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Suspect Face Depiction and Recognition

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Abstract: ***In forensic science, it's seen that hand-drawn face sketches are still very inadequate and time-consuming when it involves using them with the newest technologies used for the identification of criminals. Through this paper, we introduce an independent software that allows users to make composites suspect face sketch of the suspect without the assistance of forensic artists using the drag-drop feature inside the software and automatically match the suspect face sketch with the police database much faster and efficiently using deep learning and cloud infrastructure.***

Keywords: Suspect Sketch, Suspect Face Sketch Depiction, Suspect Face Recognition, Criminal Identification, Deep Learning, Machine Locking, Two-Step Authentication.

I. INTRODUCTION

An outlaw is often effortlessly identified and delivered to justice employing a face sketch drawn considering the outline been provided by the eye•witness, nevertheless during this world of innovation the normal way of hand drawing a sketch isn't found to be useful and time•saving when used for matching and identifying from the already accessible database or real- time databases.

In the past, there were numerous methods been suggested to transform hand-drawn suspect face sketches and utilize them to spontaneously identify and acknowledge the suspect from the police force database, but these methods couldn't offer the specified accurate results. Software to make a compound face sketch were even presented which too had several constraints like limited countenance kit, cartoonish feel to the created suspect face which made it much tougher to use this software and obtain the designated results and effectiveness.

The above needs inspired us into thinking of creating a software that wouldn't just offer a set of individual countenance like eyes, ears, mouth, etc. to be chosen to create a suspect face sketch nevertheless would also enable the user to upload hand- drawn individual countenance on the program which would then be transformed into the software component set. This successively would make the created suspect sketch far more like the hand-drawn sketch and would be much simpler for the enforcement departments to adjust to the software. Our software would even enable the law enforcement team to load a previous hand-drawn suspect sketch to use the program to identify and acknowledge the suspect utilizing the much more efficient deep learning algorithm and cloud infrastructure provided by the software. The machine learning algorithm would discover from the sketches and accordingly use the database to suggest to the user all the similar countenance that would be used with one selected feature so as to reduce the timeframe and enhance the efficiency of the program.

II. RELATED WORK

There are lots of studies on face sketch depiction and recognition using various approach. Dr. Charlie Frown alongside Yasmin Basheer, Kamren Nawaz, and Anna Petkvic developed a software for depicting and recognizing the facial composites, the primary system was found to be time- consuming and puzzling because of the conventional method, later changing to an alternate approach during which the victim was given the choice of faces and was made to choose similar face resembling the suspect and at the top, the system would merge all the chosen face and check out to predict automatically the criminal's facial composite. The outcomes were encouraging and 11 out of 14 composite faces were named correctly out of which the outcome was 22.04% when the eyewitness was assisted by the enforcement employee to depict the faces and 18.02% when the eyewitness attempted depicting faces by themselves[2].

Xiaou Tang and Xiagang Wang propose a recognition approach of photo sketch synthesized employing a Multiscale Markov Random Field Model the project could synthesis provided sketch into a photograph or a provided photo to sketch then look the database for an appropriate match for this the model divided the face sketch into patches. In this, they first synthesized the accessible photos in to sketch then trained the model making the model reduce the dissimilarity among photos and sketch this improved the overall efficiency of the model. For testing this few samples in which the photos were synthesized in to sketch and the same faces were drawn from sketch artist and then the model was trained from 80% data and therefore the remaining 20% data for testing the model. The general results were desired but not up to the mark[3].

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Other proposed method was sketching to photo-matching proposed by Anil Jain and Brenden Klare which utilized SIFT Descriptor, the strategy suggested showed results based on the calculated SIFT Descriptor distance between the face photos within the database and thus the sketches. The algorithm first transforms the face photographs using linear transformation which was endorsed on Tang and Wang's proposed model then the sketch was applied to evaluate the SIFT descriptor distance compared to the face photo and in some cases, the distance between images in the databases too was calculated for best accuracy. The experimental outcome shows that the dataset utilized was nearly like the those employed by Tang in their experiment and the extra in the algorithm was the measurement of the descriptor which delivered a far better outcome and accuracy from the model proposed by Tang and Wang[5].

