FORENSIC FACE SKETCH CONSTRUCTION AND RECOGNITION

A PROJECT REPORT

Submitted by

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REG NO : TKM20MCA-2014

In partial fulfillment for the award of the degree of

MASTER OF COMPUTER APPLICATIONS

Thangal Kunju Musaliar College of Engineering
Kerala

DEPARTMENT OF COMPUTER APPLICATIONS JULY 2022

DECLARATION

I undersigned hereby declare that the project report on “FORENSIC FACE SKETCH CONSTRUCTION AND RECOGNITION”, submitted for partial fulfillment of the requirements for the award of the degree of Master of Computer Applications of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Prof. Alshaina S. This submission represents my ideas in my own words and where ideas or words of others have been included; I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to the ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not previously formed the basis for the award of any degree, diploma, or similar title of any other University.

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C E R T I F I C A T E

This is to certify that, this report titled ***FORENSIC FACE SKETCH CONSTRUCTION AND RECOGNITION*** is a bonafide record of the **Project Work** presented by **BLESSY P ROY (TKM20MCA-2014)**, under our guidance and supervision, in partial fulfillment of the requirements for the award of the degree, **MASTER OF COMPUTER APPLICATIONS** in **APJ Abdul Kalam Technological University** .

Internal Supervisor Head of the Department External Examiner

ACKNOWLEDGEMENT

A successful project is a fruitful culmination of efforts by many people, some directly involved and some others indirectly, by providing support and encouragement. Firstly I would like to thank the almighty for giving me the wisdom and grace for making my project a memorable one. I thank him for steering me to the shore of fulfillment under his protective wings.

I express my sincere gratitude to **Dr. T A SHAHUL HAMEED**, Principal of T.K.M College of Engineering for giving me an opportunity to present my project. I would like to thank **Dr. Fousia M Shamsudeen**, Assistant Professor and Head of the Department, MCA, TKMCE, for her constant support and encouragement throughout the project work.

With a profound sense of gratitude, I would like to express my heartfelt thanks to my guide **Prof. ALSHAINA S**, Assistant Professor, MCA, TKMCE, for her expert guidance, cooperation, and immense encouragement. I also extend my thanks to the entire faculty and staff of the Department of Computer Applications, TKMCE, who has encouraged me throughout this work.

I also express my thanks to my loving parents, brother, and friends, for their support and encouragement in the successful completion of this project work.

Blessy P Roy

ABSTRACT

The overall crime rate is rising daily in the modern day, and in order to keep up, law enforcement agencies must also discover ways to streamline investigations and aid in bringing offenders to justice. Utilizing face recognition technology to identify and confirm the culprit is one such method. The conventional method in this case is to utilize the hand-drawn face sketches created by forensic sketch artists to identify the offender; modernizing this would entail using the hand-drawn sketch and then comparing them with the database of the law enforcement agency to identify the offender. This method would have a number of technological restrictions and even take a lot of time because there are so few criminalists who draw sketches accessible compared to the increased crime rate.

By giving the law enforcement department a stand-alone platform that would enable users to generate an accurate face sketch of the suspect without a forensic sketch artist's assistance, particular training, or creative abilities, this initiative aims to shorten the duration and speed up the procedure. With a range of face elements, the sketch may be made using the drag-and-drop functionality of the program. The created composite face sketch is then automatically compared with the database of the law enforcement agencies using deep learning.

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Chapter 1
Introduction

An eyewitness account can be utilized to make a face sketch that can be used to quickly identify and catch offenders, but in today's technologically advanced world, hand-drawn sketches aren't considered as being as effective or powerful if used for coordinating and recognising from publically availability or instant data sets.

Face recognition and Face sketch creation are two steps of the proposed system. Face sketch is created in the application utilizing drag and drop features and a range of face components.

VGG16, a well-liked pre-trained deep learning model based on CNN, is used in face recognition. This software would attempt to enable the police to transfer the composite sketch for use. The purpose of the software is to enable the police to transmit the composite sketch and use the platform to distinguish and comprehend the criminal much more successfully.

Using preset face feature sets that are provided as tools and can be scaled and placed in line with requirements or eyewitness descriptions, users of this standalone application can produce precise composite face sketches.

Additionally, the created composite face sketch can then be compared with the database of the police force using deep learning to identify and confirm the offender.

1.1 Problem Statement

The suggested technique builds a composite sketch and uses VGG16 to estimate how well it will match the real image.

1.2. Objective

With the help of predefined facial feature sets that may be enlarged and positioned according to needs or descriptions from eyewitnesses, users of this standalone application can create accurate composite face sketches.

Deep learning can also be used to match the created composite face drawing with the dataset.

- This software was created to create a composite face drawing without the aid of a forensic artist and identify criminal similarities.
- Create a facial drawing using the features of the face, then save it.
- Publish the resulting face sketch.
- Determine whether that sketch resembles any of the criminals in the database.

Chapter 2

Literature Survey

The full analysis of the literature that is relevant to a given issue is known as a literature review. When conducting a literature review, research questions are first identified, after which one attempts to provide a solution by looking up and assessing pertinent material. The ability to re-examine the study's findings might lead to the development of fresh insights, which is one benefit of literature reviews. A literature review summarizes and explains the whole and most recent body of information about a subject that may be found in academic books and journal articles. You might write one of two types of literary evaluations in college: one is a standalone essay that students are required to write for a class, and the other is part of an introduction to or setup for a longer piece, typically a thesis or research report. Depending on the type of review you are writing, your topic, point of view, and type of hypothesis or thesis argument will all be influenced. Reading published literature reviews or the introductory sections of theses and dissertations in your own field of study might help you better comprehend the distinctions between these two forms. Examines the manner they address the issues and the organization of their arguments.

2.1. Purpose of the Literature Review

- By choosing top-notch research papers or studies that are pertinent, significant, vital, and valid and compiling them into a single comprehensive report, it makes it simple for readers to get information on a given issue.
- It offers a great place to start for scholars who are commencing their research in a new field. by making them summarize, assess, and contrast the relevant original research.
- It makes sure that previous work is not repeated by researchers.
- It can suggest topics to focus on or give hints about the direction that future study should take.

- It emphasizes the important findings.
- It points up gaps, discrepancies, and inconsistencies in the literature.
- It offers a helpful critique of the methods and strategies used by other researchers.

2.2 Related Works

Many studies have looked at various methods for creating and recognising face drawings. A standalone programme for making and detecting facial composites was created by[1] Dr. Charlie Frowd, Yasmeen Bashir, Kamran Nawaz, and Anna Petkovic.The system was initially discovered to be just as time taking and perplexing as the conventional method, so they switched to a new strategy in which the suspect was given a choice of faces and forced to select comparable faces that resembled the suspect; eventually, the system would combine all the selected faces and triangulate the identity of the suspect. The outcomes were favorable; 10 of the 12 composite faces could be recognised accurately. 21.3 percent of these instances involved a department employee helping the witness create the faces, and 17.1 percent had the witness making an independent attempt. To age the face drawings and extract the component features from the face, PCA was utilized. They recognised the idea at the heart of acquiring the input image as one. To first assign existing face traits onto developing image regions, PCA is applied. The results of the experiment demonstrate that the recommended methodology works better than the most recent methods.

[2] Ke Pan et al. created a part-based NIR (Near Infrared Images) system for extraordinarily precise and successful face detection systems on varying illumination situations. This technique will also improve resistance to changes in posture. Before generating a component descriptor for each block using SLBPH, they disassemble the NIR face into a facial component.

Ken Pan and colleagues pioneered the process of determining the proper weights for each component of the face photo using LDA (Linear Discriminant Analysis). Their method outperforms the holistic method by 4.53%.

In their most recent experiment, Sannidhan et al. created a coloured image from a drawing. The coloured picture created was further recognised using several classification algorithms. The GAN and CNN were integrated to process the coloured pictures with the pix2pix model. The author also recommended using a particular multimodal framework to link the drawing to the source photos. They then ranked the significance of a variety of facial features in identifying a person. They ran experiments utilising forensic, semi-forensic, and previously collected datasets, and the

results were contrasted with those attained using state-of-the-art techniques. Results from experiments show the promise of the fuzzy principle-based approach.

[3] Hu Han . established a component-based representation in order to assess the degree of resemblance between computer produced face drawings (also known as composite sketches) and face photos found in mugshot databases (CBR). In order to automatically recognise facial landmarks in face drawings and photos, they also used the (ASM) and (MLBP). The recommended technique has made use of gender information (male/female) to raise recognition accuracy. They used the (PCSO) and Multiple Encounter Dataset II databases to perform their analyses (MEDS II). The findings clearly outperformed COTS face matcher when compared to their suggested approach. They advised employing demographic information to boost the system's efficiency.

[4] Brenden F. Klare et al. suggested a method for suspect recognition using face attribute representations. They have developed 46 different facial qualities to encompass all conceivable identifiable facial component features (such as eyes, mouth, nose, etc.). Experiments were carried out to compare their method with hand-drawn sketch recognition. Although they demonstrate that accuracy may be raised through fusion, the recommended solution performs poorly when compared to earlier sketch recognition systems. Xiaoou Tang and Xiaogang Wang compare the conventional eigenfaces technique and geometric measure on a database produced by The Chinese University by means of a particular set of tests. The findings of this study show how successfully pictures and drawings may be matched using "The photo-to-sketch synthesize approach."

