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CHEHRA: An Application for Forensic Face Sketch Construction and Recognition

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Abstract: *In this modern age, the overall crime rate is increasing day-by-day and to cope up with this the law enforcement departments too should find ways that would speed up the overall process and help them in bringing one to justice. One such way can be using face recognition technology for identifying and verifying the criminal. The traditional approach here is to use the hand-drawn face sketches drawn by forensic sketch artist to identify the criminal, modernizing this would mean using the hand drawn sketch and then matching them with the law enforcement departments database to identify the criminal. We believe, there is a need for creating an application which would not just provide a set of individual features like eyes, ears, mouth, etc. to be selected to create a face sketch but also would help in finding the criminal much faster and efficiently.*

Keywords: Face sketches, Construction, Recognition, Deep learning, AWS, Security, Two Step Verification, Machine Locking, Criminal Identification.

I. INTRODUCTION

Offenders are easily identified and delivered to justice by a hand drawn face sketch drawn based on the outline provided by the eye-witness, however in these modern times the long-established way of hand drawing a sketch is not much feasible and time efficient when used for matching and identifying from the already provided database or real-time databases.

During the past there has been variety of different techniques proposed to convert hand-drawn face sketches and use them to automatically identify and recognize the suspect from the police database, but they could not provide the desired precise results. Applications which could construct complex face-sketches were even introduced which too had various limitations like limited facial features kit, cartoonist feel to the created suspect face which made it much harder to use and get the desired results.

The above limitations and needs motivated us into thinking of developing a system which would not just provide a set of individual features like eyes, ears, mouth, etc. to construct a face sketch but also would allow user to upload a set of hand-drawn facial features on the platform. This would make the developed sketch much more relatable to the drawn sketch and it becomes much easier for the law enforcement departments to adapt the application. Our system would allow the law enforcement team to upload an already hand-drawn sketch in order to use the platform to identify and recognize the suspect using the much more efficient deep learning algorithm and centralized cloud infrastructure provided. The services like s3 bucket and recognition from Amazon Web Services (AWS) would learn from the sketches and the database in order to suggest to the user all the matched facial features that could be used with a single selected feature in order to decrease the time and increase the efficiency of the platform.

II. LITERATURE REVIEW

There are varies studies on face sketch construction and recognition using different kinds of approaches. Dr. Charlie Frowd in conjunction with Yasmeen Bashir, Kamran Nawaz and Anna Petkovic(1) created a standalone application for constructing and identifying the facial composites, the first system was found to be time consuming and confusing because the traditional method, later switching to a replacement approach during which the victim was given option of faces and was made to choose 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 outcome came out to be very 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 to sketch out the faces and 17.1% when the witness tried created faces by themselves.

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Xiaoou Tang and Xiaogang Wang [2] 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. In this they first synthesized the available photos in to sketch then trained the model making the model to decrease the difference between photos and sketch this enhanced the overall efficiency of the recognition model. For testing this they took few samples in which the photos where synthesized in to sketch and the same faces were drawn from sketch artist and then the model was trained from 60% data and remaining 40% data for testing the model. The overall results where impressive but not up to the mark needless to say.

Another proposed method was sketch to photo matching proposed by Anil K Jain and Brendan Klare[4] which used SIFT Descriptor, the method proposed displayed result based on 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 wont to measure the SIFT descriptor distance compared to the face photo and in some cases distance between images in the databases 4 too were measured for better accuracy. The experimental result shows that the dataset used where very almost like the those employed by Tang within the ir experiment and therefore the addition in the algorithm was the measurement of the descriptor which gave a far better result and accuracy from the model proposed by Tang and Wang.

70% in the experimental results, which was fair decent but still lacked the accuracy needed by the law enforcement department. The common issue with all the proposed algorithm where that they compared the face sketches with face 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 front facing picture from the database.