P. C. Yuen and C. H. Man too proposed a method to look at human faces using sketches, this approach converted sketches to mug shots then matched those mugshots to faces using some local and global variables been declared by the face matching algorithms. Nevertheless, in few cases, the mugshots were tough to be matched with the human faces within the databases like FERET Database and Japanese Database. The proposed approach showed precision of about 70% in the experimental results, which was decent but still lacked the accuracyrequired by the law enforcement department[6].

The general problem with all the proposed algorithm where that they matched the face sketches with a person's face which were commonly front-facing making it simpler to be charted both in drawn sketch and face photo, but when a photo or sketch collected had their faces in a different direction the algorithms were less likely to chart it and match with a face from the database which is front-facing[7]. There are even method been proposed for composite face depiction but most methods used countenance which were taken from photo then been selected by the operator as described by the eyewitness and eventually compiled to make one face making it far more complex for human as well as an algorithm to match it with a criminal face as every facial aspect was taken from the separate face photo having several differences and when combined made tougher to acknowledge.

Thereby, all the prior approach proved either inefficient or time-consuming, and sophisticated. Our software as stated above wouldn't only conquer the restrictions of the referred proposed techniques but would also fill the gap between the normal hand-drawn face sketch technique and the new modernized compound face sketch technique by allowing users upload the hand-drawn face sketches and countenance.

III. OVERVIEW AND FEATURES

A. *Security and Privacy*

The main interest of the enforcement division before adapting to any method is security and privacy. Holding this in mind the software is meant to protect the privacy and perform security measures in the following manner.

1) *Machine Locking:* The Machine locking method would make sure that the software once installed on a platform couldn't be interfered with and won't be functioned on any other system, for which the software utilizes two locking parameters i.e., one software and one hardware locking parameter. Hard drive ID –Volume serial of HD with OS. Hardware ID – Net ID – MAC Address.
2) *Two-Step Authentication:* Every law-enforcement authorized employee would be provided an official e- mail ID which would be applied to sign in on to the software, thereby using this step would demand the employee to enter a random code been shared with them on their e-mail ID to finish the signing process.
3) *Centralized Usage:* The system on which the software is installed would be linked to a centralized server of the law-enforcement division containing the database and therefore the other significant feature set of the software, thus the software couldn't be functioned once disconnected from the centralized server.

B. *Backward Compatibility*

The main obstacle in adopting any new system is that the difficulty been involved in finishing migrating from the earlier method to the new method, thus leading to the squandering of time resources.

To beat this problem, we've designed our software in such a manner that even the hand-drawn sketches could be uploaded and thus the user can utilize the deep learning algorithms and cloud infrastructure to spot and recognize the criminal utilizing the hand-drawn sketch.

C. *Suspect Face Sketch Depiction using Drag and Drop*

In this software, a precise composite suspect face sketch can be depicted utilizing the pre-defined countenance provided as tools enabling them to be rescale and reposition as per requirement by the eyewitness.

Here, the face is classified into several countenance like head, eyes, eyebrow, lips, nose, ears, etc., and a couple of significant wearable elements like hats, specs, etc. are available inside the software to be used.

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Each and every countenance when chosen would open a wide range of choices to choose from based on the requirement of the eyewitness. The machine learning algorithm would learn and, later, attempt to indicate all the countenance which could suit the single chosen feature and would try to assist in finishing the composite face sketch sooner and far efficiently.

Fig. 1. Shows the sketch of the countenance viz. Head Fig. 2. Shows the sketch of the countenance viz. Eyes Fig. 3. Shows the sketch of the countenance viz. Ears

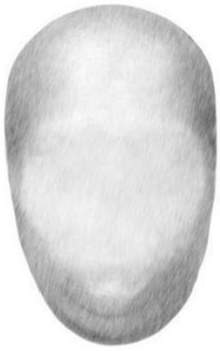

Fig. 1. Countenance – Head

Fig. 2. Countenance – Eyes

Fig. 3. Countenance – Ears

Suchlike is the countenance that can be utilized in the software to build the composite face sketch of the suspect based on the description given by the eyewitness to the law enforcement and forensic department.

