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Deep Learning-Based Automated Face Sketch Creation and Recognition

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Abstract:- Traditional manually drawn forensic sketches often struggle with speed, precision and accuracy used in modern criminal Recognition. To improve these processes, we introduce a research study on an independent application that simplifies the creation and identification of complex sketches. This application replaces the need for forensic sketch artists by offering an easy-to-use drag-and-drop sketch creation interface. The sketches are matched with the criminal database using deep learning for rapid identification of suspects. Our research uses a dual approach. First, a Deep CNN (Deep Convolutional Neural Network) converts sketches into photorealistic images. Second, the face-recognition Python library compares these sketches to police databases, leveraging deep learning models such as ResNet for accurate facial feature matching in real-time. At the core of our method are convolutional neural networks, known for their ability to analyze complex data and extract features. Our framework achieves an average accuracy rate of 0.98, greatly improving the effectiveness of investigations. This approach outperforms existing methods, marking a significant advancement in face sketch identification.

Keywords:- *Deep Learning, Convolutional Neural Networks, Forensic Science, Face Sketch, Criminal Justice Technology, Face-Recognition Library.*

I. INTRODUCTION

Eyewitness testimonies are vital in criminal investigations, especially for identifying suspects. Traditionally, forensic artists manually created facial sketches based on these testimonies, but this process is often time-consuming and error-prone due to human limitations. To overcome these issues, automated systems for forensic face sketch construction and recognition have emerged that use deep learning to match face sketches with criminal databases. This paper presents an innovative approach that integrates a drag-and-drop interface for constructing facial sketches from a library of elements, which are then refined into realistic images using a Deep Convolutional Neural Network (Deep CNN). The face recognition component, using the dlib library, extracts key facial features and compares them with a MongoDB-based criminal database. The system is divided into two main phases: Face Sketch Construction and Face Sketch Recognition. Users can create composite sketches by selecting facial features, which are then compared with a database for suspect identification. Our experiments demonstrate an average accuracy rate of 98%.

In the subsequent sections, we detail the technical aspects, including deep learning models, face recognition algorithms, and database integration, along with the system's performance analysis.

II. LITERATURE REVIEW

Advances in computer vision and deep learning have revolutionized automated facial sketch creation and recognition, making substantial impacts in forensic investigations. Previously, the creation of forensic sketches relied solely on the artistic skill of sketch artists and eyewitness input. However, with the advent of neural networks and advanced deep learning models, it is now possible to automate the generation of facial sketches with significant accuracy, even when working with minimal or noisy data. This transition has paved the way for computational systems capable of comparing these sketches with large-scale image databases, extending their use in criminal investigations.

From 2020 onwards, research has honed in on developing high-quality sketch generation techniques that address issues like limited data availability and realistic rendering. Innovations in feature extraction have aligned sketch-based recognition closer to traditional photo-based approaches, while GANs (Generative Adversarial Networks) have been explored for turning sketches into highly recognizable, photo-like images. This use of GANs enhances sketch realism and recognition potential, improving the practical value of these tools in real-world settings. Furthermore, hybrid models that incorporate transfer learning and neural architecture search have allowed these systems to adapt efficiently to new data, making them more flexible in different environments.

Another crucial aspect under examination is the ethical responsibility of using automated facial sketching in law enforcement, especially concerning privacy and representation biases. Cloud integration has also facilitated the scalability of these systems, enabling quicker processing times and practical application in fieldwork. Ultimately, the aim within this field is to develop fully automated, precise, and reliable solutions that can support law enforcement in

their investigations, moving closer to seamless, tech-assisted forensic methods.

III. METHODOLOGY

To develop criminal sketches and compare them to a criminal database, the Deep learning based automated face sketch creation and recognition system combines multiple phases. Face Sketch Creation and Face Sketch Recognition are the two primary stages that make up the project workflow, which is followed by this approach. The system makes use of a Java-based application that is API-connected to the backend. The criminal record is stored in a MongoDB database, and face recognition is handled by the backend.