[5] P. C. Yuen and C. H. Man also suggested a technique for finding human faces in drawings. Drawings were transformed into mugshots using this technique, and mugshots were then matched to faces using the local and universal attributes specified by the face matching algorithms. Sometimes it was difficult to match human faces in databases like the FERET and Japanese Database with mugshots. The results of the testing revealed that the proposed method had an accuracy of around 70%, which was respectable but still fell short of the precision required by the law enforcement agency.

By utilizing a Multiscale Markov Random Field Model, Xiaoou Tang and Xiaogang Wang suggested a method for recognising photo-sketching. A given drawing or photo may be converted into another using the project, which will then lookup a match in the database. They initially

transformed the available pictures into drawings before training the model to lessen the disparity between photographs and sketches. They improved the recognition model's overall effectiveness by doing this. For testing, they employed a few samples in which a sketch artist made drawings using the faces from the images. After then, 60% of the samples were used to train the model, and the remaining 40% were used to test it. The results weren't quite what was anticipated, although being amazing overall.

The first effort at face identification was made by Kim et al, who used component-based linear discriminant analysis to describe the faces in the facial image. They proposed a technique for characterizing the face that relies on the projection of facial photos and the LDA decomposition of a picture into facial components. The accuracy rate of their cascade LDA algorithm is higher than that of ICA/PCA/LDA methods and other descriptive approaches. According to Javid Sadro et al., the problem of determining which face features or attributes are more noticeable during recognition has been addressed. They present data from studies showing that brow traits may be as unique as eye features. In lieu of focusing on the brows and eyes, their approach disregards other physical characteristics like the nose and facial shape.

Javeriya Ashraf et al. recommended component-based representation to match computer-generated composite face drawings with mugshot pictures (CBR). With just minimal modifications, they employed the Active Shape Model for feature extraction instead of the 10*10 windows with 50% overlapping technique stated (Active Shape Model). Along with this, they used light preprocessing and rotation using line coordinates, which improved identification accuracy by 27%.

The sketch to image matching method, also put out by Anil K. Jain and Brendan Klare, made conclusions based on the measured separation between the drawings and the face photographs in the database and made use of the SIFT Descriptor. For greater precision, the distance between pictures in the databases and, in certain cases, the SIFT descriptor distance from the face shot were also measured using the drawing. Based on the model presented by Tang and Wang, the programme first transforms the face pictures using a linear transformation. The experiment's findings show that Tang and Wang's datasets and the ones used in this study are quite similar utilized in their research. In comparison to Tang and Wang's model, the algorithm's addition of descriptor measurement produced a superior result and higher level of accuracy.

The issue with all algorithms was that they matched the front-facing human faces with the drawings of the faces, which made it simpler to map both the sketches of the faces and the images of the faces. The algorithms were less map and match a face in an image or drawing with a face that is facing in a different direction with a face from the database that is facing.

There are even methods that have been developed for the creation of composite faces, but the bulk of these systems employ facial elements that were obtained from images, selected by the operator based on the witness's account, and then merged to make a single human face. Because each facial component was acquired from a distinct face photograph with varied dissimilarities, it is much more challenging for a human and any algorithm similar to a criminal.

Consequently, every prior technique was either ineffective or laborious and difficult. According to what was indicated before,here the solution will allow customers to submit their own hand-drawn face sketches and facial features, bridging the difference between the new, contemporary composite face sketch method and the traditional hand-drawn face sketch methodology.

AUTHOR	PROPOSED APPROACH	LIMITATION
Yasmeen Bashir, Kamran Nawaz, Charlie Frowd, and Anna Petkovic	Using automation to identify faces in facial composites and Production Processes	The produced facial composite was inaccurate and challenging to accurately match with the database.
X. Tang,., and X Wang, .	Face sketch finding	The problem The facial drawings were compared with all of the suggested algorithms with actual human faces, despite the fact that human faces are often front facing and are thus easier to map in both drawn sketches and photographs of human faces. When an image or drawing was captured with faces looking in a different direction, the algorithms had a lower likelihood of mapping and matching a face from the database that was front facing.
B. Klare and A. Jain	A technique based on features for comparing drawings and photographs	
C. Man and P. Yuen	System for finding human faces in images using drawings	
B.Klare,K. Bonnen, A. Jain, H. Han, and	A component-based approach to face matching in composite drawings	

Table 2.1: Earlier methods for creating and identifying forensic face sketches have been offered. The Author's Name, Proposed Approach, and Limitation are all listed in the Table.

Chapter 3

Methodology

3.1. Proposed System

Face recognition and Face sketch creation are two steps of the proposed system. Face sketch is created in the application utilizing drag and drop features and a range of face components.VGG16, a well-liked pre-trained deep learning model based on CNN, is used in face recognition. The created composite face sketch can then be compared with the database of the police force using deep learning to identify and predict the similarity of offender.

3.2. System Architecture

This application would be primarily used by the Law Enforcement Departments to shorten the total amount of time needed to prosecute a criminal, as well as to improve worker efficiency and speed up the system while maintaining accuracy. In order to ensure that a user may generate a sketch in the program without receiving formal instruction, the platform is created with this situation in mind.

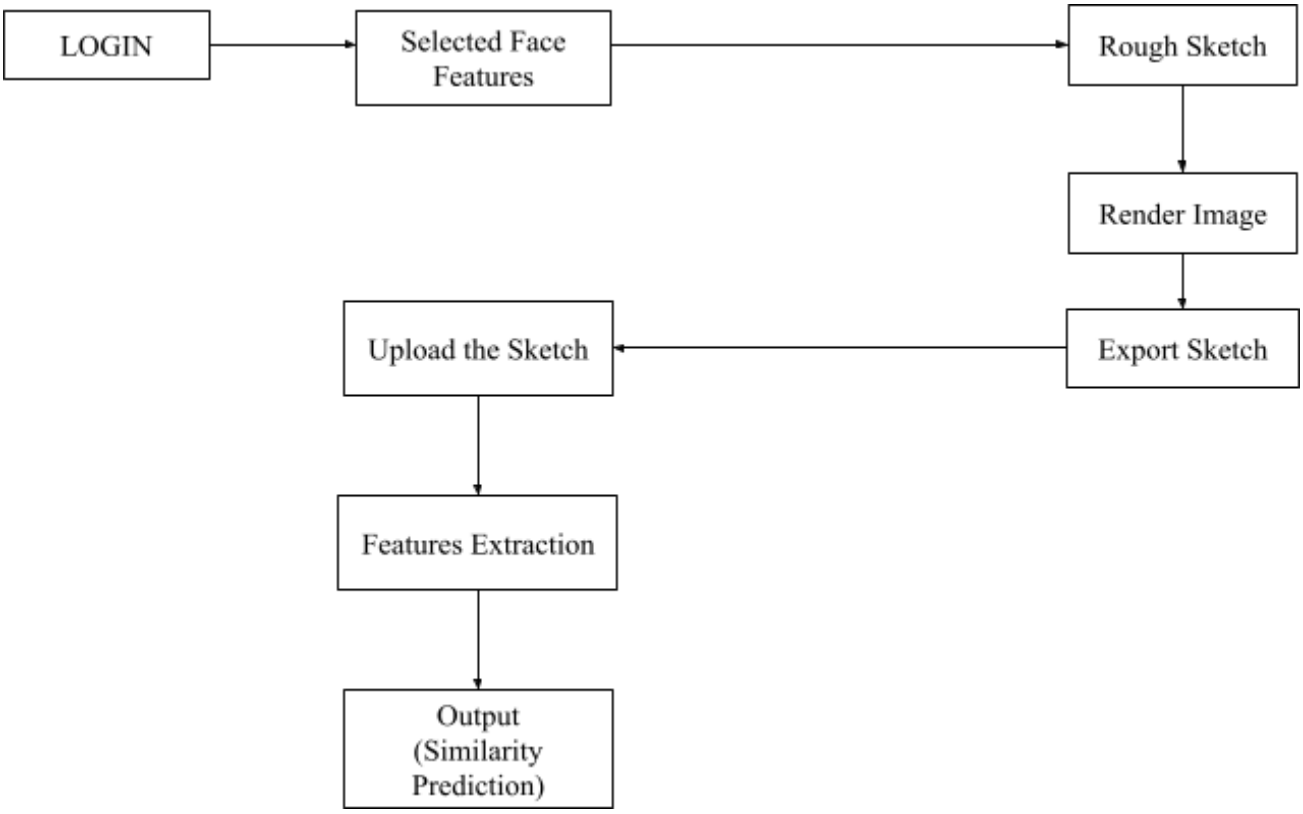

Fig 3.1 System Flow Chart of the Application

The flowchart above shows how the system operates overall, from the login page to the results that are displayed once the sketch is compared to the database information.

