MAJOR PROJECT

FORENSIC FACE SKETCH CONSTRUCTION AND RECOGNITION SYSTEM

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Project Guide:

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Agenda

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Introduction

Imagine a world where a suspect's face can be pieced together from a witness's memory and matched to a criminal database in minutes—not hours or days. That's the power of AI in forensic science.

Forensic face sketching has long been a cornerstone of criminal investigations, bridging the gap when cameras fail. But it's not just about drawing anymore—it's about building and recognizing faces with precision.

Dual Focus

- **Construction**:
Turning vague eyewitness descriptions into detailed, realistic sketches that capture a suspect's true identity.
- **Recognition:**
Matching those sketches to real faces in databases, cutting through the noise of artistic variation.

Why It Matters

In high-stakes investigations, every second counts. Manual methods are slow and subjective—AI steps in to make them fast, accurate, and reliable.

We're introducing a system that transforms how law enforcement constructs suspect faces and identifies them, blending cutting-edge technology with real-world impact.

Motivation

Justice Delayed is Justice Denied

Criminals slip through the cracks when sketches take hours and recognition fails. AI speeds up the process, ensuring suspects are identified before they escape or strike again.

Human Limits, High Stakes

Eyewitness memory fades, and artists can’t always capture the truth. We need a system that overcomes human error to protect communities.

Bridging the Sketch-Photo Gap

Sketches and photos don’t speak the same language–until now. AI builds faces and matches them with precision, turning hunches into evidence.

Empowering Law Enforcement

Small agencies deserve big tools. Our solution scales justice, making accurate face construction and recognition accessible to all.

Abstract

The Challenge:
Traditional forensic sketching is slow, subjective, and often inaccurate in matching sketches to real faces.

Our Solution:
An AI-driven system that:

- Constructs realistic sketches from eyewitness input using AI recommendations.
- Transforms sketches into photorealistic images while retaining identity.
- Recognizes and matches faces to a database with deep learning, providing top matches and similarity scores.

Innovation:
Reduces human bias by ensuring anatomical consistency and preserving critical facial features throughout the process.

Scalability:
Designed to empower all law enforcement agencies, from small units to large forces, with accessible, high-quality tools.

Impact:
Enables faster, more accurate suspect identification for law enforcement.

Literature Survey

S.No	Paper Title	Keywords	Problem Domain	Methods Used	Limitations	Future Work	Findings
[1]	Domain Alignment Embedding Network for Sketch Face Recognition	Sketch recognition, deep metric learning	Face Sketch-Photo Matching	Domain Alignment Embedding Network (DAEN)	Struggles with diverse sketch styles	Improve robustness to different artistic styles & real-time deployment	Achieved high accuracy across datasets, reducing the domain gap
[2]	Feature Encoder Guided Generative Adversarial Network for Face Photo-Sketch Synthesis	GANs, Image-to-image translation	Face Photo-Sketch Synthesis	Cyclic GAN with two generators & two discriminators	High computational cost	Use adaptive loss functions, train on diverse datasets	Improved face recognition accuracy by making sketches photorealistic
[3]	An Identity-Preserved Model for Face Sketch-Photo Synthesis	Identity preservation, Image translation	Face Synthesis	U-Net with two discriminators, identity-verifying ResNet-50, LightCNN-29v2	Needs improvement for diverse demographics	Improve sketch-style adaptation & real-time synthesis	Retained facial identity features effectively, achieving over 85% recognition rates
[4]	Dual-View Normalization for Face Recognition	Face nor-malization, CNN, ArcFace	Face Recognition	Dual-View Normalization with LightCNN	Sensitive to extreme variations in sketch quality	Apply self-supervised learning to improve generalization	Enhanced consistency in sketch-photo matching under different styles
[5]	Forensic Face Photo-Sketch Recognition Using a Deep Learning-Based Architecture	CNN, Deep Learning, Morphable Model	Face Recognition	3D Morphable model, transfer learning, DCNN	Requires extensive training data	Improve synthetic sketch realism & expand datasets	Improved sketch-photo matching by incorporating facial variations

Limitations of Previous Works

🔎 **No Unified System:** Current solutions lack an integrated approach combining face sketch construction and recognition, leading to disjointed workflows.

🔎 **Missing Recommendations:** No system offers AI-driven facial feature recommendations during sketch creation, limiting consistency and realism.

