International Journal of Medical and All Body Health Research

International Journal of Medical and all body Health Research
ISSN: 2582-8940
Received: 20-09-2021; Accepted: 23-10-2021
www.allmedicaljournal.com
Volume 2; Issue 4; October-December 2021; Page No. 64-69

Forensic face sketch recognition

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DOI: https://doi.org/10.54660/IJMBHR.2021.2.4.64-69

Abstract
Crime has taken a drastic revolution, and so does the demand for enhancing the security of the forensic files and records. Nowadays, there is an increased requirement to use technological measures in the field of crime as well for identification, detection and recognition of the suspects.
To deal with safety and security biometric recognition is necessary. One of the most common biometric techniques is face recognition, as the face is one of the most convenient and reliable way of identification. On the contrary, hand-drawn sketches and sketchers are limited in number although sketches are drawn in almost every criminal case.
To come to the rescue, face recognition using a biometric mechanism using computer vision helps in solving the case in special circumstances where the suspects use masks to hide his face or some features. Suspect can conveniently hide the face like nose, eyes, lips, face colour, etc. but the outliner features of face cannot be duplicated.
Face sketches have essential information about the face structure and topology and to deal with such precision, there is a requirement of intervention with some assisted computer mechanisms like Deep Convolutional Neural Network which helps in recognizing specific features.

Keywords: Forensic, face, sketch, application

1. Introduction
A criminal can be easily identified and brought to justice using a face sketch drawn based on the description been provided by the eyewitness, however in this world of modernization the traditional way of hand drawing a sketch is not found to be that effective and time saving when used for matching and identifying from the already available database or real-time databases.
Our application would even allow the law enforcement team to upload previous hand-drawn sketch in order to use the platform to identify and recognize the suspect using the much more efficient deep learning algorithm and cloud infrastructure provided by the application.
The machine learning algorithm would learn from the sketches and the database in order to suggest the user all the relatable facial features that could be used with a single selected feature in order the decrease the time frame and increase the efficiency of the platform.

1.1 Problem statement:
A complete face recognition system includes face detection, face pre-processing and face recognition processes. Therefore, it is necessary to extract the face region from the face detection process and separate the face from the background pattern, which provides the basis for the subsequent extraction of the face difference features. Face recognition of the separated faces is a process of feature extraction and contrast identification of the normalized face images in order to obtain the identity of human faces in the images.

1.2 Objective:
The aim of the project is to focus on developing a technique that provides a solution for an efficient face sketch identification system in forensic applications.
The digital image mugshot is considered to be used as an original face image police database and the corresponding sketches of different faces is considered to be drawn by a forensic artist.

2. Literature Survey
In [1], Dr. Charlie Frowd along with Yasmeen Bashir, Kamran Nawaz and Anna Petkovic designed a standalone application for

constructing and identifying the facial composites, the initial system was found to be time consuming and confusing as the traditional method, later switching to a new approach in which the victim was given option of faces and was made to selected similar face resembling the suspect and at the end the system would combine all the selected face and try to predict automatically the criminal's facial composite. The Results where promising and 10 out of 12 composite faces where named correctly out of which the results 21.3% when the witness was helped by the department person to construct the faces and 17.1% when the witness tried constructing faces by themselves.

In [2] P. C. Yuen and C. H. Man too proposed a method to search human faces using sketches, this method converted sketches to mug shots and then matched those mugshots to faces using some local and global variables been declared by the face matching algorithms. However, in some cases the mugshots where hard to be matched with the human faces in the databases like FERET Database and Japanese Database. The proposed method showed an accuracy of about 70% in the experimental results, which was fair decent but still lacked the accuracy needed by the law enforcement department.

3. System Analysis

Problems with Existing System

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

Proposed System

Our application as mentioned above would not only overcome the limitations of the mentioned proposed techniques but would also fill in the gap between the traditional hand-drawn face sketch technique and new modernized composite face sketch technique by letting user to upload the hand-drawn face sketches and facial features.

Advantages of Proposed System

Our application would even allow the law enforcement team to upload previous hand-drawn sketch in order to use the platform to identify and recognize the suspect using the much more efficient deep learning algorithm and cloud infrastructure provided by the application.

Feasibility Study

Technical feasibility

--> does the necessary technology exist to do what is suggested? – Yes, we can use AWS (Amazon Web Services) to implement the project.