III. Project Design and Implementation

3.1 System Flow

Our application would be majorly used by the Law Enforcement Departments in order to reduce the overall time required to bring the criminal to justice and even to enhance the workforce and speed up the system by keeping accuracy in mind. So, keeping this scenario in mind the platform is designed to be as simple as possible in order to make sure that a user can create a sketch in the application without a formal training.

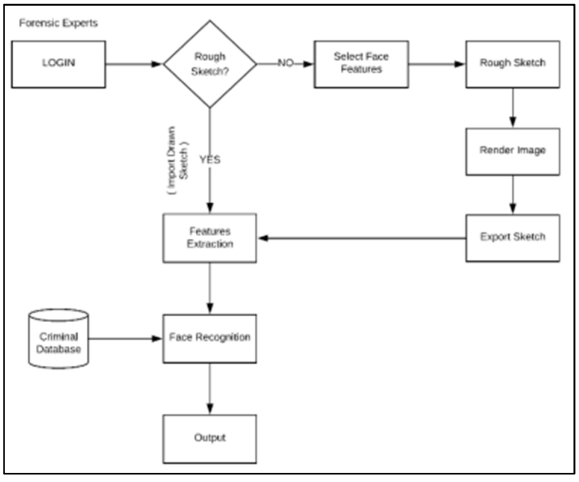

Figure 1: System Flow Chart of the Application

The above flowchart represents the overall flow of the system starting with the login page to the actual results been displayed after the sketch is been matched by the records in the database.

The privacy and security are been kept in mind from the very first stage itself starting with the login page itself, the login page consists of two parts. At the start the login page fetches the Mac Address along with IP Address and HDD ID which is then been matched with the data been collected while installing the platform in the host machine and if the data does not match the platform would lock itself and won't allow the user to move further and use any feature of the platform. This

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would make sure that the platform could not be accessed when the host machine is been tampered or the hard-disk is been tampered to be used in other machine making it more secure and much more reliable than any other platform currently available.

Moving further the second part consist of authenticating the user which consist of making sure that the user accessing the platform can have total privacy and security with the data and their credentials, for this we made use of Two Step Verification where in the user when enters his/her credential on to the platform the platform checks the authenticity of the user after which the platform mails an OTP to the registered email id making sure that no one other than the verified user can access the platform even if they have the login credentials. The OTP is been generated real-time for every login. After the secure login on to the platform and moving further the platform uses something called as Backward Compatibility, this feature is been introduced in order to make a smooth transition from the current technique on to the new platform.

The current technique been the use of hand drawn sketch been drawn by an expert forensic artist with years of experience and then the sketch been used by the law enforcement department to be showed on to various platforms in order to create a sense of awareness in people in order to find someone to recognize the suspect. So backward compatibility allows the law enforcement department to upload those hand drawn sketches on to the platform in order to use our face recognition module and match the suspect sketch with the large record and reducing the overall time and the efforts used in the previous age-old technique. If the law enforcement department doesn't have a hand drawn sketch and the law enforce department would wish to use the platform for creating a face sketch using our platform, they can access the canvas where they would find a wide range of facial elements in the database. The elements can be easily selected to create a described face sketch of the suspect and use the feature like drag and drop in order to arrange the elements according to the eye witness's description. The platform is designed in such a way that one can use the platform without a prior professional training and knowledge of sketching. The user thus can select the main face category he/she wishes to select and would then prompt with a variety of option under that particular face category and then can select one feature based on the description provided by the suspect Once the sketch is created the platform gives access to the face prediction module, where in the database of all the criminals until now in been saved on the data centres for maintaining a level of security and for this purpose the sketch too is been uploaded to the data centre first and then the prediction is been performed on the cloud for security purpose. Our platform uses deep learning alongside with Amazon Web Services (AWS) in order to give the best and accurate result so as to bring the criminal to justice. The prediction module divides the screen in to four parts, first the sketch to be predicted is been uploaded to the data centres for security purposes and the second part is the match found in the database followed with the third part which is the accuracy been shown in the predicted/match images and lastly the fourth part is called the meta which can be customized in order to show the data about the match as per need and then can be exported and shared with other if required.

