# Visvesvaraya Technological University

## Belagavi, Karnataka-590 018

**A PROJECT REPORT ON**

*"Forensic Face Sketching And Recognition"*

*Submitted in partial fulfillment of the requirements for the* ***Project (18CSP83)*** *course of the 8th semester*

**BACHELOR OF ENGINEERING**
**IN**
**COMPUTER SCIENCE AND ENGINEERING**

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**JSS MAHAVIDYAPEETHA, BENGALURU**

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# CERTIFICATE

This is to certify that the Project work entitled **"FORENSIC FACE SKETCHING AND RECOGNITION"** is a bonafied work carried out by **Mr. SHASHI KIRAN S G (1JS18CS148), Mr. SUJAY S (1JS18CS163)** and **Mr. SUTEJ Y M (1JS18CS169)** in partial fulfillment of the degree of Bachelor of Engineering in Computer Science and Engineering of the Visvesvaraya Technological University, Belgaum during the academic year 2021 - 2022. It is certified that all corrections and suggestions indicated for Internal Assessment have been incorporated in the report. The project has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

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# ABSTRACT

In this cutting-edge age, the general crime percentage is expanding step by step and to adapt up to this the policing also ought to find ways that would accelerate the general cycle and help them in dealing with one. One such way can be involving face acknowledgment innovation for recognizing and checking the lawbreaker.

The customary methodology here is to utilize the hand-drawn face outlines drawn by measurable sketch craftsman to recognize the crook, modernizing this would mean utilizing the hand-drawn sketch and afterward coordinating them with the policing information base to distinguish the lawbreaker. Utilizing this approach would bring about the different restrictions with most recent advances and, surprisingly, would be tedious as there are not many measurable sketch craftsmen accessible when contrasted with the rising wrongdoing proportion.

Our venture is pointed on diminishing the time frame and accelerating this interaction by giving an independent stage to the policing which would permit clients to make precise face sketch of the suspect without the assistance of scientific sketch craftsman and no extraordinary preparation or creative abilities. The sketch can be made utilizing simplified highlight in the application with assortment of face components and can consequently coordinate the drawn composite face sketch with the policing data set a lot quicker and effectively utilizing profound learning and cloud foundation.

**Keywords**: Forensic Face Sketch, Face Sketch Construction, Face Recognition,Criminal Identification, Deep Learning, Machine Locking, Two Step Verification.

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# CHAPTER 1

# INTRODUCTION

A crook can be effortlessly recognized and dealt with utilizing a face sketch drawn in view of the portrayal been given by the observer, but in this universe of modernization the conventional method of hand drawing a sketch isn't viewed as that powerful and efficient when utilized for coordinating and distinguishing from the generally accessible data set or continuous data sets.

During the past there were a few methods been proposed to change over hand-drawn face portrays and use them to consequently distinguish and perceive the suspect from the police data set, yet these strategies couldn't give the ideal exact outcomes. Application to make a composite face draw were even presented which also had different restrictions like restricted facial elements unit, cartoonist feel to the made suspect face which made it a lot harder to utilize these applications and obtain the ideal outcomes and proficiency.

The above applications and requirements persuaded us into considering making an application which wouldn't simply give a bunch of individual highlights like eyes, ears, mouth, and so on to be chosen to make a face sketch yet additionally would permit client to transfer hand-drawn individual elements on the stage which would then be changed over in to the applications part set. This, hence would make the made sketch significantly more like the hand-drawn sketch and would be a lot simpler for the policing to adjust the application.

Our application would try and permit the policing to transfer a past hand-attracted sketch request to utilize the stage to distinguish and perceive the suspect utilizing the significantly more effective profound learning calculation and cloud foundation given by the application.

The AI calculation would gain from the representations and the data set to propose the client every one of the engaging facial elements that could be utilized with a solitary chose highlight all together the decline the time span and increment the effectiveness of the stage.

## 1.1 Overview:

This is a standalone application, allowing user to construct accurate composite face sketch using the predefined facial feature sets provided as tools that can be resized and repositioned as per requirement/described by the eye-witness.

Moreover, the constructed composite face sketch can then be matched with the law enforcement departments database using deep learning and the speed and efficiency of cloud infrastructure to identify and verify the criminal. The same process can even be done with the hand-drawn sketch making the application backward compatible with traditional approaches.

## 1.2 Problem Statement:

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. Using this approach would result in the various limitations with latest technologies and even would be time consuming as there are very few forensic sketch artists available when compared tothe increasing crime ratio.

Thus, 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 that would help in finding the criminal much faster and efficiently.

## 1.3 Motivation for project:

The existing methods are conventional and time consuming. But we know that the first 24 hours after a crime are crucial and many cases go cold due to the failure to do anything by then. Hence we wanted to build a stand alone application to overcome these problems.

## 1.4 Objective:

- To Identify and recognize the suspect using much more efficient deep learning algorithm and cloud infrastructure.
- 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.
- Our Main focus is to create a face sketch based on the description provided by the Eye-Witness to the Law Enforcement Department.

## 1.5 Machine Learning:

Machine Learning is said as a subset of artificial intelligence that is mainly concerned with the development of algorithms which allow a computer to learn from the data and past experiences on their own. The term machine learning was first introduced by Arthur Samuel in 1959. We can define it in a summarized way as: " Machine learning enables a machine to automatically learn from data, improve performance from experiences, and predict things without being explicitly programmed." With the help of sample historical data, which is known as training data, machine learning algorithms build a mathematical model that helps in making predictions or decisions without being explicitly programmed. Machine learning brings computer science and statistics together for creating predictive models. Machine learning constructs or uses the algorithms that learn from historical data. The more we will provide the information, the higher will be the performance.

Features of Machine Learning:

- Machine learning uses data to detect various patterns in a given dataset.
- It can learn from past data and improve automatically.
- It is a data-driven technology.

**Classification of Machine Learning:**

At a broad level, machine learning can be classified into three types:

**1. Supervised learning:** Supervised learning is a type of machine learning method in which we provide sample labeled data to the machine learning system in order to train it, and on that basis, it predicts the output. Supervised learning can be grouped further in two categories of algorithms:

- Classification
- Regression

**2. Unsupervised learning:** Unsupervised learning is a learning method in which a machine learns without any supervision. The training is provided to the machine with the set of data that has not been labeled, classified, or categorized, and the algorithm needs to act on that data without any supervision.In unsupervised learning, we don't have a predetermined result. The machine tries to find useful insights from the huge amount of data. It can be further classifieds into two categories of algorithms:

- Clustering
- Association

## 1.6 Facial Recognition:

A facial recognition system is a technology capable of matching a human face from a digital image or a video frame against a database of faces, typically employed to authenticate users through ID verification services, works by pinpointing and measuring facial features from a given image.

Development began on similar systems in the 1960s, beginning as a form of computer application. Since their inception, facial recognition systems have seen wider uses in recent times on smartphones and in other forms of technology, such as robotics. [3] Because computerized facial recognition involves the measurement of a human's physiological characteristics, facial recognition systems are categorized as biometrics. Although the accuracy of facial recognition systems as a biometric technology is lower than iris recognition and fingerprint recognition, it is widely adopted due to its contact-less process. [6] Facial recognition systems have been deployed in advanced human–computer interaction, video surveillance and automatic indexing of images.

Facial recognition systems are employed throughout the world today by governments and private companies. Their effectiveness varies, and some systems have previously been scrapped because of their ineffectiveness. The use of facial recognition systems has also raised controversy, with claims that the systems violate citizens' privacy, commonly make incorrect identifications, encourage gender norms and racial profiling, and do not protect important biometric data. The appearance of synthetic media such as deepfakes has also raised concerns about its security. These claims have led to the ban of facial recognition systems in several cities in the United States. As a result of growing societal concerns, Meta announced that it plans to shut down Facebook facial recognition system, deleting the face scan data of more than one billion users. This change will represent one of the largest shifts in facial recognition usage in the technology's history.

# CHAPTER 2

# LITERATURE SURVEY

Numerous studies have looked at different methods for creating and recognizing facial sketches. [2] The initial system was found to be time-consuming and confusing as the conventional method, so Dr. Charlie Frowd, Yasmeen Bashir, Kamran Nawaz, and Anna Petkovic created a stand-alone application for creating and identifying facial composites. They later switched to a new approach in which the victim was given options of faces and was forced to choose similar faces resembling the suspect, and at the end the system would combine all the selected faces and try to predict the perpetrator. The results were encouraging: 10 out of 12 composite faces were properly identified, with outcomes of 21.3 percent when the witness received assistance from a department employee and 17.1 percent when the witness attempted to assemble the faces on their own.

[4,24] A recognition method of photo-sketch synthesized using a Multiscale Markov Random Field Model was proposed by Xiaoou Tang and Xiaogang Wang. The project may synthesize a given sketch into a photo or a given photo into a sketch and then search the database for a relevant match. In order to train the model to reduce the difference between photographs and sketches, they first converted the available photos into sketches. This increased the recognition model's overall efficiency. For testing, they used a small sample size in which the faces from the pictures were synthesized into sketches and created by a sketch artist. The model was then trained using 60% of the data, with the remaining 40% being used to test the model. Although the overall results were good, they fell short of expectations.

Anil K. Jain and Brendan Klare also proposed the sketch to picture matching approach, which used the SIFT Descriptor. The method's results were based on the measured SIFT Descriptor distance between the face photos in the database and the sketches. The sketch was used to measure the SIFT descriptor distance compared to the face photo after the algorithm first transforms the face photos using linear transformation, which was based on Tang and Wang's proposed model. In some cases, distance between images in the databases was also measured for better accuracy.

The results of the experiment reveal that the datasets utilized were fairly comparable to those Tang and Wang used in their experiment. The algorithm's addition of descriptor measurement produced results and accuracy that were superior to those of the Tang and Wang model.

[7] A method to find human faces using sketches was also proposed by P. C. Yuen and C. H. Man. This method turned sketches into mug shots, which were then matched to faces using the local and global variables specified by the face matching algorithms. However, in some instances it was difficult to match the faces in the mugshots with those in databases like the Japanese Database and the FERET Database. The experimental findings for the proposed method indicated an accuracy of roughly 70%, which was reasonable but still fell short of the precision required by the law enforcement department.

The problem with all of the proposed algorithms was that they compared the face sketches with human faces, which are typically front facing and make it easier to be mapped in both drawn sketches and human face photographs. However, when a photograph or sketch was collected with faces facing in a different direction, the algorithms were less likely to map it and match with a face from the database which is front facing.

There are even systems that have been proposed for composite face construction, but the majority of these systems use facial features that were taken from photographs, selected by the operator based on the witness's description, and then combined to form a single human face, making it difficult for humans and any algorithm to match it with a criminal face because each facial feature was taken from a separate face photograph with varying dissimilarities.

Therefore, all of the earlier methods were either ineffective or time-consuming and difficult. By allowing users to upload hand-drawn face sketches and facial features, our application, as previously mentioned, would not only overcome the shortcomings of the aforementioned proposed techniques, but it would also bridge the gap between the traditional hand-drawn face sketch technique and the new modernized composite face sketch technique

**The below table shows previous proposed approaches in the field of forensic face sketch construction and recognition. The Table consist of the Author name along with the Proposed Approached and their Limitation.**

**Table2.1**

| Author | Year | Technology | Limitation |
|---|---|---|---|
| X. Tang and X. Wang | 2004 | Face sketch synthesis and recognition | Works only for front facing, but when a photograph or sketch facing in another direction was presented, it was likely to fail. |
| Q. Liu, X. Tang, H,Jin, H. Lu, and S. Ma | 2005 | A nonlinear approach for face sketch synthesis and recognition | Block artifacts and blur effects. |
| P. Yuen and C. Man | 2007 | Human face image searching system using sketches | Works only for front facing images. Fails otherwise. |
| Charlie Frowd, Anna Petkovic, Kamran Nawaz and Yasmeen Bashir | 2009 | Automating the Processes Involved in Facial Composite Production and Identification | Varying pixel intensity, hindered accuracy and hard to match with images in the database. |
| B. Klare and A. Jain | 2010 | Sketch to photo matching: a feature based approach | Hindered accuracy as it failed to work with different angles other than front facing. |

| | | | |
|---|---|---|---|
| Y Zhang, J Sullins, K Bommen and A Jain | 2010 | Hand drawn sketch recognition and PCA based algorithm for forensic application | Worked on smaller sample, less robust. |
| W. Zhang, X. Wang and X. Tang | 2011 | Coupled information theoretic encoding for face photo-sketch recognition | Worked only for front facing images, failed otherwise. |
| Hamed Kiani Galoogahi and Terence Sim | 2012 | Face Sketch Recognition By Local Radon Binary Pattern: LRBP | Does not function accurately when the detailing is not high. |
| Hu Han, Brendan F. Klare, Kathryn Bonnnen and Anil K. Jain | 2013 | Achieving age-invariant by Photo-to-Photo matching | Doesn't work with composite-to-photo matching. |
| Phillip Isola, Jun-Yan Zhu, Timghui Zhou and Alexei A. Efros | 2017 | Conditional Adversarial Networks (CAN) is promising for many image-to-image translation outputs (especially those involving highly structured graphical outputs) | Works efficiently for highly structured graphicalimages. Fails when extreme transformation, especially on geometric changes. |
| Phillip Isola, Jun-Yan Zhu, Timghui Zhou and Alexei A. Efros | 2017 | To learn to translate an image from a source domain to a target domain in the absence of paired examples | Tough/often succeeds on translation tasks that involve color and texture changes also on tasks that require geometric changes. |

| | | | |
|---|---|---|---|
| Y. Song, J. Zhang, L Bao and Q Yang | 2017 | A fast-preprocessing method called Bidirectional Luminance Remapping (BLR), which interactively adjusts the lighting of training and input photos. It can be directly integrated into state-of-the-art exemplar-based methods to improve their robustness with ignorable computational cost. | Failure in search of similar patch candidates for an input photo patch. |
| Y C Lai, B A Chen, K W Chen, W L Si, C Y Yao and E Zhang | 2017 | Replacing static water flow scenes with animations Transforming a static Chinese painting to an interactive walk-through with seamless and vivid stroke-based flow animations in its original dynamic spirits without flickering artifacts. | Cannot animate more dynamic water effect such as wave breaking and wave spreading. |
| F L Zhang, J Wang, E Shechtman, Z Y Zhou, J X Shi and S M H | 2017 | A simple method for image inpainting using low rank approximation, which avoids the time-consuming iterative shrinkage. | Fails to measure the similarity between image patches. |

| | | | |
|---|---|---|---|
| A. Krizhevsky, L Sutskever and G E Hinton | 2017 | ImageNet Classification with Deep Convolutional Neural Networks | Network's performance degrades if a single convolutional layer is removed. |
| M. Zhu, N. Wang, X. Gao, and J. Li, | 2017 | Deep discriminative representations derived from dCNNs | Lacks of representation ability and robustness to light variations and clutter backgrounds. |
| Q. Liu, X. Tang, H. Jin, H. Lu, and S. Ma | 2017 | Pseudo sketch synthesis | Application accepts only hand drawn sketches. |
| N. Wang, X. Gao, L. Sun, and J. Li | 2017 | Bayesian framework | Neglects the constraint either in the neighbor selection model or in the weight computation mode. |
| Y. Song, L. Bao, S. He, Q. Yang, and M.-H. Yang | 2017 | Single exemplar | Fails when the exemplar does not contain sufficient stylized facial components for a given photo. |
| Nannan Wang, and Xinbo Gao, and Jie Li | 2018 | Random Sampling for Fast Face Sketch Synthesis | Random sampling is an offline stage and it cannot search neighbors online as done in existing methods. |

| | | | |
|---|---|---|---|
| Y. J. Huang, W. C. Lin, I. C. Yeh, and T.Y Lee | 2018 | A model stylization approach which combines base and style models while preserving user-specified shape features of the base model and the attractive features of the style model with limited assistance from a user | Worked only for frontfacing images and failure in search of similarpatch candidates for an input photo patch. |
| S. S. Lin, C. C. Morace, C. H. Lin, L. F. Hsu, and T. Y. Lee | 2018 | Escher transmutation | It uses dual perception which most of the users felt complex and difficult to work with, because on image gets deformed when the other image is gradually revealed. |
| Bin Sheng, Ping Li, Chenhao Gao, Kwan-Liu Ma | 2019 | Enhanced 3D PatchMatch and cross-layer cost aggregation methods | Manipulate the whole process directly in the field of RGB space because of which edges would be blurred and face structures could not be restored. |

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# CHAPTER 3

# SYSTEM ANALYSIS

## 3.1 Security and Privacy

The main pressing issue of the policing prior to adjusting any framework is security and protection. Remembering this the application is intended to safeguard the protection and complete the safety efforts in the accompanying ways.

