Face Detection and Recognition using Haar Cascade

The above mini project is submitted in partial fulfilment of the requirements of the degree of

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University of Mumbai
2018-19

CERTIFICATE

This is to certify that the mini project titled "University Assist System" is a bonafide work of

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INTRODUCTION

1.1. INTRODUCTION

The following document is a report on the mini project which involves building a system for face detection and face recognition using several classifiers available in the open computer vision library (OpenCV). Face recognition is a non-invasive identification system and faster than other systems since multiple faces can be analysed at the same time. The dfference between face detection and identification is, face detection is to identify a face from an image and locate the face. Face recognition is making the decision 'whose face is it? ", using an image database. In this project both are accomplished using different techniques and are described below. The report begins with a brief history of face recognition. This is followed by the explanation of HAAR-cascades, Eigenface algorithms. Next, the methodology and the results of the project are described. A discussion regarding the challenges and the resolutions are described. Finally, a conclusion is provided on the pros and cons of each algorithm and possible implementations.

1.2. PROBLEM STATEMENT

Design an application/website which will detect face from the video, and will recognize whose face it is from the dataset. Use various python libraries and machine learning algorithm to achieve the same. Train and Test the dataset to get the best accuracy.

1.3. SCOPE

This project traverses a lot of areas ranging from business concept to computing field. The area covers include:

• Studying what factors are used to detect a face in a video, and what are used to recognize a face.

• Haar Cascade used to detect a face and Eigen face to recognize the face.

• Police Department can use this system for detecting criminals.

• Web-platform means that the system will be available for access 24/7.

1.4. APPLICATIONS

Face recognition is currently being used to instantly identify when known shoplifters, organized retail criminals or people with a history of fraud enter retail establishments. Photographs of individuals can be matched against large databases of criminals so that loss prevention and retail security professionals can be instantly notified when a shopper enters a store that prevents a threat. Face recognition systems are already radically reducing retail crime. According to our data, face recognition reduces external shrink by 34% and, more importantly, reduces violent incidents in retail stores by up to 91%.

A variety of phones including the latest iPhone are now using face recognition to unlock phones. This technology is a powerful way to protect personal data and ensure that, if a phone is stolen, sensitive data remains inaccessible by the perpetrator.

Face recognition has the ability to make advertising more targeted by making educated guesses at people’s age and gender. Companies like Tesco are already planning on installing screens at gas stations with face recognition built in. It’s only a matter of time before face-recognition becomes an omni-present advertising technology.

Face recognition can be used to find missing children and victims of human trafficking. As long as missing individuals are added to a database, law enforcement can become alerted as soon as they are recognized by face recognition—be it an airport, retail store or other public space. In fact, 3000 missing children were discovered in just four days using face recognition in India!

Mobile face recognition apps, like the one offered by FaceFirst, are already helping police officers by helping them instantly identify individuals in the field from a safe distance. This can help by giving them contextual data that tells them who they are dealing with and whether they need to proceed with caution. As an example, if a police officer pulls over a wanted murderer at a routine traffic stop, the officer would instantly know that the suspect may be armed and dangerous, and could call for reinforcement.

LITERATURE SURVEY

2.1. LITERATURE SURVEY

Face Detection & Face Recognition Using Open Computer Vision Classifiers.

Identifying a person with an image has been popularised through the mass media. However, it is less robust to fingerprint or retina scanning. This report describes the face detection and recognition mini-project undertaken for the visual perception and autonomy module at Plymouth university. It reports the technologies available in the Open-Computer-Vision (OpenCV) library and methodology to implement them using Python. For face detection, Haar-Cascades were used and for face recognition Eigenfaces, Fisherfaces and Local binary pattern histograms were used. The methodology is described including flow charts for each stage of the system. Next, the results are shown including plots and screen-shots followed by a discussion of encountered challenges. The report is concluded with the authors' opinion on the project and possible applications.

Implementation of Face Recognition Based on Deep Learning Framework Caffe

At present, deep learning has been recognized as the best research direction of face recognition. This paper describes the basic principle of neural network technology, uses deep learning framework Caffe to build neural network, and realizes face recognition by experiment. It also puts forward the major issues for face recognition research by the use of neural network, which provides reference for construction and implementation of Caffe Face Recognition.

