

CrimeVision AI: An Intelligent Criminal Sketch Generation System Using Deep Learning

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ABSTRACT- This research paper proposes an advanced web-based platform designed to enhance criminal investigation and identification by converting forensic sketches into highly realistic facial images employing conditional Generative Adversarial Networks (GANs). The system is architected using a React frontend for an interactive user experience, a robust Spring Boot backend managing application logic and APIs, and PostgreSQL as a secure, scalable database to store and track suspect profiles and criminal records efficiently. The GAN model addresses the challenges faced in converting traditional, often imprecise police sketches into images that closely resemble real human faces, thereby

aiding law enforcement agencies in faster and more accurate suspect identification. The combined system streamlines the workflow from image generation through database matching, enabling effective case analysis with high data security and auditability throughout the process. Methodological decisions and system implementation choices are supported by relevant, peer-reviewed research to ensure this work contributes meaningfully to ongoing investigation research and forensic image synthesis analysis.

Keywords— Conditional GAN, Forensic Sketch-to-Image Translation, Suspect Identification, Deep Learning, Criminal Record Management, Image Synthesis

INTRODUCTION- In criminal investigations, the ability to quickly and accurately recognize suspects from eyewitness sketches is vital yet challenging due to the inherent limitations of human memory and artist interpretation. Forensic sketches often lack sufficient detail and may vary significantly in resemblance to the actual suspect, complicating search and identification procedures used by law enforcement agencies. These issues can lead to delays in investigations and possibly wrongful identification, which seriously impede justice delivery. Recent advancements in artificial intelligence, specifically in Generative Adversarial Networks (GANs), have demonstrated promising results in converting sketches into highly-realistic facial images, improving visual interpretation and recognition accuracy dramatically. Building on these advances, this research presents the development of an integrated web-based system employing React for the user interface, Spring Boot for backend services, and PostgreSQL for secure data management. This technology stack was selected to provide seamless, scalable performance and data security, aligned with modern application development best practices.



Fig. 1.1 Login Page of the Proposed System

The figure shows the login interface of the proposed Crime Law Enforcement system. The page allows authorized users to securely access the platform using username and password credentials. The interface is designed with a

simple and user-friendly layout to improve accessibility and security.

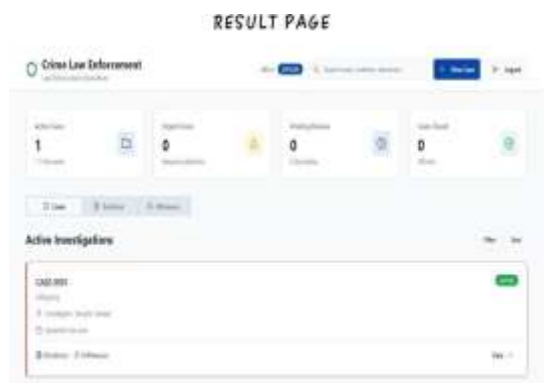


Fig. 1.2 Dashboard and Case Management Interface

The dashboard displays active an investigations, case statistics, and the evidence management features. It enable officers to efficiently monitor and to manage criminal cases through a best centralized interface.

System Architecture-The proposed system architecture is designed to provide an efficient, secure, and scalable platform for converting forensic sketches into realistic facial images using Generative Adversarial Networks (GANs). The architecture mainly consists of four major components: the frontend interface, backend server, database management system, and the GAN-based image generation model.

The frontend of the system is developed using React, which provides an interactive and user-friendly interface for investigators and authorized users. Through this interface, users can upload forensic sketches, view generated facial images, and access suspect records efficiently.

The backend services are implemented using Spring Boot, which handles application logic, API communication, user authentication, request processing, and interaction between the frontend and the AI model. The backend ensures smooth data flow and secure communication throughout the system.

PostgreSQL is used as the database management system to securely store criminal records, suspect details, uploaded sketches, generated facial images, and investigation-related information. The database provides

reliability, scalability, and efficient data retrieval mechanisms.

The core component of the system is the Generative Adversarial Network (GAN) model, which processes the uploaded forensic sketch and generates a realistic facial image. The GAN consists of two neural networks: the generator, which creates realistic images from sketches, and the discriminator, which evaluates image authenticity to improve generation quality continuously.