3.2 Face Sketch Construction Module

As mentioned earlier, security and accuracy are the key features been focused while developing our platform for the law enforcement department. So, this module of the project mainly focuses on creating a face sketch based on the description been provided by the Eye Witness to the Law enforcement department.

The above flowchart illustrates the users flow been followed by the platform to provide a construct accurate face sketch based on the description, the dashboard is designed simple in order to encourage no professional training to go through before using this platform already saving the timeframe which would have been taken a lot time and resources of the Department. Keeping it simple thus ensures that the user doesn't have to be a professional sketch artist from the forensic department rather any one from the law enforcement department using the descriptions narrated by the eye witness or in some cases the eye witness too can take control of the platform but that would not be recommended as it can tamper the security protocols. Moving further the dashboard consists of Five main modules, First the important module is the Canvas been shown at the middle of the dashboard which would house the face sketch components and therefore the elements of the face sketches helping within the construction of the face sketch. Creating the face sketch would be a complicated thing if all the face elements are given all together and in an unordered manner making the process 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.

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making it much easier for the user to interact with the platform and construct the face sketch. This is available in the column in the left on Canvas on the dashboard click on a face category allows user to get various other face structure.

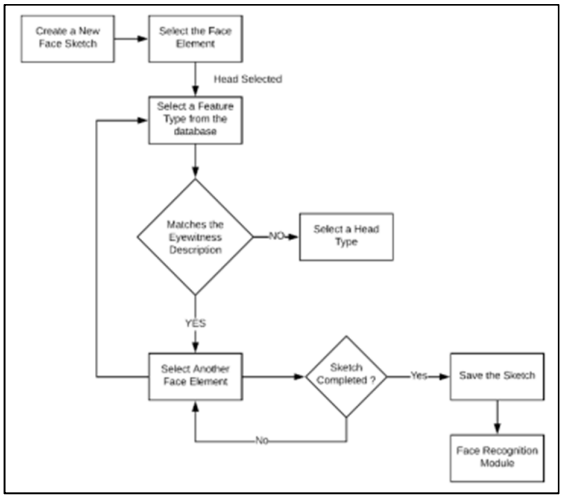

Figure 2: Flow Chart for Creating a sketch in the application.

The elements when selected are shown on the canvas and can be moved and placed as per the description of the eye witness to get a better and accurate sketch and the elements have a fixed location and order to be placed on the canvas like the eye elements would be placed over the head element irrespective of the order the were selected. Same for every face element. The final module is the options to enhance the use of the dashboard, suppose in cases the user selects an element which is not to be selected so that could be rectified using the choice to erase that specific element which might be seen when selecting the face category from the left panel.

The major important buttons are placed within the panel on the proper which features a button to completely erase anything on the canvas of the dashboard making it totally blank. Then we have a button to save the constructed face sketch, saving the face sketch as a PNG file for better future access. This could be any location on the host pc or on the server depending on the Law Enforcement Department.

3.3 Face Sketch Recognition Module

As mentioned earlier, security and accuracy are the key features been focused while developing our platform for the law enforcement department. So, this module of the project mainly focuses on recognizing a face sketch in the Law enforcement department face photo records with accuracy and confidence.

