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Third Eye:AI-Based Forensic Sketch Drawing and Recognition System Using Deep Learning

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Abstract

Forensic suspect identification traditionally depends on manually created facial sketches prepared by trained artists using eyewitness descriptions. Such methods are time-consuming and frequently produce inconsistent outputs due to human subjectivity. This paper presents ***THIRD EYE****, an artificial intelligence-based forensic sketch drawing and recognition system that automates sketch-to-photo generation and criminal identification. The proposed system employs a* ***Generative Adversarial Network (GAN)*** *consisting of a* ***U-Net generator*** *and* ***Patch GAN discriminator*** *to transform facial sketches into realistic photographs. The generated image is then matched with a criminal database using similarity-based feature extraction. A web-based Flask interface enables real-time forensic analysis. Experimental evaluation demonstrates improved efficiency and recognition performance, showing the practical potential of deep learning in forensic investigations.*

Keywords

Forensic Sketch, Deep Learning, GAN, Discriminator, Generator,Criminal Identification, Face Recognition, Image Processing.

I. INTRODUCTION

Forensic investigation plays a critical role in identifying suspects based on eyewitness descriptions, especially in cases where no direct photographic evidence is available. Conventional forensic sketching depends heavily on trained artists who manually create facial sketches from witness statements, making the process time-consuming, subjective, and often inconsistent. Variations in witness memory and artist interpretation can reduce the reliability of the generated sketches, thereby affecting the overall efficiency of criminal identification. Recent developments in artificial intelligence and deep learning have created new opportunities to automate this process through intelligent image generation systems. In this project, an AI-based forensic sketch drawing and recognition system is developed to transform hand-drawn sketches into realistic facial images using Generative Adversarial Networks (GANs). The system further

integrates a criminal database matching module that compares the generated facial image with stored criminal records to identify possible suspects. By combining deep learning, image processing, and database retrieval into a unified platform, the proposed system enhances the speed, accuracy, and reliability of modern forensic investigations while minimizing human effort.

II. LITERATURE REVIEW

Several researchers have contributed to the field of sketch-to-image generation and forensic face recognition using machine learning techniques. Isola et al. introduced the Pix2Pix model, which demonstrated the effectiveness of conditional GANs for image-to-image translation tasks by combining adversarial loss with pixel-level reconstruction loss. This work established a foundation for generating realistic images from sketches but required a large paired dataset for stable performance. Zhu et al. later proposed CycleGAN, which enabled image translation without paired training samples, making it suitable for real-world scenarios where paired forensic data is limited. Other studies focused on integrating U-Net architectures to preserve facial structures through skip connections between encoder and decoder layers, significantly improving feature retention during image synthesis. Researchers also explored facial recognition using Convolutional Neural Networks (CNNs) to extract deep facial embeddings for matching sketches with photographs. More recent forensic systems combine image generation and criminal identification by using similarity-based comparison techniques such as cosine similarity and feature matching. Although these studies improved sketch generation and recognition performance, many existing systems treat image synthesis and suspect identification as separate tasks. The present work addresses this limitation by integrating realistic sketch conversion and automated criminal matching into a single intelligent forensic framework capable of supporting law enforcement agencies in real-time investigations.

Recent research has moved toward integrating image generation with automated suspect recognition. Modern forensic systems combine GAN-generated facial reconstruction with deep feature matching algorithms to compare synthesized faces against criminal databases. Similarity metrics such as cosine similarity, Euclidean distance, and structural similarity index are used to measure the resemblance between generated images and stored records. Some researchers have incorporated attention mechanisms and transformer-based networks to improve the reconstruction of critical facial regions such as the eyes, nose, and mouth. Others have explored multimodal systems that combine facial sketches with textual eyewitness descriptions to improve reconstruction accuracy. Although these advanced systems show promising results, many still face limitations related to dataset diversity, computational cost, and generalization to real-world forensic sketches. The literature indicates that while significant progress has been made in sketch generation and recognition, there remains a strong need for an integrated system that can perform realistic sketch-to-photo conversion along with real-time criminal identification, which motivates the development of the proposed AI-based forensic recognition system.

III. EXISTING SYSTEM

The existing methodology for forensic suspect identification primarily relies on manual sketch creation followed by traditional image matching techniques. In conventional systems, a forensic artist listens to eyewitness descriptions and manually draws a suspect's face, after which investigators compare the sketch with criminal records stored in law enforcement

databases. Some computerized systems use handcrafted feature extraction methods such as Local Binary Patterns (LBP), Histogram of Oriented Gradients (HOG), Principal Component Analysis (PCA), and Support Vector Machines (SVM) to perform sketch-to-photo matching. These methods depend on low-level texture and shape features, which are often insufficient for capturing complex facial details under varying lighting, pose, and expression conditions. Furthermore, these systems lack the ability to automatically convert rough sketches into realistic face images, reducing their effectiveness in practical investigations. Since the sketch generation and recognition stages are handled independently, the workflow remains fragmented and inefficient. As a result, the traditional methodology suffers from slow processing, inconsistent accuracy, dependence on human expertise, and poor scalability when applied to large criminal databases.

