Face Sketching and Prediction Application

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ABSTRACT: Facial sketches are widely used by law enforcement agencies to assist in the identification and apprehension of suspects involved in criminal activities. Sketches used in forensic investigations are made by forensic artists following the verbal description provided by an eyewitness or the victim. These sketches are posted publicly in hopes that some viewers would provide information about the identity of the suspect. This method of identifying suspects is slow and tedious and may not lead to apprehension of the suspect.

In forensic science, it is observed that hand-made face sketches are still very limited and time consuming when it comes to usingthem for recognition and identification of criminals. In this paper, we present an application which would allow users to create composite face sketches of the suspect without the help of any professional artists by usingdrag and drop features in the application and then the application can predict or match the drawn composite face sketch with the police in an efficient way usingdeep learning and cloud infrastructure.

Keywords: —Face Sketch synthesis, Face Sketch Construction, Face Prediction, Criminal/Suspect Identification, Deep Learning, Centralized Usage.

I. INTRODUCTION

Types of Sketches: Facial sketches can be classified into three types as described below:
1) Viewed Sketches:
- These type of sketches are drawn by hand while viewing the photograph.
- They are not relevant to forensic as they are not based upon the description.
- Hence, such sketched cannot be used in law enforcement scenarios.

2) Forensic Sketches:
- These are facial sketches drawn by forensic artists based on the description provided by an eye-witness
- Forensic sketches are being used in criminal investigations since the 19th century.[17]

3) Composite Sketches:
- Composite sketches are facial sketches created using software kits allowing an operator to select different facial components
- These type of sketches have been proved to be a popular and more affordable alternative to forensic sketches.
- Almost 80% of law enforcement agencies reported of using some kind of software to create facial sketches.[17]

Facial sketches are commonly used in law enforcement to assist in identifying suspects involved in a crime when no facial image of the suspect is available at the crime scene. After a sketch of a suspect's face is created, authorities disseminate the sketch with the hope that someone will recognize the individual and provide pertinent information leading to an arrest.Unfortunately, this process is inefficient and does not leverage all available resources, and consumes a lot of enforcement's time.

During the past there have been varied techniques been planned to convert hand-made face sketches and use them to mechanically establish and acknowledge the suspect from the police info, however these techniques couldn't offer the required precise results. Application to form a composite face sketches were even introduced that too had varied limitations like restricted facial expression kit, cartoonist feel to the created suspect face that created it a lot of tougher to use these applications and acquire the required results and potency.

Sketch artists usually need a couple of years of coaching to become skillful in drawing sketches, solely a couple of hours of coaching are needed before a policeman becomes skillful in victimization composite sketch software system. regardless of the standard and capability of the software system, most composite software system kits deem selecting a collection of facial parts (e.g., eyes, nose, mouth, etc.) depending on the data

contained within the suspect's description.

Difficulties in face sketch recognition
- Basically photographs and sketches belong to two different modalities. So, matching a photograph with a sketch or vice versa is a difficult and complicated job. The major difficulties that arise during matching face sketches with photos are:
- Due to the great difference between sketches and photos and the unknown psychological mechanism of sketch generation, face sketch recognition is much harder than normal face recognition based on photo images.
- The patches drawn by pencil on paper have different texture compared to human skin captured on a photo. In order to convey the 3D shading information, some shadow texture is often added to sketches by artists.
- For shape, a sketch exaggerates some distinctive facial features just like a caricature, and thus involves shape deformation

The above applications and desires motivated us into thinking of making an application which might not just provide a collection of individual features like eyes, ears, mouth, etc. to be selected to form a face sketch but also would allow user to upload hand-drawn individual features on the platform which might then be converted in to the applications component set. This successively would make the created sketch way more the same as the hand-drawn sketch and would be much easier for the enforcement departments to adapt the appliance.

This application would allow the enforcement team to upload traditional hand-made sketch so as to use the platform to spot and predict the suspect using efficient deep learning algorithm and cloud infrastructure provided by software.

The implemented machine learning algorithm would learn from the sketches and also the database so on suggest the user all the relatable facial expression that might be used with one selected feature so as to decrease the time consumption and increase the efficiency of the platform.