### 3.1.1 Machine Locking:

The Machine locking method would guarantee that the application once introduced on a framework couldn't be altered and couldn't been worked on some other framework, for which the application utilizes two locking boundaries for example one programming and one equipment locking boundary.

**HD ID** – Volume serial of hard-drive with OS.
**NET ID** – Hardware ID – MAC Address.

### 3.1.2 Two Step Verification:

Each policing client would be given an authority E-Mail ID which would use to login on to the application, consequently utilizing this step would require the client to enter an irregular code been imparted to them on their versatile/work area to finish the logging system.

### 3.1.3 Centralized Usage:

The framework which has the application been introduced would be associated with a concentrated server of the policing grounds containing the information base and the other significant list of capabilities of the application, in this manner the application couldn't be worked once separated from the server

## 3.2 Backward Compatibility

The significant downside in adjusting any new framework is the difficulty been engaged with finishing moving from the past method to the new procedure, hence bringing about the wastage of time assets.

To defeat this issue, we have planned our application so that even the hand-drawn representations can be transferred and the client can utilize the profound learning calculations and cloud framework to distinguish and perceive the crook utilizing the hand-drawn sketch.

## 3.3 Face Sketch Construction using Drag and Drop

In this application, exact composite face sketch can be developed utilizing the predefined facial capabilities gave as apparatuses permitting to be resized and repositioned according to necessity/depicted by the onlooker.

Here, the human face is be classified into different facial highlights like head, eyes, eyebrow, lips, nose, ears, and so forth and a few significant wearable parts like caps, specs, and soon. too are been accessible in the application for use.

Each facial component when chosen would open many choices to browse in light of the prerequisite/depiction of the onlooker.[10] The AI calculation would learn and in future attempt to propose every one of the facial elements which could suit the single chosen highlight and would attempt to assist in finishing the composite face with outlining a whole lot earlier and much proficiently.

Fig. 3.3.1. Shows the sketch of the facial feature viz. Head
Fig. 3.3.2. Shows the sketch of the facial feature viz. Eyes
Fig. 3.3.3. Shows the sketch of the facial feature viz. Ears

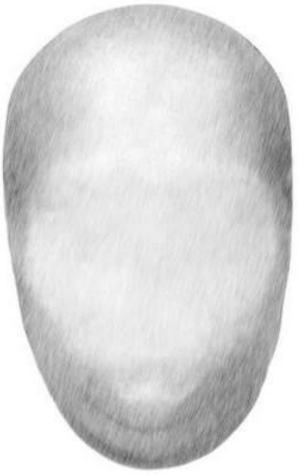

Fig. 3.1. Face Feature – Head

Fig. 3.2. Face Feature – Eyes

Fig. 3.3. Face Feature – Ears

Such are the facial features which can be used in the application to create the composite face sketch of the suspect based on the description been provided by the eye-witness to the law enforcement and forensic department.

## 3.4 System Specification:

### 3.4.1 Hardware Specification

This application is been designed to run on the minimum possible configuration of hardware.

**Client/ Node Machine:**

- Processor: Intel Dual Core CPU and above
- RAM: 1 GB and above
- Hard Disk: 250GB and above

**Server Machine:**

- Processor: Intel Core i3 CPU and above
- RAM: 4 GB and above
- Hard Disk: 1 TB and above

### 3.4.2 Software Specification

This application is been designed to run as a desktop application with part of the data saved on server for security purpose.

**Client/ Node Machine:**

- Operating System: Windows 7 and above
- Framework: Java JDK
- Cloud: Amazon Web Services CLI

**Server Machine:**

- Operating System: Windows Desktop OS or Windows Server Edition
- Framework: Java JDK
- Cloud: Amazon Web Services CLI
- Database: SQLite

# CHAPTER 4

# DESIGN AND IMPLEMENTATION

## 4.1 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.

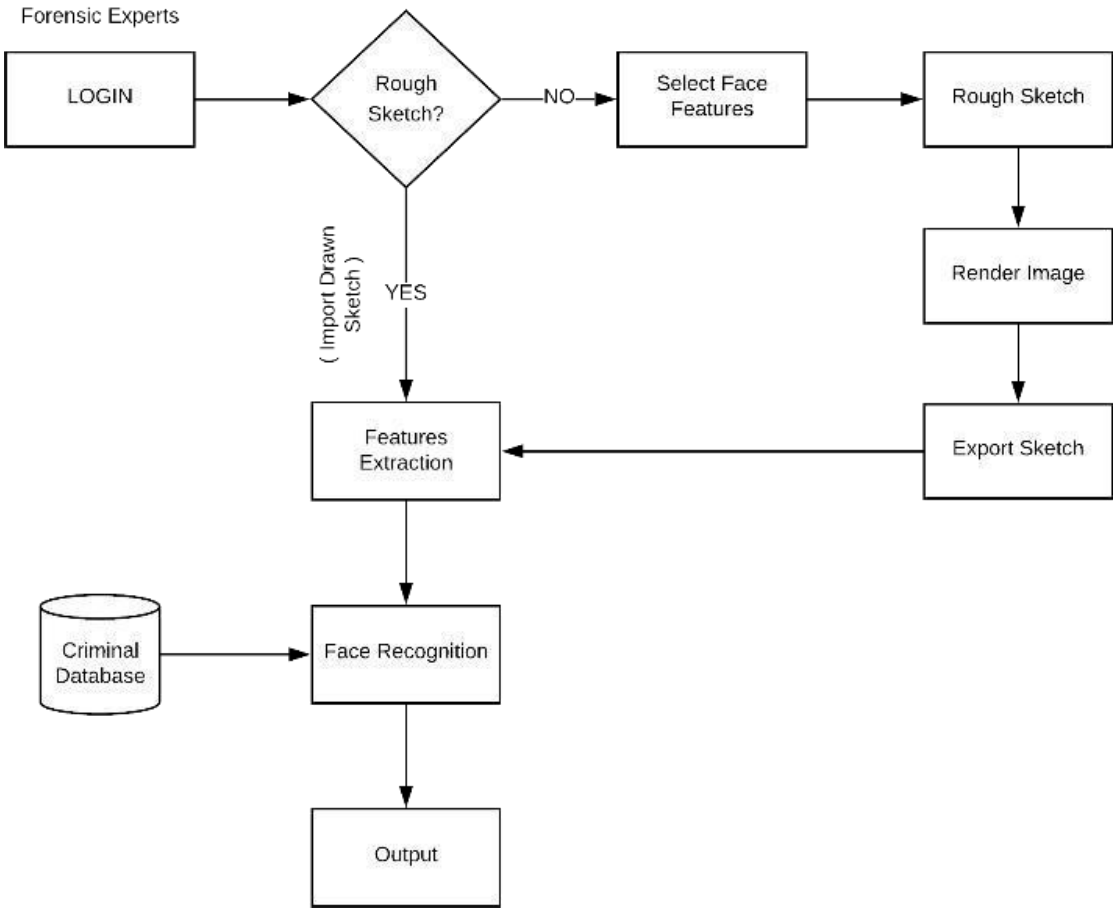


Fig 4.1 System Flow Chart of the Application

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 theplatform would lock itself and won't allow the user to move further and use any feature of the platform. This 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, [25] For this we made use of Two Step Verification where in the user when entershis/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. Sobackward 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. The platform even would allow the user to change a selected feature to be replaced by any other feature if it does not match the description even after selection.

The selected face categories would be placed one another to create a complete face sketch and can be moved on using the mouse for placing that face feature on to another spot based on the description been provided by the eye witness. This canvas can then be saved as JPG format image in order to further use the image in possible medium other than out platform like sharing on social media or for printing purpose.

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 centers for maintaining a level of security and for this purpose the sketch too is been uploaded to the data center first and then the prediction is been performed on the cloud for security purpose. [19]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 centers 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.

## 4.2 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.

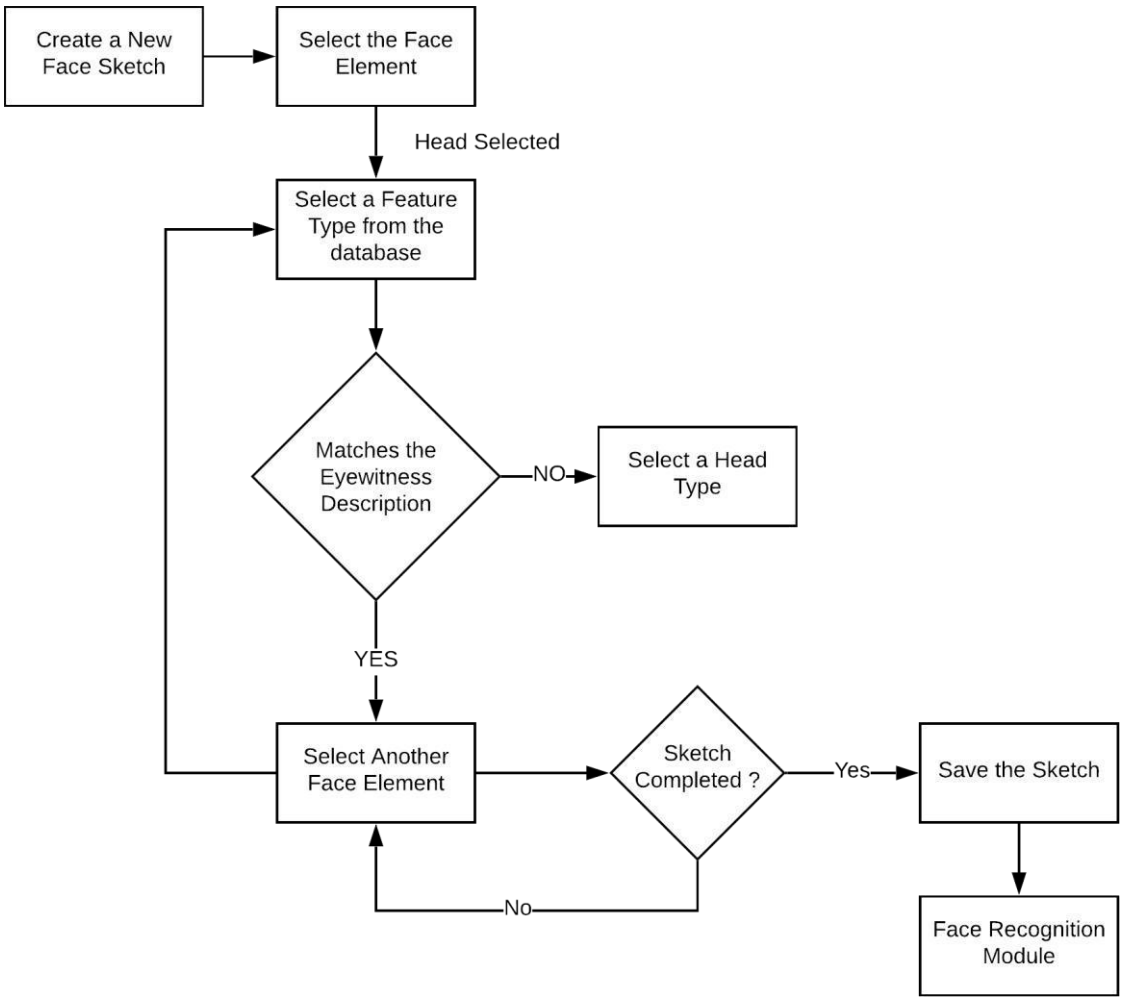


Fig 4.2 Flow Chart for Creating a sketch in the application

The above flowchart illustrates the users flow been followed by the platform to provide and 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 time frame 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 theplatform but that would not be recommended as it can tamper the security protocols.

Moving further the dashboard comprises of Five principal modules, First the significant module is the Canvas been displayed at the center of the dashboard which would house the face sketch parts and the components of the face draws assisting in the development of the face with portraying.

Making the face sketch would be something muddled assuming all the face components are given alltogether and in an unordered way making the cycle hard for the client and confounded to build a precise face which would be against the plan pointed in the proposed framework. [14] Thus, to over come this issue we anticipated requesting the face components in light of the face classification it has a place with like head, nose, hair, eyes, and so on making it a lot simpler for the client to cooperate with the stage and develop the face sketch. This is accessible in the section in the left on Canvas on the dashboard click on a face classification permits client to get different other face structure.

Coming to the different face components in a specific face classification we could have various and n number of components for a solitary class, so to settle this our foundation would utilize AI in future to anticipate the comparable face components or foresee a propose the components to be chosen in the face sketch however this would just work once we have fitting information to prepare the model on this calculation and work to upgrade the stage.

In this way, presently when the client taps on a specific face classification and afterward another module to one side of the material opens and lets client to choose a component from the choice of face components to build a face sketch. This choice can be chosen be chosen in light of the portrayal given by the observer.

The components when chosen are displayed on the material and can be moved and put according to the depiction of the observer to get a superior and exact sketch and the components have a proper area and request to be put on the material like the eye components would be set over the head component regardless of the request the were chosen. Same for each face component.

The last module is the choices to upgrade the utilization of the dashboard, assume in cases the client chooses a component which isn't to be chosen so that could be amended utilizing the choice to deletethat specific component which would be seen while choosing the face class from the left board. The major significant buttons are put in the board on the right which has a button to totally delete anything on the material of the dashboard making it thoroughly clear.

Then we have a button to save the developed face sketch, saving the face sketch as a PNG record forbetter future access. This could be any area on the host pc or on the server relying upon the Law Enforcement Department.

