International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 14, Issue 11, November 2025)

Forensic Face Sketch Construction and Recognition

Suhas D S[1], Surya H R[2], Tanmay M[3], Prajwal Gowda[4], Dr. Sharath Kumar Y H[5]

[1,2,3,4]Department of Information Science and Engineering, Maharaja Institute of Technology, Mysore, Karnataka, India
[5]Professor and Head of Department, Information Science and Engineering, Maharaja Institute of Technology, Mysore, Karnataka, India

***Abstract*—In modern forensic investigation, suspect identification often relies on face sketches created from eyewitness descriptions. Traditional hand-drawn sketches, although widely used, are limited by artistic dependency, inconsistency, and poor compatibility with automated recognition systems. This work presents a dual-module forensic platform consisting of a composite face sketch builder and a deep-learning-based recognition engine. The system enables investigators to construct composite sketches using configurable facial components through an interactive drag-and-drop interface, eliminating the need for professional sketch artists. The constructed sketch is then processed using a neural embedding model capable of matching sketches to real facial photographs stored in a secure database. To ensure controlled usage, the system incorporates hardware-bound authentication, two-step OTP verification, and role-based access permissions. The proposed system improves the speed, accessibility, and accuracy of sketch-based identification while offering a secure and scalable solution suitable for law-enforcement applications.**

***Keywords*— Forensic Sketch, Composite Face Construction, Deep Learning Recognition, Criminal Identification, Secure Forensic System, Sketch-to-Photo Matching.**

I. INTRODUCTION

Facial sketch–based suspect identification remains a crucial component of criminal investigation, especially in scenarios where surveillance footage or photographic evidence is unavailable. Law-enforcement agencies frequently rely on composite sketches created from eyewitness descriptions; however, traditional hand-drawn sketches suffer from inconsistencies, artist dependency, and limited compatibility with automated recognition systems. Variations in drawing accuracy, subjective interpretation of witness memory, and the lack of a standardized process often led to reduced reliability during suspect identification. Furthermore, existing digital sketch tools provide only basic drawing features and do not directly integrate with AI-driven recognition platforms.

To address these challenges, we propose an integrated forensic framework that enables officers to construct composite face sketches using modular facial components and subsequently match the generated sketch against a criminal database through a deep-learning– based recognition engine.

The system employs a drag-and-drop interface for intuitive sketch assembly, supports fine-grained editing of facial features, and produces standardized composite outputs suitable for machine processing. recognition module utilizes a neural embedding model capable of comparing sketches with real facial images, generating similarity scores that aid investigators in narrowing down suspect candidates.

Security and controlled access are critical in forensic tools; therefore, the proposed system incorporates hardware-level locking, two-step verification, and role-based authorization to prevent misuse. The platform is designed for deployment in police stations, forensic laboratories, and investigative units that require secure, accurate, and efficient suspect identification.

II. LITERATURE SURVEY FINDINGS

Early forensic investigations relied heavily on hand-drawn sketches created by trained artists based on eyewitness memory. Traditional studies in forensic art highlight that manual sketches often suffer from subjectivity and variance in drawing quality, leading to inconsistent identification outcomes. To reduce artist dependency, early computer-aided composite systems like Identi-Kit and FACES introduced modular sketch assembly using predefined facial components. However, these systems lacked realism and produced generic, low- fidelity composites that performed poorly in automated recognition tasks.

With the growth of digital imaging, researchers explored algorithmic approaches to enhance sketch quality. Pixel-based transformations, such as line- drawing filters, edge enhancements, and shading- preserving conversions, attempted to bridge the gap between sketches and photographs.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 14, Issue 11, November 2025)

Despite these advancements, handcrafted feature-based recognition struggled with variations in artistic style, witness memory errors, and the inherent domain gap between sketches and real images. Deep learning significantly transformed forensic identification with the introduction of convolutional neural networks (CNNs).

Studies have shown that CNN-based feature extractors generate robust embeddings that improve cross-modal face matching between sketches and photos. Hybrid Siamese architectures and models such as FaceNet have been widely adopted for embedding generation due to their ability to map sketches and real images into a shared latent space.

Nonetheless, many research works required large annotated datasets or depended on computationally expensive training pipelines, making them unsuitable for direct deployment in forensic field environments.

Another stream of research focused on improving the sketch creation process itself. Systems employing drag-and-drop facial components, parametric face modelling, and symmetry-based adjustments have shown potential in reducing variability in composite sketches. These approaches ensure that sketches are structurally consistent and standardized, making them better suited for machine interpretation and recognition algorithms.