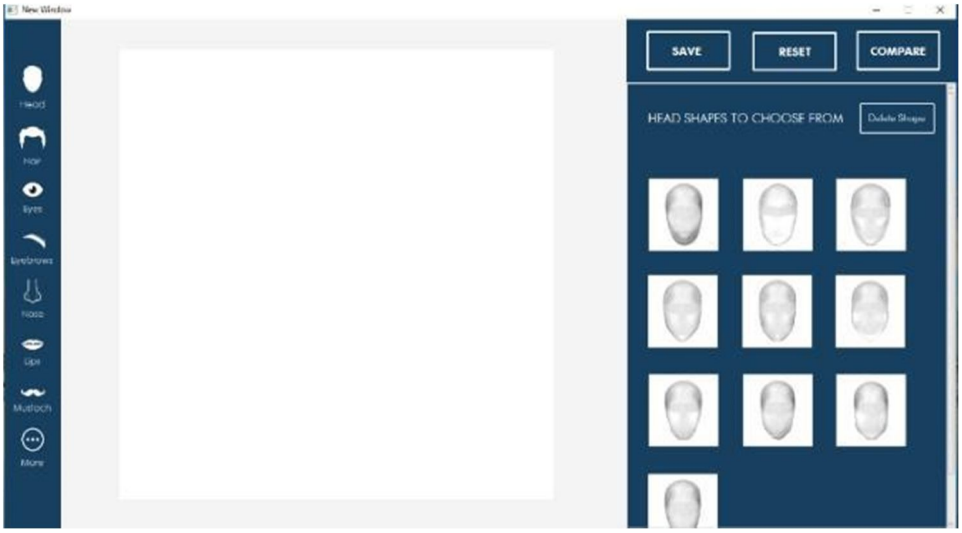

Fig. 4. User Interface of the software (with a blank canvas)

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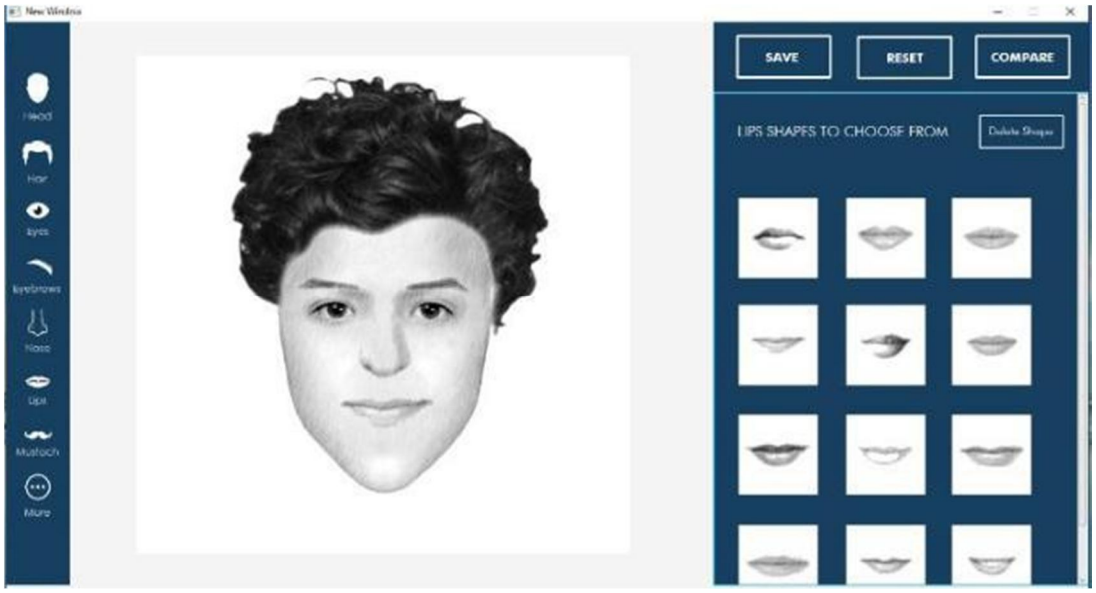

Fig.5. User Interface of the software (with countenance been dragged on to the canvas)

Fig. 4. displays the user interface of the software been presented to create a composite facial sketch with the set of countenance on the right-hand side to be picked and tools for resetting, saving, deleting etc. are on the top right-hand side.
Fig. 5. displays the user interface of the software with the countenance been dragged onto the canvas from the right-hand side and to be utilized with other countenance to create a composite face sketch.

