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FACETRACE- TURNING TEXT INTO FACES

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ABSTRACT

In the modern era, the rapid rise in crime rates has made it increasingly important for law enforcement agencies to adopt faster and more efficient methods to identify and apprehend criminals. Traditional investigation methods often involve manual and time-consuming processes that may not keep pace with the growing complexity of criminal activities. One crucial aspect of criminal identification is facial recognition, which has long relied on hand-drawn sketches created by forensic sketch artists based on eyewitness accounts. These sketches are then circulated or matched manually with existing records in police databases, making the process slower and prone to human error. Modernizing this traditional method can significantly enhance the speed and accuracy of criminal investigations. Instead of solely depending on manually drawn sketches, law enforcement can leverage advanced face recognition technologies to match these sketches with digital criminal databases automatically. This not only reduces the time taken to identify suspects but also increases the likelihood of accurate matches, especially in cases where multiple suspects share similar features.

A more innovative and efficient approach would be to develop an application that allows the creation of a facial sketch by selecting and combining individual features such as eyes, ears, nose, mouth, hair, and face shape. This modular, feature-based system ensures that sketches are more precise and standardized, minimizing variations caused by different artists' drawing styles. Once the composite sketch is generated, it can be instantly compared with a centralized facial recognition database to identify potential matches. Such a system would significantly speed up criminal identification, enabling law enforcement to respond quickly and effectively. It would also reduce reliance on artistic skills and make the process more accessible, even to non-artists. Furthermore, integrating automated face recognition with forensic sketching provides a hybrid solution that combines human intelligence with artificial intelligence, ultimately leading to more efficient investigations, faster suspect identification, and improved public safety.

Keywords: Face sketches, Construction, Recognition, Deep learning, AWS, Security, Two Step Verification, Machine Locking, Criminal Identification, Natural Language Processing(NLP).

1. INTRODUCTION

In the past, identifying offenders based on eyewitness accounts relied heavily on the expertise of forensic sketch artists. A hand-drawn facial sketch, created from the eyewitness's description, was often a key tool in locating and apprehending criminals. However, while effective in earlier times, this traditional method of manual sketching and identification has become less feasible and time-efficient in today's digital era, especially when law enforcement agencies must match the sketch against large, complex, and often real-time criminal databases. Manual matching is slow, prone to human error, and often lacks the precision required to identify suspects quickly in high-stakes situations.

Over the years, several techniques have been proposed to digitally convert hand-drawn sketches into formats that could be matched against databases using automated recognition algorithms. While these approaches showed promise, they often failed to deliver the level of precision required for real-world investigations. Similarly, existing face-sketch construction applications, though helpful, had their own drawbacks limited facial feature libraries restricted how accurately a sketch could represent a suspect, and the output often had a cartoonish appearance rather than a realistic one. This lack of realism made it harder to generate reliable matches, thereby reducing the effectiveness of the identification process. These challenges highlight a clear gap between traditional sketching methods and modern facial recognition technologies. To bridge this gap, the proposed solution aims to develop an advanced and flexible face-sketch recognition system. Unlike conventional applications that only allow feature selection from a predefined set of facial components (eyes, nose, mouth, ears, hair, etc.), this system will also enable users to upload hand-drawn facial features. By integrating the uploaded sketches with the digital interface, the generated facial composite becomes much more accurate and personalized, preserving the unique characteristics captured in the eyewitness-based drawing. This

makes the tool more practical and easier for law enforcement agencies to adopt, as it complements their existing workflow rather than replacing it entirely. The system will leverage deep learning models combined with cloud-based infrastructure to enhance performance and scalability. Using services like S3 buckets and the facial recognition capabilities of Amazon Recognition from Amazon Web Services (AWS), the platform can store, process, and compare sketches with large centralized databases efficiently. The recognition model will not only match uploaded sketches with existing records but also intelligently suggest compatible facial features that align with the chosen attributes, thereby assisting investigators in refining and finalizing the sketch quickly.