II. RELATED WORK

There are lot of studies on face sketch construction and recognition using various approaches. Xiaoou Tang and Xiaogang Wang proposed a recognition method of photo-sketch synthesized employing a Multiscale Markov Random Field Model the project could synthesis a give sketch into photo or a given photo in to sketch then search the database for a relevant match for this the model divided the face sketch in to patches. during this they first synthesized the available photos in to sketch so trained the model making the model to decrease the difference between photos and sketch this enhanced the general efficiency of the recognition model. For testing this they took few samples within which the photos where synthesized in to sketch and therefore the same faces where drawn from sketch artist then the model was trained from 60% data and remaining 40% data for testing the model. the general results where impressive but not up to the mark of course.

Dr. Charlie Frowd together with Yasmeen Bashir, Kamran Nawaz and Anna Petkovic designed a standalone application for constructing and identifying the facial composites, the initial system was found to be time consuming and confusing because the traditional method, later switching to a replacement approach within which the victim was given option of faces and was made to chose similar face resembling the suspect and at the top the system would combine all the chosen face and check out to predict automatically the criminal's facial composite. The Results where promising and 10 out of 12 composite faces where named correctly out of which the results 21.3% when the witness was helped by the department person to construct the faces and 17.1% when the witness tried constructing faces by themselves

Another proposed method was sketch to photo matching proposed by Anil K Jain and Brendan Klare which used SIFT Descriptor, the tactic proposed displayed result supported the measured SIFT Descriptor distance between the face photos within the database and therefore the sketches. The algorithm first converts the face photos using linear transformation which was supported Tang and Wang proposed model then the sketch was accustomed measure the SIFT descriptor distance compared to the face photo and in some cases distance between images within the databases too where measured for better accuracy. The experimental result shows that the dataset used where very the same as the those employed by Tang within their experiment and therefore the addition in the algorithm was the measurement of the descriptor which gave an improved result and accuracy from the model proposed by Tang and Wang.

P. C. Yuen and C. H. Man too proposed a way to search human faces using sketches, this method converted sketches to mug shots and so matched those mugshots to faces using some local and global variables been declared by the face matching algorithms. However, in some cases the mugshots where hard to be matched with the

human faces within the databases like FERET Database and Japanese Database. The proposed method showed an accuracy of about 70% within the experimental results, which was fair decent but still lacked the accuracy needed by the enforcement department.

The common issue with all the proposed algorithm where that they compared the face sketches with external body part which were usually front facing making it easier to be mapped both in drawn sketch and face photograph, but when a photograph or sketch collected had their faces in several direction the algorithms were less likely to map it and match with a face from the database which is front facing.

There are even system been proposed for composite face construction but most system used countenance which where been taken from photographs then been selected by the operator as per described by the witness and finally complied to create one external body part making it rather more complicated for human still as any algorithm to match it with a criminal face as every facial feature was been taken from the separate face photograph having various dissimilarity and when combined together made it harder to acknowledge.

Thus, all the previous approaches proved either inefficient or time consuming and complex. Our application as mentioned above wouldn't only overcome the constraints of the mentioned proposed techniques but would also fill within the gap between the standard hand-drawn face sketch technique and new modernized composite face sketch technique by letting user to upload the hand-drawn face sketches and facial expression.

III. OVER VIEW AND FEATURES OF THE APPLICATIONS

A. Security and Privacy

The major concern of the law enforcement departmentbefore adapting any system is security and privacy of the data. Keepingthis thinginmindtheapplicationhas beendesignedtobeconservetheprivacy and take all the necessary security actionsby using the followingways.

a) **CentralizedUsage:**Thesystemwhichhastheapplicationinstalled on it, wouldbeconnectedtoacentralized server of the enforcement departmentconsisting of the database and the other importantfeaturesetoftheapplication,thustheapplication could not be operated once disconnectedfromthe central server.

b) **MachineLocking Mechanism:**The Machine locking techniqueensures that the application once installed on asystemcannotbetamperedandbeenoperatedonanyothersystem,forthistheapplicationusestwolockingparametersi.e.onesoftwareandonehardware lockingparameter.