In order to facilitate a seamless transfer from the existing method to the new platform, something is used for logging into the platform and moving about it. The present method involves using hand-drawn sketches created by a forensic artist with years of experience. The sketch is then used by the law enforcement department to be displayed on numerous platforms in an effort to raise public awareness and identify the suspect.

As a result, backward compatibility enables the law enforcement agency to upload those hand-drawn sketches onto the platform in order to use this face recognition module and match the suspect sketch with the large record, saving time and resources compared to the previous time-tested method.

If the police agency doesn't have a hand-drawn drawing and wants to use this platform to create a face sketch, they can visit the canvas where they will find a broad variety of facial elements in the database. In order to organize the pieces in accordance with the eyewitness account, the elements can be readily picked to generate a drawing of the suspect's face that is mentioned. The platform is made to be used by anybody with no prior professional experience or understanding of sketching. Thus, the user can choose the primary face category they want to select. They will then be presented with a number of possibilities within that specific face category, from which they can choose one feature depending on the suspect's description. If, after selection, a feature does not meet the description, the platform will even let the user change it to be substituted by any other feature.

The chosen face categories will be arranged next to one another to form a complete face sketch, and the mouse can be used to shift a face characteristic to a different location according to the description from a witness. The image from this canvas can then be saved in PNG format for use in future projects that go beyond our platform, such as printing or sharing on social media.

Once the sketch is created it goes to the face recognition module, for this purpose the sketch too is uploaded to the database first and then the prediction is performed. Our platform uses deep learning in order to give the best and accurate result so as to bring the criminal to justice.

3.2.1. Face Sketch Construction Module:

As was already indicated, security and accuracy are the main aspects which I concentrated on designing this platform for the law enforcement sector. As a result, the major goal of this project module is to create a facial sketch using the description that the EyeWitness gave to the law enforcement agency.

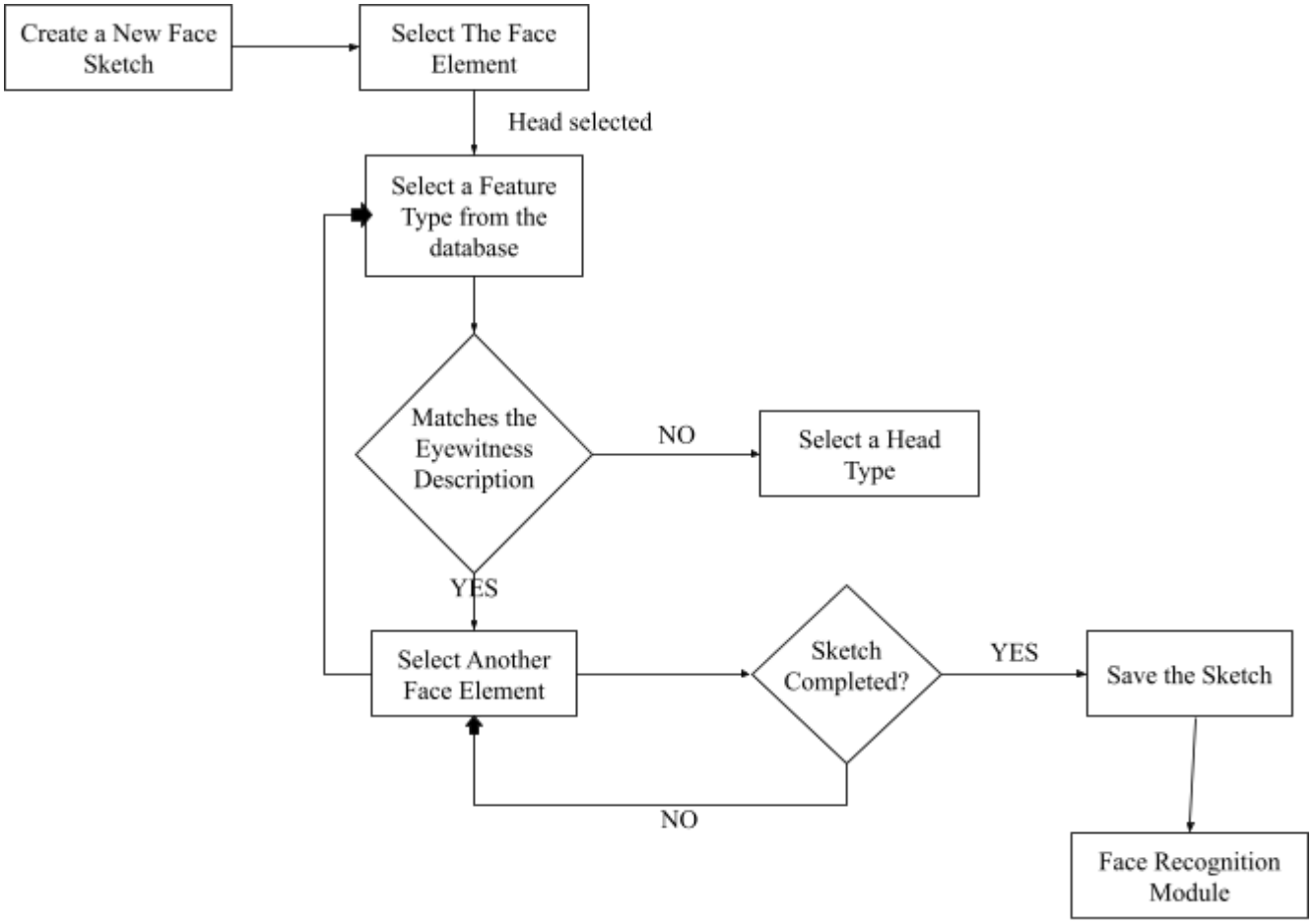

Fig 3.2.The application's flowchart for creating sketches

The dashboard is made with the simple intention of encouraging users to use this platform without first completing any kind of professional training. This will save the Department time and resources. In order to create realistic facial sketches based on the description, users use the platform, as shown in the flowchart above.

By keeping it straightforward, it is ensured that anyone from the law enforcement branch can use the descriptions provided by the eye witness instead of requiring a professional sketch artist from the forensic department. In some cases, the eye witness may even be able to take control of the platform, though that is not advised because it could compromise the security protocols.

Pay close attention to the Canvas module, which is visible in the dashboard's center and contains the components necessary for creating the facial sketches.

If all the facial components were shown at once and in a random order, the user would not be able to sketch an accurate representation of the face, which would be against the system's intended goals. By classifying the face features into the appropriate facial categories, such as head, nose, hair, eyes, etc., this problem was intended to be overcome. Users would find it more simpler to use the platform and create the facial sketch as a result. Users can access a variety of alternative face structures by choosing one of the face categories from the left-hand column of the Canvas dashboard.

In regard to the various face elements, there may be multiple elements for a single category. After it has the data needed to train the model in this way and continue to enhance the platform, this platform will utilize machine learning to anticipate similar face attributes or to forecast and recommend the components to be chosen in the face sketch. However, this won't be feasible before then.

Therefore, a new module to the right of the canvas appears, when a user clicks on a certain face category, allowing them to choose one element from the available face elements to build a face sketch. Based on the eye witness's account, this alternative may be chosen.

The elements have a fixed location and order to be placed on the canvas, such as the eye elements would be placed over the head element regardless of the order they were selected. The elements when selected are shown on the canvas and can be moved and placed according to the description of the eye witness to get a better and accurate sketch. Similar for each face component. The dashboard choices are the last module. For example, if a user picks an element that shouldn't be picked, they may undo it by choosing the option to delete that element, which is available by

choosing the face category from the left panel. The most crucial controls are located in the panel to the right, which also features a button to fully delete anything on the dashboard's canvas and leave it blank.

You can save the finished facial sketch by pressing a button, and it will be saved as a PNG file for future use. Depending on the Law Enforcement Department, this could be located anywhere on the server or host computer.