Figure 3: Flow Chart for Recognizing a sketch in the application

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The above flowchart illustrates the users flow been followed by the platform to provide an recognize accurate face sketch based on the description, the dashboard is designed simple in order to encourage no professional training to go through before using this platform already saving the timeframe which would have been taken a lot time and resources of the Department. Keeping it simple thus ensures that the user doesn't have to be a professional sketch artist from the forensic department rather any one from the law enforcement department using the descriptions narrated by the eye witness or in some cases the eye witness too can take control of the platform but that would not be recommended as it can tamper the security protocols. Now, the Module which is majorly designed to be run on the Law enforcements server for security protocols, is been executed where in the user first opens either the hand drawn sketch or the face sketch constructed on our platform saved in the host machine, after which the opened face sketch is been uploaded to the Law enforcements server housing the recognition module so that the process or the data of the record are not tampered and are secure and accurate. After the sketch is sent(uploaded) on to the server the algorithm in rekognition service of AWS traces the sketch image in order to learn the features in the sketch and map the features to match those with the features of the face photos in the records. After mapping the sketch and the face sketch with the records to find a match, the platform displays the matched face along with the similarity percentage and other details of the person from the records.

IV. TECHNOLOGY STACK

Below is the list of features and technologies and a brief explanation of them used to develop this application.

1. Machine Locking: The Machine locking technique would make sure that the project once installed on a system couldn't be tampered and will not been operated on the other system, that the application uses two locking parameters i.e., one software and one hardware locking parameter.
2. OTP (One Time Password): Every enforcement authorized user would have a registered E-Mail ID which might use to login on to the system, thus using this step would require the user to enter a random code been shared with them on their mobile/desktop or registered email in order to complete the logging process. An OTP is a randomly and automatically generated numeric or alphanumeric string of characters that authenticates the user for one transaction or login session. An OTP is safer than a static password, especially a user-created password, which may be weak and/or reused across multiple accounts. OTPs may replace authentication login information or could also be utilized in addition thereto so as to feature another layer of security.
3. JAVA: Java is a computing platform and programming language which was first released by Sun Microsystems in 1995. There are various standalone applications and websites that will not work unless you have Java installed, and more are getting developed every passing day. Java is fast, secure, and reliable. Java is everywhere, i.e., from laptops to datacentres, game consoles to scientific supercomputers, cell phones to the Internet and many more. Java offers higher cross- functionality and portability as programs written in one platform can run across desktops, mobiles, embedded systems. Java is free, simple, object-oriented, distributed, supports multithreading and offers multimedia and network support. Java is a mature language, therefore more stable and predictable. The Java Class Library apart from various features also enables cross-platform development. Being highly popular at enterprise, embedded and network level, Java has a large active user community and support available. Unlike C and C++, Java programs are compiled independent of platform in bytecode language which allows the same program to run on any machine that has a JVM 22 installed. Java has powerful development tools like Eclipse SDK and NetBeans which have debugging capability and offer integrated development environment. Increasing language diversity, evidenced by compatibility of Java with Scala, Groovy, J Ruby, and Clojure. Relatively seamless forward compatibility from one version to the next. In conclusion, almost 20 years after its inception, Java continues to deliver considerable value to the world of software development.
4. JavaFX: JavaFX may be a set of graphics and media packages that permits developers to style, create, test, debug, and deploy rich client applications that operate consistently across diverse platforms. Written as a Java API, JavaFX application code can reference APIs from any Java library. For example, JavaFX applications can use Java API libraries to access native system capabilities and hook up with server-based middleware applications. The look and feel of JavaFX applications are often customized. Cascading Style Sheets (CSS) separate appearance and elegance from implementation in order that developers can consider coding. Graphic designers can easily customize the looks and elegance of the appliance through the CSS. If you've got an internet design background, or if you'd wish

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to separate the interface (UI) and therefore the back-end logic, then you'll develop the presentation aspects of the UI within the FXML scripting language and use Java code for the appliance logic. If you favour to style UIs without writing code, then use JavaFX Scene Builder. As you design the UI, Scene Builder creates FXML markup which will be ported to an Integrated Development Environment (IDE) in order that developers can add the business logic.

