Face Trace AI: Face Sketch Recognition and Secure Criminal Identification System

Darshan Simpi[1], Chiranjeevi M P[2], M J. Abhishek[3], Shivananda[4], Deepthi D' Souza[5]
[1,2,3,4]*Students, Department of Computer Science and Engineering, Srinivas Institute of Technology (S.I.T), Mangalore, Karnataka, India*
[5]*Assistant Professor, Department of Computer Science and Engineering, Srinivas Institute of Technology (S.I.T), Mangalore, Karnataka, India*
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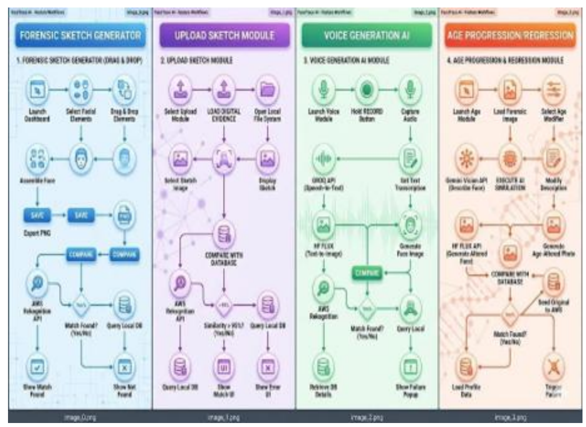
***Abstract*—In many criminal investigations, identifying suspects becomes difficult when photographic or video evidence is unavailable. Law enforcement officers often depend on eyewitness descriptions to create facial sketches that help in identifying potential suspects. Traditional forensic sketching methods require trained artists and involve manual interpretation, which can output inconsistencies and delays during investigations. This research proposes Face Trace AI, an intelligent forensic identification system can utilize artificial intelligence to assist in generating facial sketches and matching them with criminal databases. The system enables investigators to construct facial sketches digitally through an interactive interface and automatically compare the generated sketches with stored criminal records using facial recognition techniques. In addition, a voice processing module can be incorporated to analyze suspect voice samples as an additional verification factor. By combining digital sketch generation, AI-based recognition, and database matching, the system improves the speed and reliability of suspect identification in criminal investigations.**

***Index Terms*—Artificial Intelligence, Computer Vision, Criminal Identification, Forensic Technology, Facial Recognition, Sketch Generation,**

I. INTRODUCTION

Identifying suspects is a major stage in criminal investigations. In situations where surveillance footage or photographs are unavailable, investigators often depend on eyewitness descriptions to reconstruct the appearance of suspects. These descriptions are traditionally converted into sketches by forensic artists who manually interpret the witness statements. Although this approach can be utilized for many years, it has several limitations such as dependency on artistic skills, variations in interpretation, and the time required to produce accurate sketches.



Advancements in artificial intelligence and computer vision have created opportunities to improve this process. Automated facial recognition systems can now analyze facial structures and compare them with large image databases efficiently. Similarly, digital sketch generation tools allow investigators to create facial representations quickly using predefined facial components.

The Face Trace AI system aims to enhance the forensic identification process by integrating digital sketch creation with artificial intelligence–based facial recognition techniques. The system provides a graphical interface where investigators can construct facial sketches based on eyewitness descriptions. Once the sketch is generated, the system analyzes the facial features and compares them with records in a criminal database to see if they might be related.

By automating the sketch generation and comparison process, the system reduces the time required for suspect identification and improves the response of forensic investigations.

II. METHODS

The Face Trace AI system is developed using a structured methodology that integrates multiple AI technologies into a single forensic platform. The system is made up of separate parts that work together. performs a specific function such as input processing, feature extraction, AI-based generation, and matching. The workflow starts with client's verification, followed by data input through sketches, images, or voice descriptions. Voice input is processed using speech-to-text technology, and the resulting text is used by generative AI models to create facial images. Uploaded images and sketches are used deep learning models to look at and pullout facial features.

These features are compared to stored data in a centralized database using similarity matching algorithms. The system calculates similarity scores and retrieves potential matches. Additionally, age progression techniques are applied to simulate changes in facial appearance over time. The system also uses image enhancement methods to make the input data clearer and better quality, which helps with accuracy. Real-time processing capabilities be sure that the results are produced quickly, supporting time-sensitive investigations. Furthermore, continuous learning mechanisms can be put together to make the system work better over time by adapting to new data patterns.

III. SYSTEM DESIGN

The system design of Face Trace AI defines the overall architecture, workflow, and interaction between different modules required for efficient forensic identification. It acts as a bridge between system requirements and implementation, ensuring that all components function cohesively. The design focuses on modularity, scalability, real-time processing, and secure data handling to support multi-modal inputs such as sketches, images, and voice descriptions.

There are many layers in the system, such as the user interface layer, application logic layer, AI processing layer, and data storage layer. Each layer has a specific job to do and can talk to the other parts without any problems. This structured design makes processing faster, maintenance easier, and future growth possible.