D. System Flow

The Fig. 6. Demonstrates the overall flow of the system beginning with the sign in section which ensuring the two-step authentication process. Furthermore, the software can either be used with a hand-drawn sketch or a composite suspect face sketch can be created through the drag and drop feature, either of the pictures would then proceed to features extraction process which would support the software to use image processing and computer vision algorithm and lastly match the sketch with the database and then show the proportion of likenesses between the sketch and therefore the database photograph.

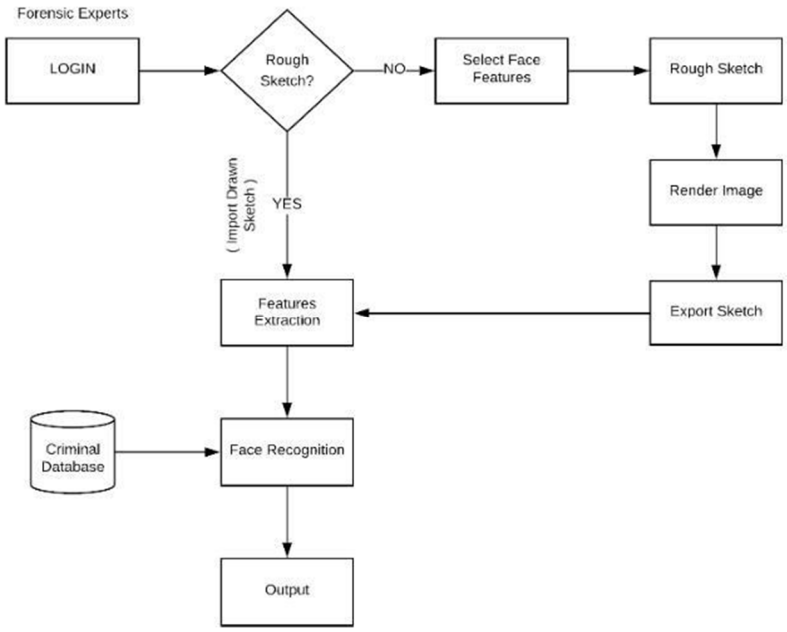

Fig. 6. System Flow of the software

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IV. OVERVIEW AND FEATURES

In this software, Operations are executed in two stages.

A. Suspect Face Sketch Depiction

The flowchart demonstrates the flow been followed by the platform to depict accurate suspect face sketch based on the description, the control panel is intended simply to support no professional training to go through for using this platform, already saving the timeframe which would've taken a lot of time and resources of the department.

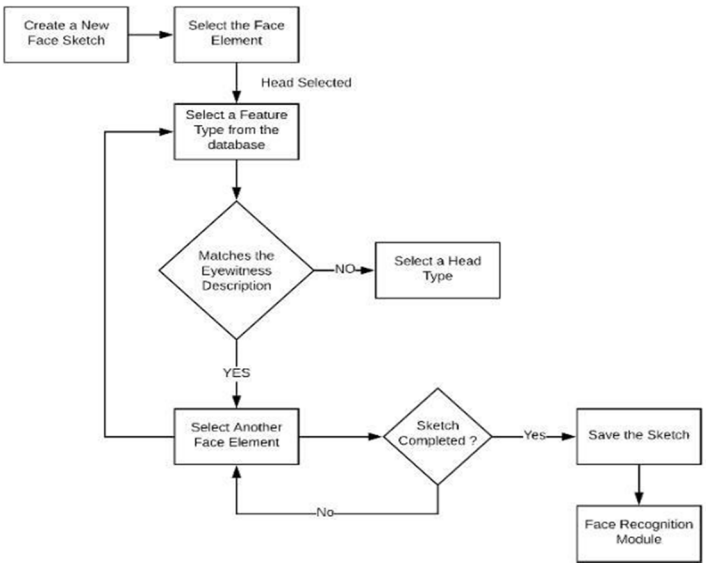

Fig. 7. Flow Chart for depicting a sketch in the software The dashboard comprises of five main modules, first, the essential module is the Canvas been displayed in the middle of the dashboard which would place the face sketch elements and the elements of the face sketches helping in the depiction of the face sketch.