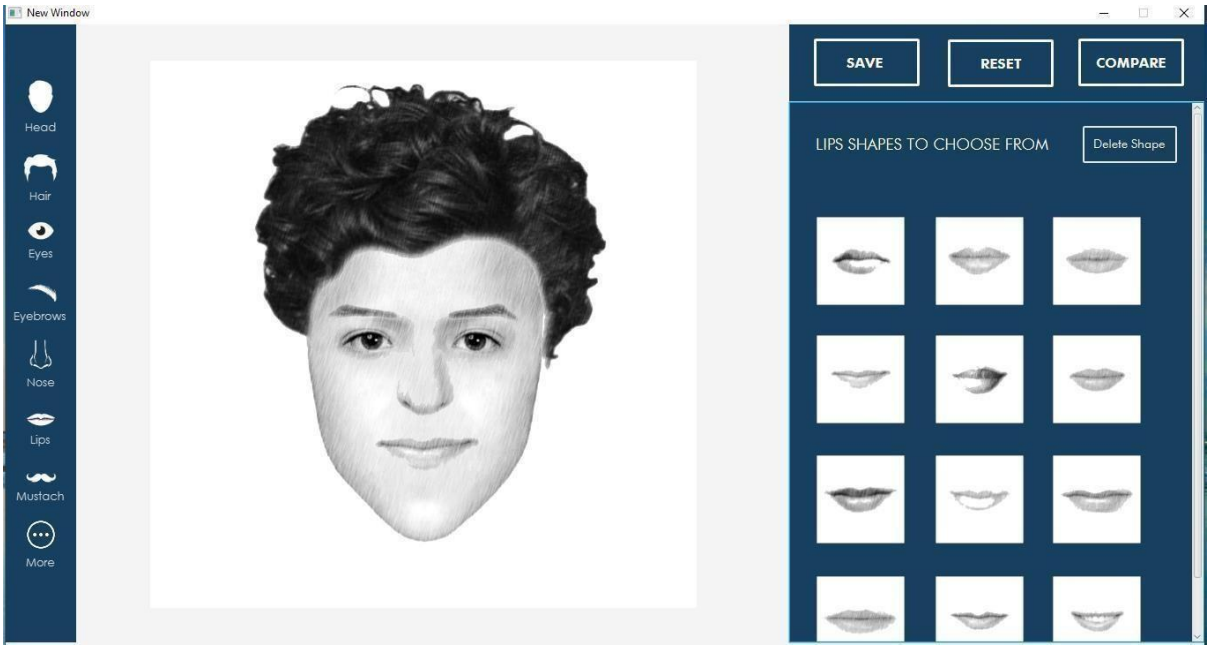


Fig 4.3. A Complete Face Sketch in Dashboard

(The Complete Face Sketch been displayed on the Dashboard Canvas)

## 4.3 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

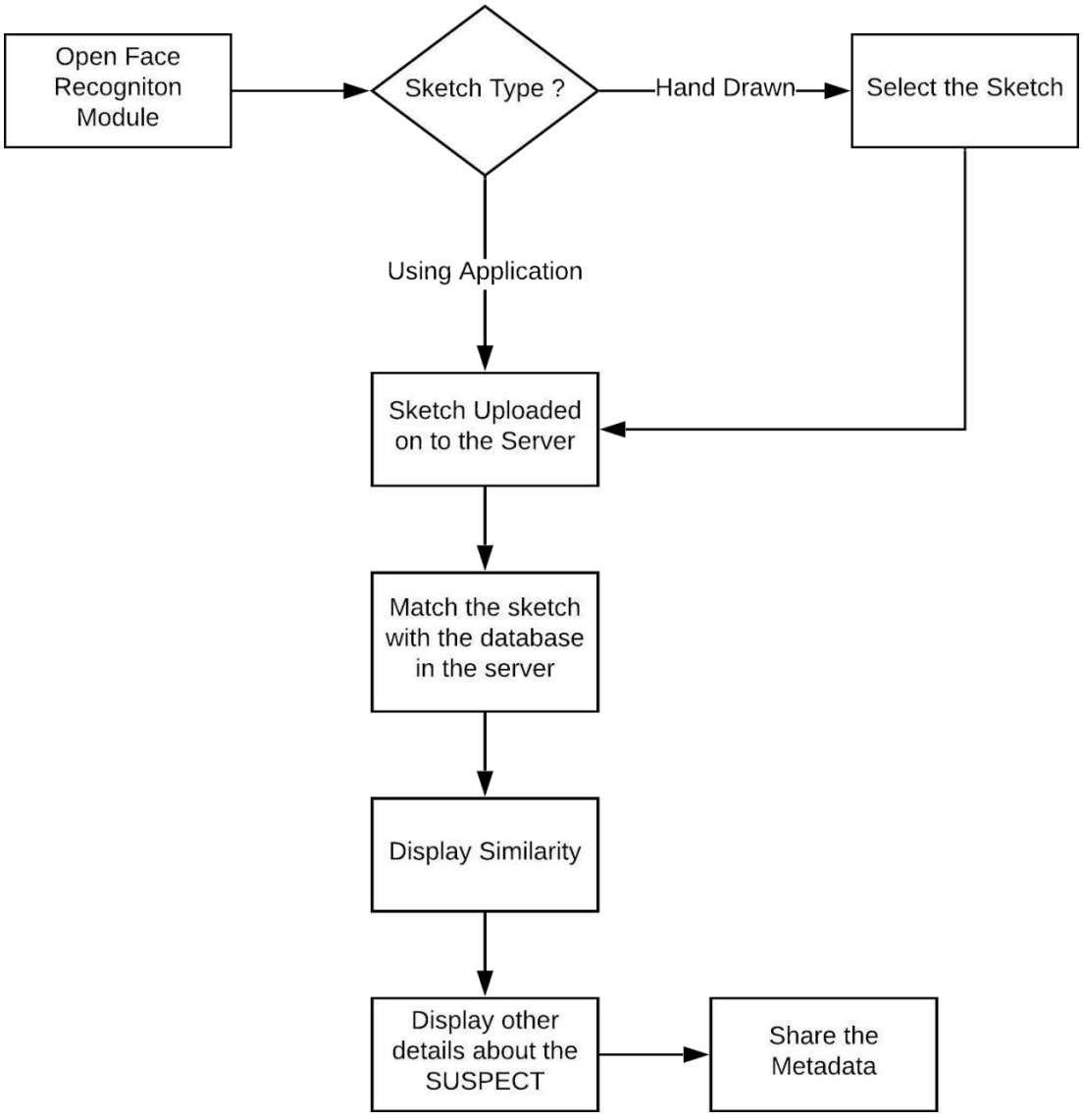


Fig 4.4 Flow Chart for Recognizing a sketch in the application

The above flowchart illustrates the users flow been followed by the platform to provide and 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 time frame 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.

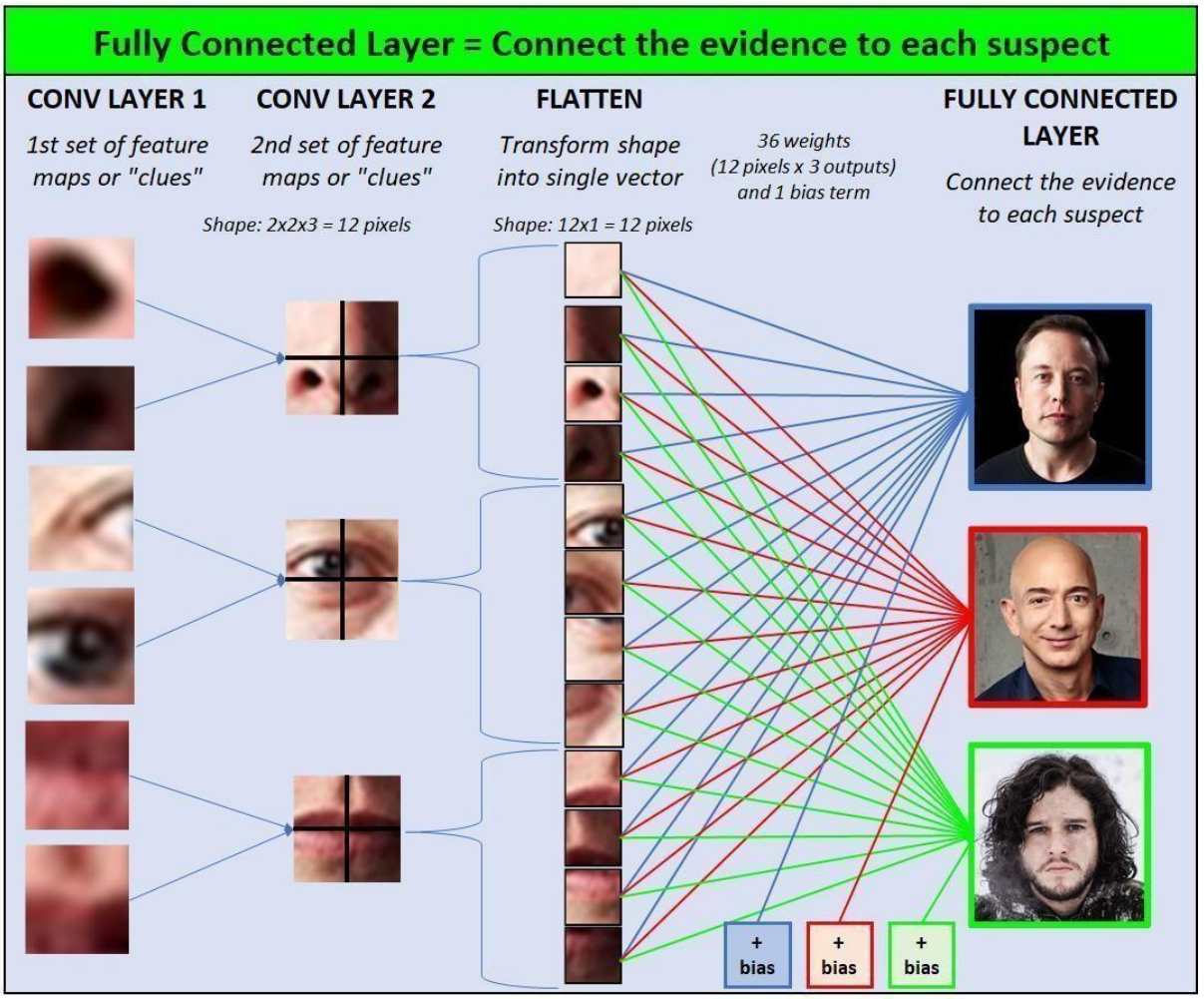


Fig 4.5 Feature extraction by the Platform

The above image demonstrates the first part before using the platform to recognize faces is making the existing records in with the law enforcement department suitable for our platform by training and making the platforms algorithm recognize and assign IDs to the face photo to the user in the existing records in with the law enforcement department. [ 2 2 ] For this the platforms algorithms gets connected to the records and breaks each face photo in to various smaller feature and assign an ID to the multiple features generated for a single face photo.

Now, the Module which is majorly designed to be run on the Law enforcement 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 enforcement server housing the recognition module so that the process or the data of the record are not tampered and are secure and accurate.

Once the sketch is uploaded on to the server the algorithm first traces the sketch image in order to learn the features in the sketch and map the features as shown in the below figure in order to match those with the features of the face photos in the records.

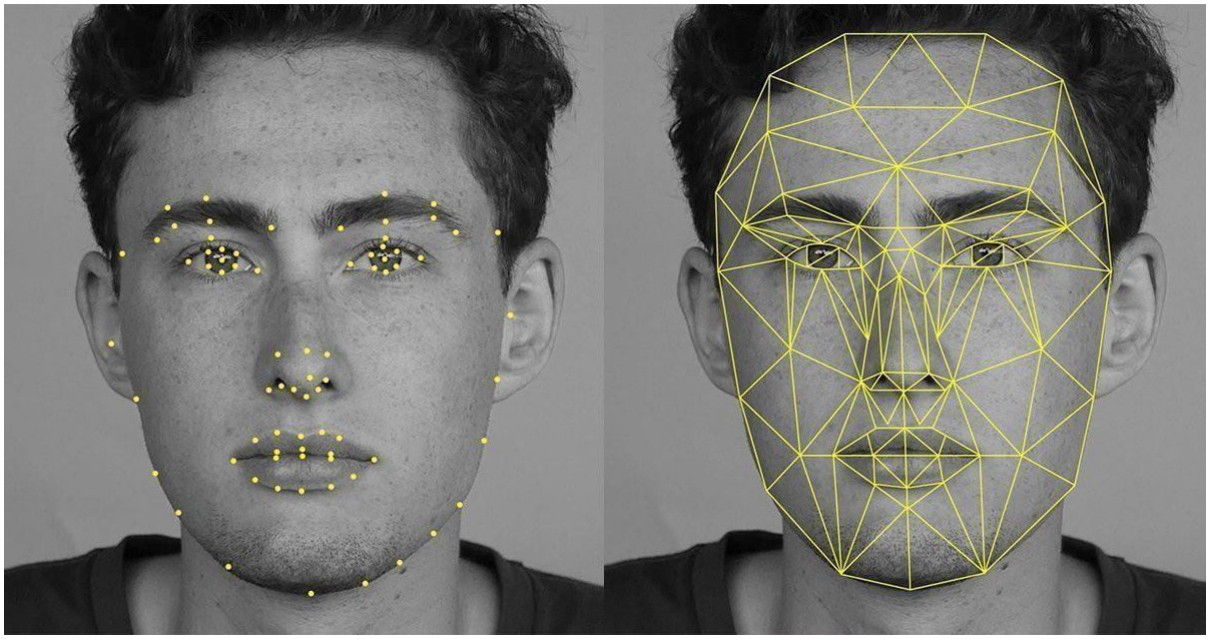

Fig 4.6 Face Sketch been mapped on the Platform

After mapping the sketch and matching the face sketch with the records and finding a match the platform displays the matched face along with the similarity percentage and other details of the person from the records. The platform displaying all this and the matched person is shown in the below figure.

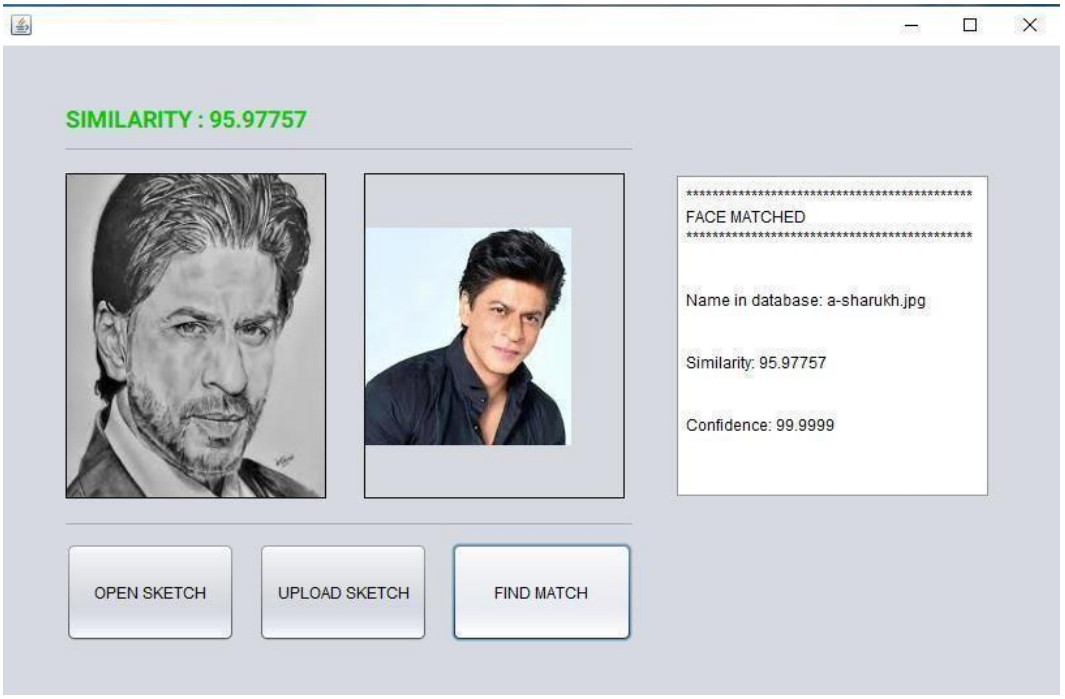


Fig 4.7. Face Sketch matched to Database Record

(The Face Sketch when Matched with the Record shows the Further Details)

# CHAPTER 5

# TECHNOLOGY STACK

Our platform was designed and developed using various technology stack in order to provide the law enforcement department with state-of-the-art security features and accuracy which in turn provide the law enforcement department with a better crime solving rate and efficiency.

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## 5.1 MACHINE LOCKING:

The Machine locking technique would ensure that the application once installed on a system could not be tampered and could not been operated on any other system, for which the application uses two locking parameters i.e. one software and one hardware locking parameter.

HD ID – Volume serial of hard-drive with

OS.NET ID – Hardware ID – MACAddress.

## 5.2 OTP (ONE TIME PASSWORD):

Every law enforcement authorized user would be given an official E-Mail ID which would use to login on to the application, thus using this step would require the user to enter a random code been shared with them on their mobile/desktop in order to complete the logging process.

A one-time password (OTP) is an automatically generated numeric or alphanumeric string of characters that authenticates the user for a single transaction or login session.

An OTP is more secure than a static password, especially a user-created password, which can be weak and/or reused across multiple accounts. OTPs may replace authentication login information or may be used in addition to it in order to add another layer of security.

In OTP-based authentication methods, the user's OTP app and the authentication server rely on shared secrets. Values for one-time passwords are generated using the Hashed Message Authentication Code (HMAC) algorithm and a moving factor, such as time-based information (TOTP) or an event counter (HOTP). The OTP values have minute or second timestamps for greater security. The one-time password can be delivered to a user through several channels, including an SMS-based text message, an email or a dedicated application on the endpoint.

Security professionals have long been concerned that SMS message spoofing and man-in-the-middle (MITM) attacks can be used to break 2FA systems that rely on one- time passwords. However, the U.S. National Institute of Standards and Technology (NIST)announced plans to deprecate the use of SMS for 2FA and one-time passwords, as the

Method is vulnerable to an assortment of attacks that could compromise those passwords and codes. Asa result, enterprises considering deployment of one-time passwords should explore other delivery methods besides SMS

## 5.3 JAVA:

Java is a programming language and computing platform first released by Sun Microsystems in 1995. There are lots of applications and websites that will not work unless you have Java installed, and more are created every day. Java is fast, secure, and reliable. From laptops to data centers, game consoles to scientific supercomputers, cell phones to the Internet,Java is everywhere!