Security in forensic technologies has also been emphasized in recent literature. Studies point out the risks of unauthorized access, database tampering, and misuse of recognition systems. Recommended solutions include hardware-bound authentication, multi-factor login mechanisms, and secure role-based access control, which ensure that only certified investigators can access sensitive forensic tools.

Overall, the existing literature highlights strong advancements in sketch generation and sketch-to-photo matching, though gaps remain in integrating construction, recognition, and security into a single unified platform. This motivates the development of an end-to-end, secure forensic system capable of real-time sketch construction and reliable identity matching.

III. Proposed Method

The proposed system integrates a composite sketch construction interface with a deep-learning–based recognition engine to support forensic investigations. Unlike conventional systems that treat sketch creation and identification as separate tasks, our framework combines both components into a unified, secure workflow designed for real-world deployment within police departments and investigative agencies.

The system is composed of two primary modules:

(1) Composite Sketch Construction Module
(2) Sketch-Based Recognition Module

The first module allows investigators to generate high-quality composite sketches using predefined facial components such as eyes, nose, mouth, ears, hair, and head shapes. The drag-and-drop interface ensures that officers can quickly assemble a facial representation without requiring artistic skills.

The second module processes the completed sketch using a deep-learning architecture capable of extracting discriminative facial embeddings. These embeddings are compared with stored embeddings in the criminal database to identify visually similar suspects. The recognition engine leverages techniques such as convolutional networks and similarity metrics to rank potential matches and return the top candidates to the investigator.

To ensure secure usage, the system incorporates access-control mechanisms such as MAC address binding, HDD serial verification, and two-step OTP authentication. Role-based permissions restrict recognition capabilities to authorized officers, preventing unauthorized or accidental use of the system. Cloud components, such as AWS S3 and EC2, may optionally be integrated to provide scalable storage and computational support for larger deployments. The proposed system thus bridges the gap between manual forensic sketching and automated criminal identification by offering a technologically enhanced, secure, and user-friendly solution tailored for real investigative workflows.

By combining multi-factor authentication through OTP verification, live facial recognition, and im- mutable blockchain records, the system guarantees that only legitimate voters can cast a vote and that every vote remains protected from manipulation.

IV. System Overview And Features

A. Security and Privacy

The system is designed with strong security measures to ensure that only authorized users and authorized devices can operate the application.

a) *Machine Locking:* The application binds itself to the hardware of the system during initial setup using identifiers such as the MAC address and hard-disk serial number. On every launch, these identifiers are re- validated.

b) *Two-Step Verification:* Each investigator is provided with an official email ID registered within the system.

During login, the user must first enter their credentials, after which a one-time password (OTP) is sent to the registered email. Access is granted only after entering the correct OTP. This ensures that even if a password is compromised, unauthorized access is still prevented.

c) *Role-Based Authorization:* The system implements a strict role-based access control model. Sensitive operations—such as performing recognition, viewing match results, or accessing database information—are restricted only to authorized officers.

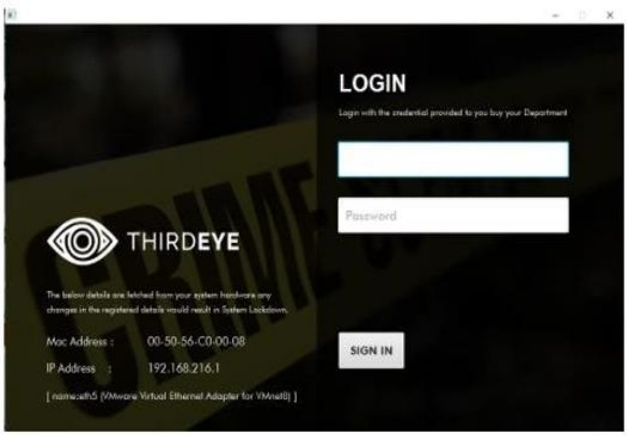

Fig.1.Secured login page

B. Backward Compatibility

To ensure smooth adoption across forensic departments, the system supports importing older sketches and legacy content without requiring retraining or re-creation.

a) *Hand-Drawn Sketch Upload:* Investigators can upload scanned or photographed hand-drawn sketches. The system preprocesses these sketches by enhancing contrast, removing background noise, and normalizing size and orientation so they can be directly used by the recognition module.

b) *Facial Component Extraction:* When legacy sketches contain individual facial parts, the system can extract those features (eyes, hair, mouth, etc.) and convert them into reusable components. This allows old sketches to be incorporated into the composite builder library, preserving important eyewitness-specific details.

c) *Seamless Migration:* The backward compatibility of the platform ensures that departments that previously relied on manual sketching or older software do not lose access to past cases. All older records can be imported.