DESIGN

3.1. DESIGN

Face Detection and Recognition includes several functionalities described as below:

- User Login It allows the user to register and then login. The login credentials are verified and then the user is redirected to the home page.
- User feedback for improving performance of the website.

ARCHITECTURE DIAGRAM

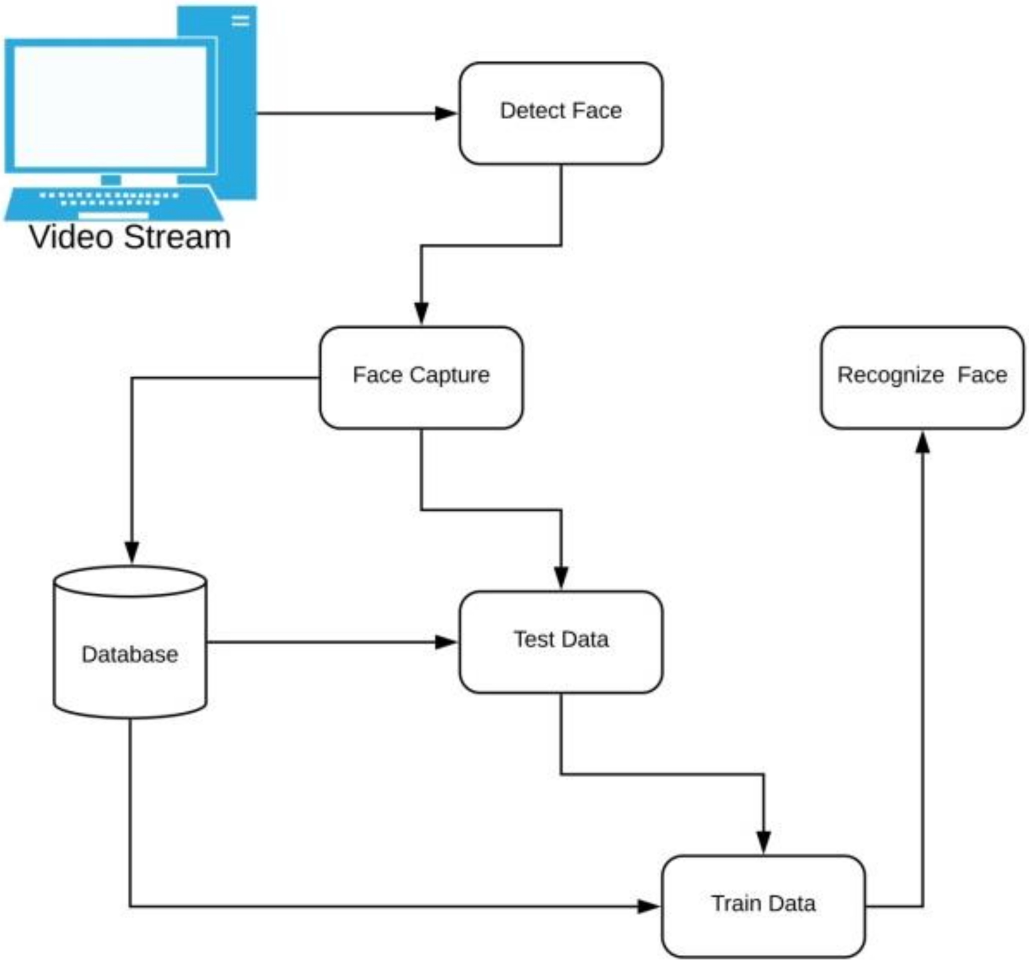

Fig. 3.1. Architectural Diagram

Architecture diagram gives the graphical represention of the system.