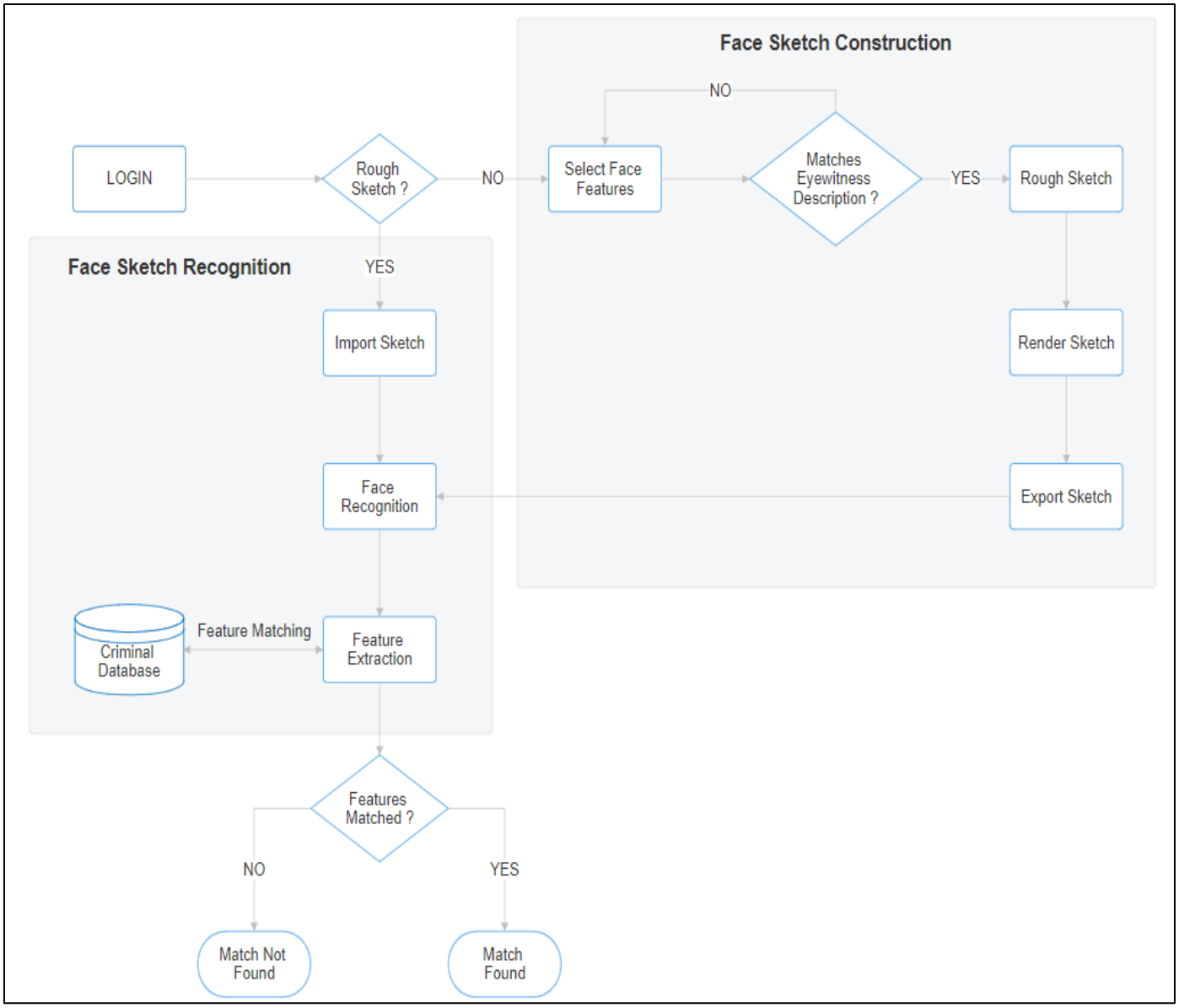

Fig 1: Workflow Diagram of Face Sketch Construction and Recognition

A. *Login Process.*

The process starts with the user logging into the system. This login functionality allows only authorized personnel, such as forensic artists or law enforcement officials, to access the face sketch construction and recognition interface.