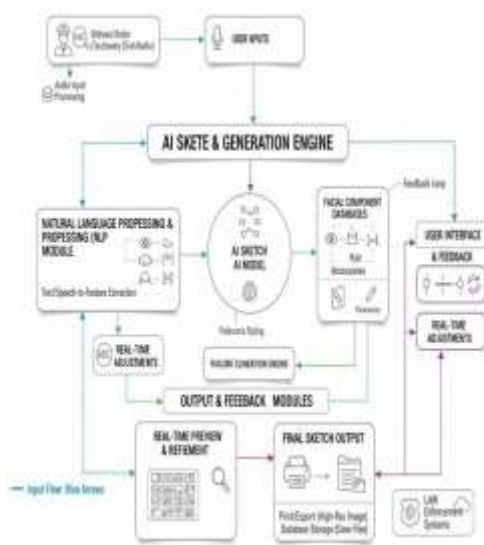


Fig. 1.3 System Architecture of the Proposed System.

The architecture represents the interaction between frontend, backend, database, and AI modules used in the system.

Workflow of the Proposed System-The workflow of the proposed CrimeVision AI system begins with the collection and input of facial features provided by eyewitnesses or investigating officers. These features may include details such as face shape, eye structure, nose type, hairstyle, lips, beard, skin tone, and other identifying characteristics of the suspect. The system provides an interactive interface through which users can select and customize these facial attributes according to the witness description.

After receiving the selected features, the system processes the input data and forwards it to the AI-based sketch generation module. The deep learning model analyzes the selected facial characteristics and combines them to generate a realistic forensic facial sketch of the suspect.

The sketch generation process is performed using advanced image synthesis techniques and Generative Adversarial Networks (GANs), which improve the quality and realism of the generated facial image.

Once the sketch is generated, the system stores the generated image and related case information in the PostgreSQL database for future investigation and record management purposes. The generated sketch can then be reviewed, modified, or enhanced further by the investigating officer if required.

After sketch generation, the system compares the generated facial image with existing criminal records available in the database. The facial matching module analyzes similarities between the generated sketch and stored criminal profiles to identify possible matches. If matching records are found, the system displays suspect details, criminal history, and associated case information on the dashboard interface.

Finally, the generated results are presented to the user in a structured and user-friendly format. The overall workflow helps law enforcement agencies reduce manual effort, improve suspect identification accuracy, and accelerate criminal investigation procedures through intelligent AI-based facial sketch generation and recognition technology. The workflow of the proposed CrimeVision AI system begins with the collection of eyewitness information by investigating officers. The officers carefully observe and record the suspect's facial characteristics based on witness descriptions. These characteristics may include eye shape, nose structure, hairstyle, lips, facial hair, skin tone, face shape, and other identifying attributes. The collected information is then entered into the system through a user-friendly web interface developed using React.

After receiving the input data, the backend server developed using Spring Boot processes the information and securely transfers it to the AI-based image generation module. The system utilizes Conditional Generative Adversarial Networks (CGANs) to convert the provided sketch features into realistic human facial images. The generator network creates facial outputs according to the selected attributes, while the discriminator network evaluates the authenticity and quality of the generated images.

Through continuous training, the model improves the accuracy and realism of facial synthesis.

Once the facial image is generated, the result is displayed on the dashboard for review by authorized officers. Investigators can further refine the facial features if required to obtain a more accurate representation of the suspect. The generated images and investigation records are securely stored in the PostgreSQL database for future reference and criminal record management. This workflow reduces manual effort, improves suspect identification accuracy, and accelerates the criminal investigation process using advanced artificial intelligence techniques.

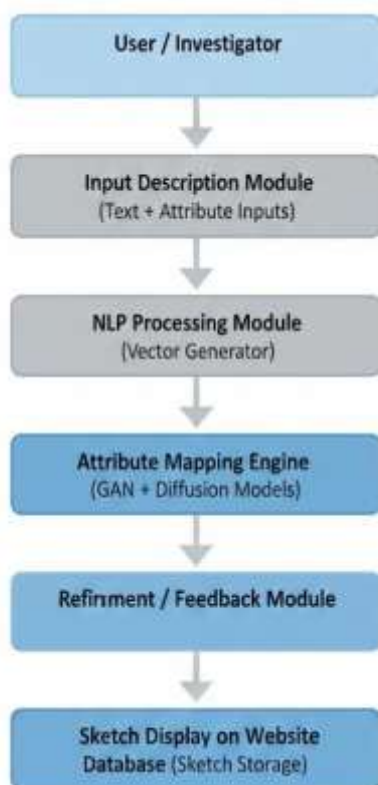


Fig.1.4 Work flow of Criminal Identification System

Modules Description-The proposed CrimeVision AI system is divided into multiple functional modules to ensure efficient operation, secure data management, and accurate criminal identification. Each module performs a specific task within the system and collectively contributes to the overall functionality of the platform.