HD ID – Volume serial of hard-drive with OS.NETID–HardwareID –MAC Address.

c) **TwoStepVerification:**Everylawenforcementa uthorized user would be providedaUser ID (which would be an E-Mail),which can be used to login into the software,usingthisstepwouldrequiretheusertoen terarandomcodethat would besharedwiththemontheirmobile/desktopinorde rtocompletetheloggingprocess.

B. Compatibility of the software

The major drawback in adapting any new system is that the complication been involved in completing migrating from the previous technique to the new technique, hence leading to the wastage of your time resources.

To overcome this issue, we've got designed our application in such the simplest way that even the hand-drawn sketches are often uploaded and therefore the user can use the deep learning algorithms and cloud infrastructure to spot and recognize the criminal using the hand-drawn sketch.

C. Drag andDrop Feature

Software provides the feature to design and construct accurate composite face sketch usingthe pre existing facial feature providedastoolsthat canberesizedandrepositionedasper according to therequirement/description providedby theeye-witness.

The human face has been categorized into various facialfeatures such as head, eyes, eyebrow, lips, nose, ears, etc. andsome wearable components also such as hats, specs, etc.arealsoprovided in thesoftwareforuse. Everyfacialfeaturewhenselectedwouldopenalot ofoptionsthat can bechoosenbasedontherequirement/descriptionofthee ye-witness.Themachinelearning algorithm would learn and in future try to suggest allthe facial features which could suit the single selected featureand would try to help in completing the composite face sketchmuchsooner and much efficiently.

Fig. 1. sketch of the facial feature viz. Head
Fig. 2. sketch of the facial feature viz. Eyes
Fig.3.sketchof the facialfeatureviz. Ears

Fig.1.FaceFeature–Head

Fig.2.FaceFeature– Eyes

Fig.3.FaceFeature–Ears

Theseare some examples ofthefacialfeaturesthatcanbeusedintheapplication to construct the composite face sketch of the suspectbased on the description provided by the eye-witness totheinvestigation and forensicdepartment.
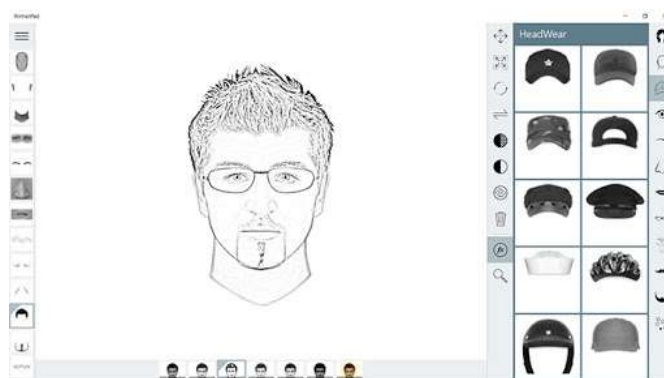
Fig.5.UserInterfaceof theapplication (withfacialfeatures beendraggedontothecanvas)

Fig. 5. shows the user interface of the application with thefacial feature been dragged on to the canvas from the right-hand side and to be used with other facial features to create acompositefacesketch.

D. Mechanism Flow of the Software
TheFig.6 below,Showstheentireflowofthesoftwareinitiating with the login section that ensures the two-stepverification process. Further the application can either be usedwith a hand-drawn sketch or a composite face sketch can also bedesigned using the drag and drop feature, The constructed sketch would go under features extraction process that wouldhelp the application to implement image processing and computervisionalgorithmandwould finallymatchthesketchwiththedatabase and then display the ratio of similarities between thesketchand the databasephotograph.
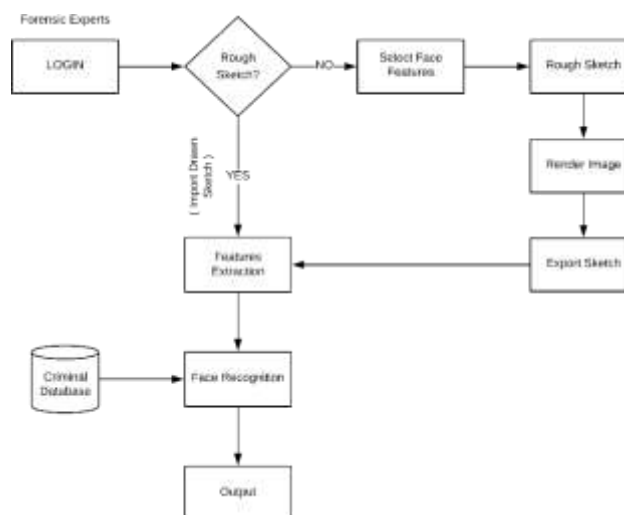