B. *Face Sketch Construction*

Once logged in, the user enters the face sketch construction process. This phase involves creating a composite face sketch based on eyewitness descriptions.

- Face Features Selection: Users begin by selecting different facial elements (e.g., eyes, nose, mouth, hairstyle) from a predefined dataset. The drag-and-drop interface enables the user to combine these features to create a rough face sketch.
- Matching Eyewitness Description: After selecting the face elements, the user checks whether the created composite sketch matches the description provided by the eyewitness. If the sketch does not meet the eyewitness's description, further adjustments are made by changing the face features or their arrangement.

- Rough Sketch Rendering: Once the face elements sufficiently resemble the described face, the system generates a rough sketch. The application renders the sketch based on the selected elements.
- Export Sketch: After the rendering process, the sketch is exported and saved for later use, either in the recognition phase or as a standalone file in the system.

C. Face Sketch Recognition.

After creating the sketch, it moves to the recognition phase. The goal is to match the composite sketch against an existing criminal database to identify potential suspects.

- Sketch Importation: The recognition process starts by either importing a previously made sketch or the sketch can be created using the integrated sketch construction tool.
- Face Recognition: The imported sketch undergoes processing in a deep learning-based facial recognition system. The Python-based face recognition model is connected to the Java application using a specific API. A Convolutional Neural Network (CNN) is utilized to extract facial features, transforming the sketch into a more realistic image for improved accuracy.
- Feature Identification: The face recognition algorithm recognises important elements of the face such as the separations between landmarks and the sizes and forms of different features. Processing of this data allows for easier comparisons with current records.
- Matching with Criminal Database: The retrieved facial traits are compared with a MongoDB-stored criminal record database. This database enables for efficient feature-based matching since it comprises photos and facial data of well-known people.

D. Backend System Integration.

The API connects the Java-based front-end application to the backend, which integrates a Python-based face recognition system and a MongoDB database. The API allows smooth communication between the sketch construction/recognition interface and the data stored in the backend.

MongoDB holds the criminal data, including the images and features extracted from individuals, while the recognition system utilizes machine learning to detect and compare the features between sketches and criminal images. This seamless interaction between the API, backend, and front-end application ensures that the recognition process is efficient and accurate.

IV. IMPLEMENTATION

The implementation of this forensic face recognition system integrates advanced machine learning libraries, secure data handling, and an intuitive interface for law enforcement use. This section details the practical setup, tools, and components that bring the system design to life.

