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Face Sketch Construction and Recognition

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Abstract: *- The traditional approach of determining and apprehending suspects in criminal investigations through hand-drawn facial drawings has encountered speed and efficiency issues in our quickly evolving modern environment. Although useful, the old approach is not as good at integrating real-time data or existing databases seamlessly. In order to overcome these obstacles, our ground-breaking program uses cutting-edge deep learning algorithms to transform forensic face detection. Law enforcement agencies can submit hand-drawn sketches into the platform, which improves the accuracy and speed of suspect identification. The program greatly streamlines the investigating process by utilizing deep learning to enable more effective matching and identification procedures from large databases.*

Keywords: - *Forensic, Face, Sketch, Database, Law Enforcement, Portraits, Security, Machine Locking, Two Step Verification.*

I. INTRODUCTION

A perpetrator can be swiftly identified and apprehended with the help of facial recognition. The description given by the eyewitness was used to create a visual representation. However, in today's contemporary society, traditional hand-drawn portraits are not as efficient or time-effective when it comes to matching and profiling data or searching through a database over a specific timeframe. Numerous approaches have been suggested in the past to convert composite facial portraits and employ them for automated identification and apprehension based on law enforcement data. Unfortunately, these methods have not been successful in producing the desired level of accuracy. Numerous methodologies has been proposed in the past to transform collaged face portraits and utilize them for automating, establishing, and recognizing culprits based on information provided by law enforcement. However, these strategies have failed to produce accurate results as desired. An application was also developed to generate composite face portraits, but it had several drawbacks, including a limited range of facial features and difficulty in using the produced suspicious face effectively to achieve desired results and efficiency[1].

Considering the increasing demand and requirements in India, we were inspired to develop a system that not only offers various options for creating face portraits, such as eyes, ears, mouth, etc., but also allows users to transfer individual options from collaged portraits to the platform. These transferred options can then be regenerated into the application's element set, resulting in artwork that closely resembles a collaged portrait. This would greatly facilitate the task of law enforcement in modifying the device.

Additionally, our module would enable law enforcement officers to upload previously hand-collaged portraits to the platform. Subsequently, users can make use of the platform's sophisticated functionalities, economical deep learning algorithm, and cloud infrastructure to detect and apprehend culprits. By analyzing the portraits and their corresponding data, the machine learning algorithm acquires knowledge and offers suggestions on comparable facial characteristics that can be employed for a specific attribute. This would significantly reduce the time required and enhance the effectiveness of the platform[2].

II. LITERATURE SURVEY

Numerous studies have been conducted on the construction and recognition of face portraits using various methodologies. Dr. Charlie Frown, in collaboration with Yasmeen Bashir, Kamran Nawaz, and the Pakistani monetary unit regulator, developed a standalone application for creating and detecting facial composites. However, the initial system was considered time-consuming and complex due to its outdated approach. As a result, the victim was provided with a selection of faces to choose from and instructed to pick a face that resembled the suspect. Out of the twenty-one outcomes, twenty of the twenty-five collaged faces were accurately identified, indicating a positive result. The assistance of a government official led to a three percent improvement in face invention by the witness, followed by an additional nineteen percent improvement. On the other hand, when the onlookers attempted to create faces independently, they achieved a success rate of only one percent. The model was then trained using sixty percent of the available data and tested with the remaining forty percent. Although the results were impressive, they did not meet the standards set by the course [3].

P.C. Yuen and C.H. Man developed a technique for identifying individuals in facial images. Mug shots were transformed into portraits, which were then compared to faces using a blend of local and global features determined by facial recognition algorithms. Matching mug shots to human faces in databases such as FERET and Japanese datasets posed challenges in certain instances. The proposed method yielded experimental results with a 70% accuracy rate, which was commendable but still fell short of the accuracy required by law enforcement agencies. The algorithmic rules devised compared facial portraits to external body parts that were typically oriented towards the front, facilitating the mapping of each facial feature in the portrait to the corresponding external body part in a photograph. However, when a photograph or portrait contained faces in multiple orientations, the algorithms struggled to accurately map and match the front-facing facial features[4].