Fig.6.SystemFlow of theapplication

IV. OVERVIEW AND FEATURES

Inthissoftware,Operationsareperformed intwosteps.

A. Design &Construction of the face sketch :

The given flowchart explains how the users flow been followed bytheplatformtobuildaccuratefacesketchbased on the description, the dashboard is designed in a very simpler manner so thatnoprofessionaltrainingis required togothrough,before using this application. This will automaticallysave the time consumption whichwouldhavebeenbeneficial to theDepartment.
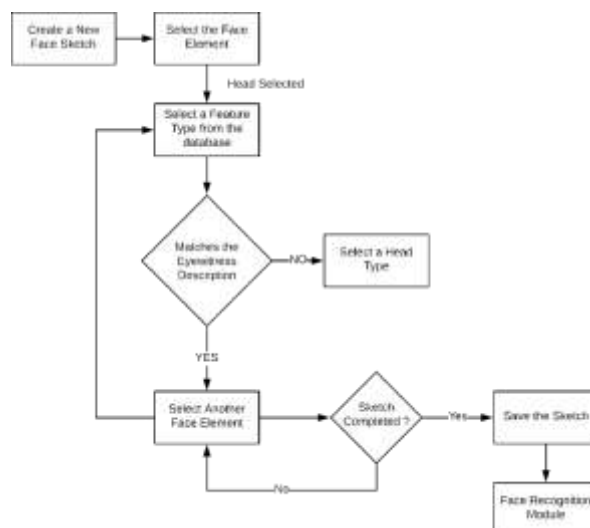

Fig. 7. Flow Chart for Creating a sketch in the application

The dashboard consists of 5 main modules:
First important module is that the Canvas that will be appearing within the middle of the dashboard, that represents the face sketch components and therefore the elements of the face sketches helping within the construction of the face sketch.

Building the face sketch would be a sophisticated thing if all the face elements are given all at once and in an unordered manner making the method difficult for the user and sophisticated to construct an accurate face which might be against the agenda aimed within the proposed system. So, to beat this issue we planned on ordering the face elements supported the face category it belongs to love head, nose, hair, eyes, etc. making it much easier for the user to interact with the platform and construct the face sketch. this is often available within the column within the left on Canvas on the dashboard click on a face category allows user to urge various other face structure.

Coming to the assorted face elements in a very particular face category we could have multiple and n number of elements for one category, so to resolve this our platform would use machine learning in future to predict the similar face elements or predict an suggest the weather to be selected within the face sketch but this might only work once we've got appropriate data to coach the model on this algorithm and work to reinforce the platform.

So, now whenever the user clicks on a specific face category, a new module to the proper of the canvas opens and lets user to pick out part from the choice of face elements to build the face sketch. This feature is often selected to support the outline provided by the witness attention.

The elements when selected are represented on the main section (i.e. canvas) and may be moved and placed as per the descriptiongiven by the witness to induce a more robust and accurate sketch and therefore the elements have a hard and fast location and we have to take care of the order of the elements to be placed on the main section, for example - like the eye elements would be placed over the pinnacle element regardless of the order in which they were selected. Same for each face element.

The final module is that the options to boost the employment of the dashboard, suppose in cases the user selects part which isn't to be selected so may be rectified using the choice to erase that individual element which might be seen when selecting the face category from the left panel. the main important buttons are placed within the panel on the correct which contains a button to completely erase anything on the canvas of the dashboard making it totally blank.

Then we've a button to save lots of the constructed face sketch, saving the face sketch as a PNG file for better future access. This might be at any location in the host pc or on the server counting on the investigation Department.