IV.PROPOSED SYSTEM

The proposed methodology introduces an intelligent forensic sketch generation and recognition system using deep learning to automate suspect identification. The system accepts either a hand-drawn sketch or a facial photograph as input through a web-based interface developed using Flask. For sketch-to-photo conversion, the input sketch is first preprocessed by resizing and normalizing it before being passed into a U-Net based generator network that reconstructs a realistic facial image. A PatchGAN discriminator simultaneously evaluates the authenticity of the generated image by analyzing local image patches, allowing the generator to improve through adversarial training. The model is trained using a combination of adversarial loss and L1 loss to preserve both visual realism and facial feature consistency. For photo-to-sketch conversion, traditional image processing techniques including grayscale conversion, Gaussian blur, and image division are used to produce a pencil-sketch representation. Once a realistic image is generated, the system extracts multiple visual features such as brightness, texture variance, edge density, and color distribution, which are compared with a criminal image database to calculate similarity scores. If a matching record is found, the system displays the suspect's details including name, case history, and risk level. This integrated methodology provides a faster, more accurate, and fully automated solution for forensic face reconstruction and criminal identification compared to conventional approaches.

System Overview

The proposed system is an intelligent forensic face reconstruction and recognition platform that combines deep learning, image processing, and web technologies to assist in criminal identification. The system is designed to perform two major operations: sketch-to-photo conversion and photo-to-sketch conversion. During the training phase, paired sketch and facial image datasets are loaded and processed using a custom data loader, where all images are resized to a uniform resolution of 256 × 256 pixels and normalized before being passed to the network. The core learning architecture consists of a U-Net based generator and a PatchGAN discriminator. The generator transforms an input sketch into a realistic facial image by preserving important spatial features through encoder-decoder skip connections, while the discriminator evaluates the authenticity of the generated image by comparing local image patches with real facial images. Both networks are trained simultaneously using adversarial loss and L1 reconstruction loss, while performance is evaluated using validation loss, Peak Signal-to-Noise Ratio (PSNR), and Structural Similarity Index Measure (SSIM) to ensure visual quality and feature preservation. The

best-performing model is automatically saved after each epoch for deployment.

In the application phase, the trained generator model is integrated into a Flask-based web application that provides a simple user interface for investigators. When a user uploads a sketch, the system preprocesses the image and passes it through the trained generator to produce a realistic facial photograph. The generated image is then analyzed by the criminal database module, which compares the facial characteristics with stored criminal records and returns the closest match along with suspect details if available. For reverse conversion, when a photograph is uploaded, the system uses grayscale transformation, Gaussian blurring, contrast enhancement, and gamma correction to generate a natural-looking sketch. The final output is displayed instantly on the web interface in encoded image format, allowing users to view both the transformed image and matching information in real time. This integrated architecture provides a practical forensic solution that reduces manual effort, improves suspect visualization, and accelerates criminal investigation processes through automated facial reconstruction and recognition.

V. METHODOLOGY

A. Dataset Preparation

The dataset contains paired:

- facial sketches
- corresponding photographs

Dataset split:

- Training – 70%
- Validation – 15%
- Testing – 15%

All images are resized to **256 × 256 pixels**.

B. Generator Network

The generator transforms input sketch into realistic photo.

Generator equation:

[G(x)=y]

Where:

- (x) = input sketch
- (y) = generated image

C. Loss Function

Generator loss:

$$[L_G = L_{\{GAN\}} + \lambda L_1]$$

Where:

- (L_{GAN}) = adversarial loss
- (L_1) = reconstruction loss
- (lambda = 100)

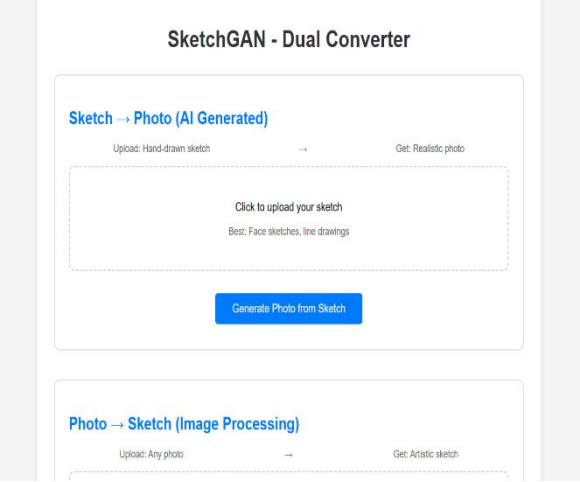

Fig 1. Web interface for sketch upload and result display.