Depicting the suspect face sketch would be a sophisticated thing if all the face elements are provided all collectively and in an unordered fashion making the method complicated for the user and complex to depict an accurate face sketch which would be against the agenda targeted at the proposed method. So, to beat this problem we planned on ordering the face elements based on the face category it belongs to like head, nose, hair, eyes, etc. making it much simpler for the user to interact with the platform and depict the face sketch. This is accessible in the column on the left on Canvas on the dashboard click on a face classification enables the user to get several other facial structures.

Approaching to the several face components in a specific face category we could have multiple and n number of components for a single category, so to solve this our platform would use machine learning in the future to predict the similar face elements or predict an suggest the elements to be chosen in the face sketch but this would only work once we have appropriate data to train the model on this algorithm and work to enhance the platform.

So, now when the user clicks on a specific face category then a new panel to the right of the canvas opens and lets the user choose a component from the option of face components to depict a face sketch. This option can be selected supported on the description given by the eyewitness.

The components when chosen are displayed on the canvas and can be moved and positioned as per the description of the eyewitness to get a better and precise sketch and the components have a fixed position and order to be placed on the canvas just like the eye components would be placed over the head element regardless of the order they were chosen. Similar for every face component.

The last module is the options to improve the use of the dashboard, assume in cases the user chooses an element which is not to be chose so that could be rectified using the option to remove that specific component which might be seen when choosing the face category from the left panel. The important buttons are positioned in the panel on the right which has a button to entirely remove everything on the canvas of the dashboard making it blank.

Then we've a button to save the depicted face sketch, saving the face sketch as a PNG file for better future access. This could be any location on the host's pc or the centralized server depending on the law enforcement division.

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B. Suspect Face Sketch Recognition

The flowchart demonstrates the users flow been followed by the platform to provide an accurate suspect face sketch based on the description, the dashboard is intended simply to promote no professional training to go through before using this platform already saving the timeframe which would've been taken a lot of time and resources of the department.

