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FACE SKETCH CONSTRUCTION AND DETECTION

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Abstract In forensic science, it is seen that hand-drawn face sketches are still very limited and time consuming when it comes to using them with the latest technologies used for recognition and identification of criminals. In this paper, we present a standalone application which would allow users to create composites face sketch of the suspect without the help of forensic artists using drag and drop feature in the application and can automatically match the drawn composite face sketch with the police database much faster and efficiently using deep learning and cloud infrastructure.
In this modern age, the general crime rate is increasing day-by-day and to cope up with this the enforcement departments too should find ways in which would speed up the overall process and help them in bringing one to justice. One such way can be using face recognition technology for identifying and verifying the criminal. The traditional approach here is to use the hand-drawn face sketches drawn by forensic sketch artist to spot the criminal, modernizing this is able to mean using the hand-drawn sketch and then matching them with the enforcement departments database to spot the criminal. Using this approach would result in the various limitations with latest technologies and even would be time consuming as there are very few forensic sketch artists available when compared to the increasing crime ratio.

IndexTerms **:- Forensic sketch, Composite sketch, Facial reconstruction, Criminal investigation, Forensic art**

I. INTRODUCTION:

In this modern age, the overall crime rate is increasing day-by-day and to cope up with this the law enforcement departments too should find ways that would speed up the overall process and help them in bringing one to justice. One such way can be using face recognition technology for identifying and verifying the criminal [1].
During the past there were several techniques been proposed to convert hand-drawn face sketches and use them to automatically identify and recognize the suspect from the police database, but these techniques could not provide the desired precise results. Application to create a composite face sketches were even introduced which too had various limitations like limited facial features kit feel to the created suspect face which made it much harder to use these applications and get the desired results [2].
The above applications and needs motivated us into thinking of creating an application which would not just provide a set of individual features like eyes, ears, mouth, etc. to be selected to create a face sketch but also would allow user to upload hand-drawn individual features on the platform which would then be converted in to the applications component set. This in turn would make the created sketch much more similar to the hand-drawn sketch and would be much easier for the law enforcement departments to adapt the application [3].
The machine learning algorithm would learn from the sketches and the database in order to suggest the user all the relatable facial features that could be used with a single selected feature in order the decrease the time frame and increase the efficiency of the platform[4].Further developments and enhancements could extend its utility for educational, recreational, and conservation purposes.

1.1 Key Features:

- Facial Feature Extraction: This involves identifying and extracting key facial features such as eyes, nose, mouth, and eyebrows from witness descriptions or rough sketches.
- Proportion and Structure: Ensuring the correct proportions and structure of the face are maintained during the sketching process is crucial for producing an accurate representation.
- Detailing: Capturing details such as hair style, facial hair, scars, wrinkles, and other distinguishing features helps enhance the accuracy and recognizability of the sketch.
- Composite Sketching Tools: Utilizing specialized software or tools designed for composite sketching that offer a wide range of facial features, shapes, and textures to create detailed and realistic sketches.

1.2 Development Process:

1. Understand the requirements and objectives of the forensic face sketch system. This includes identifying target users, expected use cases, desired features, and constraints such as accuracy requirements and available resources.
2. Gather a diverse dataset of facial images, sketches, and related metadata for training and testing the system. This dataset should cover a wide range of demographics, facial expressions, poses, lighting conditions, and ethnicities to ensure robustness and generalization.
3. Develop algorithms to extract meaningful features from facial images and sketches. This may involve techniques such as image segmentation, edge detection, feature point extraction, and texture analysis.
4. Design and implement algorithms for synthesizing facial sketches based on textual descriptions or rough sketches provided by witnesses or forensic artists. Throughout the development process, collaboration between researchers, forensic experts, software developers, and end-users is essential to ensure that the resulting system meets the needs of the forensic community and contributes effectively to criminal investigations.