By automating much of the labor-intensive work involved in sketch-based suspect identification, this system would significantly reduce the time required to identify suspects, while increasing accuracy and reliability. Its adaptability allowing both manual input through hand-drawn features and automated assistance through AI makes it a powerful hybrid solution. Ultimately, this approach has the potential to **revolutionize how law enforcement agencies conduct criminal identification**, offering a faster, smarter, and more scalable alternative to traditional methods.

2. LITERATURE SURVEY

1. Text-to-Face Generation with StyleGAN2 (2024)

D. M. A. Ayanthi and S. Munasinghe proposed a model for text-to-face generation using StyleGAN2 with text encoders. Their research demonstrated the feasibility of generating highly realistic human faces directly from textual descriptions. The study highlighted the capability of GAN architectures, particularly StyleGAN2, in bridging the gap between natural language and image synthesis.

2. GANs for Text-to-Face Synthesis: Spanish NLP Encoder Analysis (2024)

Z. Yauri-Lozano, C. Castillo-Cara, O. Orozco-Barbosa, and A. García-Castro conducted a study focusing on the impact of different text encoders on the realism and accuracy of text-to-face synthesis. Using models such as RoBERTa, Sent2Vec, and cDCGAN, they demonstrated that the choice of NLP encoder significantly influences the quality and authenticity of generated faces. Their work emphasized the importance of effective text encoding for improved GAN performance.

3. TextGaze: Gaze-Controllable Face Generation with Natural Language (2024)

Hengfei Wang, Zhongqun Zhang, Yihua Cheng, and Hyung Jin Chang developed a novel model called TextGaze, which combines Transformer-based NLP models with GANs to achieve fine-grained gaze control in face generation. Their research enabled the generation of facial images with specific gaze directions based on textual input, thereby enhancing realism and interactivity in text-to-face systems.

4. 3D Face Reconstruction: The Road to Forensics (2023)

S. Maurizio La Cava, G. Orrù, M. Drahansky, G. L. Marcialis, and F. Roli explored the use of 3D face reconstruction combined with GANs in forensic applications. Their study demonstrated how AI-driven facial reconstruction can assist in recreating 3D facial models for investigative and identification purposes. This research provided valuable insights into the integration of deep learning techniques in digital forensics.

3. METHODOLOGY

The proposed methodology begins with collecting eyewitness descriptions and creating initial hand-drawn sketches based on the provided details. These sketches are then uploaded to the platform, where advanced deep learning algorithms extract and analyze individual facial features such as eyes, nose, mouth, and ears. The system preprocesses and standardizes these sketches to ensure consistency and compatibility with the recognition model. An interactive interface allows investigators to refine or construct facial composites by selecting or adjusting features as needed. All the data, including uploaded sketches and extracted features, is securely stored in a cloud infrastructure such as an S3 bucket. The platform then uses Amazon Recognition to match the processed sketches against a centralized criminal database. Based on similarity scores, the system suggests the most probable matches in real time. This efficient and automated workflow significantly reduces the time required for suspect identification while improving precision and reliability for law enforcement investigations.

3.1 SYSTEM OVERVIEW:

The proposed system streamlines criminal identification by combining hand-drawn sketches with AI-powered facial recognition. Eyewitness sketches are uploaded and processed using deep learning to extract key facial features. These are refined through an interactive interface and securely stored in the cloud. Amazon Recognition then matches the sketches against a centralized criminal database. The system provides real-time, ranked suspect matches, improving speed, accuracy, and efficiency for law enforcement investigations.

