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Face Sketch Creation and Recognition

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Abstract: This paper presents a wisdom mapping approach to dissect the thematic elaboration of face recognition exploration. For this reason, different bibliometric tools are combined (Performance analysis, wisdom mapping and Coword analysis) to identify the most important, productive and loftiest- -impact sub fields. also, different visualization tools are used to display a graphical vision of the face recognition field to determine the thematic disciplines and their evolutionary geste. . Eventually, this study proposes the most applicable lines of exploration for the face recognition field. Findings indicate a huge increase in face recognition exploration since 2014. Mixed approaches revealed a great interest compared to original and global approaches. In terms of algorithms, the use of deep literacy styles is the new trend. On the other hand, the illumination variation impact on face recognition algorithms' performances is currently, the most important and impacting challenge for the face recognition field.
Keywords: Deep learning, Face Creation, Face Recognition, Convolutional Neural Network, Face Sketches, AWS, Security, Two-Step Verification, Criminal Identification, Pattern Recognition, Feature Extraction.

I. INTRODUCTION

The human face is crucial for social interaction and communication, aiding in recognizing individuals in various settings. From interpersonal connections to technological applications, face recognition enhances interactions and security. Traditionally, it has been used in access control, security systems, and surveillance, optimizing workflow efficiency and safety protocols. However, modern technology demands refined methodologies to meet current needs. Recent advancements in face recognition technology have led to sophisticated algorithms improving accuracy and efficiency. Two primary modes, face verification and face identification, underscore its diverse applications. Face verification determines if two images depict the same individual, while face identification identifies a person from a pool of candidates, highlighting the complexity of implementation.

Our research addresses challenges in face recognition by proposing a hybrid neural network solution. Integrating diverse computational techniques inspired by human perception, our approach combines local image sampling, a self-organizing map (SOM) neural network, and a convolutional neural network (CNN) for robustness, dimensionality reduction, and partial invariance to factors like translation, rotation, scale, and deformation.

Additionally, we explore alternative techniques such as the Karhunen–Loeve (KL) transform and a multilayer perceptron (MLP) to compare their efficacy with our hybrid model. Through experimentation and analysis, we demonstrate superior performance, especially in scenarios with limited training data and variability in facial expressions, poses, and details. Leveraging a comprehensive database of 400 images from 40 individuals, our solution proves scalable and adaptable across real-world applications. Beyond performance metrics, we consider computational complexity and strategies for accommodating new classes within the trained recognizer. By examining the thematic evolution of face recognition research and identifying emerging trends, we contribute to ongoing discussions in this dynamic field. Ultimately, our research aims to advance face recognition technology, enhancing security measures, human-computer interaction, and criminal identification processes.

A. Classical Face Sketch Creation

Classical face creation encompasses a wide array of techniques, ranging from traditional methods to cutting-edge technologies. One common approach involves utilizing specialized software platforms tailored for crafting digital portraits or composite sketches. These platforms offer a plethora of tools enabling users to manipulate facial features, tweak proportions, and add intricate details like hair, eyes, and skin texture. Whether it's for artistic expression or forensic investigation, these digital tools empower artists and investigators to produce realistic depictions of faces, drawing inspiration from their imagination or reference photographs.

Furthermore, classical face creation often entails leveraging pre-existing sketches or templates as a starting point for further customization. Forensic artists, for instance, may commence with a rudimentary outline or composite sketch provided by a witness, refining it with additional details or descriptions to achieve a more accurate portrayal. Similarly, artists across various domains may utilize stock images, historical portraits, or artistic references as foundational elements for their creations. They adapt and modify these references to align with their specific requirements or artistic vision, resulting in unique and compelling representations.

In addition to digital tools and pre-existing references, classical face creation can also involve traditional techniques such as sketching by hand or sculpting clay models. These traditional methods offer artists a hands-on approach to capturing the intricacies of facial anatomy and expression, allowing for a deeper level of artistic interpretation and creativity.