II. LITERATURE REVIEW AND OBJECTIVE:

2.1 Literature Review:

Charlie Frowd, Anna Petkovic, Kamran Nawaz and Yasmeen Bashir, “Automating the Processes Involved in Facial Composite Production and Identification” Symposium on Bio-inspired Learning and Intelligent Systems for Security, 2009: This comprehensive guide provides insights into the technical aspects designed a standalone application for constructing and identifying the facial composites, the initial system was found to be time consuming and confusing as the traditional method, later switching to a new approach in which the victim was given option of faces and was made to selected similar face resembling the suspect and at the end the system would combine all the selected face and try to predict The Results where promising and 10 out of 12 composite faces where named correctly out of which the results 21.3% when the witness was helped by the department person to construct the faces and 17.1% when the witness tried constructing faces by themselves.[2]

W. Zhang, X. Wang and X. Tang, “Coupled information theoretic encoding for face photo-sketch recognition”, in Proc. of CVPR, pp. 513-520, 2011: This paper contributes to the field of computer vision by presenting an innovative approach for face photo-sketch recognition that leverages coupled information theoretic encoding, potentially offering advancements in forensic science, law enforcement, and other domains where matching faces across different modalities is crucial.[3]

X. Tang and X. Wang, “Face sketch recognition”, IEEE Trans. Circuits and Systems for Video Technology, vol. 14, no. 1, pp. 50-57, 2004:This paper likely serves as a foundational work in the field of face sketch recognition, providing insights into the state-of-the-art techniques and methodologies for recognizing faces from hand-drawn sketches, and paving the way for further advancements in forensic science, law enforcement, and related disciplines.[4]

B. Klare and A. Jain, “Sketch to photo matching: a feature based approach”, SPIE Conference on Biometric Technology for Human Identification, 2010: This paper contributes to the advancement of biometric technology by presenting a feature-based method for improving the accuracy of sketch-to-photo matching, which has applications in forensic science, law enforcement, and other domains where facial recognition plays a crucial role in human identification.[5]

] P. Yuen and C. Man, “Human face image searching system using sketches,” IEEE Trans. SMC, Part A: Systems and Humans, vol. 37, pp. 493–504, July 2007: In this paper, Yuen and Man likely introduce a novel approach for matching hand-drawn sketches of faces with corresponding images in databases or galleries. They may discuss the design and implementation of a system that enables users to input sketches and retrieve relevant face images from large datasets. Overall, this paper likely serves as a significant contribution to the field of face recognition and biometric technology, offering a practical solution for searching human face images using sketches. The system presented in the paper has applications in forensic investigations, law enforcement, surveillance, and other domains where rapid and accurate identification of individuals is crucial.[6]

2.2 Objectives:

- **Suspect Identification:** One of the primary objectives is to assist in identifying suspects or persons of interest based on eyewitness descriptions or rough sketches provided by witnesses. By creating detailed and accurate facial sketches, law enforcement can generate leads and narrow down potential suspects in criminal cases.
- **Enhancing Witness Testimonies:** Forensic face sketch construction helps enhance the reliability and effectiveness of witness testimonies. By providing witnesses with a tool to articulate their recollections visually, it can supplement verbal descriptions and improve communication between witnesses and investigators.
- **Generating Leads in Cold Cases:** In cases where traditional investigative leads have been exhausted, forensic face sketching can provide a fresh avenue for generating leads in cold cases. By revisiting old witness testimonies or evidence, investigators can create new sketches and potentially uncover previously overlooked leads or suspects.
- **Supporting Criminal Investigations:** Forensic face sketch construction and detection serve as valuable tools in supporting various stages of criminal investigations, including suspect identification, witness interviews, evidence collection, and case resolution