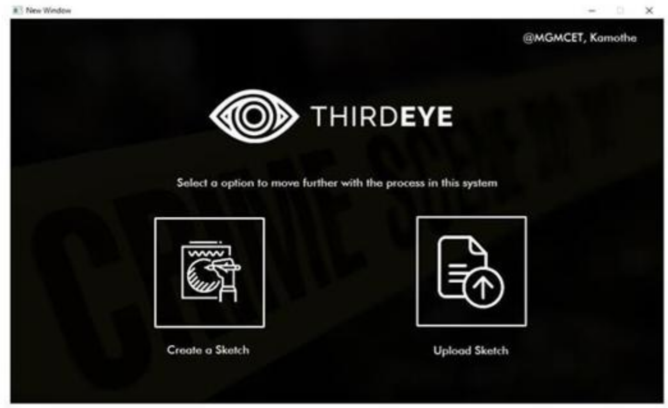

Fig.2. Backward compatibility of sketch upload

C. Face Sketch Construction Using Drag and Drop

The composite builder provides an intuitive environment where investigators can create detailed and realistic composite sketches from eyewitness descriptions.

a) *Categorized Facial Components:* Facial elements such as the head, eyes, eyebrows, nose, mouth, ears, and hair are organized into categories. This improves usability and removes confusion by presenting only relevant components when a category is selected.

b) *Drag-and-Drop Component Placement*: Users can drag components from the library and position them on the canvas. Each component supports adjustments such as resizing, rotating, flipping, and changing orientation.

c) *Intelligent Assistance***:** The system is designed to learn frequently used combinations. In later versions, it can suggest components that pair well with the one selected—helping investigators complete sketches faster and more accurately.

D. System Flow

The Fig. 3. Illustrates the overall flow of the system starting with the login section which ensuring the two- step verification process. Further the application can either be used with a hand-drawn sketch or a composite face sketch can be created using the drag and drop feature, either of the images would then go under features extraction process which would help the application to apply image processing and computer vision algorithm.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 14, Issue 11, November 2025)

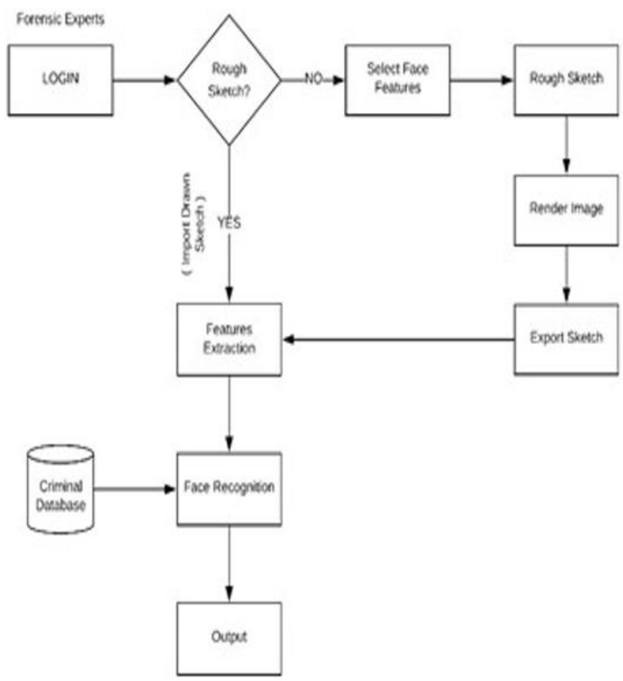

Fig.3.System flow of the application

V. Face Sketch Construction

The sketch construction process provides an intuitive, structured workflow that enables investigators to create a composite face sketch accurately based on eyewitness descriptions. The system ensures that investigators can quickly assemble facial features without requiring artistic skills, while maintaining consistency and clarity in the composite output. The major steps involved in the construction flow are described below.

The interface presents facial components organized into categories such as head shapes, eyes, eyebrows, nose, mouth, ears, and hair. This categorization simplifies navigation and ensures that investigators can locate the required facial feature quickly without searching through unrelated options.