🔎 **GAN-Based Models:** GANs excel in reducing domain gaps (up to 85% accuracy) but demand high computational resources, hindering real-time use.

🔎 **Identity Preservation:** Methods like feature decoupling with LightCNN achieve ~90% accuracy by preserving identity, yet they're computationally expensive.

🔎 **Normalization Challenges:** Dual-discriminator U-Net handles sketch quality variations well but struggles with extreme stylistic differences, reducing reliability.

🔎 **Low-Resolution Handling:** Super-resolution and graph-regularized models, along with identity-aware networks, offer flexibility for low-resolution inputs (85%+ accuracy).

🔎 **Hybrid Models & IHDA:** These perform well in real-world scenarios but require large, diverse datasets to generalize effectively across cases.

Problem Statement

❗ **Recognition Barriers:**
Domain gaps between sketches and photos, compounded by data biases, result in low matching accuracy

❗ **Construction Gaps:**
Artistic variations and witness memory inconsistencies lead to sketches that poorly reflect true identities.

❗ **Core Issue:**
Forensic face sketching and recognition struggle with accuracy and efficiency, critical for timely suspect identification.

❗ **Technical Limitations:**
Existing deep learning models (e.g., GANs, CNNs) falter with low-resolution or incomplete sketches, limiting practical use.

❗ **Need for Innovation:**
A scalable, identity-preserving system is essential to bridge these gaps and enhance law enforcement outcomes.

Methodology

Sketch Creation

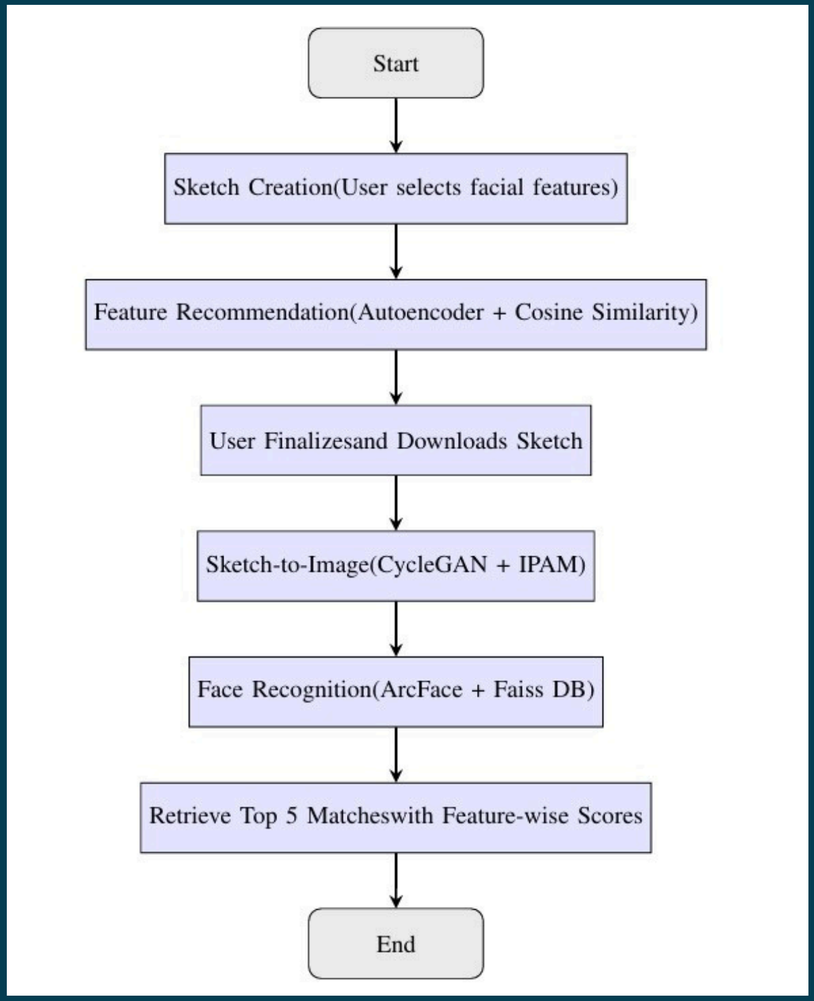
- Users select facial features (eyes, nose, lips, etc.) from a predefined library.
- AI recommends compatible features using an Autoencoder and cosine similarity for consistency.
- Users finalize and download the forensic sketch.

