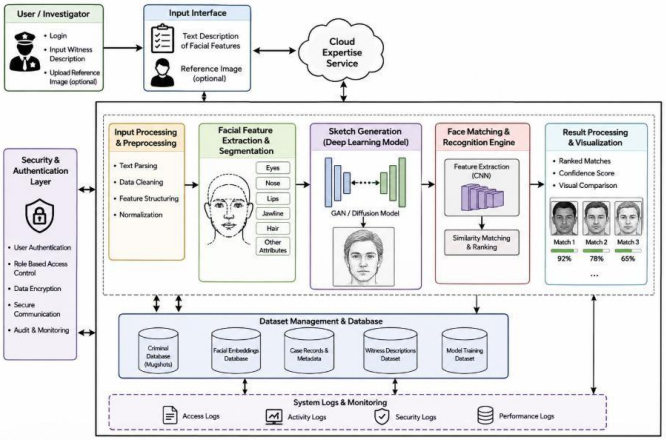

Fig. 2. System Architecture for "Revolutionizing Criminal Identification: A Deep Learning-Based Application for Forensic Face Sketching and Matching"

V. CONCLUSION

The The proposed system, "Revolutionizing Criminal Identification: A Deep Learning-Based Application for Forensic Face Sketching and Matching," presents an intelligent and automated approach to modern forensic identification by integrating deep learning techniques with facial sketch generation and matching mechanisms. The system utilizes data collection, preprocessing, and advanced neural network models such as Convolutional Neural Networks (CNNs) and Generative Adversarial Networks (GANs) to convert facial descriptions into realistic sketches and match them with existing criminal databases. This significantly improves the accuracy and speed of suspect identification in forensic investigations.

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In addition, the integration of a secure and efficient architecture ensures reliable handling of sensitive biometric data while maintaining privacy and system integrity. The combination of AI-driven sketch synthesis and facial recognition enhances investigative efficiency by providing law enforcement agencies with fast, data-driven identification support. Overall, the system improves reliability, accuracy, and transparency in criminal identification and provides a strong foundation for modern forensic applications.

Furthermore, the proposed application enhances the overall effectiveness of forensic investigations by combining deep learning-based face reconstruction, real-time image matching, and intelligent search capabilities within a unified platform. The use of biometric analysis and pattern recognition improves matching precision between generated sketches and stored facial datasets, reducing manual dependency and human error.

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