- 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 multi threading and offers multimedia and network support.
- Java is a mature language, therefore more stable and predictable. The Java Class Library 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 byte code language which allows the same program to run on any machine that has a JVM installed.

- Java has powerful development tools like Eclipse SDK and NetBeans which havedebugging capability and offer integrated development environment.
- Increasing language diversity, evidenced by compatibility of Java with Scala, Groovy, JRuby, 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. Java 8, in fact, offers new features such as a scalable and flexible platform for the Internet of Things, less boilerplate code, new date and time library and API, refreshed graphics toolkit, integration with JavaScript, and others.

## 5.4 JAVAFX:

JavaFX is a set of graphics and media packages that enables developers to design, 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 connect to server-based middleware applications.

The look and feel of JavaFX applications can be customized. Cascading Style Sheets(CSS) separate appearance and style from implementation so that developers can concentrate on coding.

Graphic designers can easily customize the appearance and style of the application through the CSS. If you have a web design background, or if you would like to separate the user interface (UI) and the back-end logic, then you can develop the presentation aspects of the UI in the FXML scripting language and use Java code for the application logic. If you prefer to design UIs without writing code, then use JavaFX Scene Builder. As you design the UI, Scene Builder creates FXML markup that can be ported to an Integrated Development Environment (IDE) so that developers can add the business logic.

JavaFX 2.2 and later releases have the following features:

- Java APIs. JavaFX is a Java library that consists of classes and interfaces that are written in native Java code. The APIs are designed to be a friendly alternative to Java Virtual Machine (Java VM) languages, such as JRuby and Scala.

- FXML and Scene Builder. FXML is an XML-based declarative markup language for constructing a JavaFX application user interface. A designer can code in FXML or use JavaFX Scene Builder to interactively design the graphical user interface (GUI). Scene Builder generates FXML markup that can be ported to an IDE where a developer can add the business logic.
- WebView. A web component that uses WebKitHTML technology to make it possible to embed web pages within a JavaFX application. JavaScript running in WebView can call Java APIs, and Java APIs can call JavaScript running in WebView.
- Swing interoperability. Existing Swing applications can be updated with new JavaFX features, such as rich graphics media playback and embedded Web content.
- Built-in UI controls and CSS. JavaFX provides all the major UI controls required to develop a full-featured application. Components can be skinned with standard Web technologies such as CSS
- Canvas API. The Canvas API enables drawing directly within an area of the JavaFX scene that consists of one graphical element (node).
- Multitouch Support. JavaFX provides support for multi touch operations, based on the capabilities of the underlying platform.
- Hardware-accelerated graphics pipeline. JavaFX graphics are based on the graphics rendering pipeline (Prism). JavaFX offers smooth graphics that render quickly through Prism when it is used with a supported graphics card or graphics processing unit (GPU). If a system does not feature one of the recommended GPUs supported by JavaFX, then Prism defaults to the Java 2D software stack.
- High-performance media engine. The media pipeline supports the playback of web multimedia content. It provides a stable, low-latency media framework that is based on the GStreamer multimedia framework.
- Self-contained application deployment model. Self-contained application packages have all of the application resources and a private copy of the Java and JavaFX runtimes.They are distributed as native installable packages and provide the same installation and launch experience as native applications for that operating system. See the Deploying JavaFX Applications document.

With JavaFX, you can build many types of applications. Typically, they are network-aware applications that are deployed across multiple platforms and display information in a high-performance modern user interface that features audio, video, graphics, and animation.

## 5.5 AWS (AMAZON WEB SERVICES):

Amazon Web Services (AWS) is a subsidiary of Amazon that provides on-demand cloud computing platforms and APIs to individuals, companies, and governments, on a meteredpay-as-you-go basis. In aggregate, these cloud computing web services provide a set of primitive abstract technical infrastructure and distributed computing building blocks and tools.One of these services is Amazon Elastic Compute Cloud (EC2), which allows users to have at their disposal a virtual cluster of computers, available all the time, through the Internet. AWS's version of virtual computers emulates most of the attributes of a real computer, including hardware central processing units (CPUs) and graphics processing units (GPUs) for processing; local/RAM memory; hard-disk/SSD storage; a choice of operating systems; networking; and pre-loaded application software such as web servers, databases, and customer relationship management (CRM)

The AWS innovation is carried out at server ranches all through the world, and kept up with by the Amazon auxiliary. Charges depend on a mix of use (known as a "Pay-more only as costs arise" model), the equipment/OS/programming/organizing highlights picked by the supporter, required accessibility, overt repetitiveness, security, and administration choices. Supporters can pay for a solitary virtual AWS PC, a devoted actual PC, or bunches of by the same token. As a component of the membership understanding, Amazon gives security to supporters' frameworks. AWS works from numerous worldwide geological areas remembering 6 for North America.

In 2020, AWS comprised more than 212 services including computing, storage, networking, database, analytics, application services, deployment, management, mobile, developer tools, and tools for the Internet of Things. The most popular include EC2 and Amazon Simple Storage Service (Amazon S3). Most services are not exposed directly to end users, but instead offer functionality through APIs for developers to use in their applications. Amazon Web Services' offerings are accessed over HTTP, using the REST architectural style and SOAP protocol for older APIs and exclusively JSON for newer ones.

Amazon markets AWS to subscribers as a way of obtaining large scale computing capacity more quickly and cheaply than building an actual physical server farm. All services are billed based on usage, but each service measures usage in varying ways. As of 2017, AWS owns a dominant 34% of all cloud (IaaS, PaaS) while the next three competitors Microsoft, Google, and IBM have 11%, 8%, 6% respectively according to Synergy Group.

## 5.6 CENTRALIZED COMPUTING (AWS FOR NOW):

Centralized computing is computing done at a central location, using terminals that are attached to a central computer. The computer itself may control all the peripherals directly (if they are physically connected to the central computer), or they may be attached via a terminal server. Alternatively, if the terminals have the capability, they may be able to connect to the central computer over the network. The terminals may be text terminals or thin clients.

It offers greater security over decentralized systems because all of the processing is controlled in a central location. In addition, if one terminal breaks down, the user can simply go to another terminal and log in again, and all of their files will still be accessible. Depending on the system, they may even be able to resume their session from the point they were at before,as if nothing had happened.

This type of arrangement does have some disadvantages. The central computer performs the computing functions and controls the remote terminals. This type of system relies totally on the central computer. Should the central computer crash, the entire system will "go down" (i.e.will be unavailable).

Another disadvantage is that central computing relies heavily on the quality of administration and resources provided to its users. Should the central computer be inadequately supported by any means (e.g. size of home directories, problems regarding administration), then your usage will suffer greatly. The reverse situation, however, (i.e., a system supported better than your needs) is one of the key advantages to centralized computing.

## 5.7 DEEP LEARNING FOR FACE RECOGNITION:

Face recognition is the problem of identifying and verifying people in a photograph by their face. [9] It is a task that is trivially performed by humans, even under varying light and when faces are changed by age or obstructed with accessories and facial hair. Nevertheless, it is remained a challenging computer vision problem for decades until recently.

Deep learning methods are able 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 refer to this as the problem of automatic "face recognition" and it may apply to both still photographs or faces in streams of video.

Humans can perform this task very easily.[17] We can find the faces in an image and comment as to who the people are, if they are known. We can do this very well, such as when the people have aged, are wearing sunglasses, have different colored hair, are looking in different directions, and so on. We can do this so well that we find faces where there aren't any, such as in clouds. Nevertheless, this remains a hard problem to perform automatically with software, even after 60 or more years of research. Until perhaps very recently.

All facial recognition and detection systems require the use face datasets for training and testing purposes. In particular, the accuracy of CNNs is highly dependent on large trainingdatasets. For example, the development of very large datasets such as ImageNet, which containsover 14 million images, has allowed the development of accurate deep learning object detection systems.

More specifically, face detection and recognition datasets developed alongside benchmarks such as the MegaFace Challenge, the Face Detection Dataset and Benchmark (FDDB) dataset and the Labeled Faces in the Wild (LFW) dataset provide a means to test and rank face detection, verification and recognition systems using real-life, highly challenging images in unconstrained settings. Notable and widely used datasets are listed in Table, along with information regarding their intended usage, size and the number of identities they contain.

Upon analysis of the results attained by face verification and identification algorithms tested on small datasets such as the LFW dataset, one may be led to believe there remains little scope for improvement. This is far from true: when tested on millions of images, algorithms achieving impressive results on smaller testing sets produce far from ideal accuracies. [27] The MegaFace Challenge was created in response to the saturation of small datasets and benchmarks, providing a large-scale public database and benchmark which requires all algorithms to be trained on the same data and tested on millions of images, allowing fair comparison of algorithms without the bias of private dataset usage. This addresses the problem of lack of reproducibility of results caused by the usage of private databases for training by state-of-the-art CNN methods.

Although a shortage of cross-age identity sets is one limitation of the MegaFace dataset, results thus far have indicated there is ample scope for algorithm improvement, with the highest identification and verification accuracies attained by the state- of-the-art method ArcFace reaching 82.55%, and 98.33% respectively. Similarly, the MS- Celeb-1M database was created to provide both training and testing data, to enable the comparison of face recognition techniques by use of a fixed benchmark. However, despite the benefits conferred by their size, both MegaFace and MS-Celeb-1M are disadvantaged by annotation issues and long tail distributions.

Face detection is a fundamental step in facial 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, such as auto-focusing ability in phone cameras. This survey will examine facial detection methods as applied to facial recognition and verification.

Historically, the greatest obstacle faced by face detection algorithms was the ability to achieve high accuracy in uncontrolled conditions. Consequently, their usability in real life applications was limited. [ 1 ] However, since the development of the Viola Jones boosting based face detection method, face detection in real life settings has become commonplace. Significant progress has since been made by researchers in this area due to the development of powerful feature extraction techniques including Scale Invariant Feature Transform (SIFT), Histograms of oriented Gradients (HoGs), Local Binary Patterns (LBPs) and methods such as IntegralChannel Features (ICF).

For 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 Haar wavelet features in capturing salient facial information under unconstrained conditions which include large variations in resolution, illumination, pose, expression, and color. Essentially, it is the limitations of these feature representations which have thus far limited the ability of classifiers to perform to the best of their ability.

Feature extraction usually occurs immediately after face detection and can be considered as one of the most important stages in face recognition systems, as their effectiveness is dependent upon the quality of the extracted features. This is because facial landmarks and fiduciary points identified by a given network determine how accurately features are represented. Traditional fiduciary point locators are model-based, whilst many recent methods are cascaded regression based.

Lately, key improvements have been made with the development of deep dual pathway methods, and other confidence map-based solutions, such as and Traditional model-based fiduciary point methodologies include Active Shape Model (ASM), which suffers from low accuracy, partially rectified by the work of, Active Appearance Model (AAM), and Constrained Local Models (CLM). CLMs are generally outperformed by cascaded regression, models due to the latter's inherent inability to mode the complex variation of local feature appearances.

It must be noted however, that highly effective methods based on CLMs have been developed. For example, is based on CLMs but takes advantage of the neural network architecture, proposing a Convolutional Experts Network (CEN) and Convolutional Experts Constrained Local Model (CE-CLM) which uses CLM as local detector, achieving very competitive results particularly on profile images.

Subsequent to feature extraction, facial recognition is performed. Recognition can be categorized as either verification or identification. [18]Modern face recognition systems using DCNNs involve deep feature extraction, and lastly, similarity comparison. More specifically, verification involves comparison of one-to-one similarity between a probe image and a gallery of a known identity, whilst identification determines one to many similarities to determine the identity of the probe.

Both these processes require robust feature representation, and a discriminative classification model or similarity measure. [15]Traditional methods used for feature representation include LBP, HoGs, and Fisher Vector. Relevant metric learning methods include cosine metric learning, Mahalanobis metric learning, and one-shot similarity kernel. [ 2 1 ] Others include large margin nearest neighbor, Joint Bayesian and attribute-based classifiers. These methods are thoroughly reviewed by. Thus, for the sake of relevance and context, we have only included a brief overview of the role these methods play in modern face recognition and have chosen to focus on the most recently developed state of the art methodologies, which largely rely on DCNNs.

[8,20] The modern CNN framework was designed in 1990 by when they developed a system known as LeNet-5 to classify handwritten digits by recognizing visual patterns from image pixels without the need for pre processing first presented a neural network used for upright, frontal, grayscale face detection, which although primitive by today's standards, compared in accuracy with state-of-the-art methods at the time.

Since then, research has accelerated significantly, leading to the development of highly sophisticated DCCNs capable of detection, recognition and verification with accuracy approaches that of humans.

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 an increase in depth, and width to allow for improved feature representation by improving non-linearity. However, this leads to issues such as reduction in efficiency and over fitting.

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. [13] CCNs are generally more suitable to object recognition than standard feed forward neural networks of similar size due to the use 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 their in variance to translation, rotation and scaling. [23,26] A CNN is comprised of a set of layers, including convolutional layers, which are a collection of filters with values known 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 in the next layer.

The use of CNNs in facial 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 involves the deployment of a trained CNN to classify observed data. The training process involves minimization of the loss function to establish the most 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. CNN face recognition systems can be distinguished in three ways; the training data used to train the model, the network architecture and settings, and the loss function design.

DCNN's have the capacity to learn highly discriminative and invariant feature representations, if trained with very large datasets. Training is achieved using an activation function, loss function and optimization algorithm. The role of the loss function is to determine the error in the prediction.

Different loss functions will output different error values for an identical prediction, and thus determine to a large extent the performance of the network. Loss function type depends on the type of problem, e.g. regression or classification.

Minimization of the error is achieved using back propagation of the error to a previous layer, whereby the weights and bias are modified. Weights are learned and modified using an optimization function, such as stochastic gradient descent, which calculates the gradient of the loss function with respect to weights, then modifies weights to reduce the gradient of the loss function.

# CHAPTER 6

# SYSTEM TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

## 6.1 TYPES OF TESTS

### 6.1.1 Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

### 6.1.2 Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

### 6.1.3 Functional test

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centred on the following items:

Valid Input : identified classes of valid input must be accepted.
Invalid Input : identified classes of invalid input must be rejected.
Functions : identified functions must be exercised.
Output : identified classes of application outputs must be exercised.
Systems/Procedures: interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

### 6.1.4 System Test

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration-oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

### 6.1.5 White Box Testing

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

### 6.1.6 Black Box Testing

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests,

must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot "see" into it. The test provides inputs and responds to outputs without considering how the software works.

### 6.1.7 Unit Testing:

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

#### 6.1.6.1 Test strategy and approach

Field testing will be performed manually and functional tests will be written in detail.

#### 6.1.6.2 Test objectives

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages and responses must not be delayed.

#### 6.1.6.3 Features to be tested

- Verify that the entries are of the correct format
- No duplicate entries should be allowed
- All links should take the user to the correct page.

### 6.1.8 Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.

The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

### 6.1.9 Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

## 6.2 Test Results

All the test cases mentioned above passed successfully. No defects encountered.