Noteworthy, although it does not meet the standards set by the course. Kanil K Nathi and Brent Clare proposed another method called Portrait to Image Matching, which utilized SIFT. The distance between the SIFT Descriptors of the face images in the information and the Portraits was measured, and the intended outcome of the strategy was displayed. The algorithmic process initially transformed the face images using linear transformation, in accordance with the proposed framework by Tang and Wang. The SIFT descriptor dissimilarity between the portrait and the facial image, along with the distance between pictures within the databases, was measured. The outcomes of the experiment indicate that the datasets used were similar to that used by Tang within their experiment. Furthermore, the

inclusion of the algorithmic rule enhanced the robustness and precision of Tang and Wang's model[5].

Each of the suggested algorithms faced a common issue in that they primarily compared facial drawings with front-facing human faces. This made it simpler to map and correspondence the drawn sketch with a front-facing photograph of a human face. However, when an image or drawing created had countenances in different directions, these algorithms could not successfully map and match them with front-facing faces over the database.

Several other systems have been proposed for constructing composite faces. However, most of these systems rely on facial features extracted from photographs and selected by the operator based on the witness's description. This approach makes it extremely challenging for both humans and algorithms to match the composite face with a criminal face. Each facial feature is taken from a different face photograph, resulting in significant dissimilarities when combined together, further complicating the recognition process.

As mentioned earlier, our application aims to surpass the limitations of both the traditional hand-drawn face Portrait technique and the innovative progressive composite face Portrait technique. Moreover, it will eventually transition to an alternative method where the victim can select their desired facial expression and utilize it to transfer the hand-drawn face Portraits and facial expressions.

III. OVERVIEW AND FEATURES

A. SECURITY AND PRIVACY

The primary focus concerning the law enforcement agency is the privacy and security aspect when implementing any system. With this in consideration, the system is developed to safeguard privacy and implement security measures through the following methods.

a) Machine Locking: The method of machine locking guarantees that the application, installed on a particular system, cannot be altered or run on any other system. This is achieved through the utilization of two locking factors - one being software-based and the other hardware-based. The software locking factor is the HD ID, which is the volume serial of the hard drive with the operating system. The hardware locking factor is the NET ID, which is MAC Address of the hardware.

b) Two Factor Authentication: Each authorized user in law enforcement will be granted with an official email address to get access into the application. This additional step involves entering a unique code sent to their mobile device or desktop to successfully complete the login process.

c) Centralized Utilization: The application installed on the system would be linked to a centralized server within the law enforcement department campus, housing the database and other essential features of the application. Consequently, the application would not function if disconnected from the server.

B. BACKWARD COMPATABILITY

The primary challenge when implementing a new system is the complexity associated with transitioning from the old method to the new one, leading to a waste of time and resources. For the purpose of addressing this issue, our application has been developed to allow users to upload drawn sketches, which can then be analyzed using deep learning algorithms and cloud infrastructure to recognize and apprehend criminals.

C. FACILITATING FACE SKETCH CONSTRUCTION THROUGH DRAG-AND-DROP TECHNIQUE.

This application enables the creation of precise face sketches with collective facial illustrations by utilizing pre-defined facial feature sets as tools. These tools can be adjusted in size and position in line to the requirements described by the eye-witness[6].

In this application, the countenance of a human being is classified into different facial attributes including the head, eyes, eyebrows, nose, lips, ears, and more. Additionally, there are essential accessories like hats and glasses which can be utilized within the application.

In this application, the countenance of a human being is classified into different facial attributes including the head, eyes, eyebrows, nose, lips, ears, and more. Additionally, there are essential accessories like hats and glasses which can be utilized within the application.

Fig. 1. Feature – Head

Fig. 2. Attribute-eyes.

Fig. 3. Attributes-ears.

Each facial characteristic chosen will provide a number of options to select from in accordance to the eye-witness's needs. The machine learning algorithm will analyze and recommend all possible facial features that complement the chosen characteristic, expediting the process of completing the composite face sketch more effectively in the future.