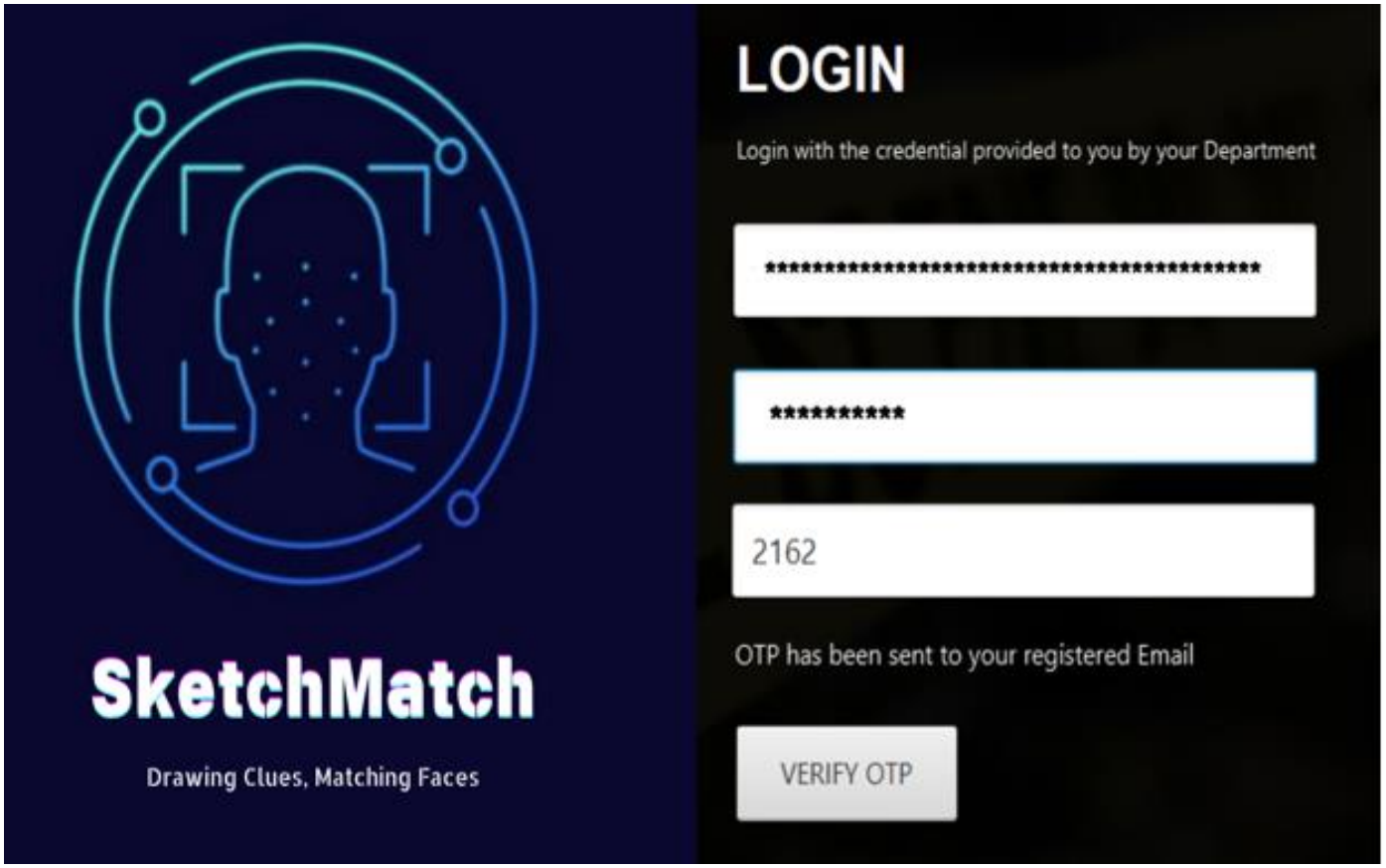

Fig 2: Login Page UI

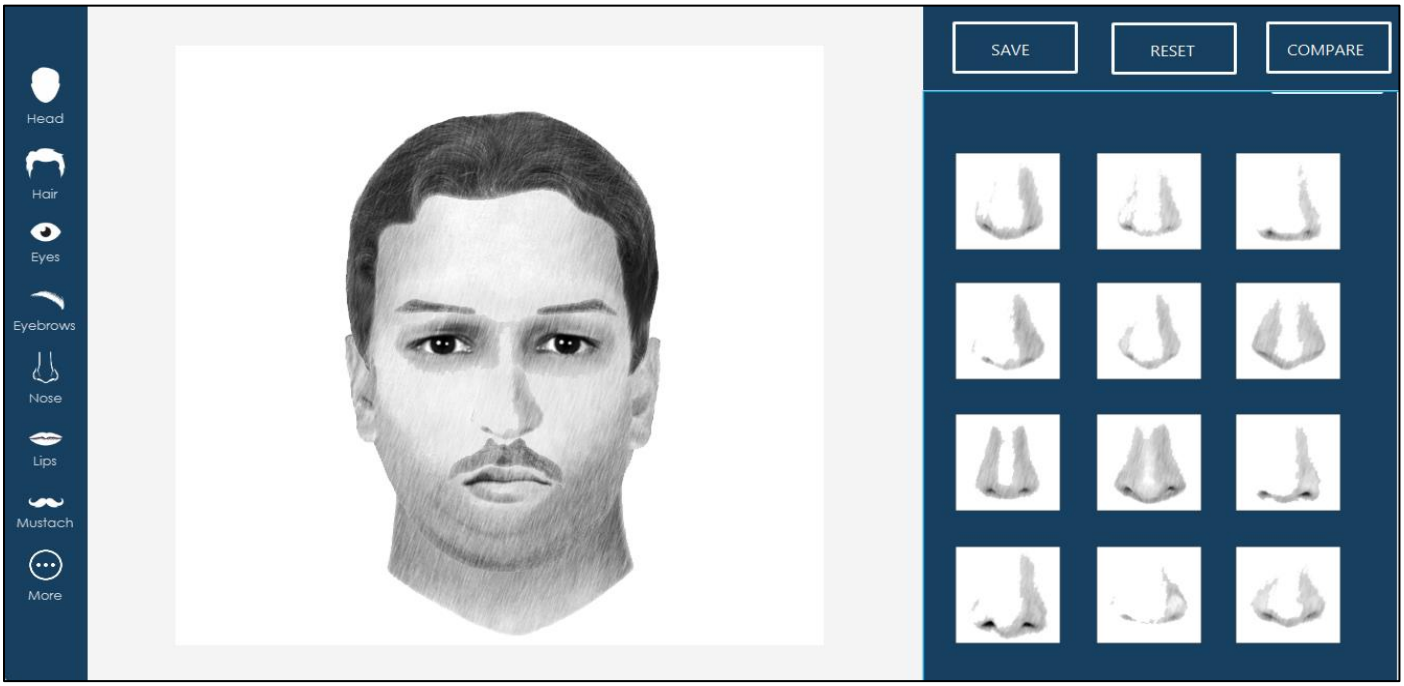

Fig 3: Face Sketch Creation

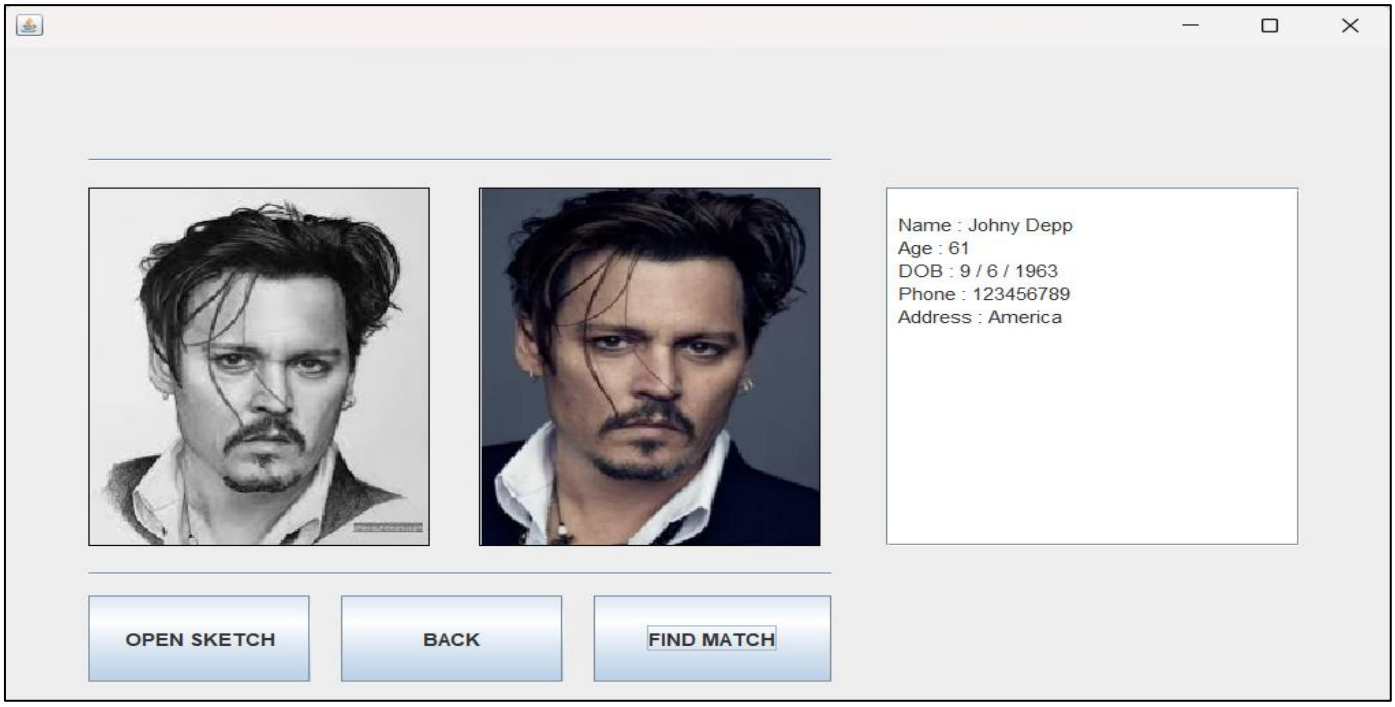

Fig 4: Face Sketch Recognition

V. RESULTS AND DISCUSSION

A. Accuracy and Efficiency.

The system demonstrates a high level of accuracy in recognizing individuals from composite sketches, achieving an average accuracy rate of 98%. By using deep learning techniques, specifically through the face_recognition library, which leverages deep convolutional neural networks (CNNs) for feature extraction, the system significantly improves on the traditionally lower accuracy rates seen in manual sketch recognition. This advancement allows law enforcement agencies to quickly and reliably identify suspects, enhancing the overall effectiveness of criminal investigations.

B. Usability and Compatibility with Previous Versions