**Test Cases:All the below mentioned test cases are tested with the trained system to find deviations from the predictions or any abnormalities.**

| Test # | Test Data(input) for sketch creation module | Expected Result | Actual Result | Pass/ Fail |
|---|---|---|---|---|
| 1 | Empty username and password fields | An alert should be displayed stating that the fields are mandatory | The alert is shown if any one or both the fields are empty. | Pass |
| 2 | Wrong Username/Password | An alert should be displayed that there is no account associated with the username or the password is wrong. | An alert is shown if there is no record of the username is present in the database. | Pass |
| 3 | Saving a Blank Sketch | An alert should be displayed if a blank sketch or an empty sketch is saved.. | An alert is shown if there is no sketch in file that is being saved. | Pass |
| 4 | Connection to the SMTP Server | Once the user enters the email and password an OTP should be sent to the users mail ID | SMTP connection failed because of the less secure feature disabled by google SMTP | Fail<br>Rectified this problem by shifting from google SMTP services to Yahoo SMTP services |

**Test Cases: All the below mentioned test cases are tested with the trained system to find deviations from the predictions or any abnormalities.**

| Test # | Test Data(input)for face recognition module | Expected Result | Actual Result | Pass/ Fail |
|---|---|---|---|---|
| 1 | An empty sketch is uploaded | Should detect if the image is empty and display an alert saying image cannot be uploaded, please try again. | Classified as an empty image and the alert “image cannot be uploaded” is shown. | Pass |
| 2 | No internet connection while uploading the sketch to AWS. | Should check the internet connection and display an alert “please check your connection” if there is no internet. | No internet connection detected and an alert “.please check your connection” is shown. | Pass |
| 3 | Sketch successfully uploaded to AWS | If the internet connection is proper an alert saying “image uploaded successfully” is to be displayed | The sketch is successfully uploaded to AWS and the alert “image uploaded successfully”is shown | Pass |
| 4 | Match found | If the sketch matches with the image is AWS, “Match found” alert and the meta data is shown. | Match is found in AWS bucket and the alert “Match found” is shown | Pass |
| 5. | No match found | If the sketch does not match “No match found” alert should be raised | No match is found in AWS and the alert “No match found” is displayed. | Pass |

# CHAPTER 7

# RESULTS and SNAPSHOTS

## 7.1 Screenshots:

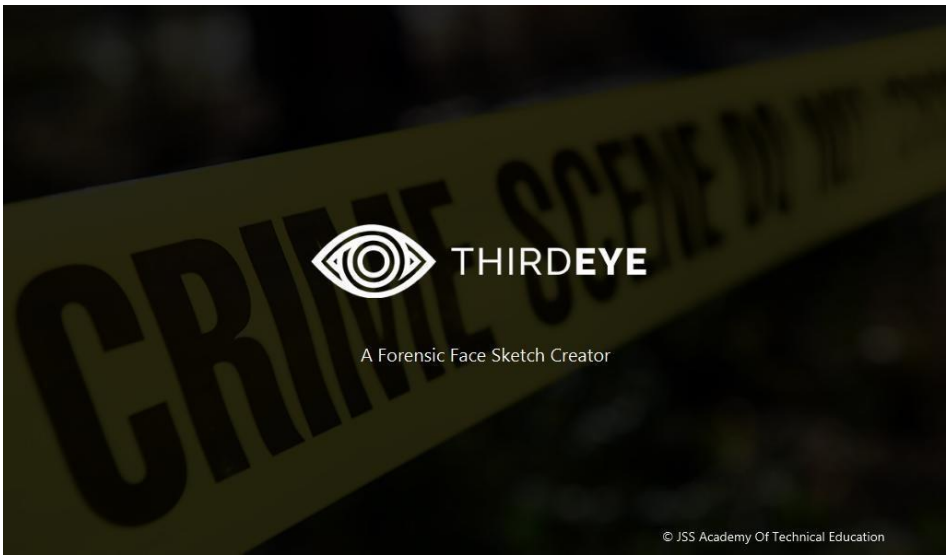


Fig 7.1. Splash Screen for our Standalone Desktop Application (Fetching MAC Address and IP Address to match with Data in Database)

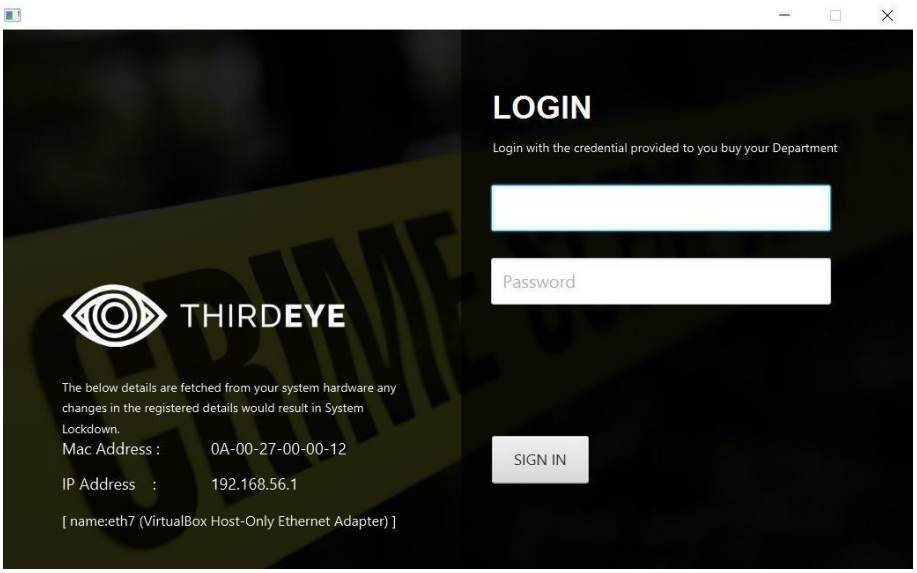


Fig 7.2. Login Screen of our Standalone Desktop Application
(Would only be displayed if the MAC Address and IP Address match with the database)

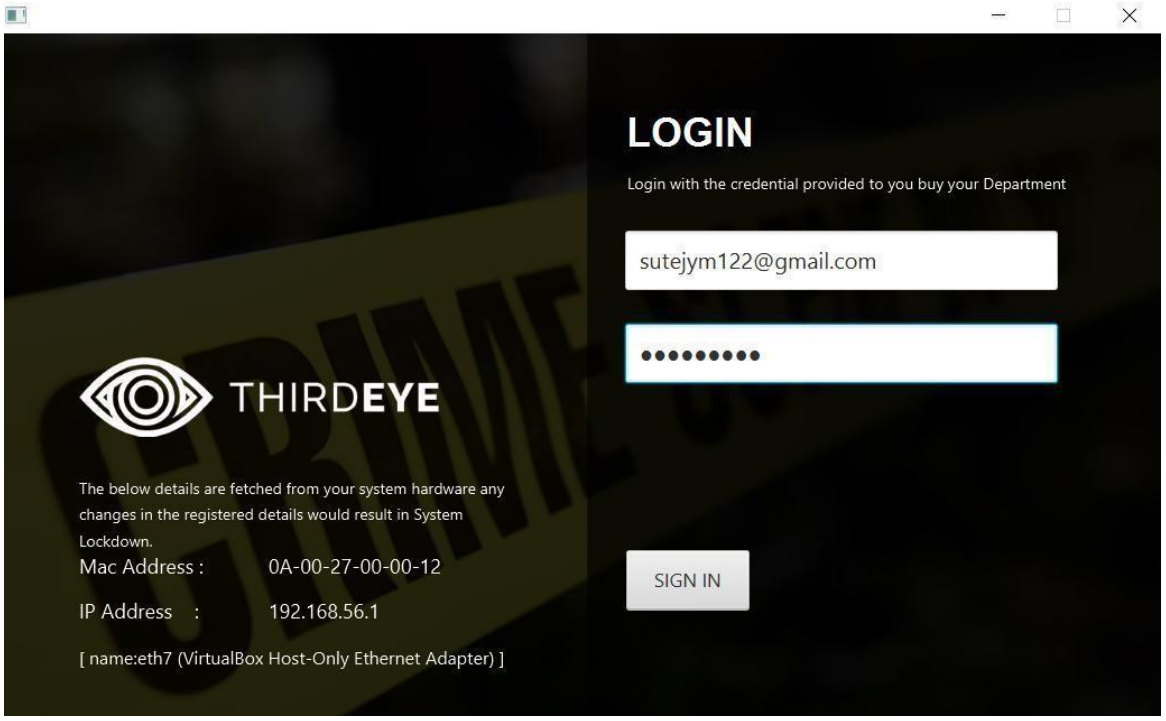


Fig 7.3. OTP sent on Registered Mail ID if the Credentials Match

(OTP will be sent only to registered email id only after the login credentials are valid)

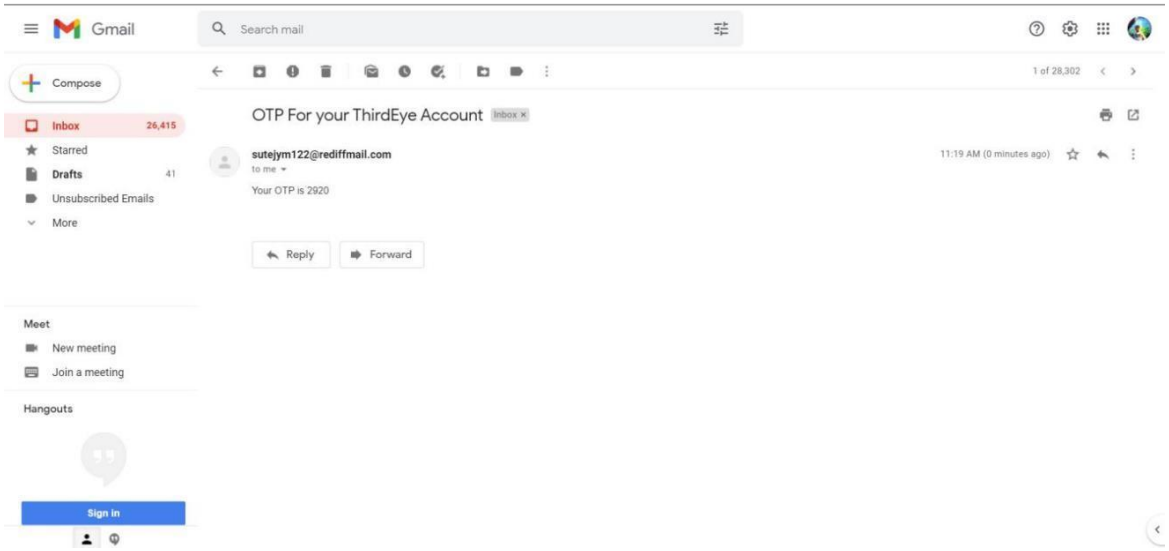


Fig 7.4. OTP sent on Registered Mail ID

(OTP will be sent only to registered email id only after the login credentials are valid)

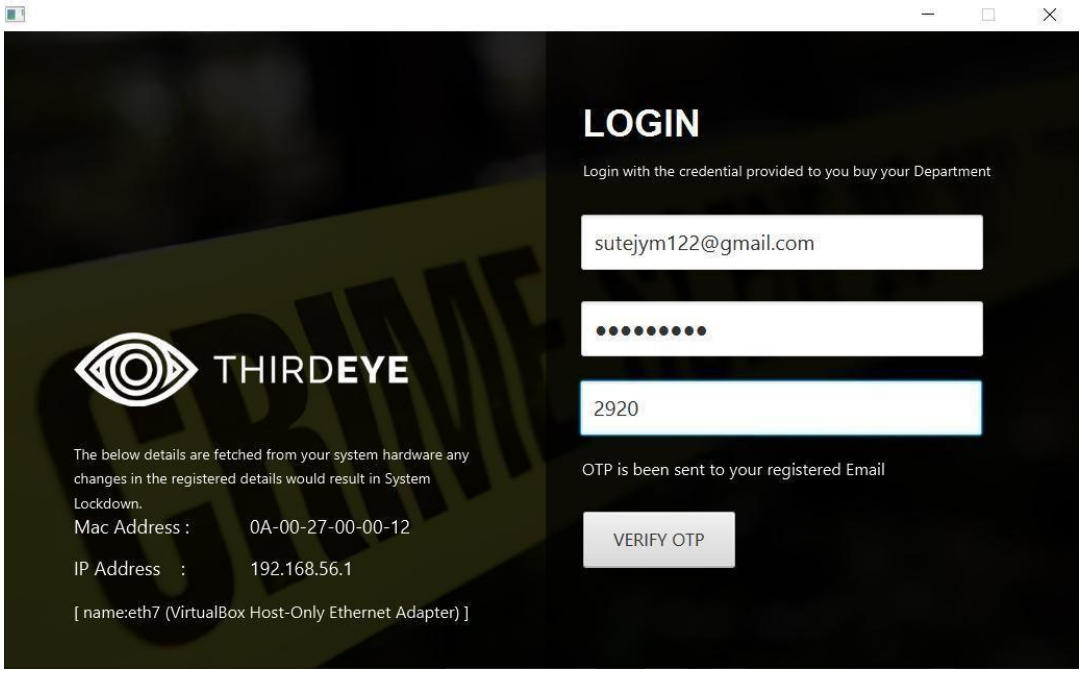


Fig 7.5. Enter OTP sent on Registered Mail ID

(OTP will be sent only to registered email id only after the login credentials are valid)

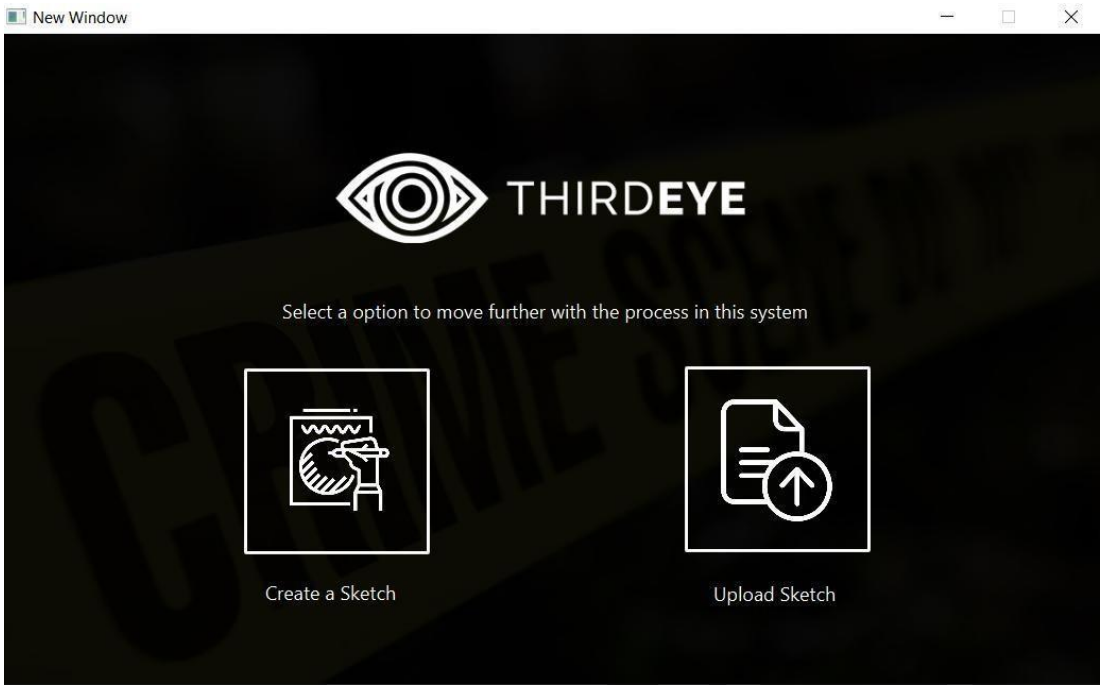


Fig 7.6. Option Selection Screen

(Select the option to work on Creating a Sketch or Matching a Sketch)

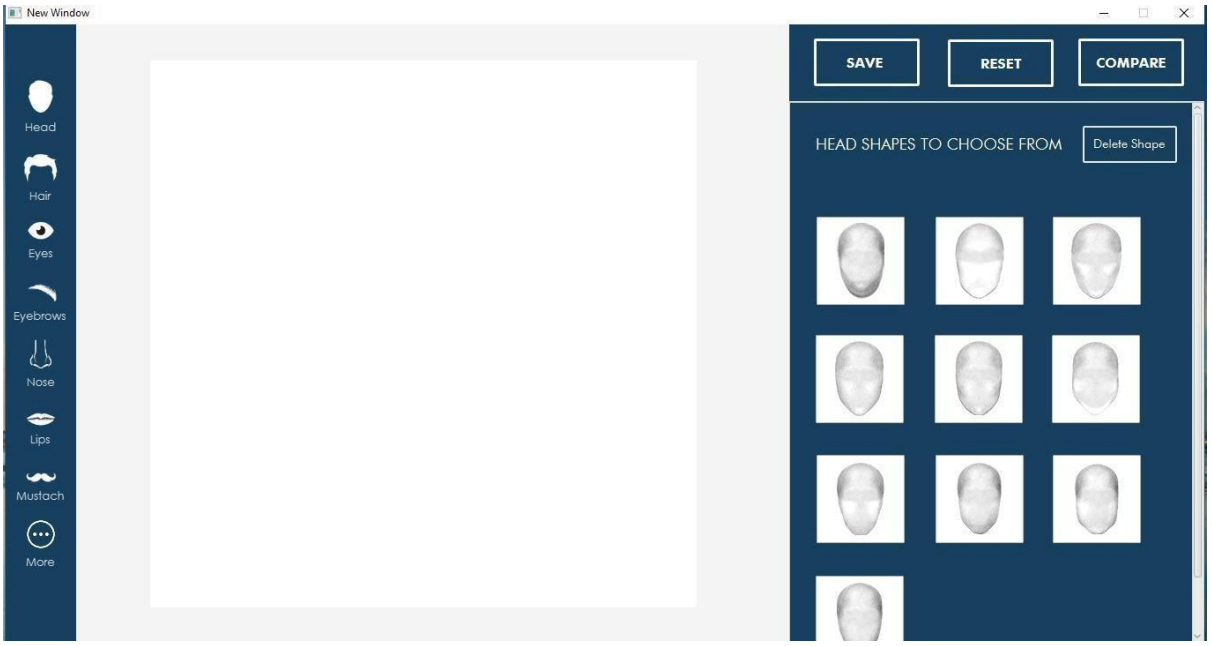


Fig 7.7. Dashboard to Create a Facial Sketch

(Dashboard with the Head Element Selected showing the various head shapes)