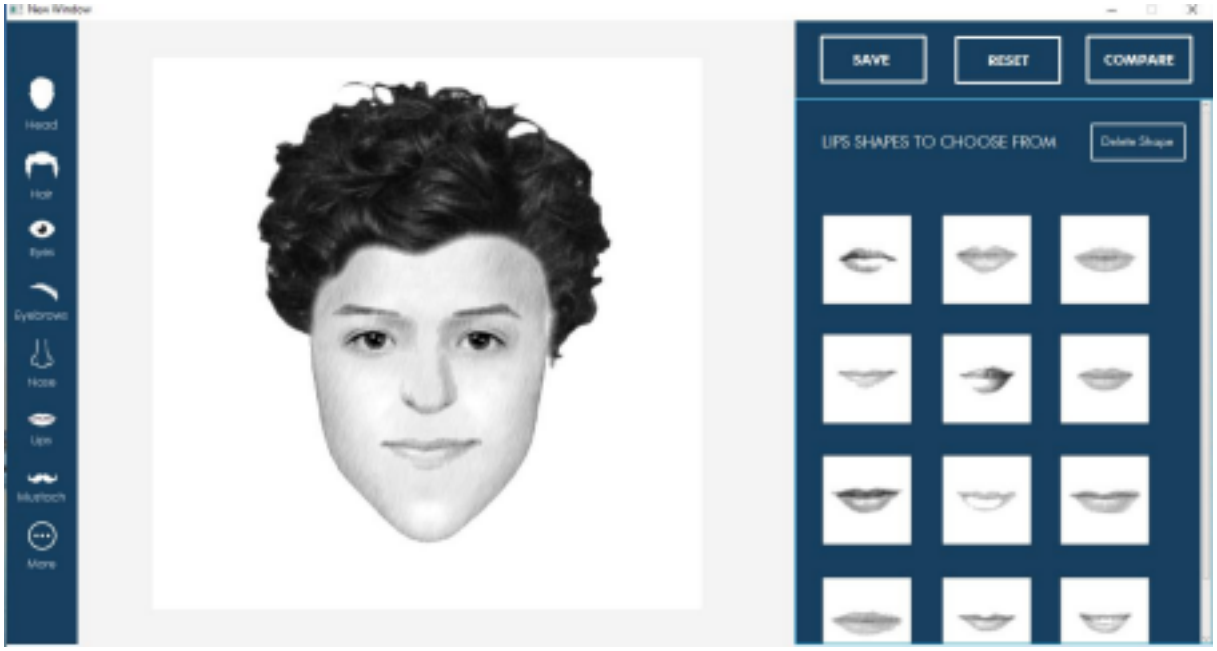

Fig 3.3. A Complete Face Sketch in Dashboard
(The Complete Face Sketch been displayed on the Dashboard Canvas)

3.2.2. Face Recognition

Dataset acquisition, data pre-processing, algorithm selection, model training, and person identification are some of the phases involved in developing a person identification system.

Data Collection

Data collecting is the first step in the process. Data collecting involves acquiring and analyzing information from many sources. A dataset from Kaggle is used for training. The dataset consists of 35 folders, each containing 35 unique photos. The pictures are jpg files.

Figure 3.4: Sample Data

Data Pre-processing

Data preprocessing is the process of transforming raw data into something that can be used by a deep learning model. It improves the data so that it can be processed later. Data is preprocessed before the model is created and the training procedure is carried out. Images make up the data, hence picture pre-processing is used. Here, the pre-processing stage converts the input image to sketch images for training.

Figure 3.5 : pre-processed image

Train Model

The next step is to train the photos in the train folder. Each person's sketch is included in the train folder. It is utilized for training, and after training, a sketch image of a person is also employed as input into the system. The algorithm utilized for training is Visual Geometry Group 16. (VGG16). Pre-processed picture datasets are used to train the algorithm, and its performance is assessed for future use.

VGG16

When used to classify 1000 images into 1000 separate categories, the object identification and classification algorithm VGG16 has a 92.7 percent accuracy rate. It is a popular method for categorizing photographs and is easy to use to communicate knowledge.

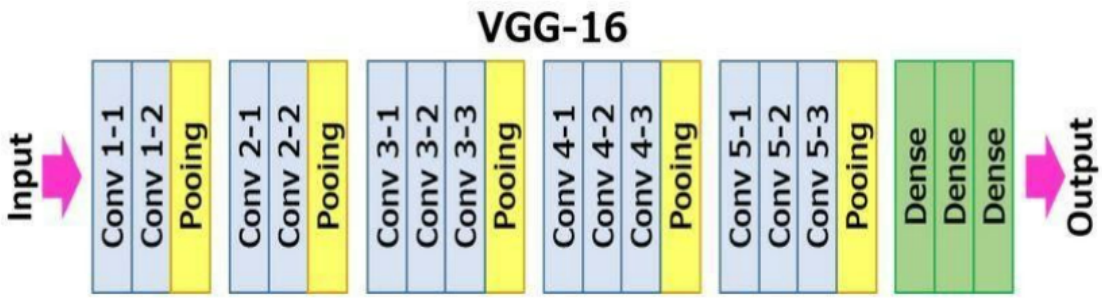

Figure 3.6 VGG Architecture

- The 16th digit of VGG16 represents the 16 weighted layers. Only 16 of the total 21 layers in VGG16 are weight layers, also known as learnable parameters layers (13 convolutional, 5 max pooling, and 3 dense).
- An input tensor with three RGB channels and a size of 224, 244 is needed for VGG16.
- The most notable aspect of VGG16 is that it continuously used the padding and maxpool layer of a 2x2 filter with stride 2, while prioritizing convolution layers of a 3x3 filter with stride 1 over a significant number of hyper-parameters.
- The max pool and convolution layers are evenly distributed across the whole design. There are 64 filters in the Conv-1 Layer, 128 filters in the Conv-2 Layer, 256 filters in the Conv-3 Layer, and 512 filters in each of the Conv-4 and Conv-5 Layers.
- Three Fully-Connected (FC) layers, the third of which performs 1000-way ILSVRC classification and has 1000 channels, are added after a stack of convolutional layers. In the highest two FC levels, there are 4096 channels (one for each class). The uppermost layer is called the soft-max layer.

Convolution Layer:The layer that identifies the network is a critical part of a convolutional neural network. The "convolution" procedure is carried out by this layer. Convolution is a linear process that involves multiplying a set of weights with the input, much like a traditional neural network. The multiplication is performed between an array of input data and a filter, which is a two-dimensional array of weights, since the approach was designed for two-dimensional input.

MaxPooling layer: The fact that convolutional layer feature maps maintain the precise position of the input features is one of its disadvantages. This implies that a distinct feature map will arise from even minor changes to the feature's location in the input picture. Re-cropping, rotation, shifting, and other insignificant alterations to the supplied picture may be the cause of this. Down sampling is a popular approach in signal processing to solve this issue. The input signal is transformed into a lower resolution version in this case, retaining the crucial structural components while eliminating any extraneous fine information. Convolutional layers allow for downsampling by modifying the convolution's stride across the picture. Pooling layers are a more dependable and typical approach. After the convolutional layer, a pooling layer is a new layer that is added. Specifically, when the feature maps of the convolutional layer have been non linearized (like ReLU).

Test Model

Each individual in the dataset can be reliably identified by the trained VGG 16 model. The outcome of the performance review demonstrates how well this system recognises people.The created composite face sketch can then be compared with the database of the police force using deep learning to identify and predict the similarity of offender.

3.3. Software Requirement and Specification

3.3.1. JAVA

Java is a computer platform and programming language that was first released by Sun Microsystems in 1995. Numerous applications and websites depend on Java to run effectively, and more are being created every day. Java is dependable, quick, and secure.Laptops, data centers, game consoles, scientific supercomputers, mobile phones, and the Internet are just a few of the gadgets that employ Java.

- It offers more cross-platform compatibility and portability since programmes developed for one platform may be utilized with desktop, mobile, and embedded devices.
- Distributed, free, simple, object-oriented, multithreading allowed, multimedia supported, and network connectivity are all features of Java.
- Java is well-liked at the business, embedded, and network levels, where it has a significant,

active user community and support system.

- Java programmes, in contrast to C and C++, are built in bytecode independent of the platform, allowing them to run on any machine with a JVM installed.
- Strong development tools for Java include the integrated development environment-providing NetBeans and the debugging-capable Eclipse SDK.
- Java's interoperability with languages like Scala, Groovy, JRuby, and Clojure demonstrates the growing linguistic variety.
- Forward compatibility between versions is essentially smooth.

Increasing the variety of languages. In conclusion, some 20 years after its start, Java is still offering the software development industry a lot of value. In truth, Java 8 has a number of new features, including a flexible and scalable platform for the Internet of Things, reduced boilerplate code, an updated graphics toolkit, a new date and time library and API, and more.

3.3.2. JAVAFX

With the help of the JavaFX collection of graphics and media packages, programmers may create complex client applications that function reliably on a variety of platforms.

JavaFX application code may use APIs from any Java library since it was created as a Java API. For instance, JavaFX applications may link to server-based middleware programmes and built-in system functionalities using Java API libraries.

It is possible to change the look and feel of apps made using JavaFX. Developers may focus on developing code because Cascading Style Sheets (CSS) separates functionality from appearance. Using CSS, graphic designers may simply alter the application's look and feel. If you have expertise with web design, you may opt to keep the user interface (UI) and the back-end logic separate and write the presentational parts of the user interface (UI) in the FXML scripting language and utilize Java code for the application logic. Use JavaFX Scene Builder if you want to create UIs without writing any code. Scene Builder generates FXML markup as you design the user interface (UI), which can be imported into an Integrated Development Environment (IDE) so that programmers can add the business logic.