--> Can the system be upgraded if developed? – The project has been implemented using JAVA and AWS, we can upgrade it as pleased.

Operational feasibility

User friendly
Portability
Availability

4. Software requirement specification product perspective:

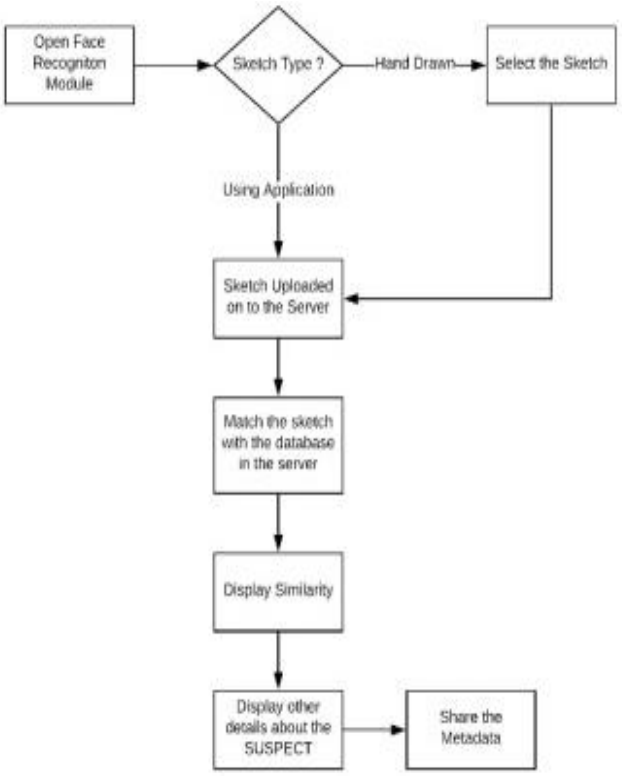

Fig 1: Flow chart for recognizing a sketch in the application

Product Function

1. Face sketch drawing is the primary step in the overall process.
2. Fetching the face from the localhost and getting it in the server is the crucial step.
3. Returning the recognized face from the server is the next step.
4. Finally, the recognized face with matched face is displayed with similarity percentage.

User classes and characteristics

1. USER – The only operation performed by the user is that it has to draw the face properly which has to be recognized.
2. SYSTEM – it has 2 major tasks to be done in order to get the correct outcome. They are:
    1. Uploading face sketch to server
    2. Face recognition

Operating environment

Software Requirements

1. Programming language: Java
2. Windows-Xp or higher

Hardware Requirements

Processor: Intel Core i5-7200U CPU @ 2.50GHz
Installed Memory (RAM) : 4.00 GB or higher
System type: 64-bit operating system or higher
A computer system will take care of the requirements of this text reader for VI in terms of supporting the code execution and audio generation. For capturing the image a 8mp or

higher mobile camera is required.

5. System Design

System Architecture

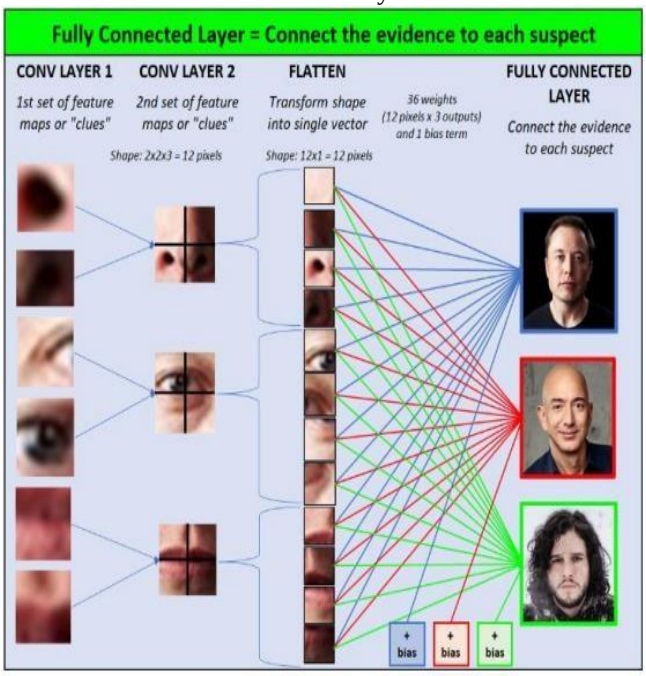

Fig 2: feature extraction by the platform

Data Flow Diagrams

A data flow diagram (DFD) maps out the flow of information for any process or system. It uses defined symbols like rectangles, circles and arrows, plus short text labels, to show data inputs, outputs storage points and the routes between each destination. Data flowcharts from simple, even hand-drawn process overviews, to in-depth, multi-level DFDs that dig progressively deeper into hoe the data is handled. They can be used to analyse an existing system or model a new one.