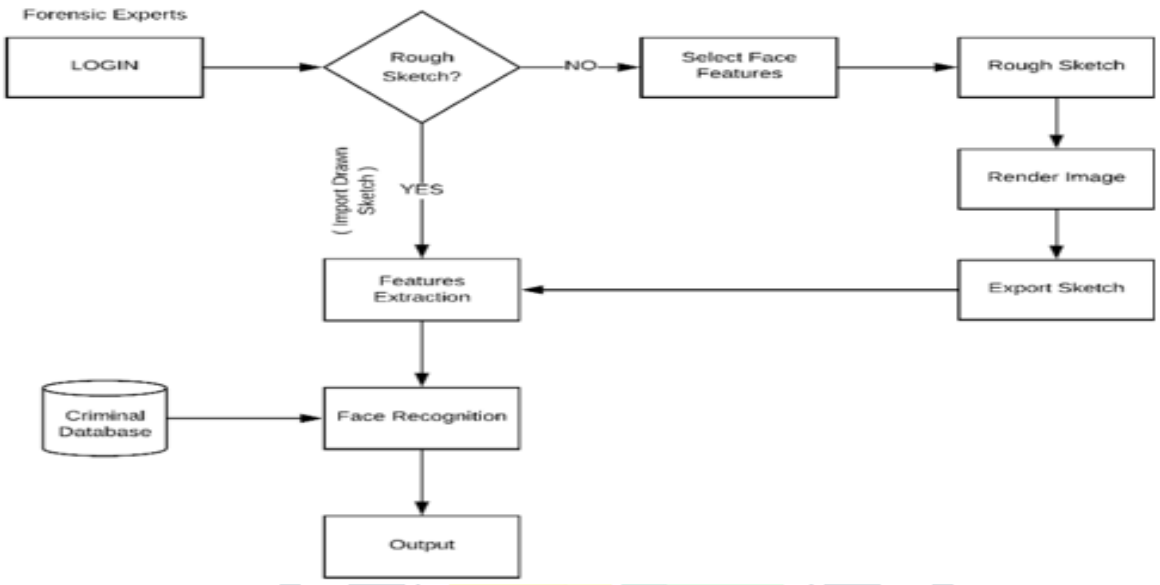

Figure 1 : System Architecture

Illustration of the system architecture of the AR furniture app, depicting the interaction between different components.

2.3 System Specifications

2.3.1 Hardware specification:

- CPU: Dual-core processor or higher.
- GPU: Adreno 540 or higher for Android devices, Apple A9 or higher for iOS devices.
- RAM: 2GB or higher.
- Storage: At least 16GB of available storage space.

2.3.2 Software specification:

- For desktop/laptop computers: Windows 10, macOS, or Linux.
- For mobile devices: iOS 11 or later for iPhones and iPads, Android 7.0 (Nougat) or later for Android smartphones and tablets. 3.IDE: VS Code
- Database: System Unit
- Mobile: Android or iOS mobile
- Language: JAVA, PYTHON

III. RESEARCH METHODOLOGY

3.1 Methodology:

Face Sketch Construction: This involves the creation or generation of a sketch or artistic representation of a human face, typically from a photograph or description. The goal is to produce a sketch that captures the essential features and characteristics of the person's face in a simplified or abstract form. This can be useful in forensic investigations, artistic endeavors, or even in digital avatar creation

Face Sketch Detection: This involves the task of identifying or detecting face sketches within images. It can be a part of broader facial recognition systems or used independently for specific applications such as searching for missing persons based on sketches, identifying suspects from security footage, or filtering and categorizing images based on content. Data Collection, Pre-processing, Feature Extraction, Sketch Construction, Integration and Evaluation, Deployment and Optimization are the Methodology.

Analysis and Argumentation:

Analysis and argumentation regarding face sketch construction and detection can be approached from various perspectives, including technical, ethical, and practical considerations.

Technical Analysis:

Algorithm Performance: Evaluate the performance of different algorithms and techniques used for face sketch construction and detection. Compare the accuracy, robustness, and computational efficiency of various approaches, such as traditional computer vision methods versus deep learning-based techniques.

Feature Representation: Analyse the effectiveness of different feature representations for both face images and sketches. Consider features related to shape, texture, and other facial attributes and assess their impact on the quality and recognition accuracy of sketches.

Ethical Analysis:

Privacy Concerns: Consider the privacy implications of face sketch construction and detection, especially in the context of facial recognition technology. Discuss the potential misuse of such technology for surveillance, tracking, or invasion of privacy. Bias and Fairness: Examine potential biases in face sketch construction and detection algorithms, such as disparities in performance across different demographic groups. Discuss strategies for mitigating biases and ensuring fairness in algorithmic decision-making.

Practical Analysis:

Application Scenarios: Explore practical applications of face sketch construction and detection, including forensic investigations, digital art, identity verification, and security systems. Analyse the benefits and limitations of using face sketches in each scenario.

Integration Challenges: Discuss challenges related to integrating face sketch technology into existing systems or workflows. Consider factors such as interoperability, data compatibility, and user acceptance.

Forensic Utility: Face sketch technology can be a valuable tool in forensic investigations, aiding in the identification of suspects or missing persons based on eyewitness descriptions or surveillance footage.

Enhanced Security: Integration of face sketch detection into security systems can improve surveillance and access control, enhancing public safety and deterring criminal activity.