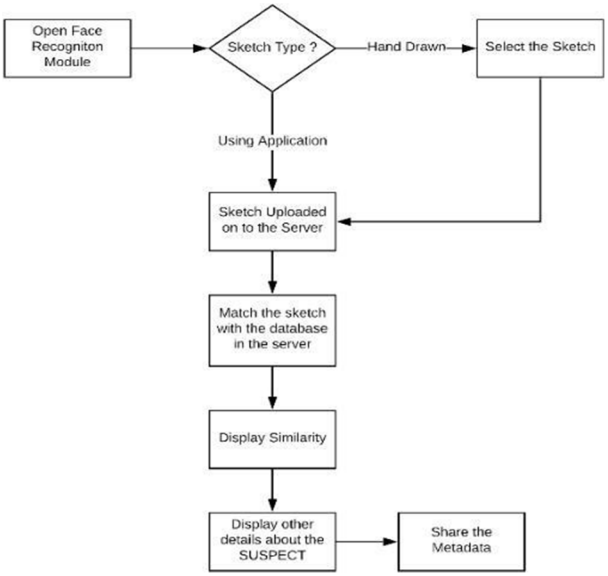

Fig. 8. Flow Chart for Recognizing a sketch in the software

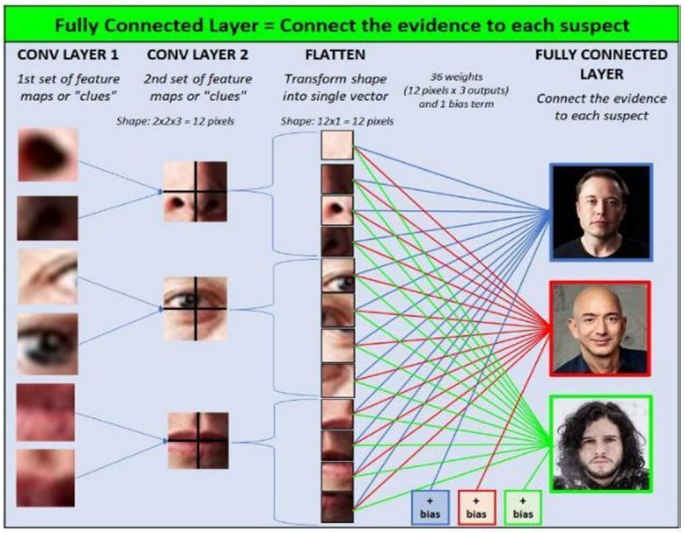

Fig. 9. Feature extraction by the Program

The above image shows the first part before using the platform to recognize faces is making the existing records in with the law enforcement division appropriate for our platform by training and making the platform's algorithm recognize and give IDs to the face sketch photograph to the user in the existent records in the law enforcement division. For this, the program's algorithms get associated to the records and split each face photograph into several little features and give ID to the multiple features generated for a single face photograph. Forthwith, the module which is majorly designed to be run on the law enforcement's server for security protocols is been accomplished wherein the user first opens either the hand- drawn sketch or the face sketch depicted on our platform saved on the host machine, after which the opened face sketch is been uploaded to the law enforcement's server housing the recognition module so that the process or the details of the record are not interfered and are secure and precise.

Once the suspect sketch is uploaded onto the server the algorithm first traces the sketch to learn the features in the sketch and chart the features as showed in the beneath figure to match those with the features of the face photograph in the records.

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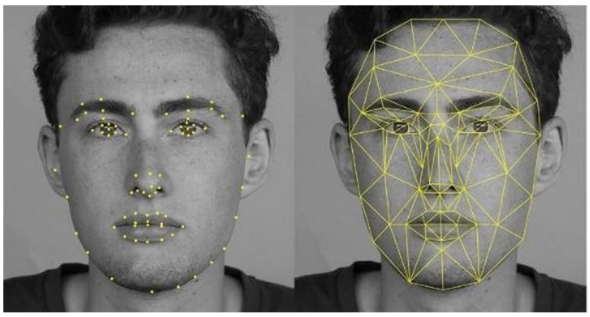

Fig. 10. Face Sketch has been mapped on the Platform

Following mapping the suspect sketch and matching the face sketch with the records and finding a match the platform shows the matched face along with the likeness portion and other information of the person from the records. The platform display all this and the matched person is shown in the beneath figure.

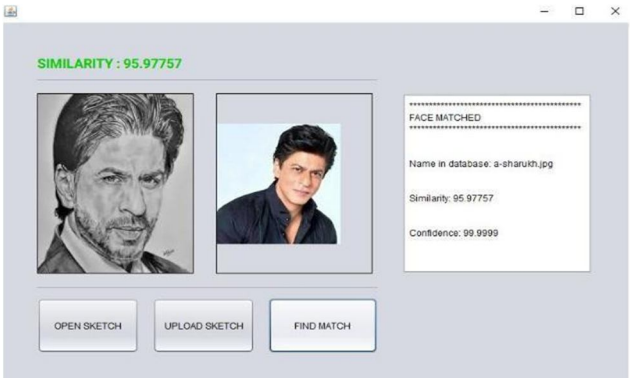

Fig. 11. Face Sketch matched to database record

V. RESULTS & CONCLUSION

The Project 'Suspect Sketch Depiction and Recognition' is been planned, developed, and lastly tested holding the real- world scenarios from the very first screen to the last screen to carry data from the records holding security, privacy, and accuracy as the key element in every scenario. The platform showed an extraordinary result on security point of view by blocking the platform use if the MAC Address and IP Address on load did not match the credentials linked with the user in the database and afterwards the OTP method proved its ability to limit the use of earlier produced OTP and even generating the new OTP every time the OTP screen is reloaded or the user attempt to log in the platform again. The software demonstrated high accuracy and speed whilst face sketch depiction and recognition process, provided accuracy of more than 90% with a confidence level of 100% when tested with several test cases, test scenario, and data sets, which means a good rate in accordance to associated studies on this field.

The software even has features that are distinct and extraordinary too when compared to associated studies on this field, improving the total security and accuracy by standing out among all the associated studies and proposed systems in this field.

VI. FUTURE SCOPE

The Project 'Suspect Face Depiction and Recognition' is presently designed to work on very few scenarios like on face sketches and matching those sketches with the face photographs in the law-enforcement records. The software can be much improved in the future to work with several technologies and scenarios allowing it to examine several media and surveillances medium and get a much wider distribute and outputs, the software can be altered to match the face sketch with the faces from the video feeds using the 3D mapping and imaging techniques and similar can be applied to the CCTV surveillance to execute face recognition on the live CCTV footage using the face sketch recognition algorithm. The software can further be linked to social media as social media platforms act as a great source for data in today's world, this technique of connecting this software with the social media platform would increase the ability of the software to find a much more precise match for the face sketch and making the process much more efficient. Over-all the software can have features which could be distinct and unique too and easy to upgrade, when compared to associated studies on this field, improving the overall security and precision by standing out amongst all the associated studies and suggested systems in this field.