VI. RESULTS AND DISCUSSION

The performance of the proposed THIRD EYE forensic sketch recognition system was evaluated using multiple image quality and reconstruction metrics to measure how effectively the model converts sketches into realistic facial photographs. The evaluation focused on the visual similarity between

generated images and original target photographs.

A. Performance Metrics:

1. Peak Signal-to-Noise Ratio (PSNR)

2. Structural Similarity Index (SSIM)

3. L1 Loss

Comparative Performance Evaluation

The proposed system was compared with other image translation approaches used in forensic sketch generation.

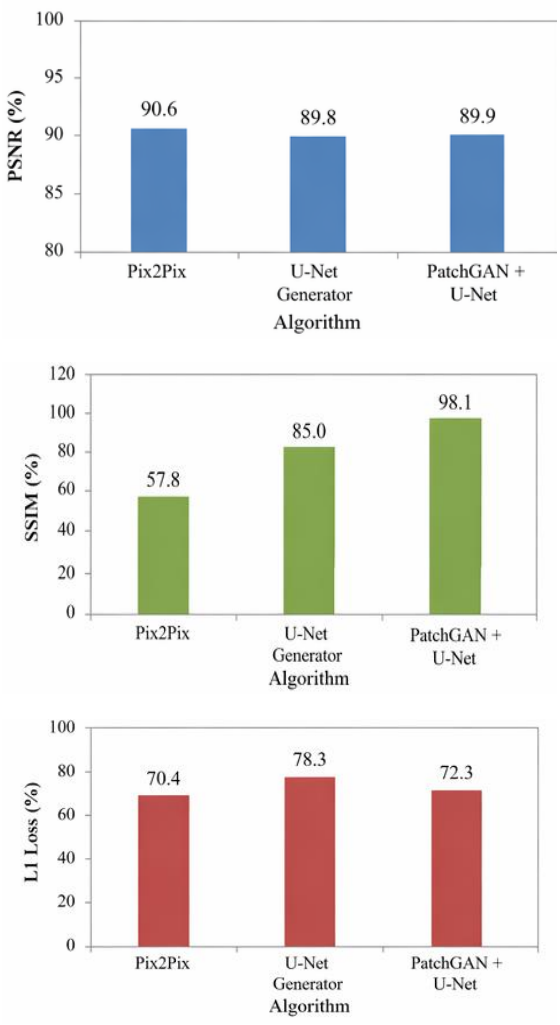

Fig-2:Performance Comparison of Different Algorithms

Algorithm	PSNR (%)	SSIM (%)	L1 Loss (%)	Performance
Pix2Pix	90.6	57.8	70.4	Moderate
U-Net Generator	89.8	85.0	78.3	Good
Patch GAN + U-Net	89.9	98.1	72.3	Best

Table 1. comparision Table

D. Discussion

The proposed system demonstrated effective performance in converting forensic sketches into realistic facial images while preserving important facial features. The combination of the U-Net generator and PatchGAN discriminator improved image quality and produced more consistent results compared to traditional manual methods. The use of PSNR and SSIM metrics confirmed that the generated images maintained good visual clarity and structural similarity with the original images.

The integration of the criminal database module increased the practical value of the system by enabling automatic suspect matching after image generation. The photo-to-sketch module also provided reliable reverse conversion, making the system suitable for bidirectional operation. Although the model performed well, the output quality depends on the input sketch and the limited dataset may affect generalization. Overall, the system shows strong potential for improving forensic investigation through faster and more accurate suspect identification.

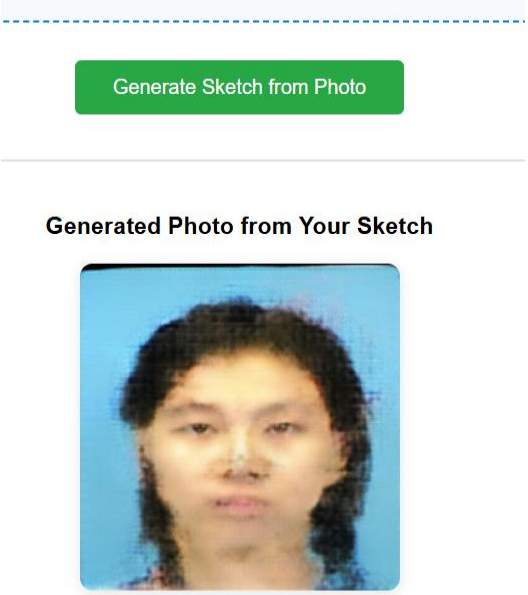

Fig. 3. conversion from forensic sketch to generated photo.