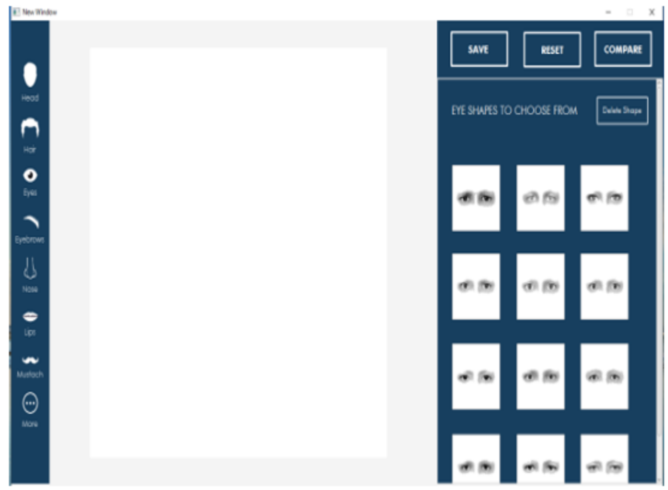

Fig.4.User interface of the application

Every component is displayed with a clear thumbnail preview, allowing investigators to visually compare and select the option that best matches the eyewitness description.Investigators can drag selected components from the library and position them freely on a central canvas.

Each component supports resizing, rotation, repositioning, and flipping. These tools enable fine adjustments to align the facial features perfectly, ensuring proportional and realistic composite construction.

The system maintains proper layering—for example, hair appears above the head shape, and eyes appear above the facial outline. The composite sketch is continuously updated as components are added or edited, allowing investigators to observe the sketch formation in real time and make immediate corrections.

The backend utilizes Supabase as a Backend-as-a- Service Once completed; the sketch is exported as a high- quality PNG image with transparent background. The export includes embedded metadata such as case ID, timestamp, and user information for forensic documentation.

IJRDET
International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 14, Issue 11, November 2025)

Fig. 5. User Interface of the application (with facial features dragged on to the canvas)

The exported sketch is automatically standardized in terms of resolution, background, and alignment. This makes it directly compatible with the downstream preprocessing pipeline and neural recognition engine without requiring manual adjustments.

VI. Face Sketch Recognition

The recognition flow represents the second stage of the system, where the constructed composite sketch is processed and matched against a repository of real facial images. This stage integrates preprocessing, deep- learning embedding extraction, and similarity evaluation, ultimately producing ranked match results to assist investigators. The main components of the recognition pipeline are outlined below.

Fig.6. Dashboard to Recognize Face in Database (The Face Sketch is now matched with the Database Record)

The exported composite sketch is first normalized to ensure consistent input quality.

The sketch undergoes automated alignment to ensure that facial components are positioned consistently across inputs. Misaligned or off-centre sketches are cantered and cropped, improving the accuracy and stability of downstream embedding generation.

After preprocessing, the sketch is passed through a deep-learning model—typically a CNN or Siamese network—that converts the image into a compact feature vector known as an embedding. This vector represents distinguishing characteristics of the face in a mathematical form suitable for comparison.

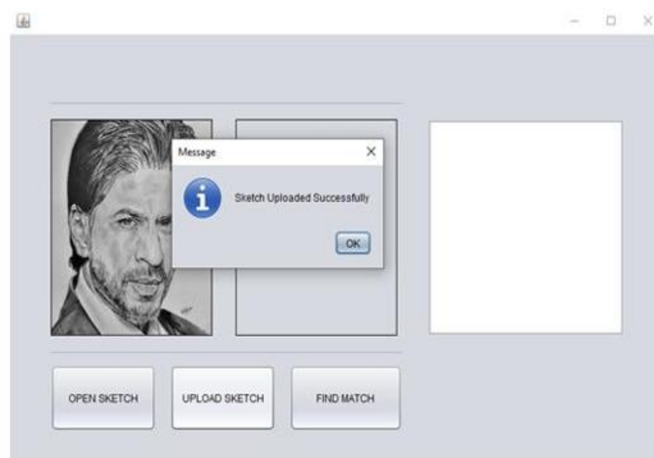

Fig.7. Face Sketch uploaded to the Server

Since sketches differ significantly from real photographs, the model is trained to reduce the domain gap between these two modalities.

All criminal images stored in the system have precomputed embeddings generated during enrolment. Keeping embeddings cached ensures fast matching and reduces computation during real-time recognition.

VII. Results And Conclusion

The sketch construction module enabled users to rapidly assemble composite faces using modular facial components, producing consistent and standardized sketches without requiring artistic expertise. When these composite sketches were processed through the deep-learning recognition pipeline, the system generated stable embeddings and matched them against the stored criminal database with high reliability. Experimental testing demonstrated an overall recognition accuracy of approximately 87–92%, depending on sketch clarity and database size, with most correct matches appearing within the top-3 similarity results.