5. Amazon Web Services (AWS): Amazon Web Services (AWS) may be a subsidiary of Amazon that gives on-demand cloud computing platforms and APIs to individuals, companies, and governments, on a metered pay-as-you-go basis. In aggregate, these cloud computing web services provide a group of primitive abstract technical infrastructure and distributed computing building blocks and tools. With Amazon Rekognition, you don't need to build, maintain or upgrade deep learning pipelines. To achieve accurate results on complex computer vision tasks like object and scene detection, face analysis, and face recognition, deep learning systems got to be tuned properly and trained with very large amounts of labelled ground truth data.

Amazon Rekognition is predicated on an equivalent proven, highly scalable, deep learning technology developed by Amazon's computer vision scientists to analyse billions of images and videos daily. It requires no ML expertise to use. Amazon Rekognition includes a simple, easy-to-use API that can quickly analyse any image or video file that's stored in Amazon S3. Amazon Rekognition is usually learning from new data, and we're continually adding new labels and facial comparison features to the service.

An Amazon S3 bucket may be a public cloud storage resource available in Amazon Web Services' (AWS) Simple Storage Service (S3), an object storage offering. Amazon S3 buckets, which are almost like file folders, store objects, which contains data and its descriptive metadata. An S3 customer first creates a bucket within the AWS region of his or her choice and provides it a globally unique name. AWS recommends that customers choose regions geographically on the brink of them to scale back latency and costs. Once the bucket has been created, the user then selects a tier for the information, with different S3 tiers having different levels of redundancy, prices and accessibility. A single bucket can store objects from different S3 storage tiers. Then, the user can specify access privileges for the objects stored during a bucket, through mechanisms like the AWS Identity and Access Management service, bucket policies and access control lists. An AWS customer can interact with an Amazon S3 bucket via the AWS Management Console, AWS instruction Interface or application programming interfaces (APIs). Sourcing, cleaning, and labelling data accurately may be a time-consuming and expensive task. Moreover, training a DNN is computationally expensive. To store our images and its metadata we have made use of Amazon s3 buckets which is a public cloud storage resource available in Amazon Web Services' (AWS) Simple Storage Service (S3), an object storage offering. and they are similar to file folders.

1. Centralized Computing: Centralized computing is done at central location, using terminals that are attached to a central computer. the pc itself may control all the peripherals directly (if they're physically connected to the central computer), or they'll be attached via a terminal server. Alternatively, if the terminals have the potential, they'll be able to attach with the central computer over the network. The terminals could even be text terminals or thin clients, as an example. It offers high level security over decentralized systems because all of the processing is controlled during a central location. In addition, if one terminal breaks down, the user can simply attend another terminal and log in again, and each one among their files will still be accessible. counting on the system, they'll even be able to resume their session from the aim they were at before, as if nothing had happened. this sort of arrangement does have some disadvantages. The central computer performs majority of the computing functions and controls the remote terminals all around.
2. Deep Learning for Recognition: Face recognition is that the matter of identifying and verifying people during a photograph by their face. It is a task that's trivially performed by humans, even under varying light and when faces are changed by age or obstructed with accessories and facial hair. Nevertheless, it's remained a challenging computer vision problem for many years until recently. Deep learning methods are ready to leverage very large datasets of faces and learn rich and compact representations of faces, allowing modern models to first perform as-well and later to outperform the face recognition capabilities of humans. Generally, we ask this because the problem of automatic "face recognition" and it's going to apply to both still photographs or faces in streams of video. Humans can perform this task very easily. We can find the faces in a picture and comment on who the people are, if they're known. We can do that alright, like when the people have aged, are wearing sunglasses, have different

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coloured hair, are looking in several directions, and so on. We can do that so well that we discover faces where there aren't any, like in clouds.