IV. RESULTS:

The Project ‘Forensic Face Sketch Construction and Recognition’ is been designed, developed and finally tested keeping the real-world scenarios from the very first splash screen to the final screen to fetch data from the records keeping security, privacy and accuracy as the key factor in every scenario.
The platform displayed a tremendous result on Security point of view by blocking the platform use if the MAC Address and IP Address on load didn’t match the credentials associated with the user in the database and later the OTP system proved its ability to restrict the use of previously generated OTP and even generating the new OTP every time the OTP page is reloaded or the user tries to relog in the platform.
The platform even showed good accuracy and speed while face sketch construction and recognition process, provided an average accuracy of more than 90% with a confidence level of 100% when tested with various test cases, test scenario and data sets, which means a very good rate according to related studies on this field.

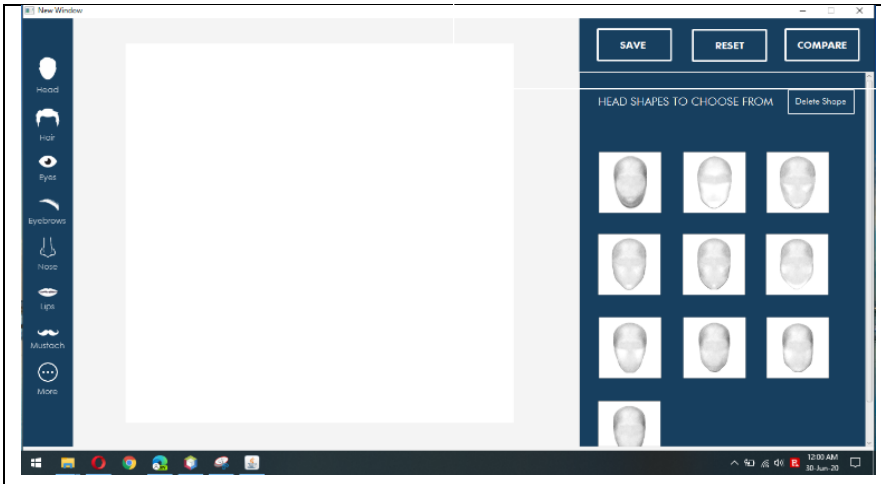

Figure 2 : User Interface of the application

Figure 4: Detection of face Sketch

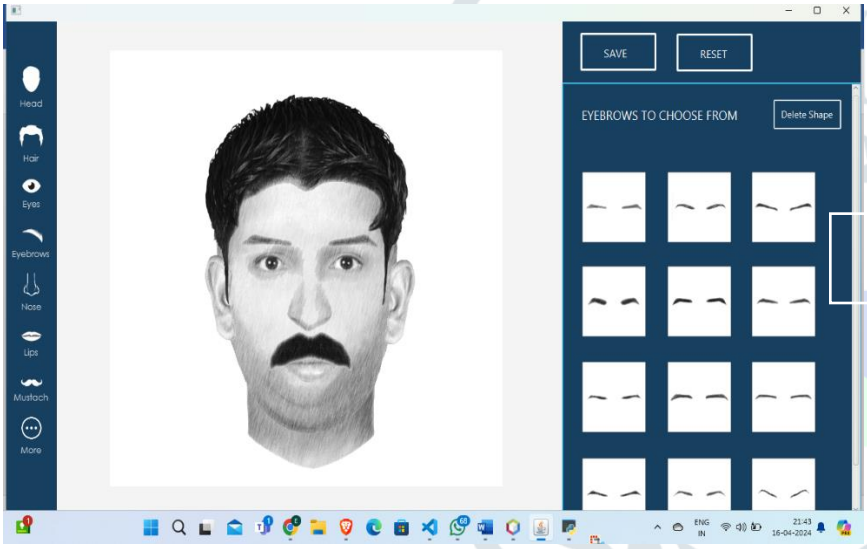

Figure 3: Construction of Face Sketch.

Figure 5: Result of Matched Faces

V. CONCLUSION:

The Project "Forensic Face Sketch Construction and Recognition" is been designed, developed represent invaluable tools in the realm of forensic science Through the collaboration of eyewitnesses, artists, and forensic experts, accurate facial sketches can be generated to aid law enforcement in identifying suspects and solving crimes. Additionally, advancements in technology have further enhanced the capabilities of facial recognition systems, enabling swift comparison of sketches with existing databases to expedite suspect identification. Ultimately, the application of face sketch construction and detection in forensic science has revolutionized criminal investigations, leading to more efficient processes, increased accuracy in suspect identification, and ultimately, greater justice for victims and communities.

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