Sketch-to-Image Transformation

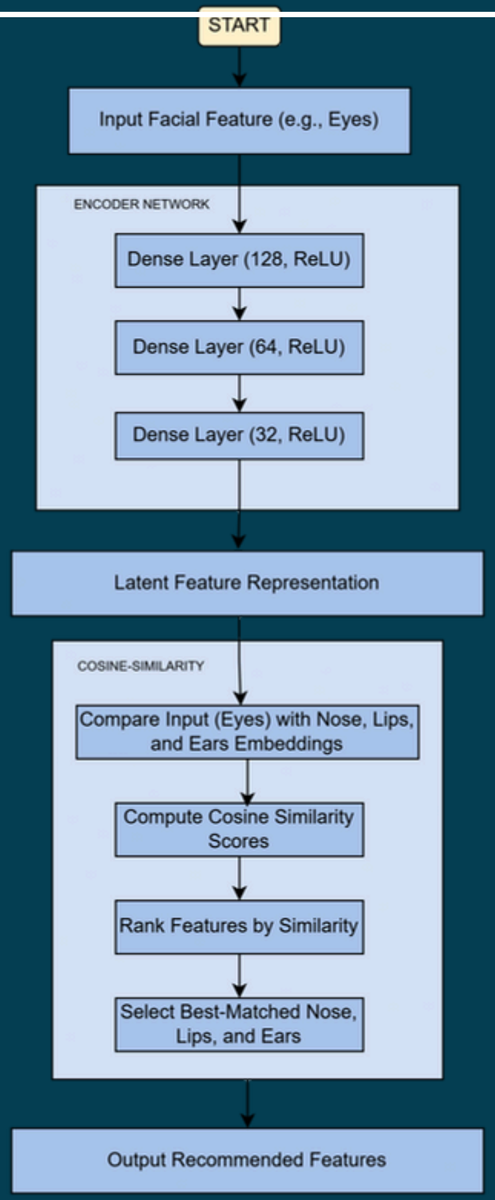
- GAN converts the sketch into a photorealistic image with adversarial and consistency loss.
- IPAM (Identity-Preserving Attribute Model) ensures identity retention during transformation.

Face Recognition

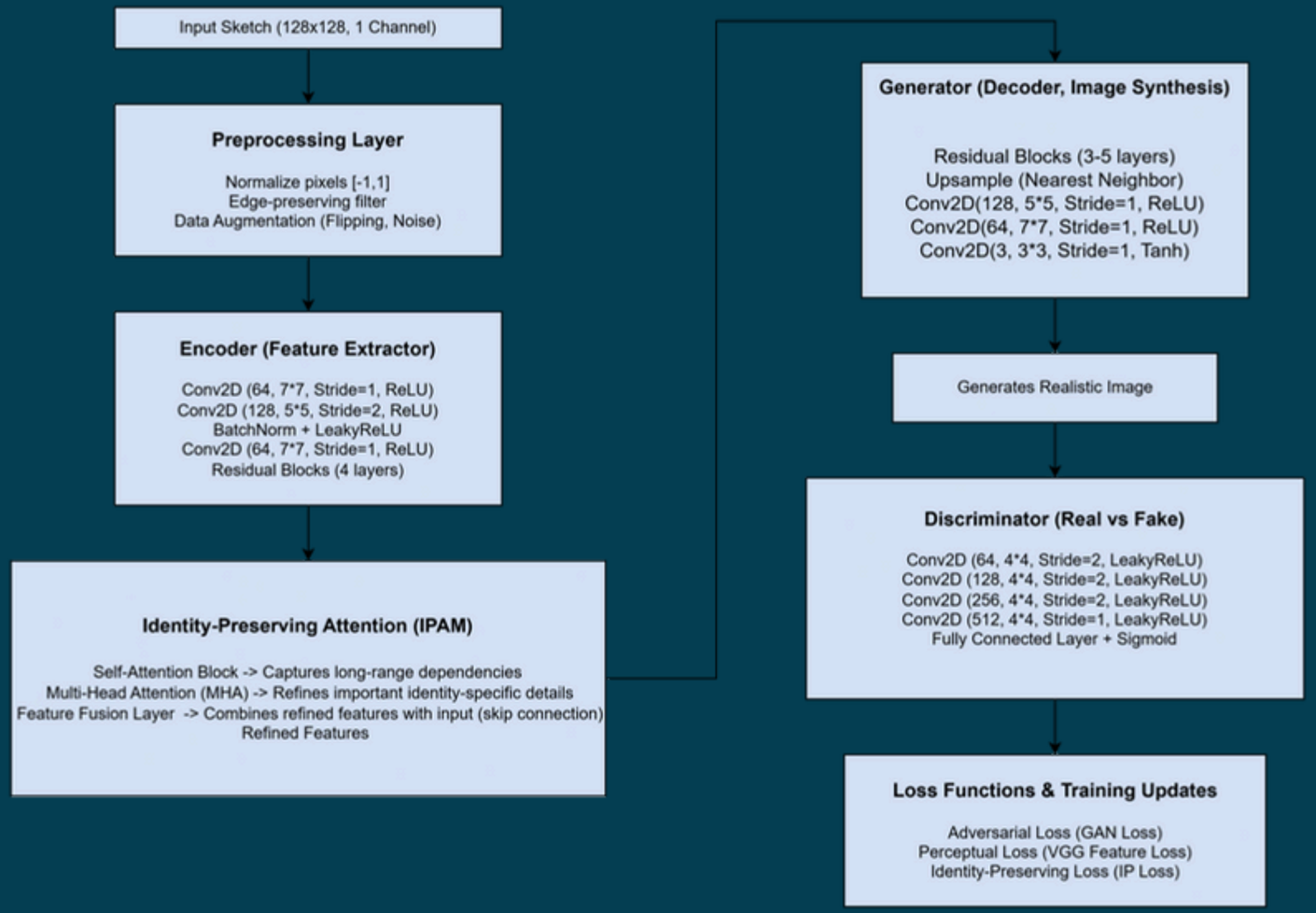
- ArcFace extracts deep facial embeddings from the generated image.
- Faiss database matches embeddings, retrieving the top 5 suspects with feature-wise similarity scores (eyes, nose, lips).