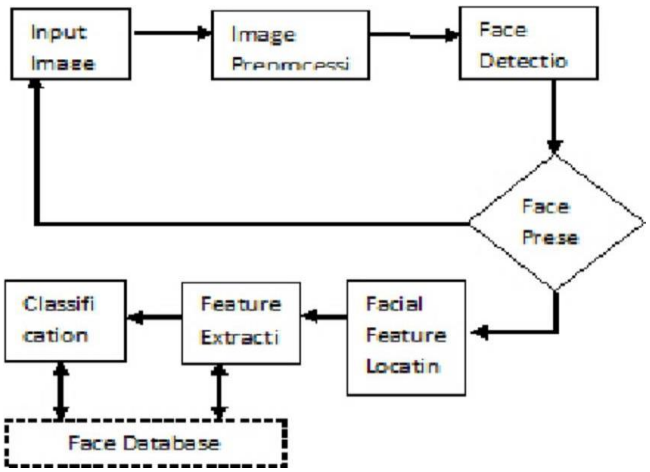

Fig 3: Data flow diagram for the system

Use case diagram

A use case diagram in the Unified Modelling Language (UML) is a type of behavioural diagram defined by and created from a use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

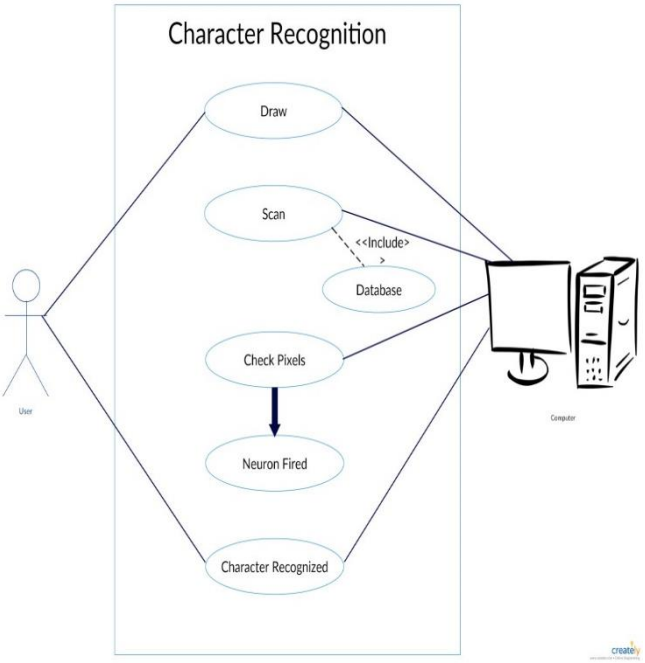

Fig 4: Use case diagram for the system

Class Diagram

In software engineering, a class diagram in the Unified Modelling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.