Fig. 1. Shows the sketch of the facial feature namely Head
Fig. 2. Shows the sketch of the facial feature namely Eyes
Fig. 3. Shows the sketch of the facial feature namely Ears

The facial characteristics can be utilized within the software to generate a composite sketch of the perpetrator, using details provided by the eyewitness to the authorities and forensic experts[7].

Fig. 4. Displays the application's User Interface, featuring a blank canvas.

Fig. 5. UI of the application.

Fig. 4 displays the user interface of the application, showcasing a set of facial features on the right-hand side for creating composite facial sketches. On the left-hand side, users can find tools for resizing, repositioning, saving, and more.

Fig. 5 The application's user interface, as depicted, displays the facial feature that has been dragged onto the canvas from the right-hand side. This feature can be combined with other facial features to produce a composite face sketch.

D. SYSTEM FLOW

Fig. 6 depicts the system flow, beginning with the login section that guarantees a two-step verification process. The application allows users to utilize either a hand-drawn sketch or a composite face sketch created through the drag and drop feature. Subsequently, the images undergo feature extraction to enable the application to implement image processing and computer vision algorithms. Finally, the sketch is matched with the database photograph, and the application displays the ratio of similarities between the two.

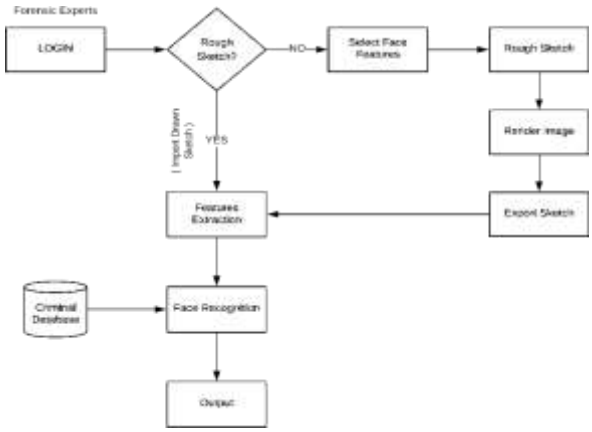

Fig. 6. System Flow

IV. OVERVIEW AND CHARACTERISTICS.

This application follows a two-step process to execute operations.

A. CONSTRUCTION OF FACE PORTRAITS.

The flowchart demonstrates the sequence of steps taken by users on the platform to generate a precise facial sketch from a given description. The dashboard is intentionally kept simple to ensure that no professional training is required before utilizing the platform, ultimately saving time and resources for the Department.

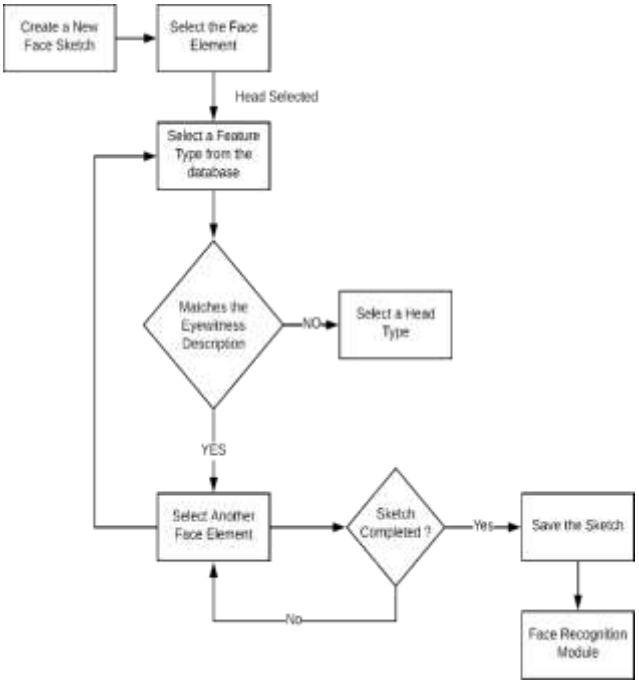

Fig. 7. Flow Chart for Construction of Face Portraits

The dashboard is comprised of five primary modules. The central module, known as the Canvas, is the most crucial as it contains the components of the face sketch and contributes to the formation of the facial drawing.