Moreover, advancements in technology have expanded the repertoire of classical face creation techniques. Techniques like 3D modeling and rendering enable artists to sculpt lifelike faces in virtual environments, adding a new dimension to the creative process. Furthermore, machine learning algorithms can analyze vast datasets of facial images to generate photorealistic portraits or predict facial features based on given parameters, pushing the boundaries of what's possible in face creation.

B. Feature Extraction

In the realm of face recognition, feature extraction refers to the process of identifying and isolating crucial facial attributes or characteristics from images or datasets. These attributes act as distinct identifiers, enabling precise differentiation between individual faces and forming the foundation for accurate classification and identification. Essentially, feature extraction entails converting raw visual data into a more condensed and representative format, facilitating efficient analysis and comparison.

A diverse array of techniques is employed for feature extraction in face recognition systems, each targeting specific aspects of facial appearance and structure. One prevalent method involves extracting geometric features, which encompass the positions and proportions of critical facial landmarks like the eyes, nose, mouth, and chin. By quantifying the spatial relationships between these landmarks, a unique geometric profile is generated for each face. This profile serves as a basis for matching and recognition tasks, contributing to the robustness and accuracy of the overall system.

In addition to geometric features, other types of facial attributes can also be extracted during the feature extraction process. These attributes may include texture patterns, such as skin texture and wrinkles, as well as statistical features like pixel intensity distributions. By combining multiple types of features, face recognition systems can achieve a more comprehensive understanding of facial characteristics, enhancing their ability to discriminate between individuals accurately

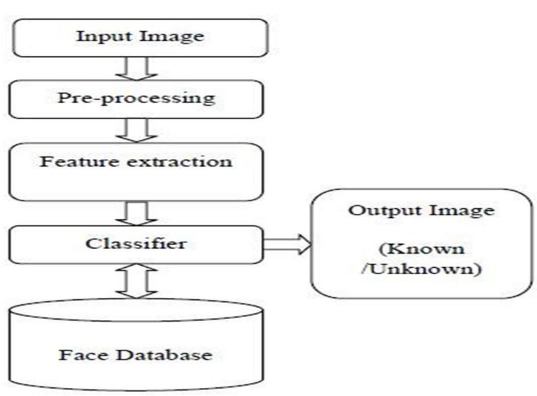
Furthermore, advancements in deep learning and convolutional neural networks (CNNs) have revolutionized the field of feature extraction in face recognition. CNNs can automatically learn hierarchical representations of facial features directly from raw image data, eliminating the need for manual feature engineering. This data-driven approach enables the extraction of complex and abstract features, leading to significant improvements in recognition accuracy and robustness.

C. Classical Face Detection

Early face detection methods, often referred to as classical face detection, mark the genesis of contemporary techniques employed to detect and pinpoint human faces within images. These foundational approaches have shaped the landscape of modern face detection technologies, serving as the cornerstone for a myriad of applications prevalent today.

Initially, classical face detection algorithms relied heavily on manually crafted features and conventional deep learning methodologies such as Convolutional Neural Networks (CNNs). Their primary objective was to discern prominent facial attributes like eyes, nose, and mouth by leveraging pre-established patterns and templates.

The evolution of classical face detection paved the path for more advanced methodologies, particularly those rooted in deep learning frameworks like CNNs. These state-of-theart techniques have revolutionized face detection capabilities, substantially enhancing accuracy and resilience. Consequently, they have become indispensable tools across a spectrum of applications, spanning from security systems to social media platforms.



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II. METHODOLOGY

The system initiates with the login phase, which incorporates a two-step verification process to ensure security. Once authenticated, users can opt to utilize either a hand-drawn sketch or a composite face sketch generated through the drag-and-drop feature. Subsequently, the selected image undergoes a feature extraction procedure, enabling the application to apply advanced image processing and computer vision algorithms.