The following functionalities are available in JavaFX 2.2 and higher releases:

- For Java, APIs. Classes and interfaces built with the native Java programming language are included in the JavaFX library.Create JavaFX application user interfaces using the declarative markup language FXML using the FXML Scene Builder.The graphical user interface can be created interactively by a designer using JavaFX Scene Builder or FXML coding (GUI). The business logic can be added to the FXML markup created by Scene Builder by a developer using an IDE.
- Using WebKitHTML technology, Website View is a web component that enables you to include web pages in JavaFX applications. Both Java APIs and JavaScript running in WebView have the ability to call each other.
- Interoperability with Swing. Existing Swing programmes may be enhanced with new JavaFX capabilities including media playback for rich visuals and integrated Web content.
- CSS and built-in UI controls. All of the essential UI controls needed to create a fully functional application are offered by JavaFX. Common Web technologies like CSS can be used to skin components.
- API for Canvas. The JavaFX scene's canvas can be directly drawn on using the Canvas API in areas where there is just one graphical element (node).
- Support for multitouch. JavaFX supports multitouch operations.
- A graphics pipeline that is hardware-accelerated. The graphics rendering pipeline provides the foundation for JavaFX graphics (Prism). When combined with the right graphics card or GPU, JavaFX produces clear visuals that render quickly thanks to Prism (GPU).
- An impressive media engine. The media pipeline enables playback of web-based multimedia material. It offers a reliable, low-latency media framework based on the multimedia GStreamer technology.
- Model for launching independent apps. In addition to all of the application resources, self-contained application packages also include a private copy of the Java and JavaFX runtimes. They provide the same installation and start procedures as native operating system programmes and are made accessible as native installable packages. Consult the Deploying JavaFX Applications document.

You may create a wide variety of applications with JavaFX. Typically, they are multi-platform, network-aware apps that show information through high-performance user interfaces including audio, video, graphics, and animation.

3.3.3. Python 3

Guido van Rossum developed the high-level, interpreted Python scripting language in the late 1980s. Version 1.0 of the original was published in 1994 and initially appeared in the alt.sources newsgroup in 1991.

The 2.x series of versions predominated the market since the release of Python 2.0 in 2000 until December 2008. The development team then produced version 3.0, which had a few very modest but significant modifications that were not backward compatible with the 2.x versions. Python 2 and Python 3 are somewhat interchangeable, and certain Python 3 features have been backported to Python 2. However, they are still incompatible in general.

With fresh versions for each, Python 2 and Python 3 have both been regularly maintained. As of this writing, the most current versions are 2.7.15 and 3.6.5. However, Python 2 will no longer be supported as of January 1, 2020, which is the official End Of Life date. If you are new to the language, it is advisable that you focus on Python 3 since that is what this session will cover.

A core development team at the Institute continues to support Python, and the community still refers to Guido as the BDFL (Benevolent Dictator For Life). By the way, Guido loved Monty Python's Flying Circus and probably still does, which is where the name Python truly originates from. Snakes are not involved in any way. Allusions to numerous Monty Python films and skits are common throughout the Python documentation.

Python is Popular

Over the past few years, Python's popularity has increased. Python was recognised as the year's most popular and desired technology in the 2018 Stack Overflow Developer Survey, where it came in seventh place overall. Top-tier software development companies worldwide often utilise Python.

Python is Simple

Python is relatively uncluttered compared to other programming languages, and its designers purposefully left it that way.The number of reserved words or keywords in a language may be used to gauge how complicated it is. These are phrases that the compiler or interpreter reserves for special meaning because they denote a particular language feature that is built-in.

Python Libraries

You may utilize a Python library in your projects or programmes as a reusable chunk of code. Python libraries are not context-specific, unlike libraries for languages like C++ or C. In this context, the term "library" is used to refer to a group of necessary modules. A library is essentially a collection of modules. Using package management technologies like rubygems or npm, a library may be installed.

Python Standard Library

The precise syntax, tokens, and semantics of Python are collected in the Python Standard Library. It includes the standard Python distribution. Python is the language it is because of the confluence of all these qualities. More than 200 core modules make up the standard library's core. This library is already present in Python. However, in addition to this library, you may also access a growing collection of several thousand components through the Python Package Index (PyPI).

1. Matplotlib

Matplotlib is a package for numerical plotting that aids in data analysis. For data science in Python, we discussed it. For 2D displays of arrays, Matplotlib is a fantastic Python visualization library. A multi-platform data visualization package called Matplotlib was created to deal with the larger SciPy stack and is based on NumPy arrays. In the year 2002, John Hunter first presented it.

2. Pandas

The Python library Pandas, which provides rapid, adaptive, and expressive data structures, makes working with "relational" or "labelled" data a simple and straightforward procedure. It aims to operate as the fundamental, high-level building block for using Python for real, practical data analysis. Pandas are crucial for data science, as we have already shown. To make dealing with structured (tabular, multidimensional, sometimes heterogeneous), and time-series data straightforward, it offers rapid, expressive, and adaptable data structures (and intuitive).

3. Requests

With the use of simple Python dictionaries, the module Requests enables you to submit HTTP/1.1 requests, add headers, form data, multipart files, and arguments. The same method may be used to collect the answer data.

4. NumPy

A general-purpose library for handling arrays is called NumPy. The ability to interact with these arrays is provided along with a very rapid multidimensional array object. Simply put, the core Python module for scientific computing. It offers sophisticated mathematical operations in addition to the basic scientific computer abilities.

5. SciPy

SciPy is an open source, BSD-licensed scientific library for Python that may be used in math, science, and engineering. The NumPy library, which offers rapid and simple N-dimensional array operations, is needed by the SciPy library. Support for NumPy arrays was the main driver behind the development of the SciPy library. one of the libraries we've often referred to. There are several simple and effective numerical algorithms. These include methods for numerical integration and optimization.

6. Scrapy

Choose Scrapy if your goal is quick, sophisticated web crawling and screen scraping. It can be used for automated testing, data mining, and monitoring.

7. Scikit

It is a free machine learning toolbox. It supports a broad variety of techniques, including the support vector machine, random forests, and k-neighbors, in addition to the NumPy and SciPy libraries from Python.

3.3.4. HTML

The standard markup language for writings intended to be read on a web browser is called Hypertext Markup Language (HTM) (HTML). JavaScript and Cascading Style Sheets (CSS) are two examples of technologies that might be beneficial. Web browsers transform HTML files downloaded from a web server or local storage into multimedia web pages. HTML is used to define the semantics of a web page's structure and to provide visual cues for the content.

HTML components are the building blocks of HTML pages. Using HTML methods, images and other elements, such as interactive forms, may be added to the newly created page. HTML provides a method for creating publications that are in the correct sequence by defining the structural semantics for text elements including headers, paragraphs, lists, links, quotes, and other objects. HTML elements are identified by tags, which are indicated by angle brackets. like input and picture tags, which instantly add content to the website. Other tags, like p>, enclose and describe the content of the page. Additionally, tags may be utilised as sub-elements. Browsers employ the HTML tags to decipher the page's content rather than displaying them.

Scripting languages like JavaScript and HTML may be used to incorporate scripts that change the appearance and content of web pages. CSS outlines how information is presented and organized. Since 1997, the World Wide Web Consortium (W3C), which originally oversaw HTML and is now in charge of CSS standards, has pushed CSS to replace explicit presentational HTML.

CSS

Cascading Style Sheets, a style sheet language, is used to display a page written in a markup language like HTML (CSS). Along with HTML and JavaScript, CSS is one of the fundamental technologies used on the World Wide Web.

Using CSS, layout, color, and font may be kept distinct from text and display.This separation can enhance content accessibility, provide more flexibility and control in the specification of presentation characteristics, allow multiple web pages to share formatting, and reduce complexity and repetition in the structural content by defining the pertinent CSS in a separate CSS file. Furthermore, it makes the.css file cacheable, which speeds up the loading of pages on websites that use the file's formatting.

For various rendering techniques, the same markup page may be shown in a variety of ways, including on-screen, in print, vocally (through a screen reader or speech-based browser), and on Braille-based tactile devices. The capability of separating layout from content makes this feasible. CSS also provides formatting recommendations for different layouts when a user is viewing the material on a mobile device. When many style rules match an element, the priority system is utilised to determine which style rule should be applied, giving cascading its name. This ranking of significance is normal.

Bootstrap

For front-end web development, a free and open-source CSS framework called Bootstrap emphasizes mobile flexibility. It offers CSS and (optionally) JavaScript-based design templates for typography, forms, buttons, navigation, and other interface components. The only two GitHub projects with more stars than Bootstrap's 142,000 are the Vue.js framework and freeCodeCamp (both with almost 312,000 ratings).

Bootstrap 2

It was introduced on January 31, 2012. Many of the more dated older components are included, along with some new ones and built-in support for Glyphicons. Since responsive web design is possible, web page layouts are often modified to take the capabilities of the device being used into account .

Bootstrap 3

It was made available on August 19, 2013. Flat design and a mobile-first philosophy are now used in updated components. Bootstrap 3 has a new plugin system with namespaced events. Despite the fact that Bootstrap 3 no longer supports Internet Explorer 7 and Firefox 3.6, a polyfill is accessible.

Bootstrap 4

On October 29, 2014, Mark Otto made the Bootstrap 4 announcement. On August 19, 2015, the first alpha version of Bootstrap 4 was made available to everyone. On August 10th, 2017, the first beta version was made available.