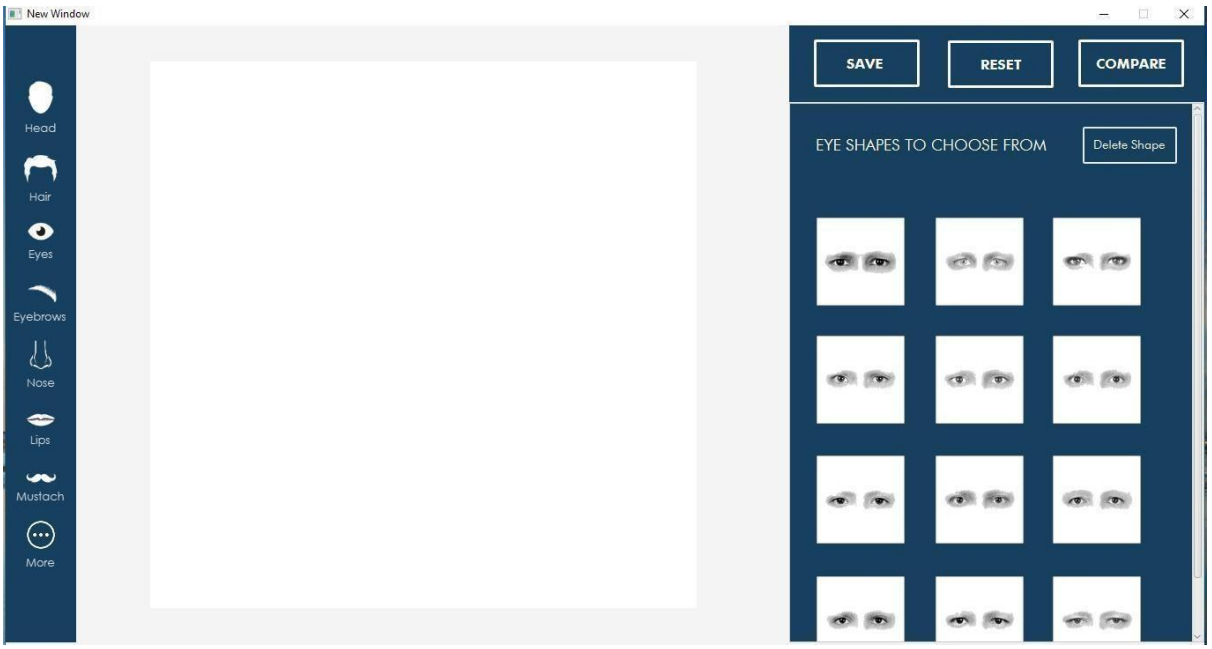


Fig 7.8. Dashboard to Create a Facial Sketch

(Dashboard with the Eyes Element Selected showing the various Eyes shapes)

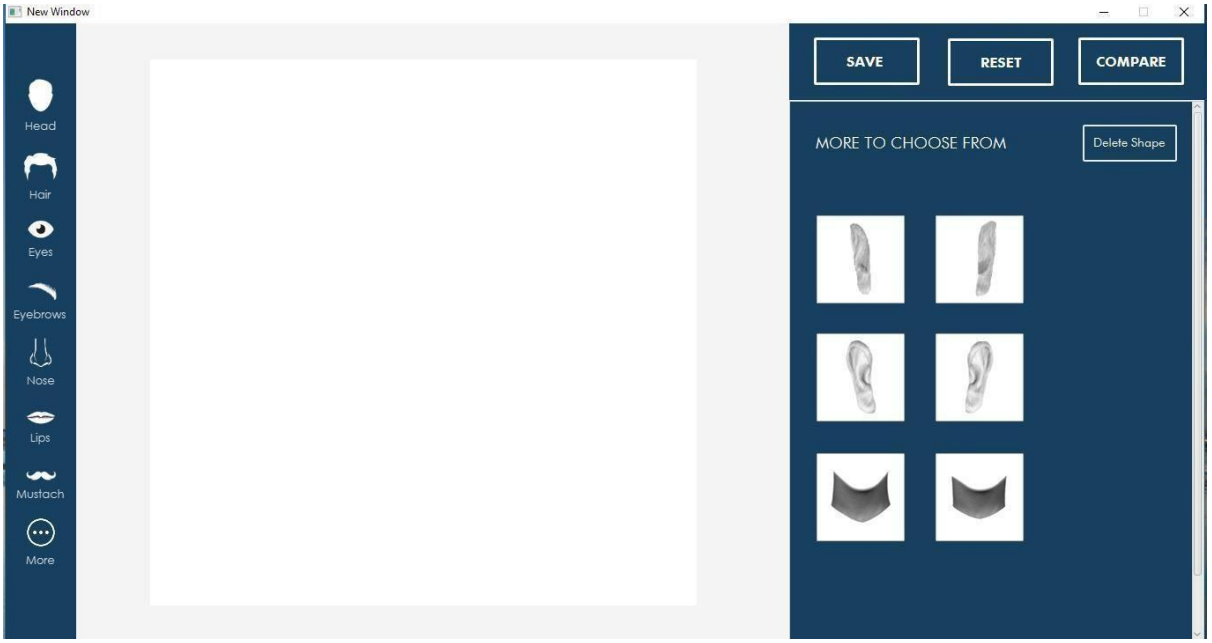


Fig 7.9. Dashboard to Create a Facial Sketch

(Dashboard with the More Element Selected showing the various more shapes)

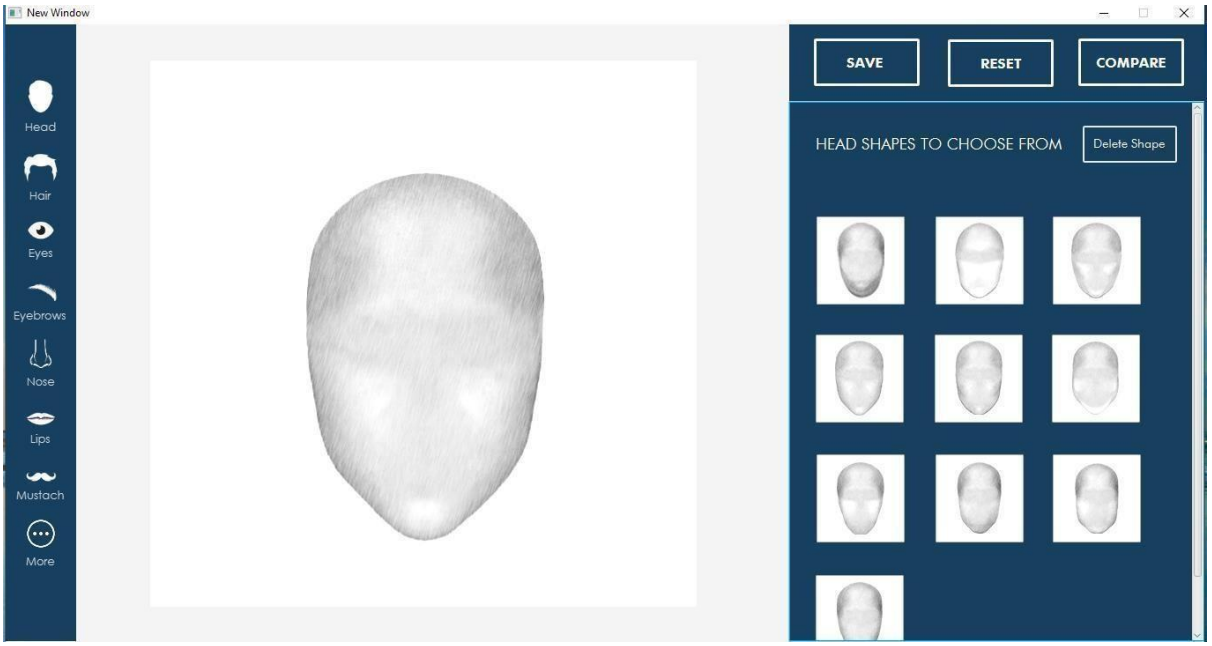


Fig 7.10. A Head Shape selected in Dashboard

(The Head Shape selected is been displayed on the Dashboard Canvas)

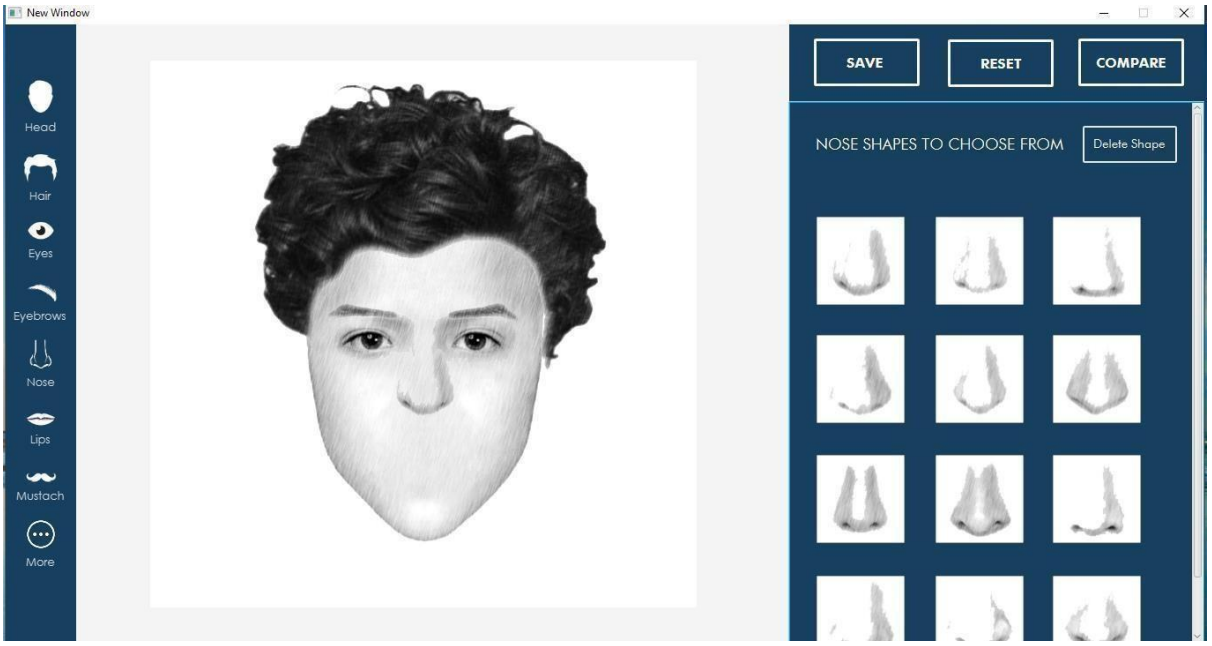


Fig 7.11. Other Shape too selected in Dashboard

(The Shapes selected too are been displayed on the Dashboard Canvas)

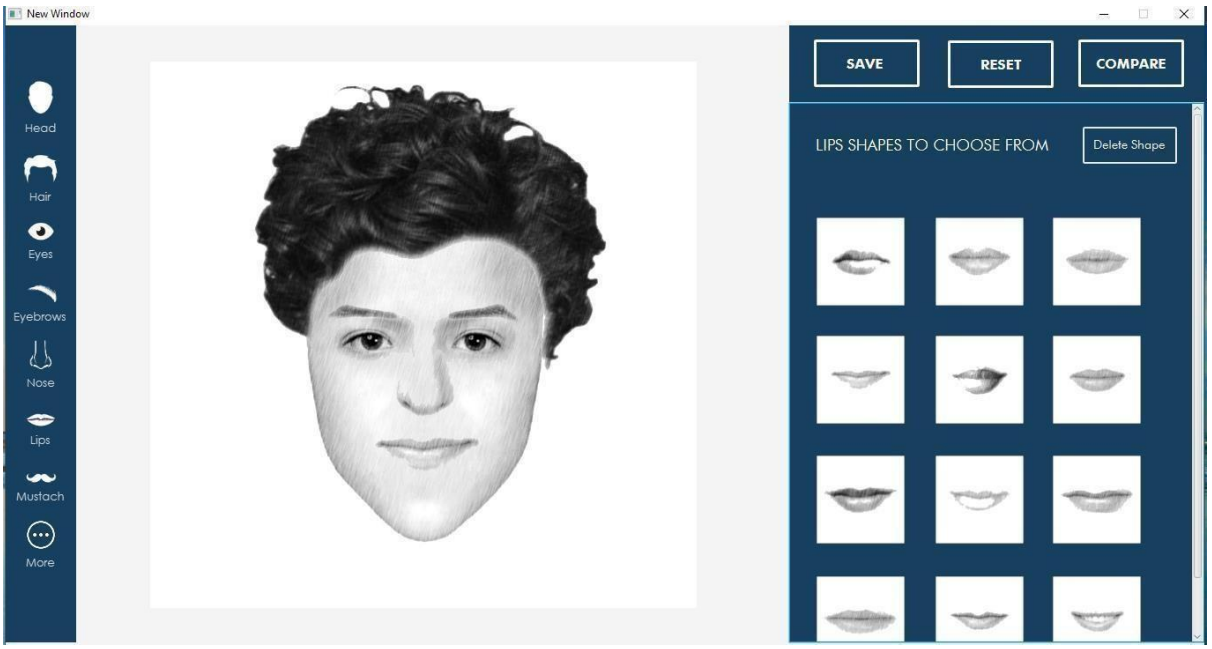


Fig 7.12. A Complete Face Sketch in Dashboard

(The Complete Face Sketch been displayed on the Dashboard Canvas)

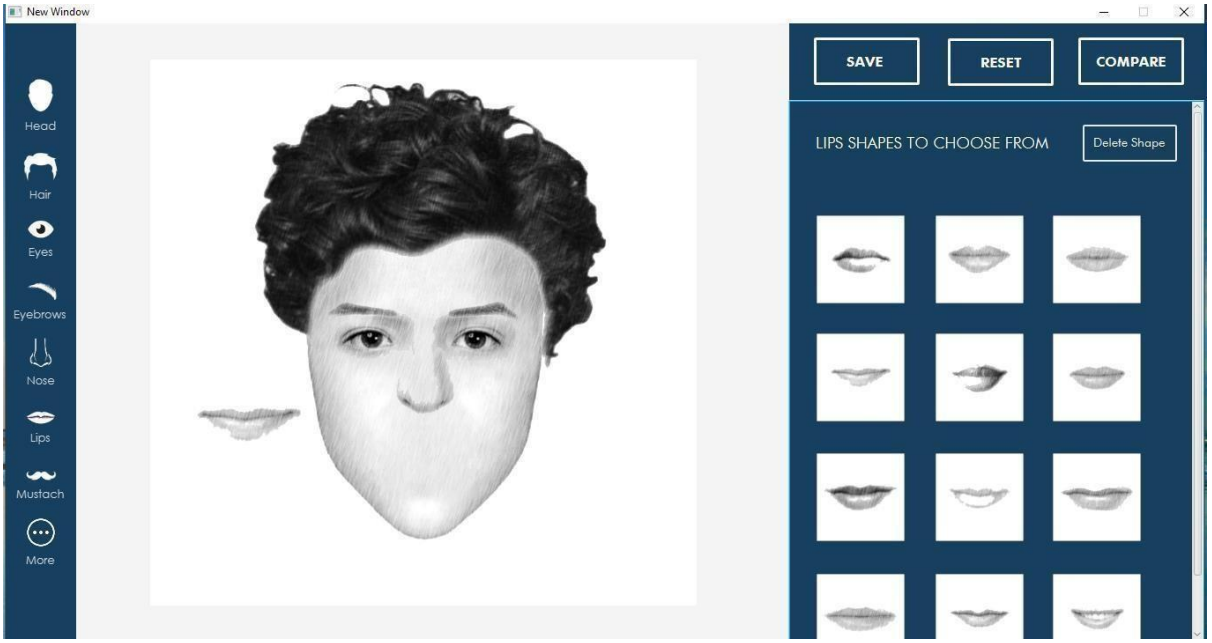


Fig 7.13. Shape selected in Dashboard can be Moved using Mouse

(Shape selected is moved freely on the Dashboard Canvas to adjust as per description)