1. User Authentication Module

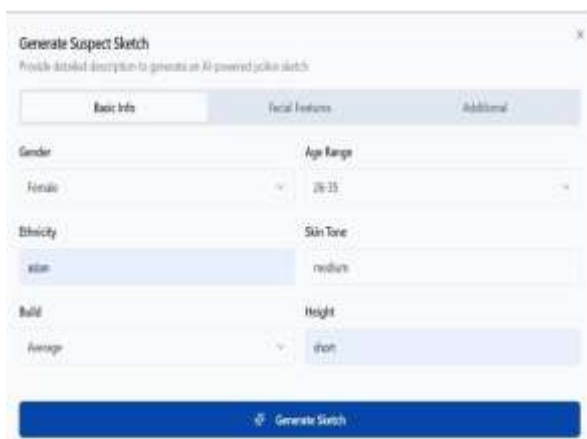
The User Authentication Module is responsible for providing secure access to the system. Authorized users such as investigating officers and administrators can log into the platform using valid credentials. This module ensures data privacy and prevents unauthorized access to sensitive criminal records and investigation details. The authentication process improves system security and maintains confidentiality within the law enforcement environment. The GAN-Based Face Generation Module is the core component of the CrimeVision AI system. This module utilizes Conditional Generative Adversarial Networks (CGANs) to convert forensic sketches into highly realistic facial images. The generator network produces facial outputs based on the selected sketch features, while the discriminator network evaluates the realism and accuracy of the generated images. Through continuous training and optimization, the model improves image quality and facial similarity. This module assists investigating agencies in obtaining clearer suspect visualizations enhancing identification accuracy and reducing manual effort in traditional sketch interpretation methods.



Fig. 1.1 User Authentication Interface

2. Feature Selection Module-

The Feature Selection Module allows investigating officers or eyewitnesses to provide facial characteristics of the suspect based on memory and observation. The system provides multiple customizable options such as face shape, hairstyle, eye type, nose structure, lips, beard style, skin tone, and other facial attributes. Users can select suitable combinations of these features to create a facial profile of the suspect. This module simplifies the process of describing suspect appearances and improves the quality of generated sketches. The selected facial features are processed and converted into structured input data for the AI-based sketch generation module. Proper feature selection plays a crucial role in improving the realism and accuracy of the generated forensic sketch. The module reduces dependency on manual sketch artists and minimizes errors that may occur due to human interpretation during traditional sketch creation methods. Additionally, the Feature Selection Module supports flexibility and easy modification of selected attributes. Investigators can review and update facial characteristics whenever required to improve the generated output according to additional eyewitness information. This capability enhances investigation efficiency and helps law enforcement agencies create more reliable.



2.

1 Facial Feature Selection Module.

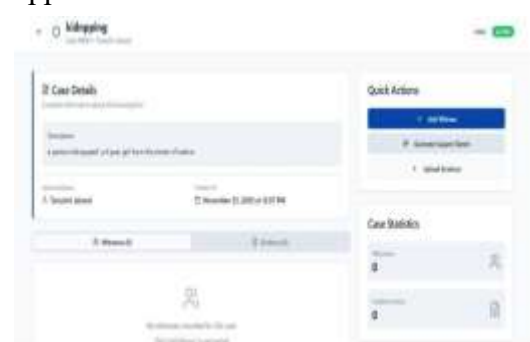
3. Database Management Module- The Database Management Module is responsible for storing, organizing, and managing all investigation-related information within the proposed CrimeVision AI system. This module

plays an important role in maintaining criminal records, generated forensic sketches, suspect details, case information, and user activity data in a secure and structured manner. The system utilizes PostgreSQL as the database management system due to its reliability, scalability, and efficient data handling capabilities.

The module allows investigators and administrators to easily add, update, retrieve, and manage criminal records through the centralized dashboard interface. All generated sketches and related suspect information are stored systematically, enabling quick access to previous investigation data whenever required. This organized storage mechanism improves investigation efficiency and reduces the risk of data loss or duplication.

The database module also supports secure data handling and user authentication features to maintain confidentiality and prevent unauthorized access to sensitive criminal information. Each record stored in the database can be linked with specific investigation cases, allowing law enforcement agencies to maintain detailed case histories and evidence records in a structured format.

Additionally, the module ensures smooth communication between the frontend interface, backend services, and AI processing components of the system. It enables fast retrieval of suspect records during facial matching operations and supports real-time updating of investigation information. The use of PostgreSQL improves overall system performance, data consistency, and reliability, making the proposed platform suitable for large-scale criminal investigation and record management applications.