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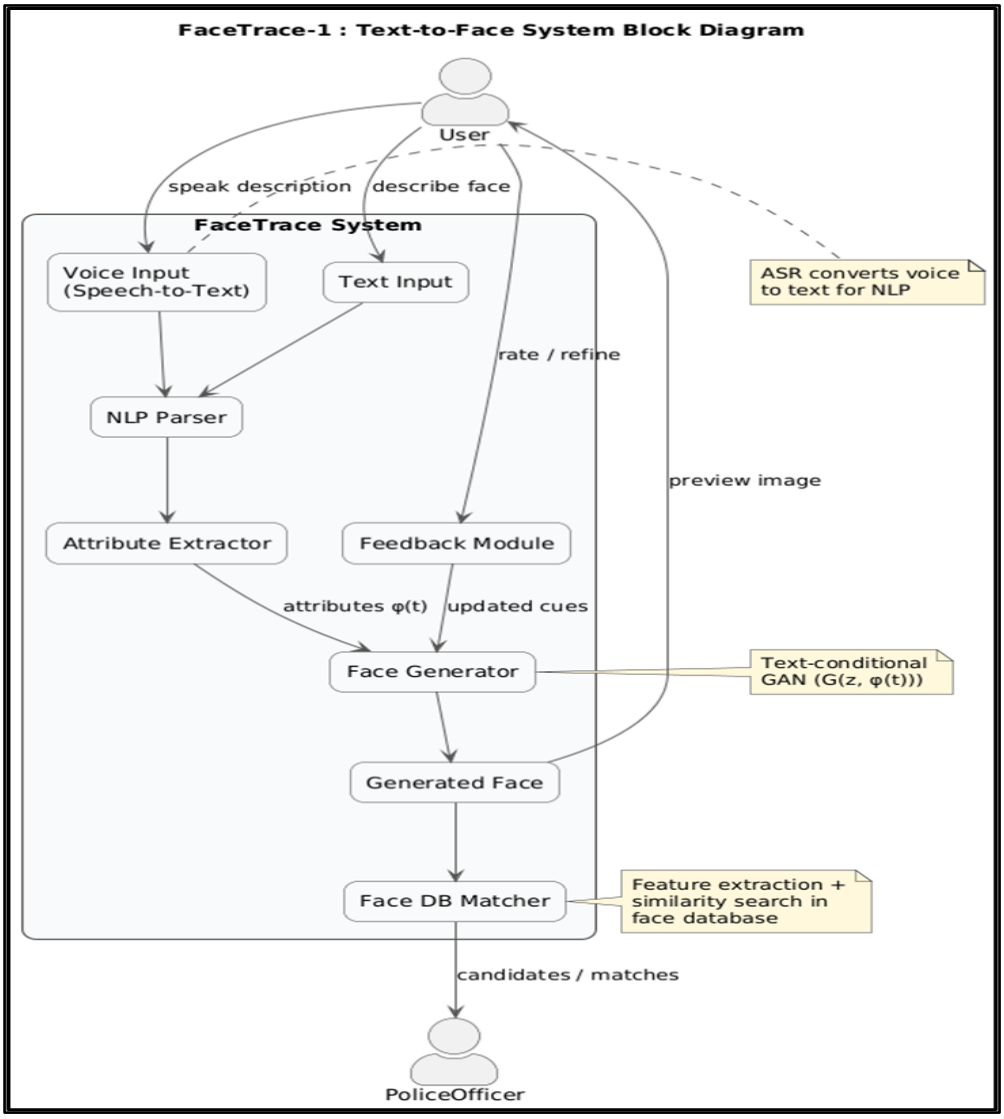
3.2 THE SYSTEM SEEKS TO:

1. It allows uploading or creating facial sketches using selectable features.
2. Sketches are matched against a centralized criminal database.
3. Provides potential matches quickly to assist investigators.
4. Aims to reduce manual effort and improve efficiency in investigations.