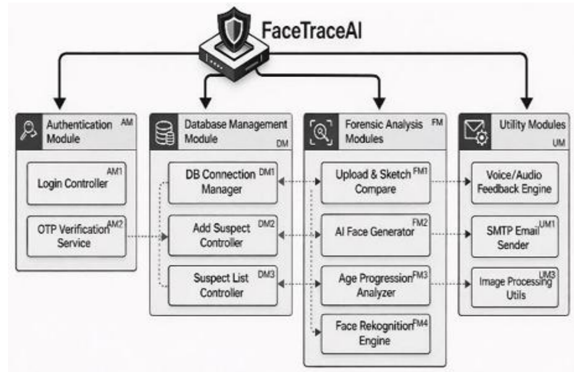


Figure 1. System Architecture

The architecture of Face Trace AI follows a multi-tier structure that makes sure that data is processed quickly, can grow, and is made correctly. It has a layer for the user interface and a layer for the application logic. AI processing and storage layer. The user interface makes investigators to interact with modules such as login, sketch creation, image upload, and voice input. The application logic layer manages authentication, session handling, and coordination between different components. The AI processing layer integrates advanced technologies such as speech-to-text conversion, generative image models, and facial recognition algorithms to analyze and generate facial data. The data storage layer securely maintains user information, suspect records, images, and logs. This layered Architecture makes it easy for people to get conversations to each other. components and supports real-time forensic operations. Additionally, the Modular design makes it easy to add new features to new features and technologies without affecting existing functionality. It also improves system maintainability and fault isolation by separating responsibilities across layers. Overall, the architecture is designed to handle large-scale data efficiently while ensuring high performance and reliability.

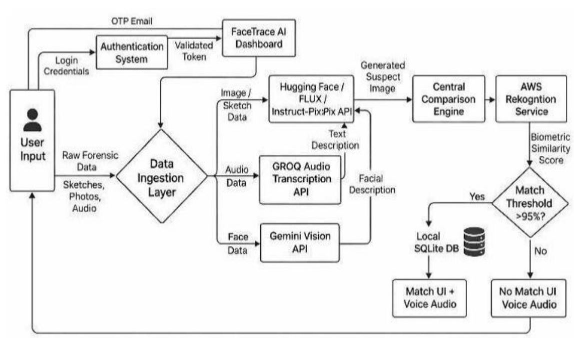


Figure 2. Data Flow Design

The Face Trace AI system's data flow shows how information moves from input to output through various processing stages. Initially, the user provides input in the form of sketches, images, or voice descriptions, which are validated by the system. The input is then processed through AI modules where feature extraction and analysis are performed using deep learning techniques. Similarity matching algorithms compare extracted features to stored records in a central database. Based on this comparison, the system generates outputs such as matched identities, similarity scores, and reconstructed images. The final results are displayed to the user via an interactive interface, ensuring efficient processing and accurate identification. The system also supports continuous data flow, allowing users to refine inputs and perform repeated searches for better accuracy. Data validation and error-handling mechanisms ensure that incorrect or incomplete inputs do not affect system performance. This structured flow improves speed, accuracy, and reliability of the overall identification process.

IV. IMPLEMENTATION

The application is primarily developed using the Java programming language, which gives platform independence and strong support for building scalable applications. The graphical user interface is developed using JavaFX, letting investigators use the system through a user-friendly dashboard where facial sketches can be created, uploaded, and analyzed.

For image analysis and Computer vision techniques are used to extract facial features to detect important facial structures such as eyes, nose, mouth, and overall facial geometry. These extracted features are processed utilizing algorithms for machine learning that convert facial characteristics into numerical feature vectors for further comparison.

The system also integrates cloud-based facial recognition services such as AWS Rekognition. When a sketch or image is generated, the system analyzes the extracted facial features and compares them with criminal images stored in the database. Similarity scores are calculated to identify potential matches between the generated sketch and existing records.

The backend system uses a SQLite database to store suspect information, criminal images, and generated sketches. This database allows efficient storage, retrieval, and management of forensic data used during the identification process.

The proposed system architecture consists of the following modules: User Interface Module, Facial Sketch Construction Module, Feature Extraction Module, Facial Recognition Engine, and Criminal Database Management System. These modules work together to automate the suspect identification process. The modular architecture ensures efficient system performance and allows future improvements such as integrating advanced AI models and expanding criminal databases

V. CONCLUSION

This paper presented Face Trace AI, an intelligent system designed to generate forensic facial sketches using artificial intelligence. The system converts witness descriptions into AI-generated sketches and compares them with criminal databases to assist in suspect identification.

The suggested system significantly improves investigation efficiency by reducing the time required to generate suspect sketches and minimizing dependence on manual forensic artists. In addition, the integration of AI-based age progression techniques allows investigators to search for suspects even after many years. Future research can focus on improving sketch realism that utilizes advanced deep learning models such as Generative Adversarial Networks (GANs) and integrating the system with national criminal databases to support large-scale law enforcement operations.

VI. APPENDIX

The FaceTrace AI system supports multiple input types, including sketch images, voice descriptions, and uploaded digital images. These inputs allow investigators to provide flexible and diverse forms of evidence based on the available information in a forensic scenario. Once the input is provided, the system processes the data through a structured pipeline that includes extracting features and making images with AI and database comparison. Each stage is designed to ensure accurate transformation of input data into meaningful visual and analytical outputs.

The output generated by the system includes a reconstructed facial image, a similarity-based match result indicating whether a suspect is identified, and detailed suspect information when a match is found. In cases where no match exists, the system clearly indicates the result to maintain transparency. This appendix demonstrates how the FaceTrace AI system effectively converts different input formats into reliable forensic outputs, thereby enhancing investigation efficiency and supporting data-driven decision-making.

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