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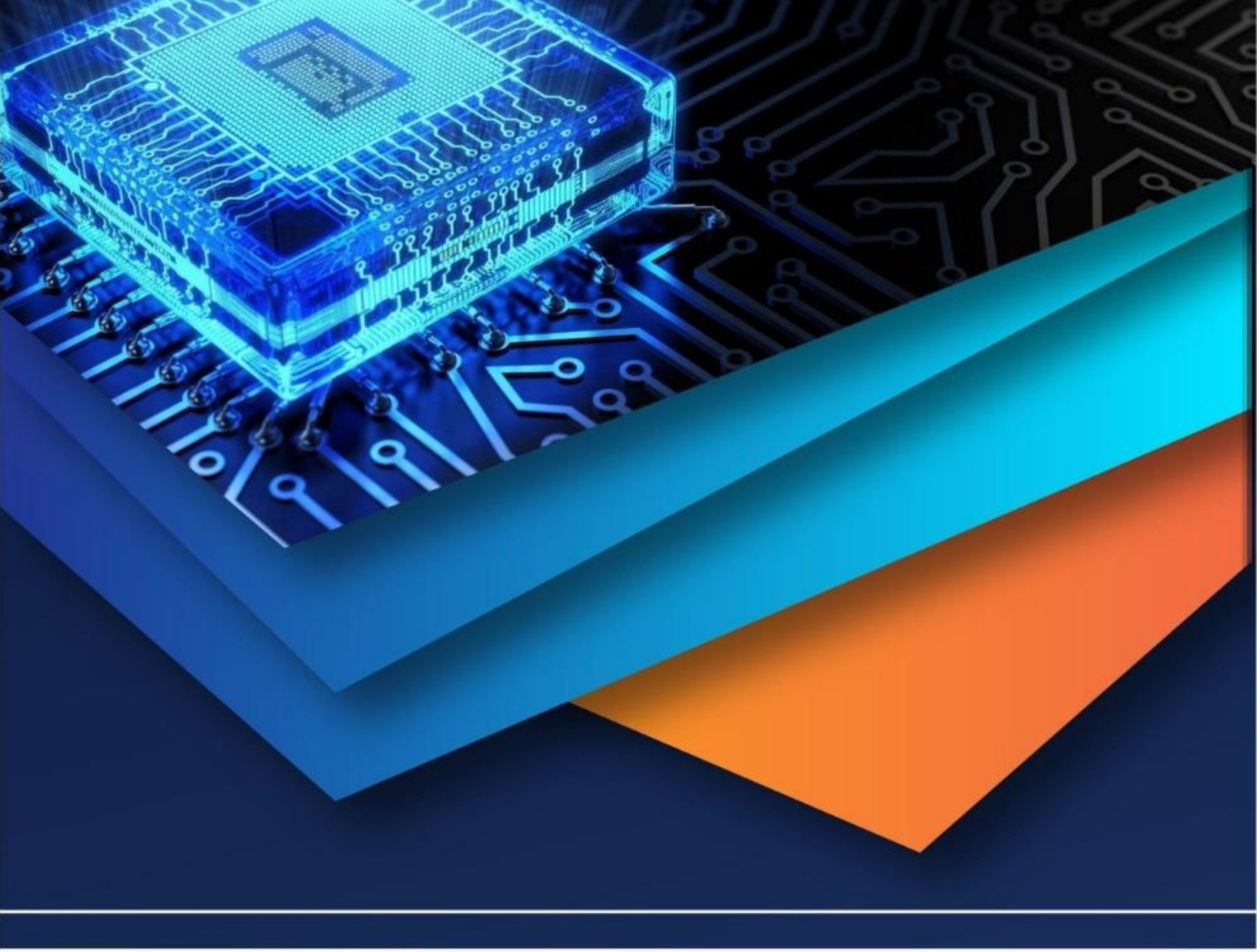

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