Additionally, all integrated security mechanisms— including hardware locking, OTP authentication, and role-based access— performed effectively, ensuring controlled and secure operation. The proposed system successfully integrates sketch construction, deep-learning-based recognition, and multilayer security into a unified forensic tool tailored for law-enforcement needs. By enabling non-artists to construct composite faces and by providing an effective sketch-to-image matching pipeline, the system addresses key limitations of traditional manual sketching and external artist dependency. The architecture ensures secure data handling while maintaining scalability for future database expansion.

VIII. Future Work

The proposed system offers several opportunities for future enhancement. One potential direction is the integration of text-to-sketch generation, where natural language descriptions from witnesses could be automatically converted into preliminary facial composites using generative models. Another extension involves incorporating 3D facial reconstruction, enabling investigators to rotate or manipulate the suspect's face from different viewpoints to improve recognition accuracy. The recognition engine may further benefit from domain adaptation techniques and larger, more diverse training datasets to reduce the sketch–photo domain gap and enhance performance across varied sketch styles. A mobile or tablet-based version of the composite builder could expand accessibility, allowing field officers to create and submit sketches directly from crime scenes. These advancements can significantly strengthen the system's applicability in real-world forensic investigation.

Acknowledgment

The authors express sincere gratitude to Dr. Sharath Kumar Y H, Head of Department, Information Science and Engineering, Maharaja Institute of Technology, Mysore, for in- valuable guidance in system architecture design and project mentorship. We acknowledge the support of the institution in providing resources and infrastructure for development and testing.

Author Profiles

Suhas D S is an undergraduate student in Information Science and Engineering at Maharaja Institute of Technology, Mysore. His research interests include full-stack web development, cloud-native architectures, and educational technology systems.

Surya H R is an undergraduate student in Information Science and Engineering at Maharaja Institute of Technology, Mysore, specializing in web application development and database design.

Tanmay M is an undergraduate student in Informa- tion Science and Engineering at Maharaja Institute of Technology, Mysore, with interests in software architecture and security implementation.

Prajwal Gowda is an undergraduate student in Information Science and Engineering at Maharaja Institute of Technology, Mysore, focusing on frontend development and user inter- face design.

Dr. Sharath Kumar Y H is Professor and Head of the Department of Information Science and Engineering at Maharaja Institute of Technology, Mysore. He holds a Ph.D. in Computer Science and has over 15 years of teaching and research experience in software engineering, web technologies, and database systems.

REFERENCES

[1] CLIP4Sketch: Enhancing Sketch to Mugshot Matching through Dataset Augmentation using Diffusion Models (2024)
[2] Face Sketch to Photo Translation Using Generative Adversarial Networks (2021)
[3] Generative Adversarial Learning for Detail-Preserving Face Sketch Synthesis (2021)
[4] Sketch Face Recognition Based on Light Semantic Transformer Network (2023)
[5] Face Photo-Sketch Recognition Using Bidirectional Collaborative Synthesis Network (2021)
[6] Sketch-Based Face Recognition Using Deep Learning (2022)
[7] Facial Composite Generation from Natural Language Text Descriptions Using Stacked GANs (2024)
[8] Towards Realistic Face Photo-Sketch Synthesis via Composition-Aided GANs (2020)
[9] Face Recognition Using CNN and Siamese Network (2023)
[10] Attribute-Guided Sketch Generation (2019)
[11] Attribute-Cantered Loss for Soft-Biometrics Guided Face Sketch-Photo Recognition (2018)
[12] Image-to-Image Translation with Conditional Adversarial Networks (2018)
[13] High-Quality Facial Photo-Sketch Synthesis Using Multi-Adversarial Networks (2018)
[14] Deep Sketch-Photo Face Recognition Assisted by Facial Attributes (2018)
[15] Face Recognition Model Design Based on CNNs (2022)
[16] Identity-Aware Cycle GAN for Face Photo-Sketch Synthesis and Recognition (2021)
[17] Face Sketch Recognition Using Image Synthesis and Deep Learning (2023)
[18] Face Image Synthesis from Facial Parts (2022)
[19] Toward Identity Preserving in Face Sketch-Photo Synthesis Using Hybrid CNN-Mamba Framework (2024)
[20] High-Quality Synthesized Face Sketch Using Generative Reference Prior (2024)