Following feature extraction, the system proceeds to match the sketch against the database of stored photographs. Utilizing sophisticated matching algorithms, it identifies similarities between the sketch and database images. Finally, the system presents users with a comprehensive analysis, displaying the ratio of similarities between the sketch and the corresponding database photograph.

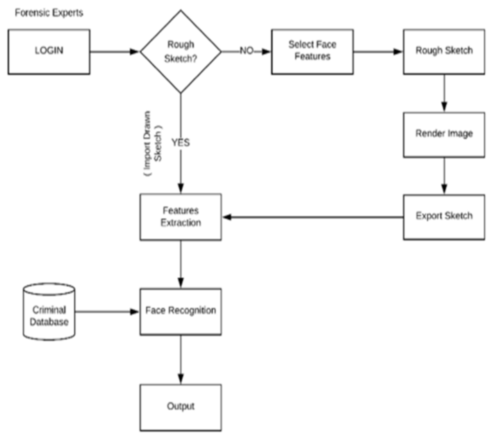

Fig. 1. System Flow Diagram

A. *Face Sketch Construction*

The user flow depicted in the flowchart outlines the sequence of steps undertaken by the platform to generate an accurate facial sketch based on user descriptions. The dashboard interface is intentionally designed with simplicity in mind, ensuring that users, even those without professional training, can navigate the platform effortlessly. This user-friendly design significantly reduces the time and resources required by the department, streamlining the sketch creation process and enhancing overall efficiency.

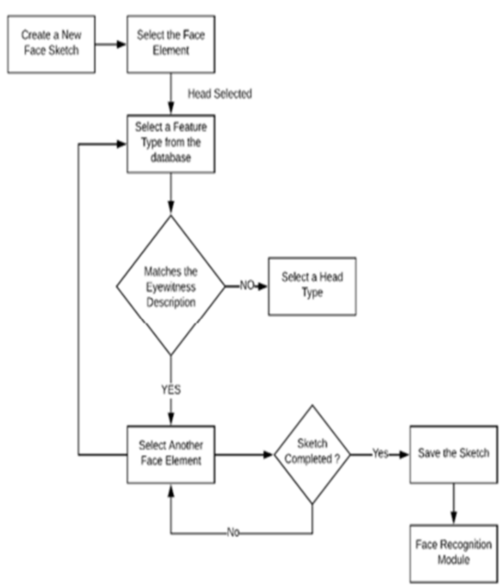

Fig. 2. Flow Chart for Creating a sketch in the application

B. Face Sketch Recognition

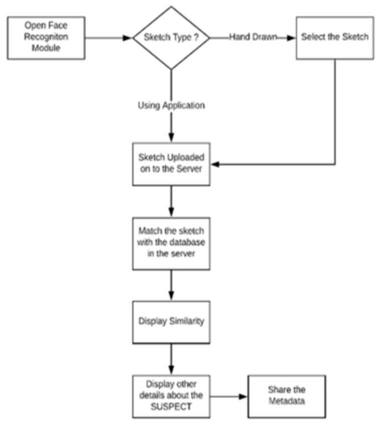

Fig. 3. Flow Chart for Recognizing a sketch in the application

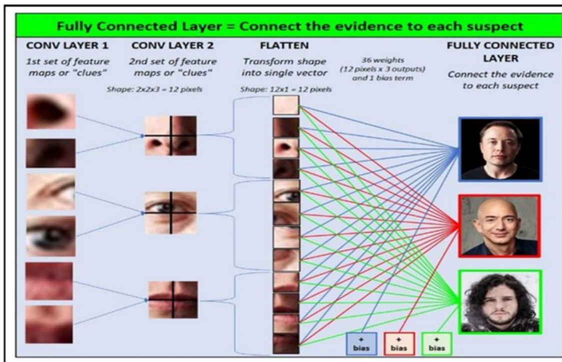

Fig. 4. Feature extraction by the Platform

The image above illustrates the initial step preceding the utilization of the platform for face recognition, which involves preparing the existing records within the law enforcement department to be compatible with our system. This is achieved through training the platform's algorithm to recognize and assign unique IDs to the facial photographs in the existing records. To accomplish this, the platform's algorithms establish connections with the records, dissecting each facial photograph into smaller features and assigning IDs to the multiple features generated from a single facial photograph.