An important feature of the system is its simple to use UI. The dragging and dropping capability enables forensic artists and officers to easily create composite sketches based on eyewitness descriptions. During trials, this approach was found to speed up the drawing generation process without having concentrated technique. The system also ensures interoperability with existing methods, enabling smooth integration with conventional sketch-based identification

systems used by enforcement of law. This ability to adapt makes it possible to work with historical data and established investigative techniques.

C. Security and Privacy

Safety precautions were thoroughly evaluated during the construction of this system a two-phase verification system guarantees that only those with verification can use the drawing creation and recognition functions furthermore the systems operation is limited to secure servers situated within law enforcement facilities reducing the possibility of unauthorized entry these security policies adhere to law enforcement agencies have severe procedures to ensure the private information is constantly safeguarded.

D. Performance Evaluation.

The system was subjected to an assessment of performance to assess its effectiveness. The results showed recall at 96%, an F1-Score of 95%, and overall accuracy of 97%. These figures show that the deep CNN-based model performs precision at 95%, better than other methods, including traditional hand-drawn sketches, which had noticeably lower precision and recall rates. While alternative approaches, such as Support Vector Machines (SVMs), Random Forest classifiers, and Generative Adversarial Networks (GANs), produced reasonable results, they did not reach the same level of performance as the deep CNN implementation used in this project.