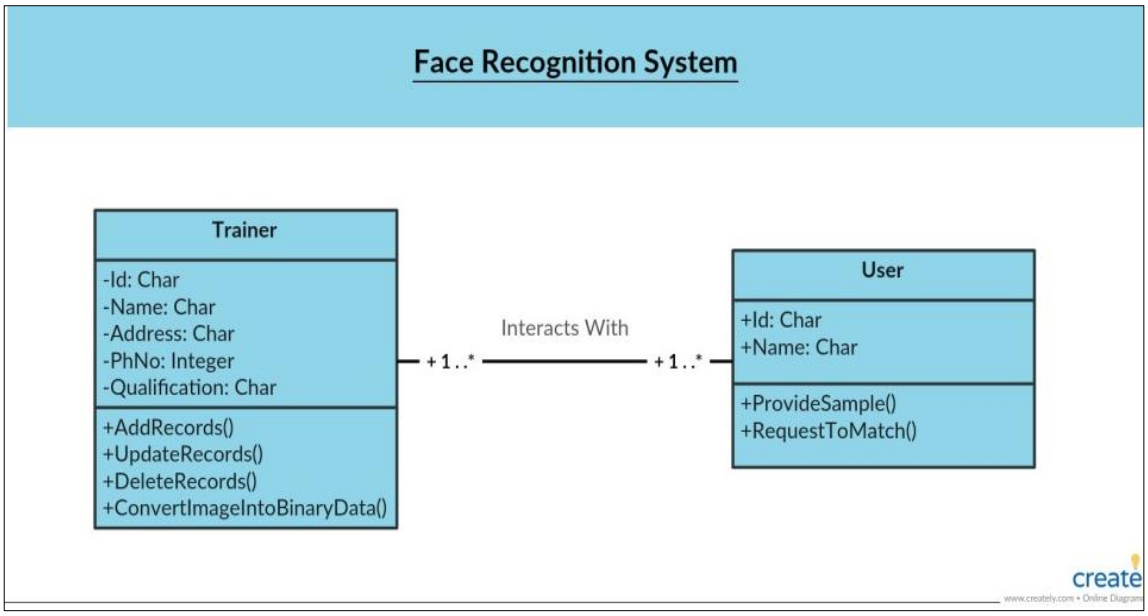

Fig 5: Class diagram for the System

Sequence Diagram

A sequence diagram in Unified Modelling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.

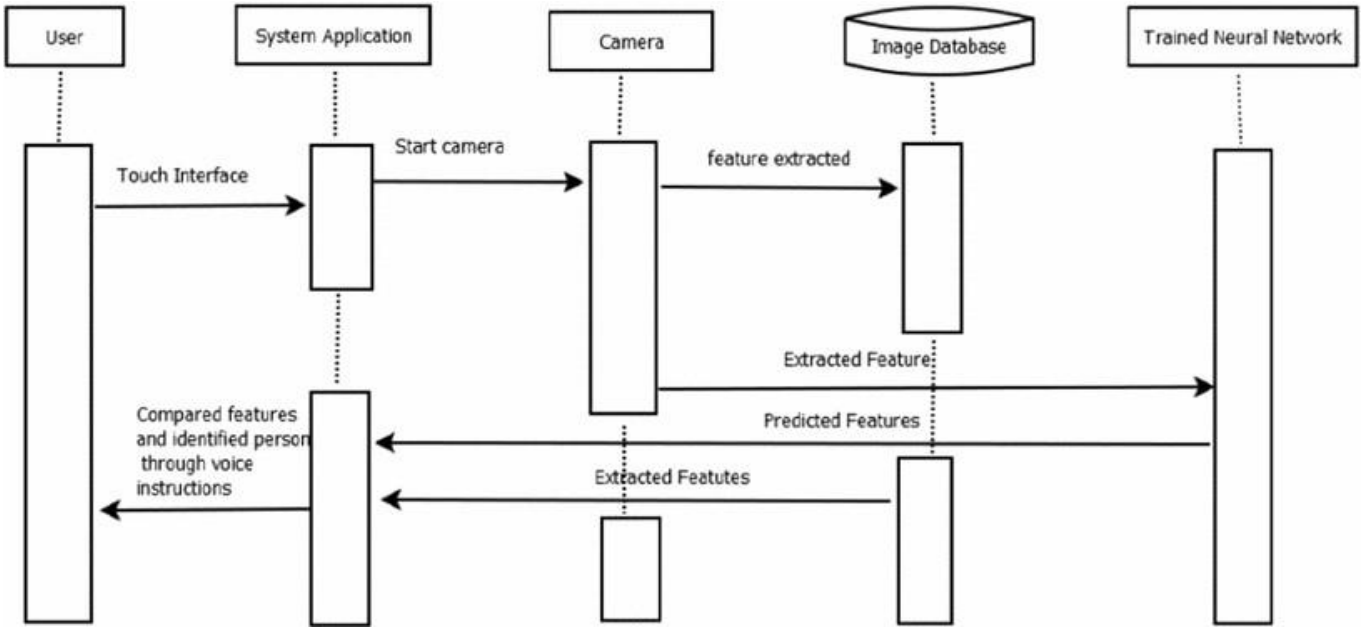

Fig 6: Sequence Diagram for the system

Activity Diagram

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modelling Language, activity diagrams can be used to describe the business and operational step-by-step workflows of components in a system. An activity diagram shows the flow of control.