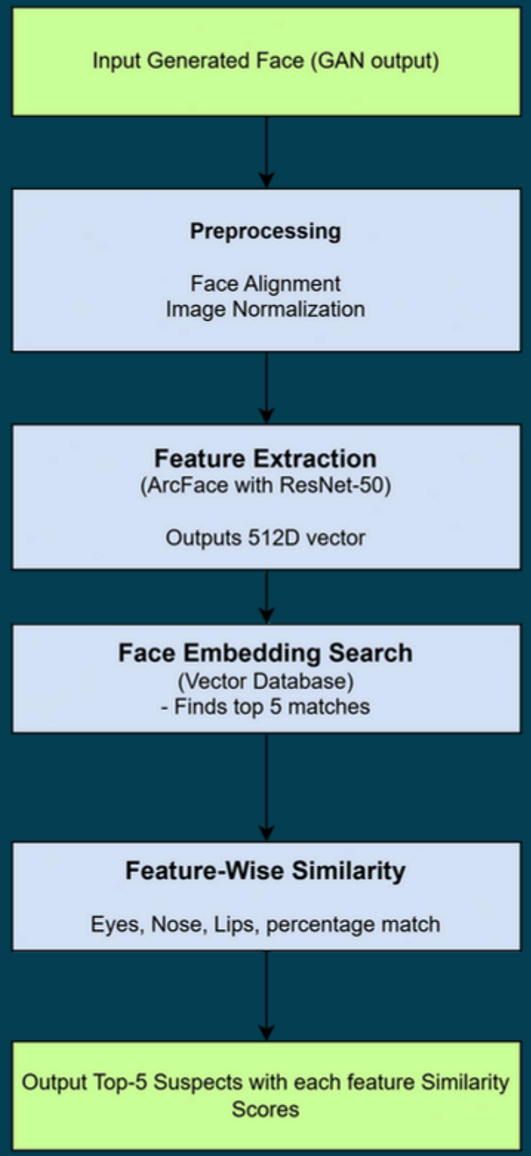
Facial feature recommendations Model



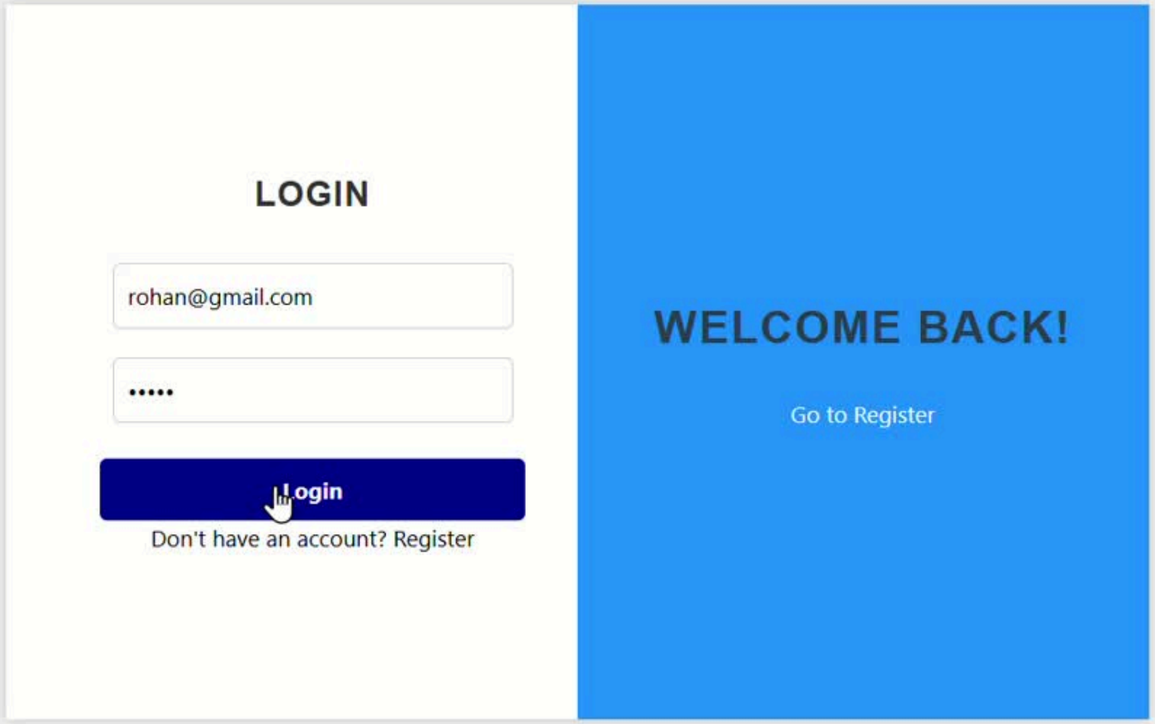
Sketch to Image Model



Face Recognition Model



Implementation



Advantages

Enhanced Accuracy

- AI-driven forensic face sketch construction improves accuracy compared to traditional manual sketching.

Scalability

- Can be used on a large scale for law enforcement and security agencies.

Integration with Databases

- AI models can compare sketches with criminal databases for quick identification.

User-Friendly Interface

- Modern AI tools provide an intuitive interface for forensic artists and officers.

Speed and Efficiency

- Automates the process, reducing time for forensic investigations.

Conclusion

- AI-driven forensic face sketching enhances the accuracy of suspect identification compared to traditional manual sketches.
- Automates the process, reducing the time required for forensic artists to create sketches.
- Converts witness descriptions into realistic facial sketches, aiding in criminal identification.
- Reduces reliance on forensic artists and enables faster suspect identification.
- AI-generated sketches can be matched with law enforcement databases for quicker and more reliable recognition.
- AI models follow a structured approach, minimizing inconsistencies in suspect sketches.
- Future advancements can enable real-time AI-generated sketches during live investigations.
- Continuous development in AI models can enhance accuracy, realism, and ethical considerations.
- AI-based forensic sketching must address bias and ensure fairness in suspect identification.
- The study highlights AI's potential to revolutionize forensic science, making criminal investigations more efficient and technology-driven.

Future Vision

Improved AI Models

- Enhancing AI algorithms to better interpret verbal descriptions and reconstruct highly realistic face sketches.

Real-Time Applications

- Developing real-time systems that generate sketches instantly during live investigations.

Cross-Modal Recognition

- Integrating AI with advanced recognition techniques for better identification.

Global Forensic Integration

- Creating a standardized AI-driven forensic system that can be adopted worldwide.

Ethical Considerations

- Addressing bias and ensuring fairness in AI-generated forensic sketches.

References

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Thank you!