JavaScript

A scripting language is JavaScript. Learning a scripting language is quick and simple. Run-time interpretation is used with scripting languages. Unlike other languages like C++, C#, VB.net, etc., it is not compiled. A client browser is required to run JavaScript, which is a client side language. It was created by Netscape and is among the most well-known scripting languages due to its simplicity. On the server side, JavaScript is also a viable option. JavaScript is compatible with the majority of popular browsers. It is simple to use to communicate with HTML components. You may disable buttons, validate forms, validate text fields, and alter the background color of your page. JavaScript makes it possible for all of this. It has variables, arrays, functions, operators, objects, and much more like any other programming language, which will help you write better scripts for your pages. To manage database entries on the server side, for instance, use JavaScript. You can add JavaScript code directly to the HTML file, or you can put it in a separate file with the.js extension and link the webpage to the.js file.

3.3.5 VS CODE - IDE

A sophisticated set of developer tools, including IntelliSense code completion and debugging, are combined with a source code editor's ease of use in Visual Studio Code. First and foremost, an editor disengages from your work. The blissfully frictionless cycle of edit-build-debug enables you to spend more time putting your ideas into practice and less time interacting with your environment.

Because of its quick source code editor as its primary feature, Visual Studio Code is ideal for everyday usage. Visual Studio Code makes it simple for you to get started fast and be productive with its wide variety of language support and features like syntax highlighting, bracket matching, auto-indentation, box selection, snippets, and more.You can easily browse your code thanks to straightforward modification, intuitive keyboard shortcuts, and keyboard shortcut mappings given by the community.

Serious work often benefits from tools that have more coding knowledge than just text blocks. With Visual Studio Code, you can do code restructuring, deep semantic code interpretation

and navigation, and IntelliSense code completion. When coding gets harder, the proficient employ the skill of debugging. We included debugging since it's often the one thing that programmers miss the most in a constrained coding environment. You can go through the source code in Visual Studio Code's interactive debugger, look at variables, see call stacks, and run console commands. VS Code also connects with build and scripting tools to complete routine chores and expedite daily activities.

3.3.6 Tensorflow

A fully functional open-source machine learning platform is TensorFlow. Researchers can advance the state-of-the-art in machine learning thanks to its vast, adaptable ecosystem of tools, libraries, and community resources, while developers can simply build and deploy ML-powered applications. The TensorFlow software library for machine learning is open-source and cost-free. Despite being especially described for deep neural network inference and training, it may be used for a variety of applications.

The second version of Google Brain technology is known as TensorFlow. The 1.0.0 version was made available on February 11, 2017. TensorFlow has the ability to utilise several CPUs and GPUs, as opposed to the single CPU and GPU found in the traditional version. Linux, macOS, Windows, and mobile operating systems like Android and iOS all support TensorFlow 64-bit versions. Thanks to its modular design, computing may be easily implemented across a range of platforms (CPUs, GPUs, and TPUs), including desktop PCs, server clusters, mobile devices, and edge devices. Stateful dataflow graphs are used to explain TensorFlow calculations. The actions that these neural networks carry out on tensors, which are multidimensional data arrays, give TensorFlow its name.

3.3.7. KERAS

A Python interface for artificial neural networks is provided by the open-source software package known as Keras. The TensorFlow library interface is provided by Keras. Humans, not robots, were considered while the Keras API was being built. By providing consistent and straightforward APIs, decreasing the amount of user engagements necessary for common use cases, and creating audible and responsive error signals, Keras complies with best practises for lowering cognitive load. There are also a tonne of developer tutorials and documentation accessible.

The Keras framework includes a number of tools for managing picture and text input in addition to the well-known neural network building components layers, goals, activation functions, and optimizers. This makes it easier to code the deep neural network architecture. In addition to classical neural networks, Keras also supports convolutional and recurrent neural networks. Dropout, batch normalization, and pooling are just a few of the often used utility layers.

In addition to classical neural networks, Keras also supports convolutional and recurrent neural networks. Dropout, batch normalization, and pooling are just a few of the often used utility layers.

TensorFlow, Microsoft Cognitive Toolkit, Theano, and PlaidML were just a few of the many backends that Keras supported up to version 2.3. One and only TensorFlow is supported as of version 2.4. Usability, flexibility, and extensibility were its main design goals since they would facilitate quick and easy deep neural network experimentation.

3.3.8. DJANGO

Django, a sophisticated Python web framework, encourages rapid iteration and logical, beautiful design. It was made by skilled programmers and takes care of a lot of the hassles related to web development, freeing you up to focus on creating your app without having to reinvent the wheel. It is both free and open source.

- Amazingly speedy.

Django was developed to enable building apps from scratch as easy as possible for developers.

- Security is ensured

  Django assists developers in avoiding several typical security problems because of its emphasis on security.

- Exceptionally scalable

Django's quick and flexible scaling features are used by some of the busiest websites on the internet.

Django is a model-template-views (MTV) architecturally open-source web framework built on Python. The American independent non-profit Django Software Foundation (DSF), which was founded independently, is responsible for maintaining it.

Chapter 4

Result and Discussion

The "Forensic Face Sketch Construction and Recognition" project was created, refined, and finally tested while considering real-world circumstances inorder to retrieve information from the records while retaining accuracy and privacy as the two most important factors in each scenario.

The platform even demonstrated high accuracy and speed when creating and recognising facial drawings, delivering a 100% confidence level and an average accuracy of greater than 90% when evaluated with a variety of test cases, according to pertinent research in this field.

The platform combines aspects that are distinctive and unusual when compared to relevant studies in this subject, which boosts the overall security and accuracy. This allows it to stand out from all other related research and proposed solutions in the area.

4.1. Comparison

The graph displays the model loss and accuracy for the train and test images.

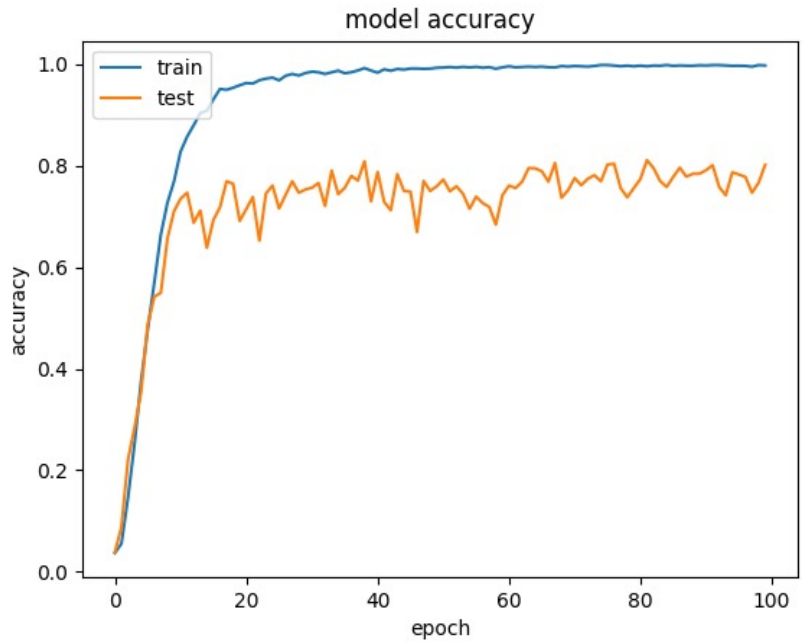

Figure 4.1 Model Accuracy Graph

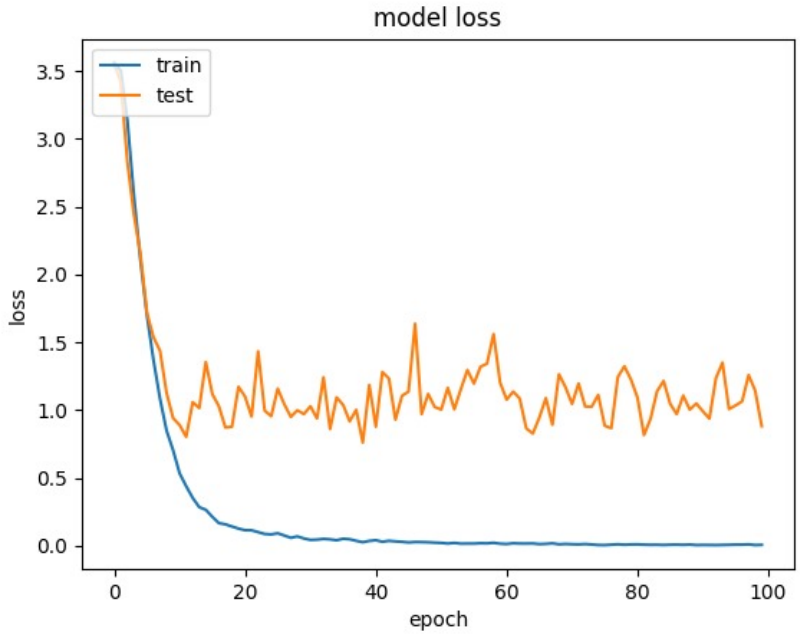

Figure 4.2 Model loss Graph

Chapter 5

Conclusion

The use of deep learning to accomplish person identification for investigative reasons. The deep learning technique utilized is called VGG 16, a convolutional neural network variation. When using an image as the input data, it is among the top algorithms. The public repository hosts the dataset that was used to develop this system. Each individual's color image from the dataset is transformed into its corresponding sketch image for training. Each individual in the dataset can be reliably identified by the trained VGG 16 model. The outcome of the performance review demonstrates how well this system recognises people.