It would be challenging to generate a face sketch if all the face elements are provided at once in a disorganized manner, hindering the user from accurately constructing a face as intended in the system. To address this problem, the face elements are organized by category such as hair, nose, head, eyes, etc. This makes it more user-friendly and allows for easier interaction with the platform to create the face sketch. Users can access this feature in the left column on Canvas dashboard by clicking on a specific face category to explore different face structures[8].

In a specific face category, there may be numerous elements to consider. Our platform aims to utilize machine learning in the forthcoming years to anticipate similar elements of the face and recommend which elements to choose when designing a face sketch. However, this can only be achieved once we have sufficient data to train the algorithm and improve the platform.

When the user clicks on a specific face category, a new module will open over the right side of the canvas. This module allows the user to choose an element from a range of face elements in order to create a face sketch. The selection of this option is based on the description given by the eye witness.

The selected elements are displayed on the canvas and can be rearranged according to the eyewitness's description to create a more precise sketch. Each element has a designated position and must be placed in a specific order on the canvas, such as placing the eye elements above the head element regardless of the selection order. This rule applies to all face elements as well.

The last module provides additional features to improve the functionality of the dashboard. In situations where the user mistakenly selects an element that should not be selected, they can

easily rectify this by utilizing the option to erase that specific element. This option is accessible by selecting the face category from the left panel. The most crucial buttons are conveniently located in the right panel, including a button that allows the user to completely erase any content on the dashboard canvas, resulting in a completely blank slate[9].

Then, we provide a dedicated button to save the created face sketch, allowing users to save it as a PNG file for convenient future retrieval. The location for saving the sketch can be chosen either on the host PC or on the server, based on the requirements of the Law Enforcement Department.

B. RECOGNITION OF FACE PORTRAITS

The flowchart depicts the sequence of steps taken by the platform to generate a precise facial sketch based on the given description. The dashboard is intentionally designed to be user-friendly, eliminating the need for any professional training before utilizing the platform. This approach not only saves time but also reduces the resources required by the Department.

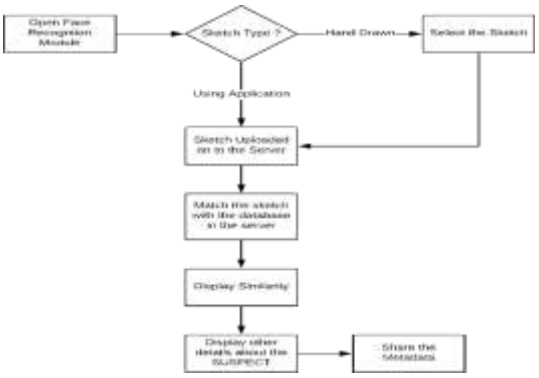

Fig. 8. Flow Chart for Recognizing face portraits

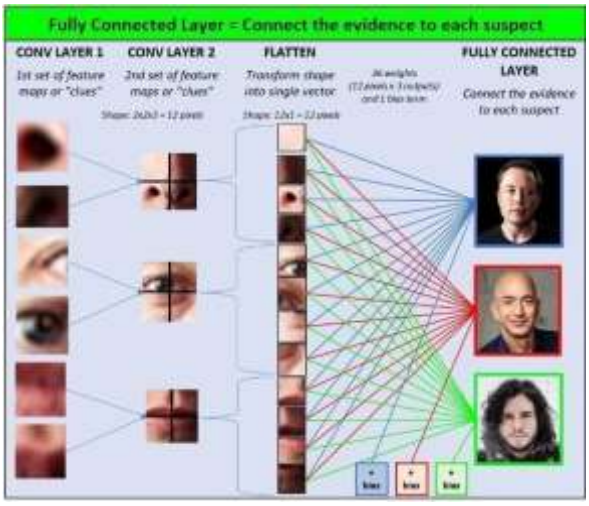

Fig. 9. Platform feature extraction.