Subsequently, a module primarily designed to operate on the law enforcement server for security reasons is activated when the user initially accesses either the hand-drawn sketch or the facial sketch created on our platform and saved on the host machine. Upon opening, the facial sketch is uploaded to the law enforcement server housing the recognition module, ensuring the integrity and accuracy of the process and data within the records. Upon uploading, the algorithm begins by analyzing the features of the sketch image to establish a reference point and then proceeds to map these features to those present in the facial photographs within the records, as depicted in the figure below.

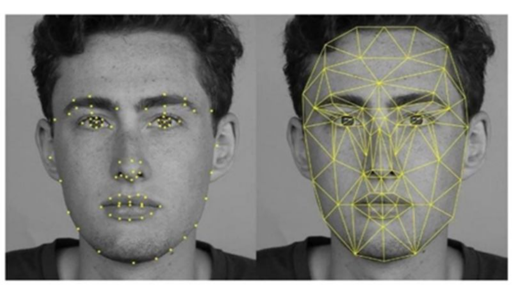

Fig. 5. Face Sketch been mapped on the Platform

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Once the sketch is mapped and matched with the records, the platform proceeds to showcase the matched face alongside pertinent details of the individual from the records. This comprehensive display, featuring the matched person and their associated information, is depicted in the figure below.

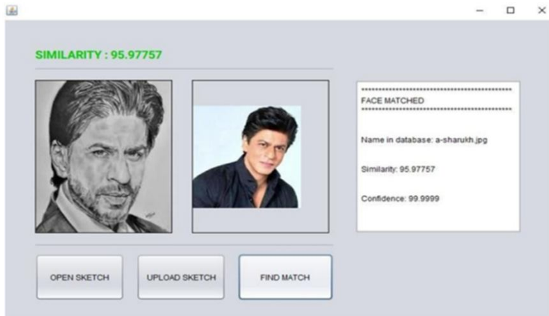

Fig. 6. Face Sketch matched to Database Record

III. LITERATURE REVIEW

Various studies have delved into different techniques for creating and recognizing facial sketches, shedding light on the challenges and advancements within the field. For instance, one study introduced an independent application tailored for constructing and identifying facial composites. Initially, the conventional approach proved cumbersome and perplexing. However, a novel method allowed victims to select faces resembling the suspect from a pool of options. Subsequently, the system amalgamated these selections to automatically generate the criminal's facial composite, yielding promising outcomes in accurately identifying composite faces. Another notable approach presented a recognition method for synthesizing photo-sketches utilizing a Multiscale Markov Random Field Model. This method facilitated the synthesis of sketches from photos and vice versa, enabling database searches for pertinent matches. By segmenting facial sketches into patches and training the model to minimize disparities between photos and sketches, the efficacy of the recognition model was augmented.

IV. CONCLUSION

The project "Forensic Face Sketch Construction and Recognition" has been meticulously designed, developed, and rigorously tested to cater to real-world scenarios, prioritizing security, privacy, and accuracy at every stage. From the initial splash screen to the final data retrieval phase, the platform has been engineered with these key factors in mind.

Significantly, the platform has demonstrated exceptional security measures by implementing strict protocols. For instance, it verifies the user's credentials by matching the MAC Address and IP Address during the loading process, effectively blocking unauthorized access. Additionally, the OTP system adds an extra layer of security by preventing the reuse of previously generated OTPs and generating new ones with each page reload or login attempt.

Moreover, the platform has exhibited impressive accuracy and speed in both face sketch construction and recognition tasks. During extensive testing with diverse test cases, scenarios, and datasets, it achieved an average accuracy rate of over 90%, coupled with a confidence level of 100%. These results align well with existing studies in the field, indicating commendable performance.