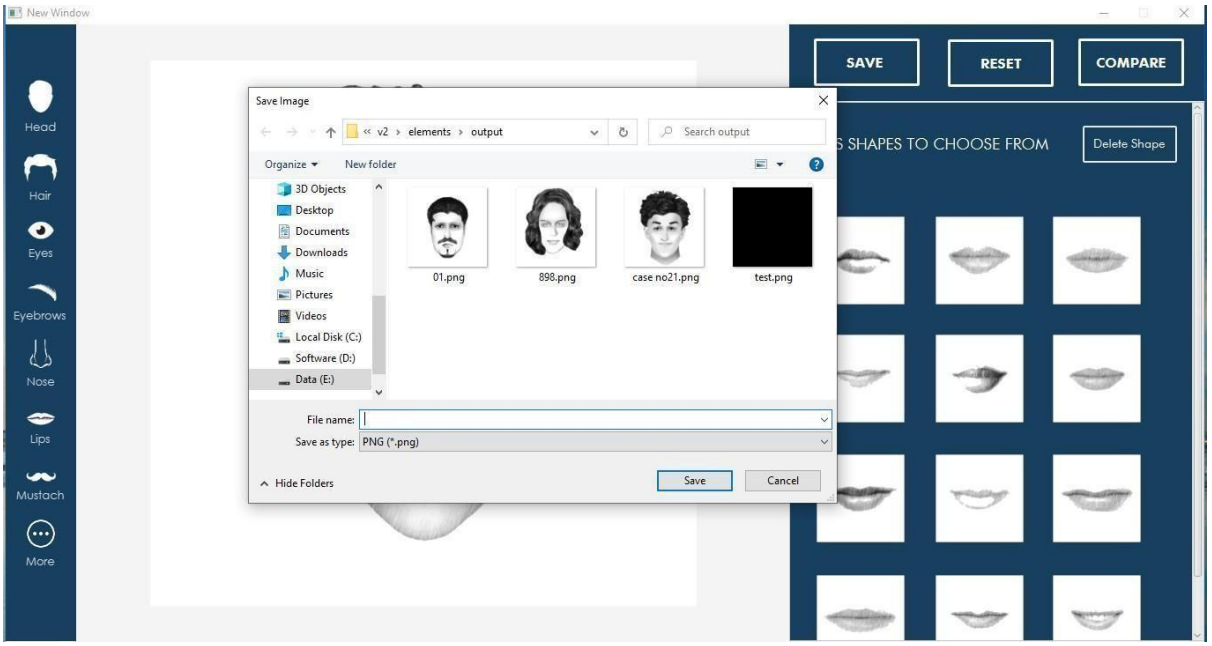


Fig 7.14. The Face Sketch can now be Saved as File

(The Face Sketch on the Dashboard Canvas can be Saved as PNG file)

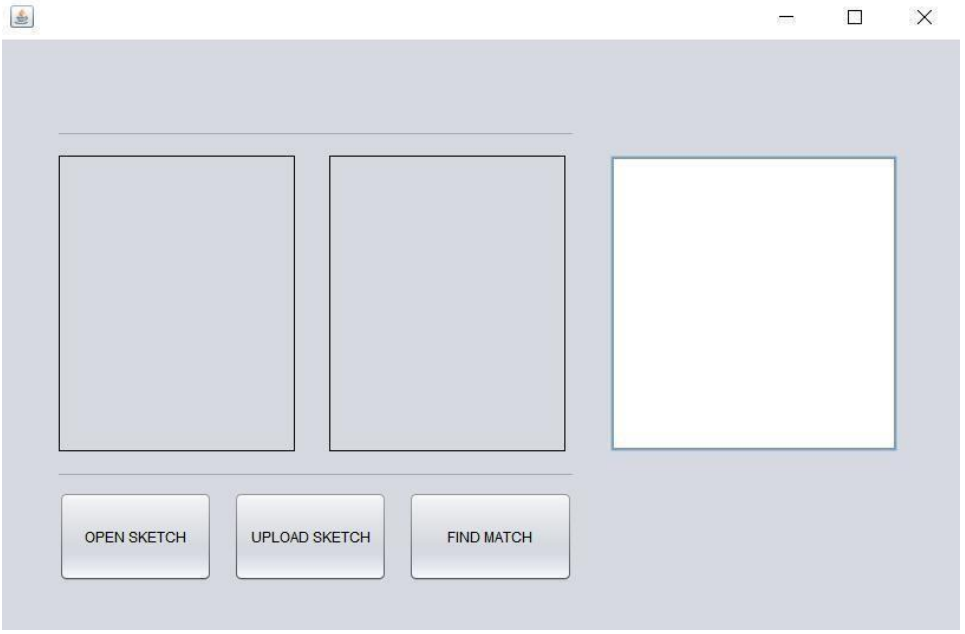


Fig 7.15. Dashboard to Recognize Face in Database (The Face Sketch is now matched with the Database Record)

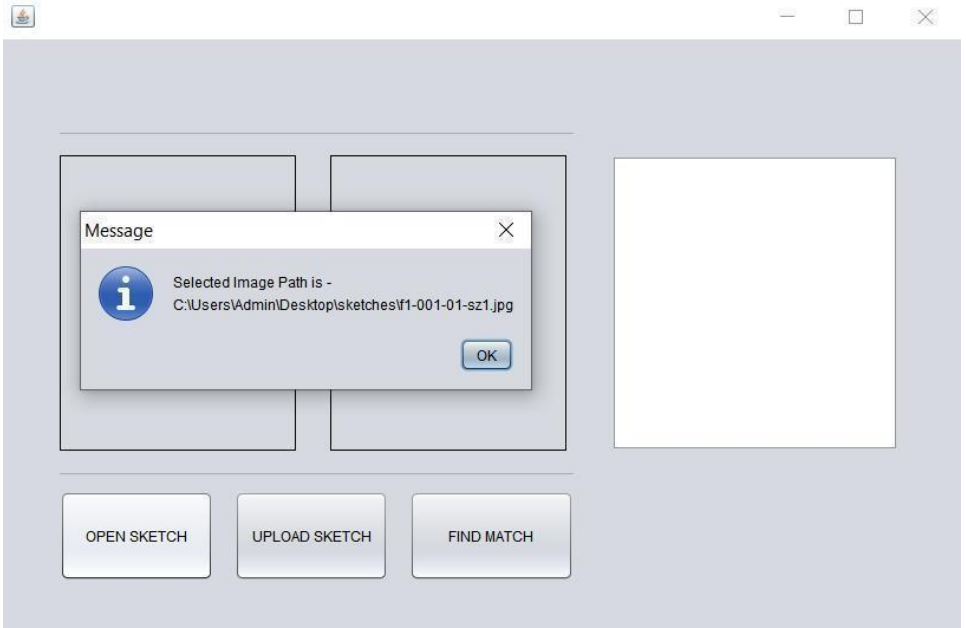


Fig 7.16. Select and Open a Face Sketch

(The Face Sketch to be match has to be Selected and Open on the Platform)

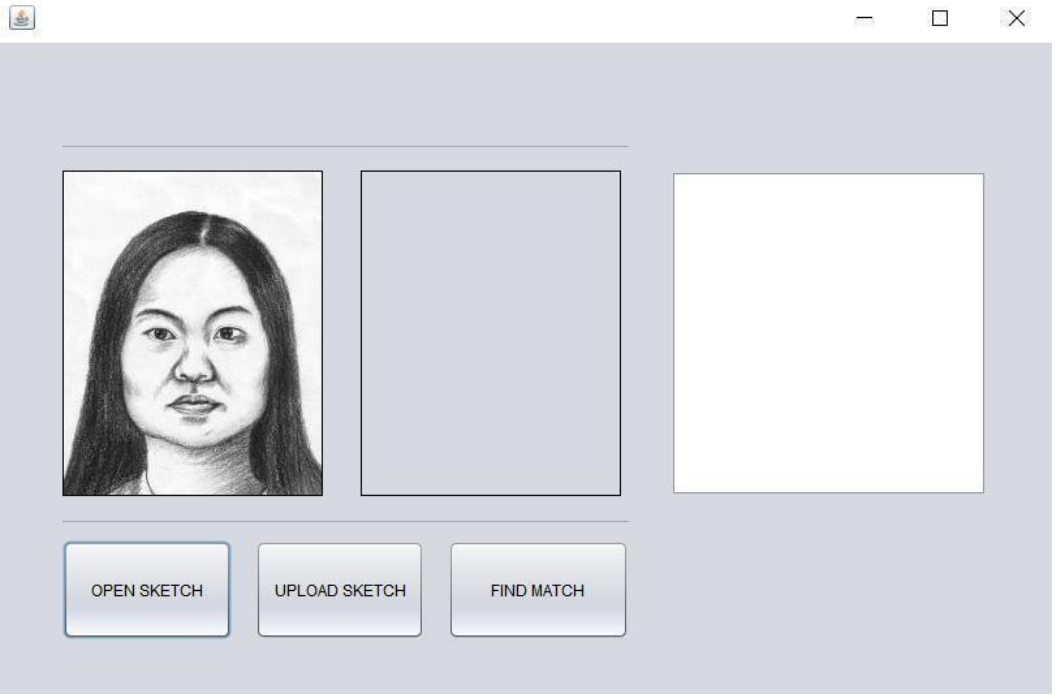


Fig 7.17. Opened Face Sketch

(The Face Sketch to be match has to be Opened on the Platform)

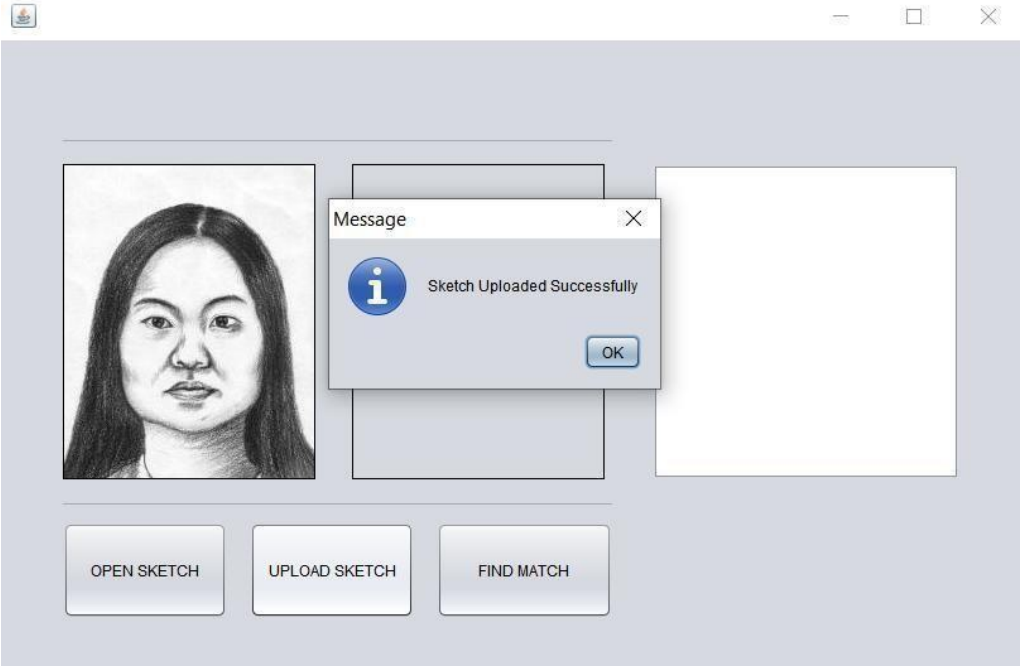


Fig 7.18. Face Sketch uploaded to the Server

(The Face Sketch is uploaded to the Server for better Security)

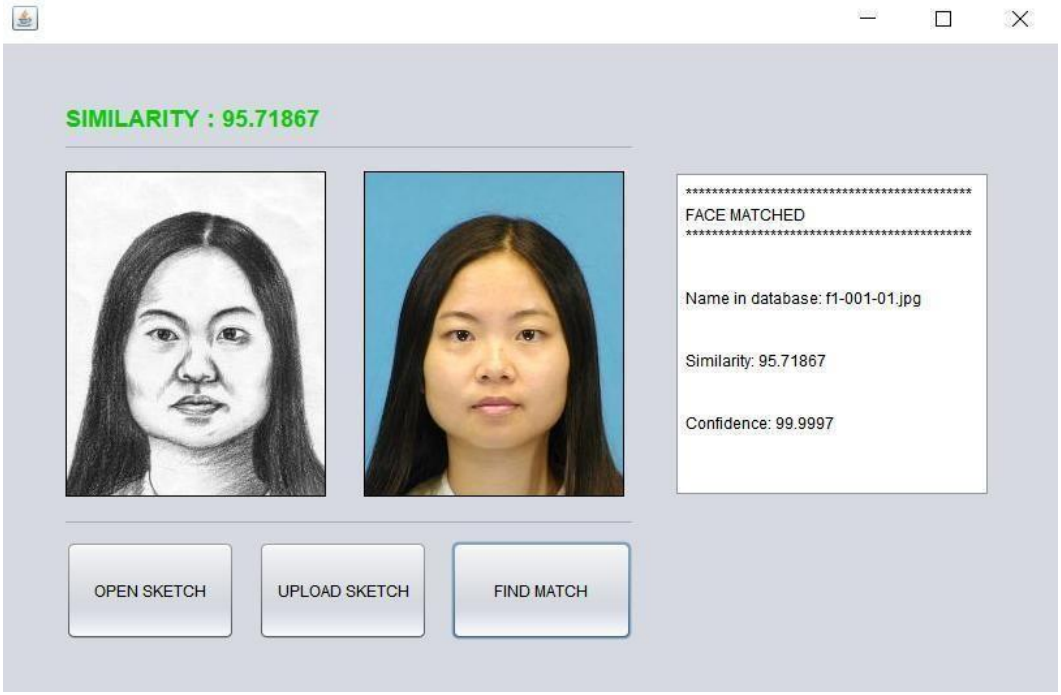


Fig 7.19. Face Sketch matched to Database Record

(The Face Sketch when Matched with the Record shows the Further Details)