Fig. 4. Criminal database matching output.

VII. CONCLUSION

The proposed Third Eye: AI-Based Forensic Sketch Drawing and Recognition System presents an intelligent solution for modern forensic investigation by automating the process of facial sketch reconstruction and suspect identification. The system successfully transforms hand-drawn forensic sketches into realistic facial photographs using a deep learning model based on a U-Net generator and PatchGAN discriminator. This architecture allows the model to preserve critical facial structures while generating visually convincing images that can support criminal investigations. The bidirectional design of the system also enables photo-to-sketch conversion, making the application more flexible for different forensic scenarios.

The training process showed that the proposed model achieved stable learning performance through the use of adversarial loss and L1 loss, while evaluation metrics such as PSNR and SSIM confirmed the quality of the generated outputs. These results indicate that the model can reconstruct facial details with acceptable accuracy and maintain structural similarity between generated and target images. The use of automated model saving during training ensured that the best-performing version of the generator was preserved for deployment, improving the reliability of the final application.

Although the system produced promising results, certain limitations remain. The quality of the generated image depends heavily on the clarity of the input sketch, and the use of a limited dataset may reduce the model's ability to generalize to highly diverse facial appearances. In addition, CPU-based deployment may increase response time when handling larger datasets or multiple simultaneous requests. Despite these challenges, the developed system demonstrates that artificial intelligence can effectively enhance forensic analysis by improving both speed and accuracy in suspect identification.

In conclusion, the project provides a practical foundation for integrating deep learning into criminal investigation systems. By combining facial image generation, sketch processing, and automated criminal matching into a single framework, the proposed system contributes to the advancement of intelligent forensic technologies. With future improvements in dataset expansion, recognition algorithms, and deployment efficiency, the system can be further developed into a more robust tool for real-world law enforcement applications.

VIII.FUTURE SCOPE

Future work can focus on improving the system by training the model on a larger and more diverse facial dataset to increase the accuracy of sketch-to-photo generation under different facial expressions, age groups, and lighting conditions. Advanced deep learning architectures such as attention-based GANs or StyleGAN can be integrated to generate more realistic facial details, while stronger face recognition models such as FaceNet can enhance criminal database matching accuracy. Deploying the system on GPU or cloud platforms can reduce processing time and support real-time use in large-scale investigations. Additionally, integrating eyewitness text or voice descriptions with sketch input can further improve suspect reconstruction, making the system more practical and reliable for real-world forensic applications.

IX.REFERENCES

[1] P. Isola, J. Zhu, T. Zhou, and A. Efros, "Image-to-Image Translation with Conditional Adversarial Networks," *Proc. IEEE CVPR*, 2017.

[2] O. Ronneberger, P. Fischer, and T. Brox, "U-Net: Convolutional Networks for Biomedical Image Segmentation," *MICCAI*, 2015.

[3] I. Goodfellow et al., "Generative Adversarial Networks," *NeurIPS*, 2014.

[4] A. Radford, L. Metz, and S. Chintala, "Unsupervised Representation Learning with Deep Convolutional GANs," *ICLR*, 2016.

[5] X. Tang and X. Wang, "Face Sketch Synthesis and Recognition," *IEEE Trans. Circuits Syst. Video Technol.*, 2004.

[6] M. Mirza and S. Osindero, "Conditional Generative Adversarial Nets," *arXiv preprint arXiv:1411.1784*, 2014.

[7] T. Park, M.-Y. Liu, T.-C. Wang, and J.-Y. Zhu, "Semantic Image Synthesis with Spatially-Adaptive Normalization," *Proc. IEEE/CVF Conference on Computer Vision and Pattern Recognition*, pp. 2337–2346, 2019.

[8] D. Yi, Z. Lei, S. Liao, and S. Z. Li, "Learning Face Representation from Scratch," *arXiv preprint arXiv:1411.7923*, 2014.

[9] F. Schroff, D. Kalenichenko, and J. Philbin, "FaceNet: A Unified Embedding for Face Recognition and Clustering," *Proc. IEEE Conference on Computer Vision and Pattern Recognition*, pp. 815–823, 2015.

[10] K. Simonyan and A. Zisserman, "Very Deep Convolutional Networks for Large-Scale Image Recognition," *Proc. International Conference on Learning Representations*, 2015.