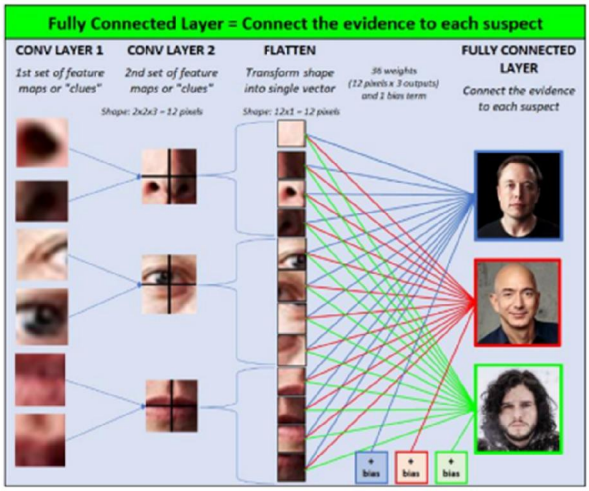

Figure 4: Feature Extraction by the platform

Face detection may be a fundamental step in face recognition and verification. It also extends to a broad range of other applications including facial expression recognition, face tracking for surveillance purposes, digital tagging on social media platforms and consumer applications in digital technologies, like auto-focusing ability in phone cameras. This survey will examine facial detection methods as applied to facial recognition and verification or a recent and comprehensive review of these traditional face detection methodologies, readers are referred to. This review will alternatively focus on more recently proposed deep learning methods, which were developed in response to the limitations of Hog and Har wavelet features in capturing salient facial information under unconstrained conditions which include large variations in resolution, illumination, pose, expression, and color. Essentially, it's the restrictions of those feature representations which have so far limited the power of classifiers to perform to the simplest of their ability.

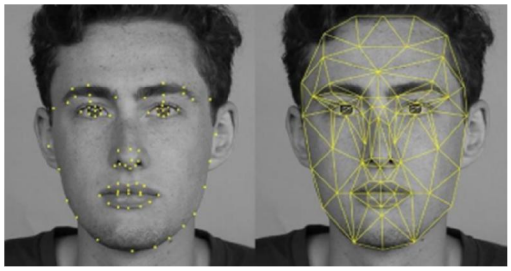

Figure 5: Face Sketch been mapped on the platform

Although the development of CNNs was impeded by lack of computing power, recent hardware advances have allowed rapid improvement and a significant increase in CNN depth, and consequently, accuracy. One outstanding feature is a rise thorough, and width to permit for improved feature representation by improving non-linearity. However, this results in issues like reduction in efficiency and overfitting. This section will explore the various methods which have aimed to address these problems in the context of facial recognition, through an examination of general improvements in DCCN architecture and loss functions. CCNs are generally more suitable to visual perception than standard feedforward neural networks of comparable size thanks to the utilization of fewer connections and parameters which facilitates training and efficiency, with only slight reduction in performance. CNNs were designed specifically for classification of 2D images due to invariance to translation, rotation and scaling. A CNN is comprised of a group of layers, including convolutional layers, which are a set of filters with values referred to as weights, non-linear scalar operator layers, and down sampling layers, such as pooling. Activation values are the output of individual layers which are used as input within the next layer.

The use of CNNs in face recognition tasks is comprised of two essential steps; namely, training and inference. Training is a global optimization process which involves learning of parameters via observation of huge datasets. Inference essentially

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involves the deployment of a trained CNN to classify observed data. The training process involves minimization of the loss function to determine the foremost appropriate parameters, and determination of the number of layers required, the task performed by each layer, and networking between layers, where each layer is defined by weights, which control computation.

V. RESULTS AND OUTPUTS

The Project 'CHEHRA: An application for forensic face sketch construction and recognition' is designed and developed keeping the real-world scenarios from the very first splash screen to the final screen to fetch data from the records keeping security, privacy and accuracy as the key factor in every scenario. The platform will provide tremendous security point of view by blocking the platform use if the MAC Address and IP Address on load didn't match the credentials associated with the user in the database and later the OTP system will prove its ability to restrict the use of previously generated OTP and even generating the new OTP every time the OTP page is reloaded or the user tries to relog in the platform.