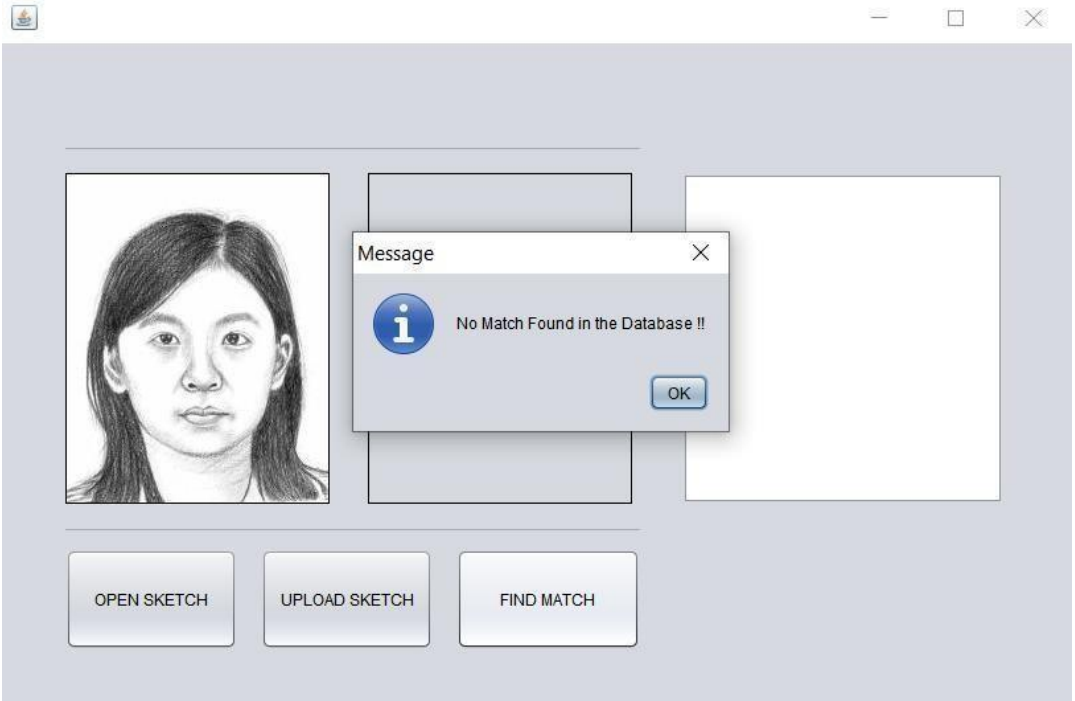


Fig 7.20. Face Sketch not matched to Database Record (The Face Sketch when not Matched with the Record shows Error)

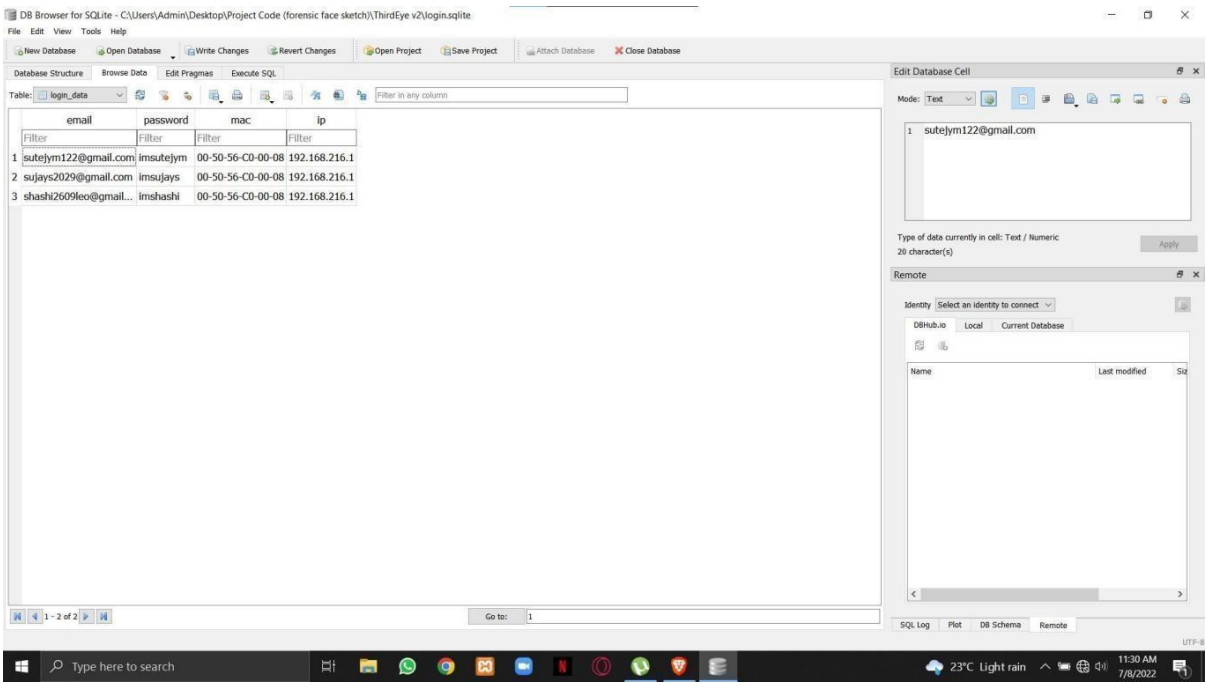


Fig 7.21. Database with User Credentials

(The User Credentials Management Dashboard)

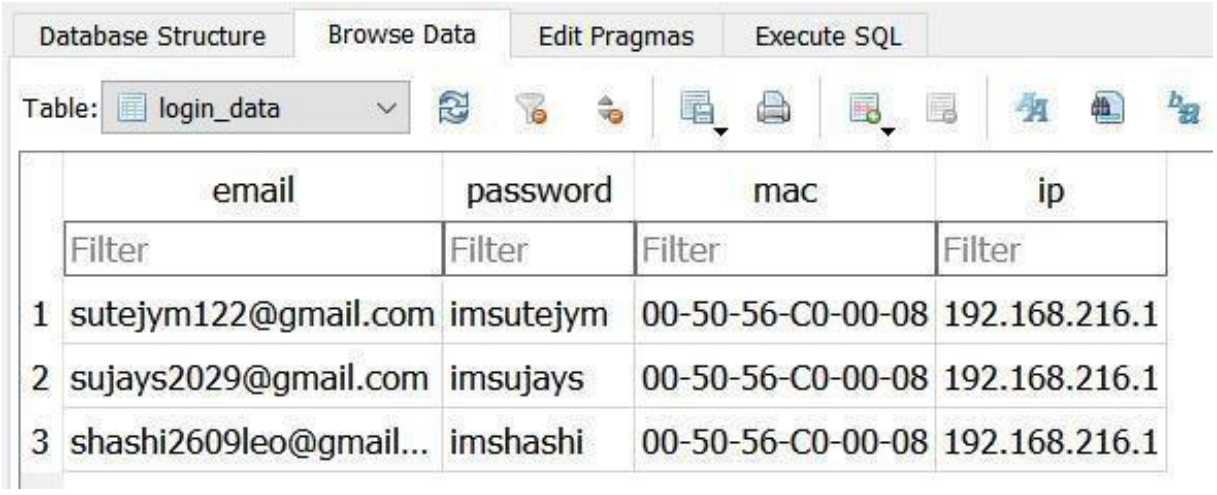


Fig 7.22. User Credentials and MAC Address and IP Address

(MAC Address and IP Address are saved in the Database while the first boot or load)

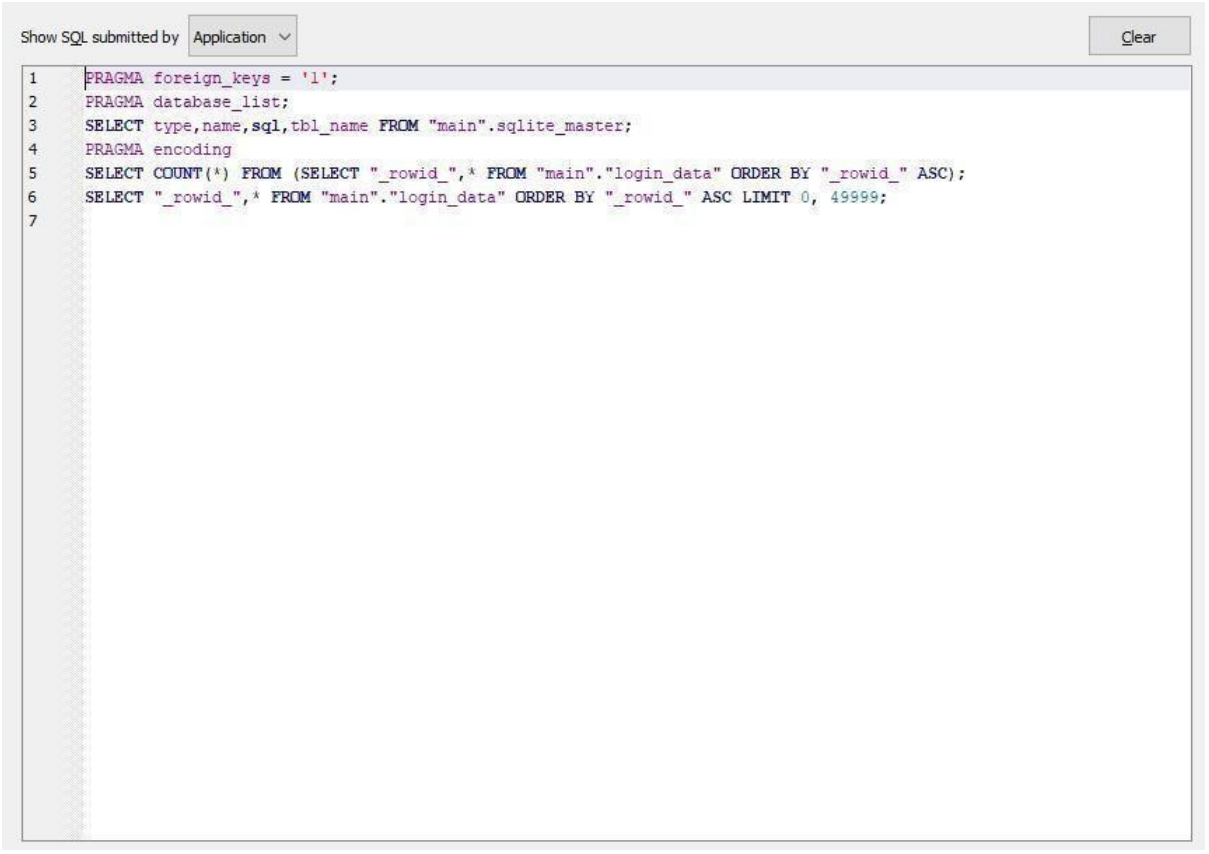


Fig 7.23. Database User Credentials Schema

(The User Credentials Schema)

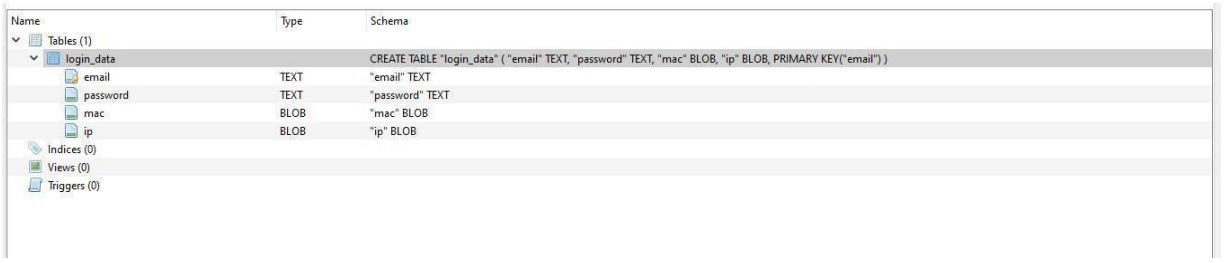


Fig 7.24. Database Schema

(The User Credentials Schema)

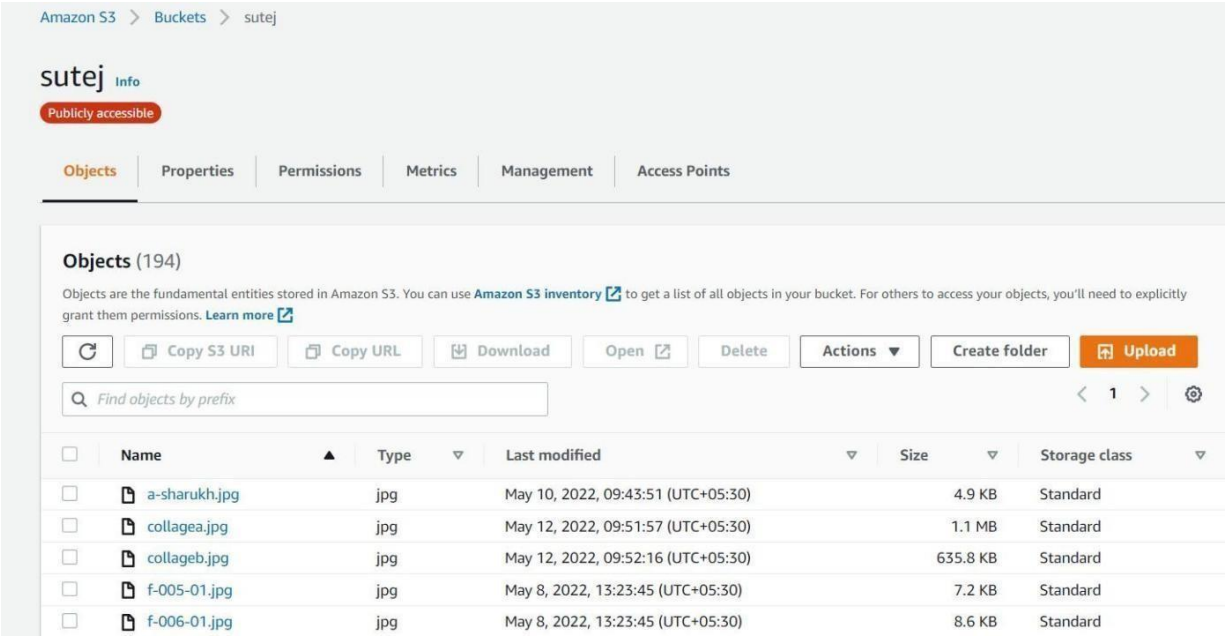


Fig 7.25. Police Record with Face Images

(Face Images Stored in the Server)

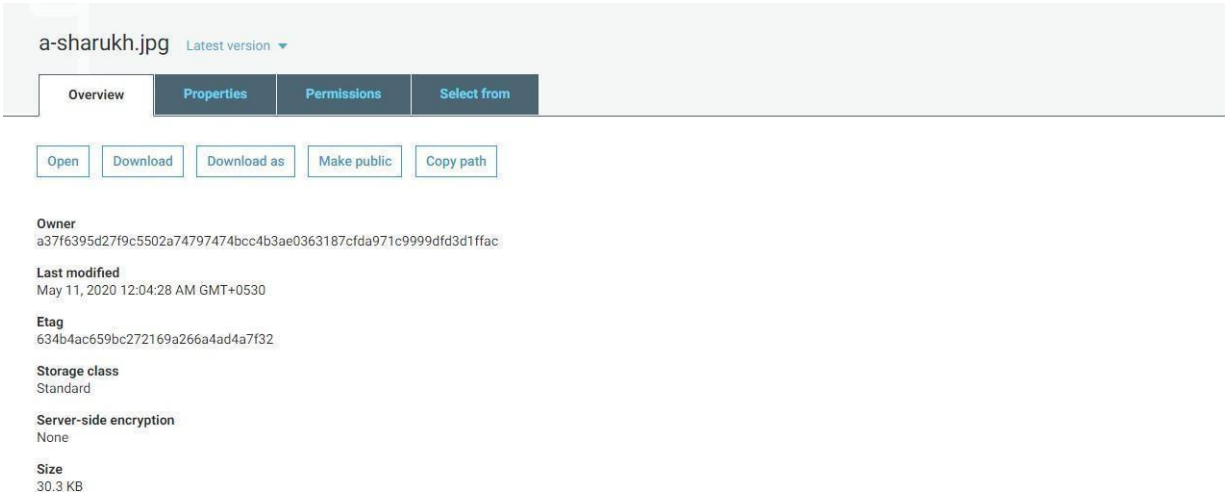


Fig 7.26. Police Record with Face Images Details

(Face Images Details Stored in the Server)

# CONCLUSION

The Project 'Forensic Face Sketch Construction and Recognition' is been designed, developed and finally tested 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 displayed a tremendous result on 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 proved 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 login the platform.

The platform even showed good accuracy and speed while face sketch construction and recognition process, provided an average accuracy of more than 90% with a confidence level of 100% when tested with various test cases, test scenario and data sets, which means a very good rate according to related studies on this field.

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# FUTURE ENHANCEMENT

The Project '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 wider spread and outputs, The platform can be modified to match the Face sketch with the human 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 speedingup 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 in this field.

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# PLAGIARISM REPORT

*Report Forensic face sketching and recognition*

**Submission date:** 21-Jul-2022 03:15PM (UTC+0530)
**Submission ID:** 1872972478
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**Character count:** 62264

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