3.1 Criminal Database Management Module

4. Result Analysis Module-The Result Analysis Module is responsible for displaying and evaluating the final output generated by the proposed CrimeVision AI system. After the facial features are selected and processed through the AI-based sketch generation module, the generated forensic sketch is presented to the investigating officer for further analysis and verification. This module helps law enforcement agencies review suspect representations in an organized and efficient manner.

The module provides a user-friendly dashboard interface where investigators can view generated sketches, suspect details, investigation records, and matching results. The generated facial image is analyzed and compared with existing criminal records stored in the database to identify possible matches. If similar profiles are detected, the system displays corresponding suspect information, criminal history, and associated case details to assist the investigation process.

The Result Analysis Module improves the speed and accuracy of criminal identification by reducing manual investigation efforts and simplifying data interpretation. Investigators can evaluate generated outputs, compare multiple suspect profiles, and make necessary modifications to facial features if required. This flexibility helps improve the reliability of forensic sketch generation and enhances overall investigation efficiency.

Additionally, the module supports organized result management by maintaining generated outputs and investigation records for future reference. The centralized dashboard allows officers to monitor ongoing investigations, track suspect information, and review previous cases in a structured manner. The integration of AI-generated outputs with database analysis provides a more intelligent and technology-driven approach to modern criminal investigation systems.

Overall, the Result Analysis Module enhances decision-making capabilities for law enforcement agencies by providing accurate visual outputs, quick access to investigation data, and efficient suspect identification support through an interactive digital platform.



Fig. 4.1 Result Analysis Dashboard

Advantages of the Proposed System-

The proposed CrimeVision AI system provides several advantages over traditional forensic sketch generation methods. The integration of artificial intelligence and deep learning technologies improves the efficiency, accuracy, and speed of criminal identification processes. The system reduces manual effort involved in sketch creation and provides a more intelligent and technology-driven solution for law enforcement agencies.

One of the major advantages of the proposed system is its ability to generate realistic facial sketches based on eyewitness-provided facial features. The use of deep learning algorithms and Generative Adversarial Networks (GANs) helps produce high-quality facial outputs that closely resemble suspect descriptions. This improves the reliability and effectiveness of forensic investigations.

The system also provides a user-friendly interface that allows investigators to easily select facial features and generate sketches without requiring professional sketch artists. This simplifies the investigation process and saves both time and operational resources for law enforcement departments. The platform reduces dependency on manual sketch interpretation and minimizes errors caused by human observation limitations. Its user-friendly interface enables investigating officers to quickly enter suspect features and generate facial outputs in less time. The integration of secure database management using PostgreSQL ensures safe storage and easy retrieval of criminal records and generated images. Additionally, the system supports faster investigation procedures, improves

identification accuracy, enhances digital record management, and provides a scalable solution for law enforcement agencies. Through automation and intelligent image synthesis, the proposed system contributes to more effective and technology-driven criminal investigation processes.



Fig.1.5 Advantages and Output Analysis of the Proposed CrimeVision AI System.

Conclusion-The proposed CrimeVision AI system provides an intelligent and efficient solution for forensic facial sketch generation and criminal identification using deep learning techniques. The system successfully allows investigating officers and eyewitnesses to provide facial features of suspects and generate realistic forensic sketches through AI-based processing. The integration of Generative Adversarial Networks (GANs) improves the quality, accuracy, and realism of generated facial outputs.

The developed platform combines frontend technologies, backend services, database management, and artificial intelligence into a centralized investigation system. The React.js frontend provides a user-friendly interface, while Spring Boot and PostgreSQL ensure secure data handling, efficient record management, and reliable communication between system modules.

The proposed system reduces the dependency on manual sketch artists and minimizes investigation delays by automating the sketch generation process. It also improves suspect

identification efficiency through organized criminal record management and intelligent result analysis. .

Overall, the project demonstrates the practical application of artificial intelligence and deep learning technologies in modern forensic science and law enforcement operations. The system provides a scalable, reliable, and technology-driven approach for improving criminal investigation procedures and digital forensic analysis.

Future Scope - The proposed CrimeVision AI system can be further enhanced by integrating more advanced artificial intelligence and forensic analysis technologies to improve criminal investigation capabilities. Although the current system successfully generates forensic facial sketches and supports criminal identification, several additional features can be implemented in the future to increase system accuracy, scalability, and real-world applicability.

One possible enhancement is the integration of real-time CCTV surveillance and live facial recognition systems. This would allow law enforcement agencies to automatically compare generated suspect sketches with real-time surveillance footage and identify suspects more efficiently. The system can also be integrated with national criminal databases to improve large-scale criminal record analysis and investigation support. Future improvements may include the use of more advanced deep learning models capable of generating highly realistic .



Fig. 7.1 Future Enhancements of the Proposed CrimeVision AI System.

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