The platform includes features that are unique and different when compared to related studies on this field, enhancing the overall security and accuracy by standing out among all the co-related studies and proposed systems in this field.

The following are the outputs of our application

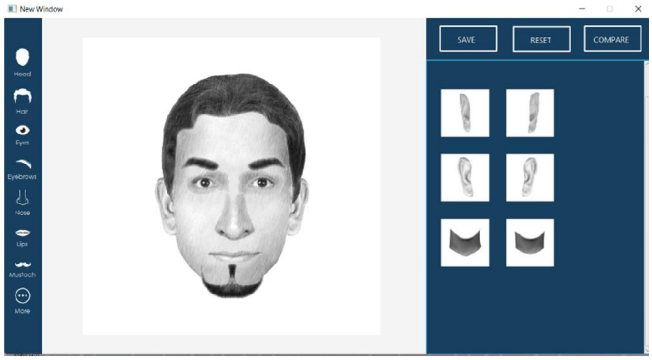

Figure 8: Face Sketch using drag and drop feature

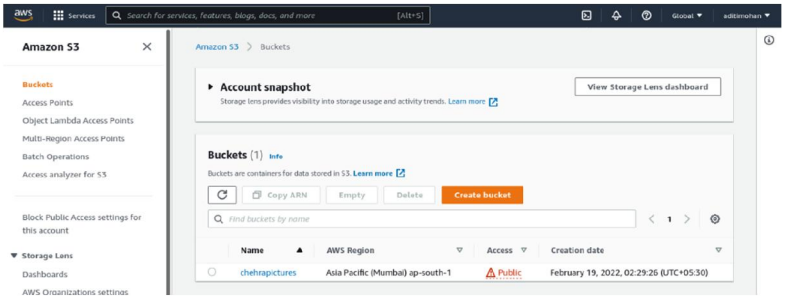

Figure 9: AWS S3 bucket

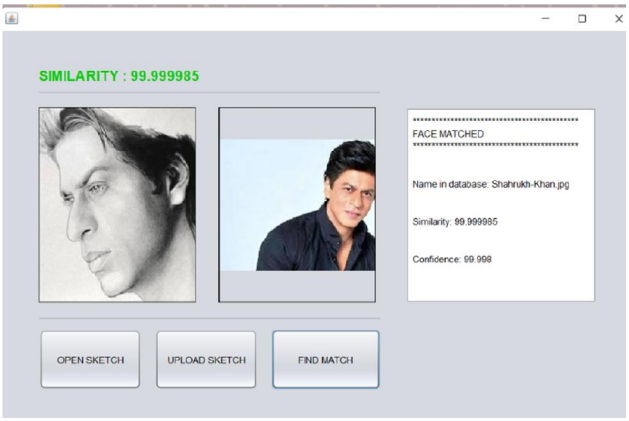

Figure 10: Details displayed after Face Recognition

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VI. Conclusion and Future Scope

The Project 'CHEHRA: An application for forensic face sketch construction and recognition is currently designed to work on very few scenarios like on face sketches and matching those sketches with the face photos in the law enforcement records. The platform can be much enhanced in the future to work with various technologies and scenarios enabling it to explore various media and surveillances medium and get a much broader outputs, the platform is often upgraded to match the Face-sketch with the faces from the video feeds by using the 3D mapping and imaging techniques and same can be implemented to the CCTV surveillances to perform face recognition on the Live CCTV footage using the Face Sketch.

The platform can further be connected to social media has social media platforms acts has a rich source for data in today's world, this technique of connecting this platform with the social media platform would enhance the ability of the platform to find a much more accurate match for the face sketch and making the process much more accurate and speeding up the process. In all the platform could have features which could be different and unique too and easy to upgrade, when compared to related studies on this field, enhancing the overall security and accuracy by standing out among all the related studies and proposed systems during this field

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