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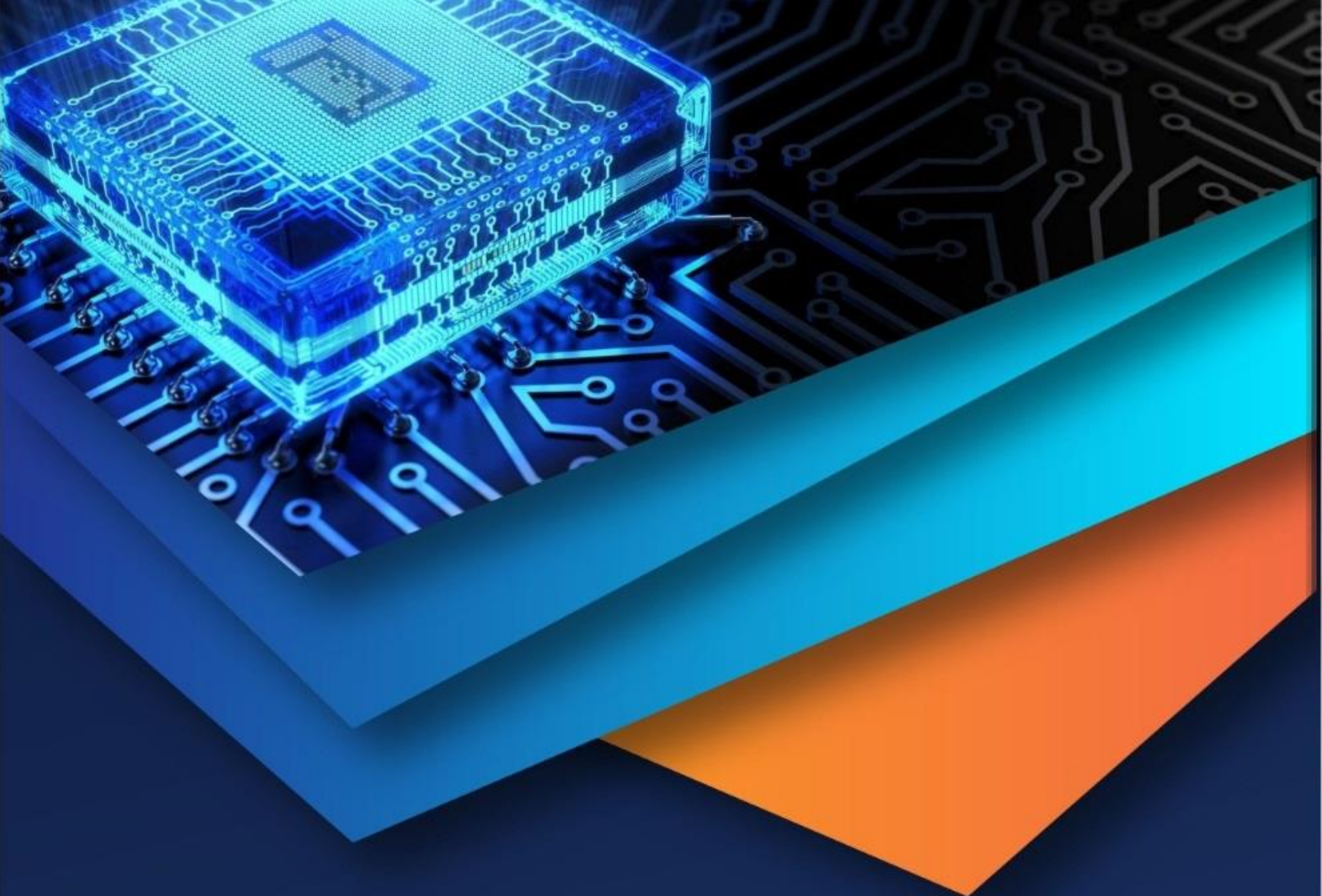

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