The image above illustrates the initial step prior to utilizing the system for facial recognition, which involves preparing the prevailing records within the law enforcement department to be

compatible with our platform. This is achieved by training the platform's algorithm to identify faces and assign unique identifiers to the corresponding face photographs in the existing records. To accomplish this, the platform's algorithms establish a connection with the records and analyze each face photographs by breaking it down into smaller features. Subsequently, multiple features are generated and assigned an ID for a single face photograph.

The Module, primarily intended for execution on the Law Enforcement server to ensure security measures, is currently being implemented. In this process, the user begins by opening either a hand-drawn sketch or a face illustration created on our system and saved on the host machine. Subsequently, the opened face illustration is deposited to the Law Enforcement server, where the recognition system resides. This confirms that the process and data of the record remain untampered and maintain a high level of accuracy and security [10,11].

After uploading the illustration to the server, the algorithm begins by tracing the illustration to identify its features. These features are then mapped, as illustrated in the figure below, to examine them against the characteristics of the facial images archived in the database.

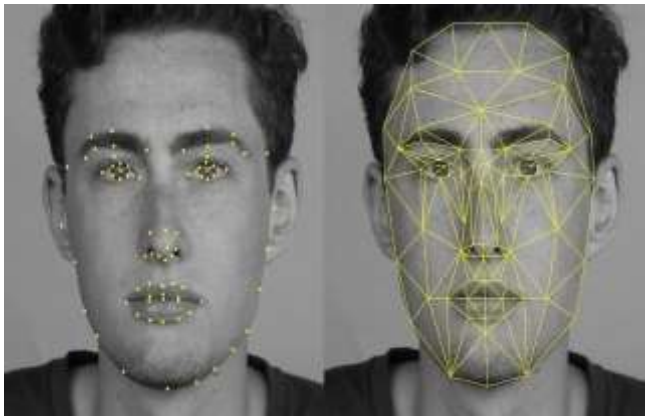

Fig. 10. Face Sketch mapped on the Platform

Upon completing the process of mapping the illustration and comparing it with the existing records, the platform proceeds to showcase the matched face. Alongside the matched face, the platform also presents the similarity percentage and additional information about the individual from the records. The figure below illustrates the platform exhibiting all of these details and the corresponding matched person.

Fig. 11. Face Portrait corresponding to database entry.

V. RESULTS AND CONCLUSION

The project “Face Sketch Construction and Recognition” has been meticulously crafted, developed, and rigorously tested with a focus on real-world scenarios. From the first splash screen to the ultimate data retrieval, utmost importance has been placed on maintaining security, privacy, and precession as the primary considerations in each scenario.

The Security aspect of the system was greatly enhanced as it prevented platform access if the IP Address and MAC Address did not align with the user's credentials in the database. Additionally, the One-time password system effectively restricted the access of old OTPs and generated new ones each time the One-time password page was refreshed or an attempt made to log back into the platform.

The platform demonstrated excellent accuracy and speed during face sketch construction and recognition, achieving an average accuracy of over 90% with a confidence level of 100% in multiple test cases, scenarios, and data sets. This performance aligns well with findings from relevant studies in the field.

The platform also possesses distinct and exclusive features in comparison to similar research in this domain, thereby augmenting the overall level of security and precision, and distinguishing itself from all other related studies and proposed systems in this field.

VI. FUTURE SCOPE

The current design of the “Face Sketch Construction and Recognition” Project focuses on a limited number of scenarios, specifically on creating face sketches and comparing them with face photographs in law enforcement databases.

The platform has the potential for significant improvement in the forthcoming days to integrate with different advancements and scenarios, allowing it to delve into various forms of media and surveillance mediums, resulting in a broader reach and increased efficiency. Furthermore, the application can undergo modifications to align the facial drawings with human faces captured in video feeds through the utilization of three dimensional mapping and imaging techniques. This same approach can also be applied to CCTV surveillance systems for conducting face recognition over real-time footage using the facial sketches.

Connecting the application to online networking platforms serves as a valuable source of data in the modern world. This integration would improve the platform's capability to determine a more precise match for facial sketches, ultimately streamlining and enhancing the identification process.

The platform may possess distinct and unique features that are easily upgradable, setting it apart from other studies in the field. This enhances overall protection and accuracy, making it stand out among associated studies and proposed solutions.

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