5.1 Future Enhancement

The "Forensic Face Sketch Construction and Recognition" project is currently only intended to function in a select few circumstances, such as comparing face drawings to images used in police databases.

The platform may be changed in the future to use video feeds to align the faces with the Face Sketch of actual individuals. This will allow it to look into other scenarios and technologies, look into different media and surveillance channels, and provide more broader findings. The same changes to CCTV surveillance systems may be made to use the Face Sketch for face identification on Live CCTV footage..

The platform may also be linked to social media since, in today's environment, social media platforms serve as rich data sources, and doing so will increase the platform's capacity to identify far high precise matches for users, enhancing the facial drawing, increasing accuracy, and quickening the process.

The platform might have qualities that make it distinct from other related research and recommended solutions in the field, which would increase the platform's overall precision and safety by making it stand out from all other relevant studies in the field and make it easier to upgrade.

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APPENDIX

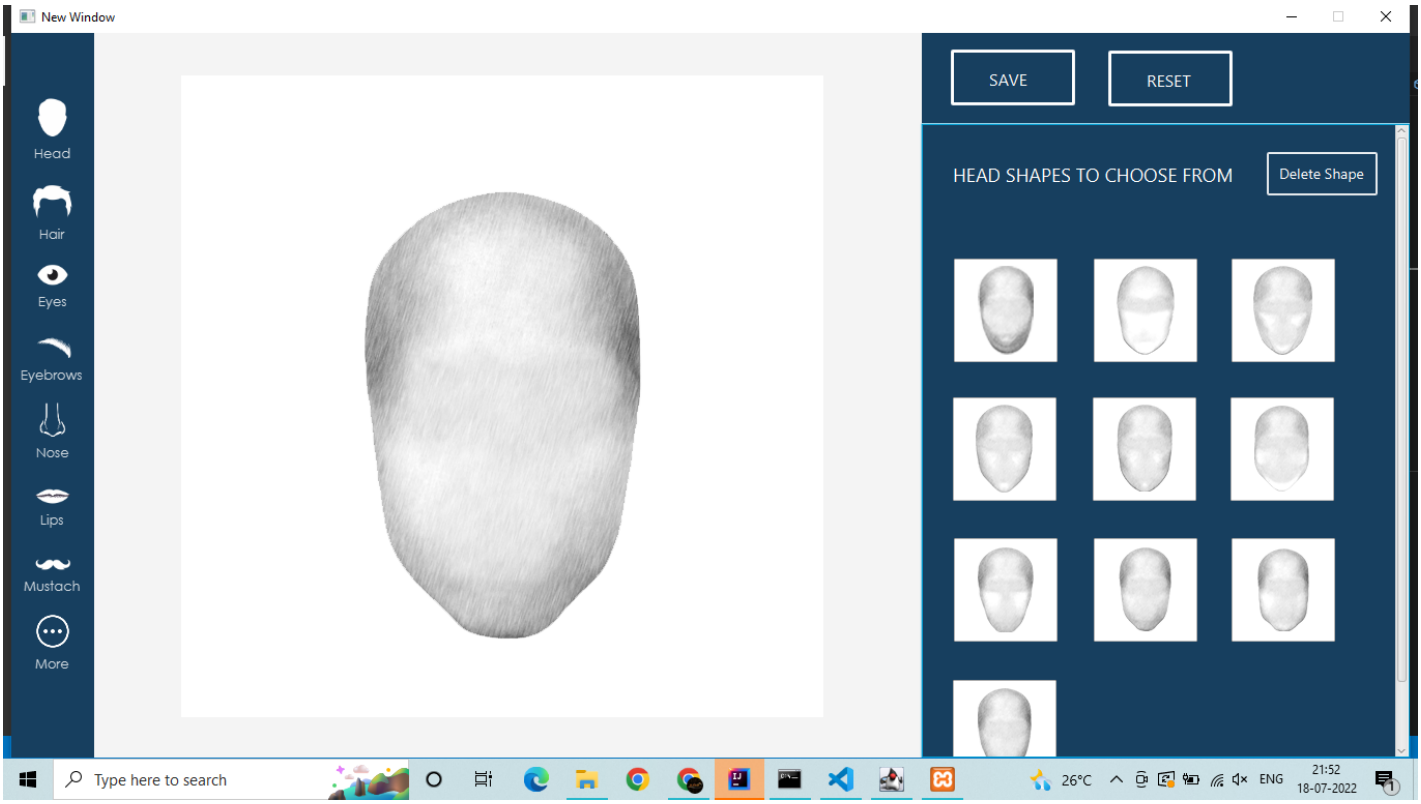

Figure A.1 Face Sketch Features

Figure A.2 Created composite Sketch

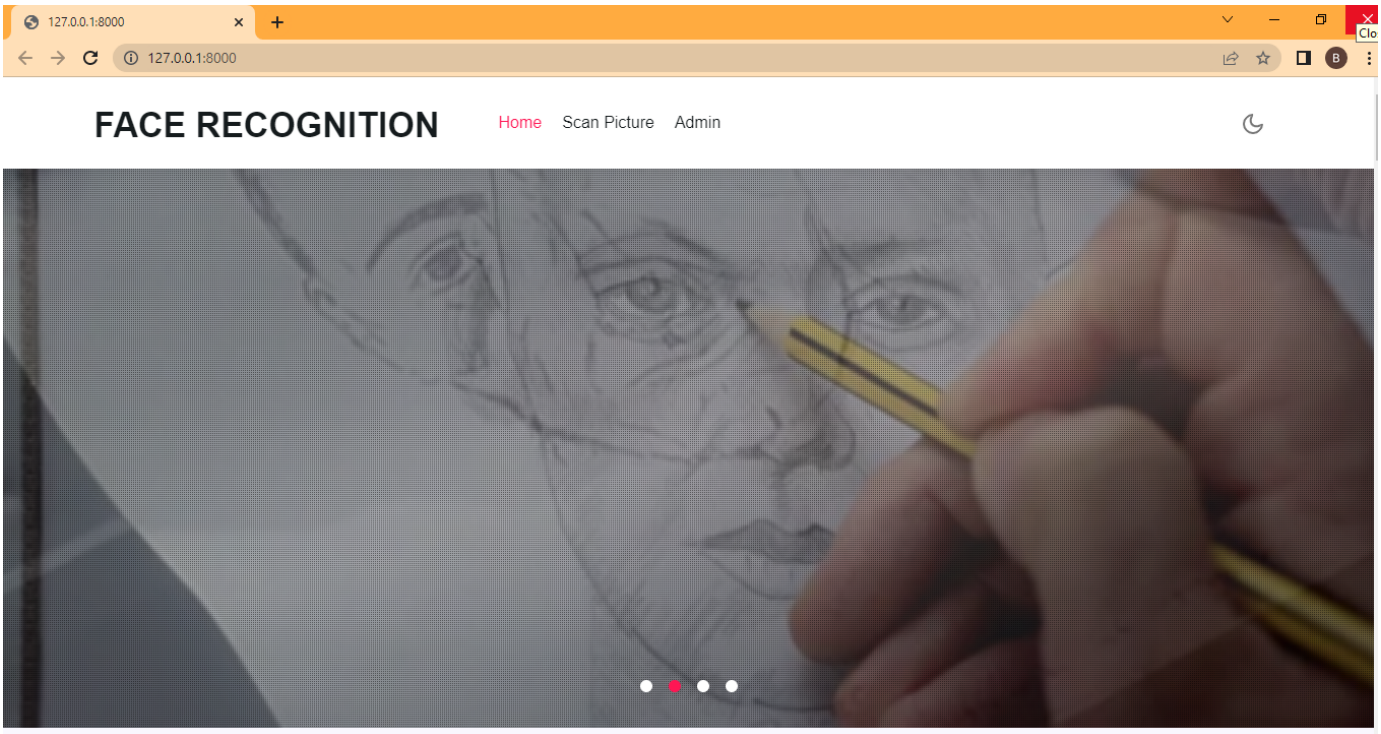

Figure A.3 Dashboard of Face Recognition

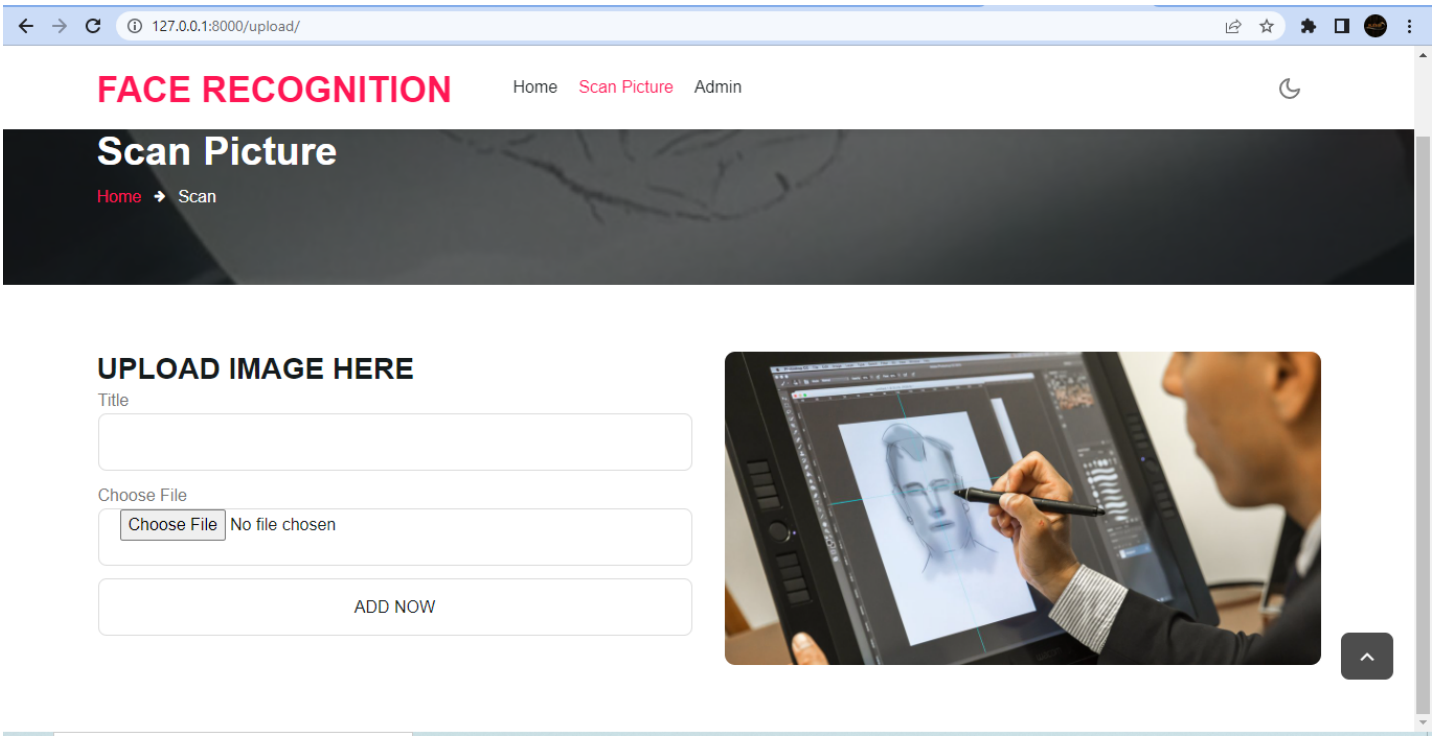

Figure A.4 Upload Composite Sketch

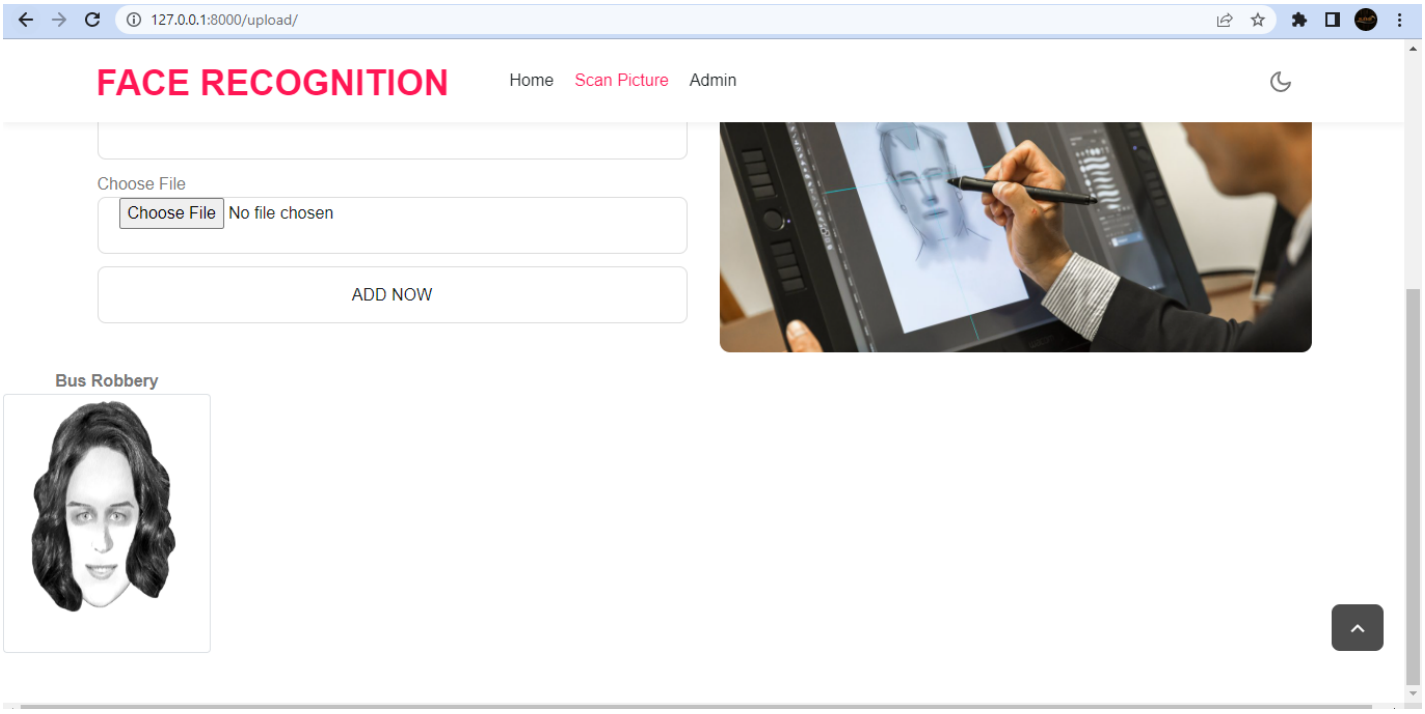

Figure A.5 Uploaded sketch

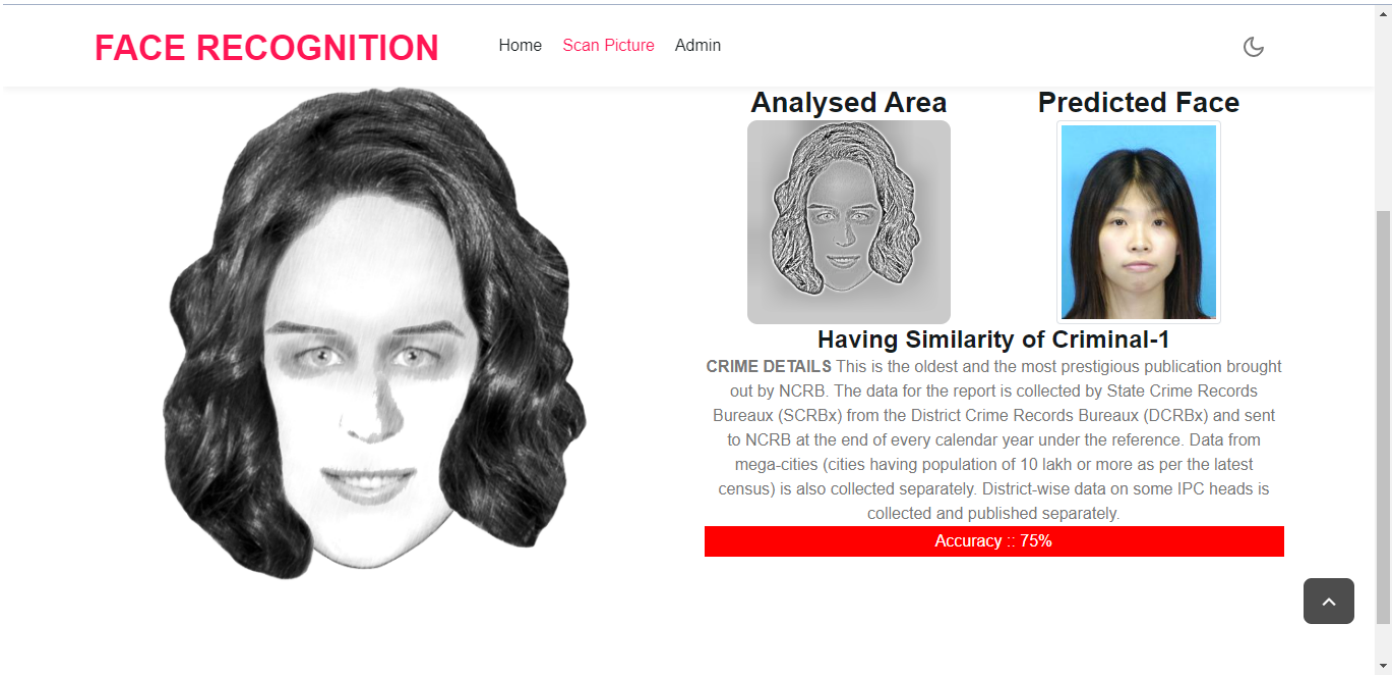

Figure A.6 Similarity Prediction