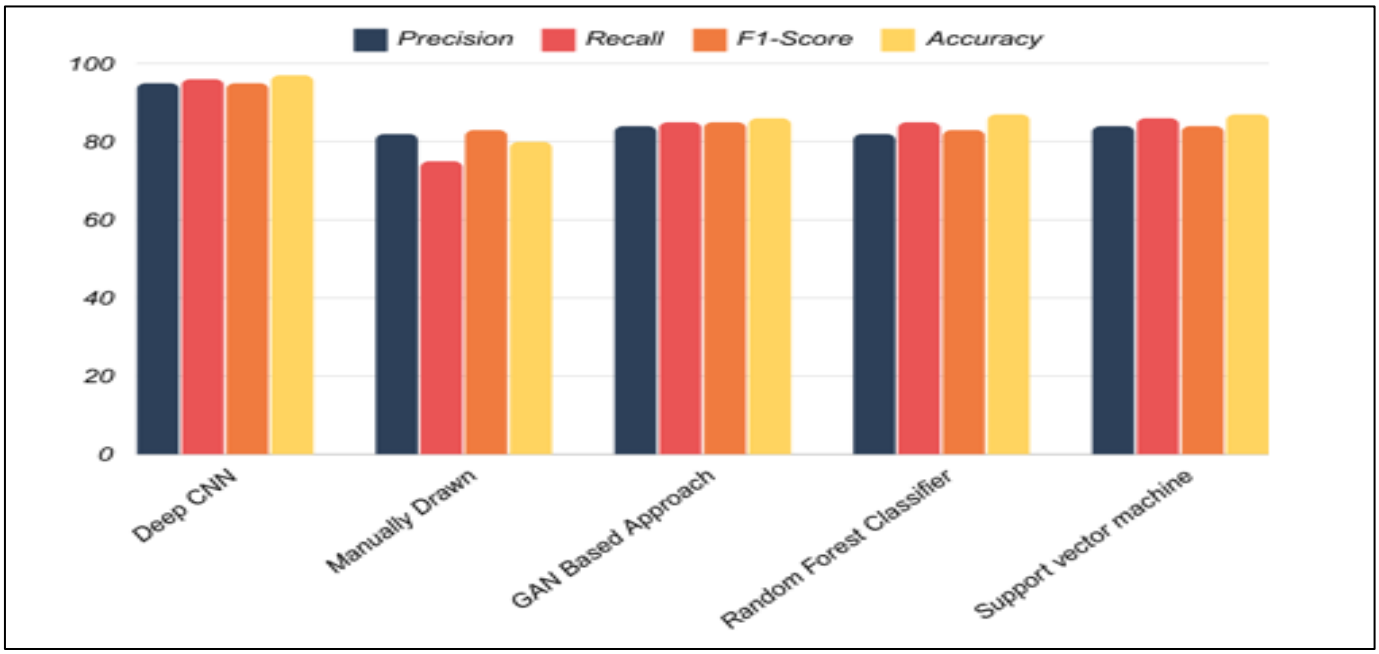

Fig 5: Comparison between Different Face Recognition Techniques

These findings demonstrate how sophisticated deep learning methods have the potential to greatly enhance the forensic face sketch recognition procedure.

VI. CONCLUSION

Through the use of deep learning algorithms, this research has created a complete system for producing and identifying forensic face drawings. By combining modern AI with a user-friendly interface, the project has addressed the limitations of conventional forensic sketch techniques. The system has shown high accuracy in identifying suspects, supported by performance metrics such as precision and recall, which demonstrates the effectiveness of Using powerful algorithms for the extraction of face features and matching. The system's ability to integrate seamlessly with existing forensic workflows enhances its practicality in real-world applications. By incorporating strong security measures, the system ensures that sensitive data remains protected while maintaining accessibility for authorized personnel. The system marks a step forward in improving the accuracy and speed of suspect identification in criminal cases investigations.

FUTURE SCOPE

The project has significant potential for expansion and improvement in several areas. One area for future work is refining the process of transforming sketches into photos to enhance photorealism. This could be achieved by exploring advanced generative models that better capture fine details and nuances of facial features, allowing for more accurate composite sketches. Another area of development involves integrating more sophisticated algorithms for matching sketches with digital images. Exploring hybrid approaches that combine deep learning techniques with traditional image processing methods may offer better performance in complex cases where sketch quality varies. There is also potential to expand the criminal database, allowing for more comprehensive searches and improving recognition accuracy across broader datasets. Incorporating larger, more diverse datasets could make the system even more effective in real-world forensic applications. Further enhancements to the user interface could be made to ensure a smoother experience for law enforcement officials, allowing for faster sketch construction and easier navigation. Additionally, ongoing feedback from forensic artists and law enforcement

agencies will help inform adjustments that improve usability and adaptability to different investigative scenarios. Finally, incorporating mobile support or cloud-based deployment could allow the system to be accessible from multiple devices, broadening its reach and ensuring it remains an essential tool for law enforcement agencies globally.

ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g.” Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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