B. Recognition of the constructed Face Sketch:
The flowchart given below explains the

users flow that been followed by the platform to supply and recognize an accurate & precise face sketch supported by the outlines, the dashboard is meant simple so as to encourage no professional training to travel through before using this platform already saving the timeframe which might are taken plenty time and resources of the Department..
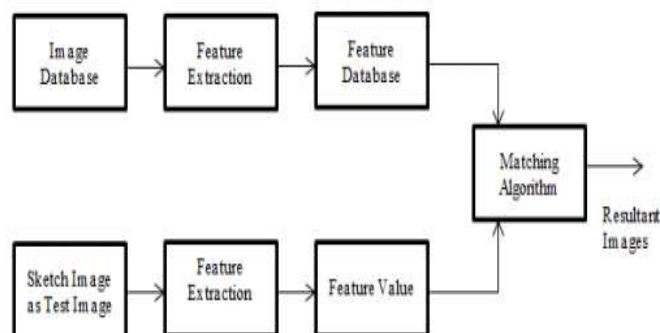

Fig.8.Flow Chartfor Recognizing a sketchin theapplication

The first part before usingthe platform to recognize faces is making the existing recordsinwiththeinvestigation departmentsuitableforoursoftwarebytrainingandma kingtheplatforms'algorithmrecognize and assign ids to the face photo of the user in theexisting records of the department. Forthis the platforms algorithms gets connected to the records andbreaks each face photo in to various smaller feature and assignanID tothemultiple featuresgeneratedforasinglefacephoto.

Now, the Module which is majorly designed to be run onthe Law enforcements server

for security protocols, is beenexecuted where in the user first opens either the hand drawnsketch or the face sketch constructed on our platform saved inthe host machine, after which the opened face sketch is beenuploadedtotheLawenforcementsserverhousingt herecognitionmodulesothattheprocessorthedataofth erecordarenot tampered and are secureand accurate.

Once the sketch is uploaded on to the server the algorithmfirsttracesthesketchimageinordertolearnth efeaturesinthe sketch and map the features as shown in the below figurein order to match those with the features of the face photos intherecords.

Fig.10.Face Sketchbeen mappedon thePlatform

After mapping the sketch and matching the face sketchwith the records and finding a match the platform displays thematched face along with the similarity percentage and otherdetails of the person from the records.

V. RESULTS & CONCLUSION
The Project 'Face Sketching and

Prediction application' has been designed, developed and eventually tested keeping the real-world scenarios from the very first splash screen to the ultimate screen to fetch data from the records keeping security, privacy and accuracy while keeping everything in mind for each scenario.

The platform displayed an amazing result

based on Security point of view by blocking the platform use. If the MAC Address and IP Address on loading didn't match up the credentials related to the employment within the database and later the OTP system proved its ability to limit the use of previously generated OTP and even generating the new OTP whenever the OTP page is reloaded or the user tries to relog within the platform.

The platform even showed good accuracy and speed while face sketch construction and recognition process, provided a median accuracy of over 90% with a confidence level of 100% when tested with various test cases, test scenario and data sets, which implies an awfully good rate in step with related studies on this field.The platform even have features that are different andunique too when compared to the related studies in this field,enhancing the overall security and accuracy by standing outamong all of them.

VI. FUTURE SCOPE

TheProject'Face Sketching and Prediction application'is currently designed toworkwithveryfewscenarios, for example - like on face sketches and matching those sketcheswiththefacephotos with the departmentrecords.

The platform can be made better in the future to workwith various technologies and scenarios enabling it to explorevariousmediaandsurveillancesmediumandto getamuchwider spread and outputs. The software can be modified tomatch the Face sketch with the human faces from the videofeeds by using the 3D mapping and imaging techniques andsamecanbeimplementedtotheCCTVsurveillance stoperform face recognition on the Live CCTV footage using theFace Sketch.

The platform can further be connected to social platforms that are a rich source for data in today's world, this system of connecting this platform with the social media platform would enhance the flexibility of the application to search out and give resultsway more accurately and match the face sketch and making the method speeding up with the increased load.

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