3.3 SYSTEM BLOCK DIAGRAM:



4. MODELING AND ANALYSIS

The following describes the suggested FaceTrace workflow:

1. Text Input: The user or investigator enters a detailed facial description in natural language (e.g., “man with curly hair and beard”).
2. Text Preprocessing (NLP): The description is cleaned, tokenized, and converted into a semantic embedding vector (φ(t)) understandable by the model.
3. Noise Generation: A random noise vector (z ~ N (0,1)) is created to introduce variation in generated faces.
4. Generator Network: The Generator combines text embedding and noise to produce a synthetic face image that matches the description.
5. Discriminator Network: The Discriminator checks if the image is real or fake and whether it aligns correctly with the given text.
6. Adversarial Training: Generator and Discriminator train together—one tries to fool, the other tries to detect—improving accuracy over time.
7. Evaluation: Generated images are evaluated using metrics like FID and expert visual inspection for quality and realism.
8. Output & Storage: The final realistic face is displayed to the user and stored in the database for forensic identification or further analysis.

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4.1 EXPECTED OUTCOMES

1. Generates realistic human faces from textual descriptions using GANs.
2. Enhances accuracy and speed in forensic suspect identification.
3. Supports multilingual input (English, Hindi, Marathi) for inclusivity.
4. Achieves better alignment between text descriptions and generated images.
5. Provides practical use in forensics, missing person identification, and media.
6. Demonstrates potential for real-world law enforcement and digital applications.

5. RESULTS AND DISCUSSION

5.1 PROTOTYPE DESIGN

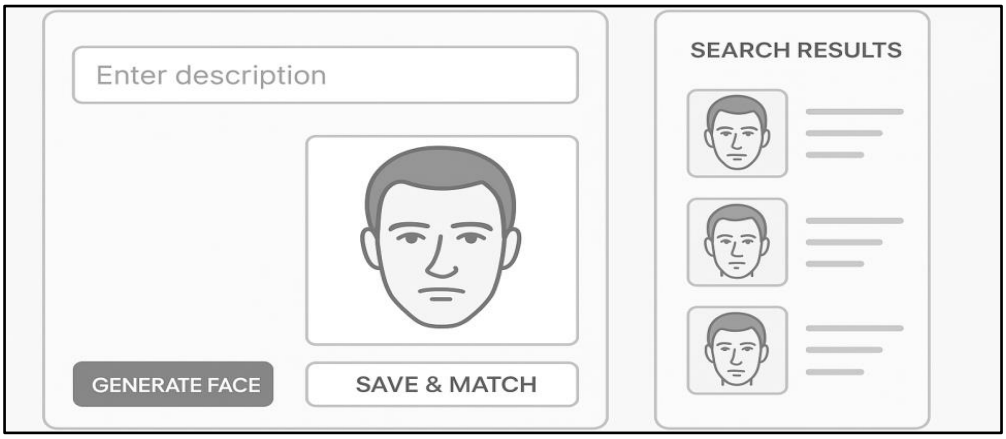

Fig 5.1: Prototype Design- FaceTrace

5.2 FUTURE ENHANCEMENTS

Following testing and successful deployment, the system can be extended to include:

1. Increase image resolution using advanced GAN models like StyleGAN or Diffusion Models.
2. Develop a real-time face generation system for instant suspect visualization.
3. Expand the dataset with more diverse faces covering age, gender, and ethnicity.
4. Integrate 3D face reconstruction for more detailed and accurate outputs.
5. Add emotion and expression control based on text input (e.g., “smiling”, “angry”)

5.3 CHALLENGES AND LIMITATIONS:

1. Data Limitations: Existing datasets like CelebA lack detailed natural language descriptions and diverse demographics.

2. Training Complexity: GANs require large computational resources and are difficult to train without instability or mode collapse.

3. Accuracy of Text Descriptions: Eyewitness statements may be vague, incomplete, or subjective, affecting face generation accuracy.

4. Evaluation Metrics Issue: Common metrics like the Inception Score do not accurately measure face realism or text–image alignment.

5. Ethical and Privacy Concerns: Generated faces could be misused or raise issues of consent and identity privacy

6. CONCLUSION

This work demonstrates a novel approach to generating realistic human faces from fine-grained textual descriptions using a text-conditional GAN. By converting CelebA attributes into natural captions and applying training stabilizations, our method achieves promising results. The study also highlights the limitations of existing evaluation metrics, emphasizing the need for better text-to-face assessment methods.

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