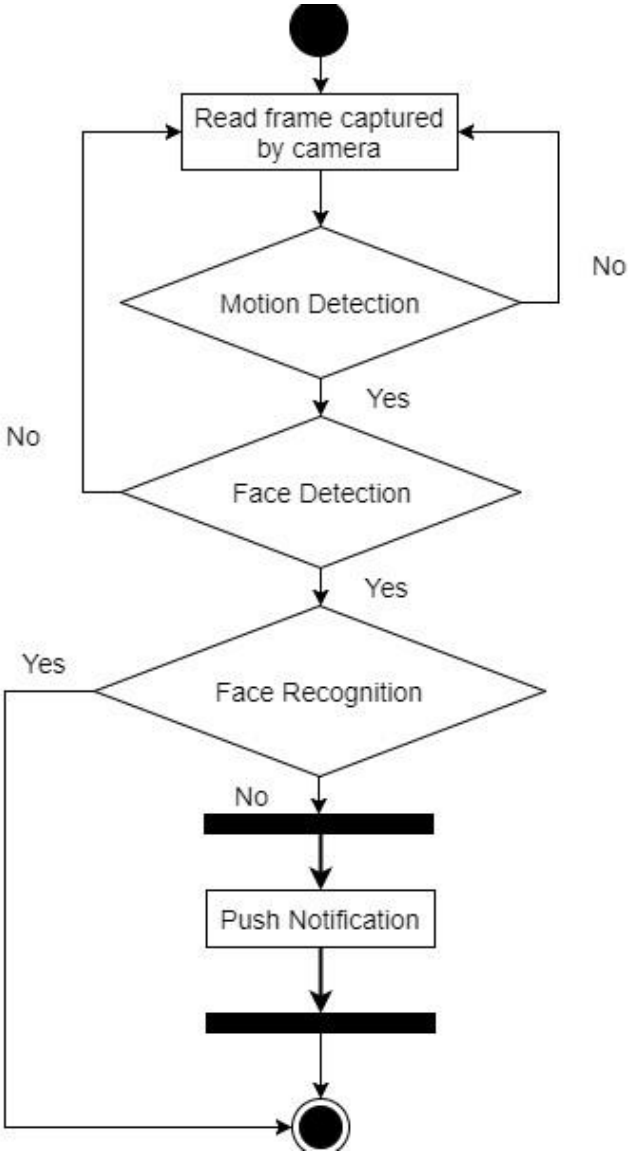

Fig 7: Activity Diagram for the system

7. Implementation

Face Recognition consists of three main modules.
They are:

1. Open Sketch Module
2. Upload Sketch Module
3. Find Match Module.

Open sketch module

Open sketch module is responsible for extracting sketch from the data. Now, the Module which is majorly designed to be run on the Law enforcements server for security protocols, is been executed where in the user first opens either the hand drawn sketch or the face sketch constructed on our platform saved in the host machine, after which the opened face sketch is been uploaded to the Law enforcements server housing the recognition module so that the process or the data of the record are not tampered and are secure and accurate.

Fig 8: dashboard to recognize face in database (the face sketch in now matched with the database record)

Fig 9: opened face sketch (The face sketch to be match has to be opened on the platform)

Upload sketch module

This module is responsible for uploading the sketch on AWS server. 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 metered pay-as-you-go basis. We have to use AWS s3 bucket and AWS recognition.

Fig 10: face sketch uploaded to (The server
the face sketch is uploaded to the server for batter security)

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.

Find match module:
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.

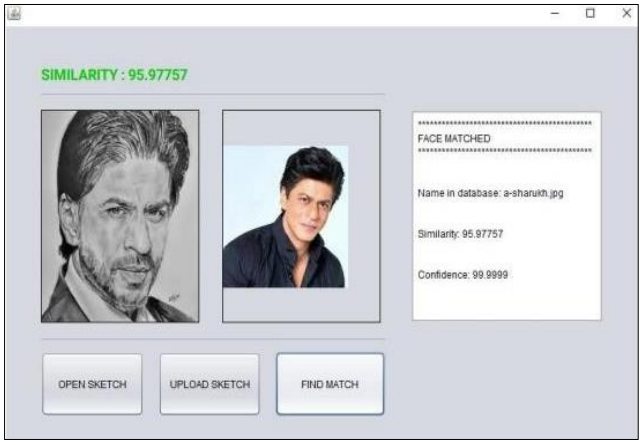

Fig 11: Face sketch matched to database Record

8. 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 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. The platform even has features which are different and unique too 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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