FLOW CHART

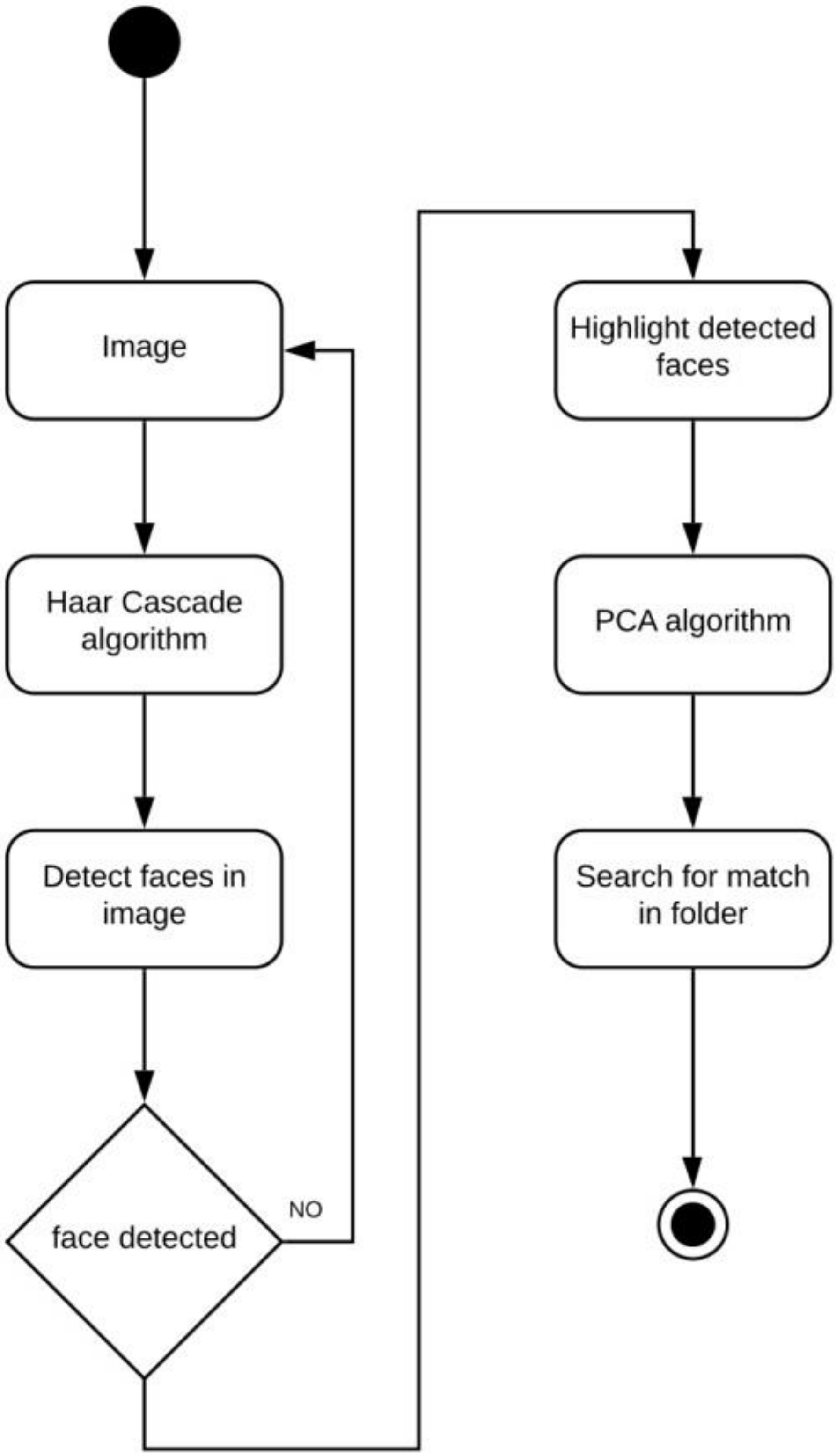

Fig. 3.2. Flowchart

The Flow chart shows the sequence of event which takes place.

USE CASE MODEL

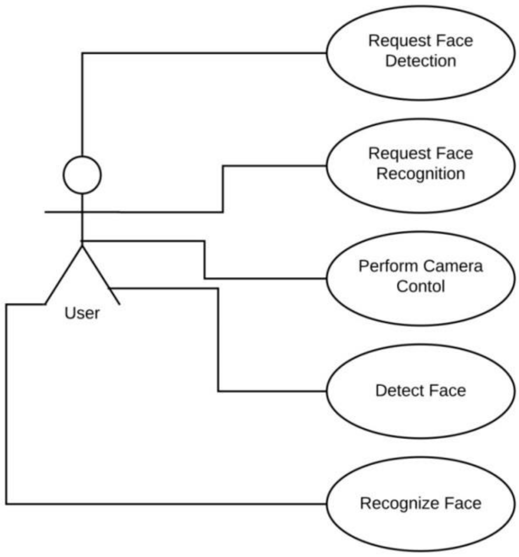

Fig. 3.3. Use Case Diagram

The activity diagram visually presents a series of actions in the system, similar to a data flow diagram.

STATE CHART

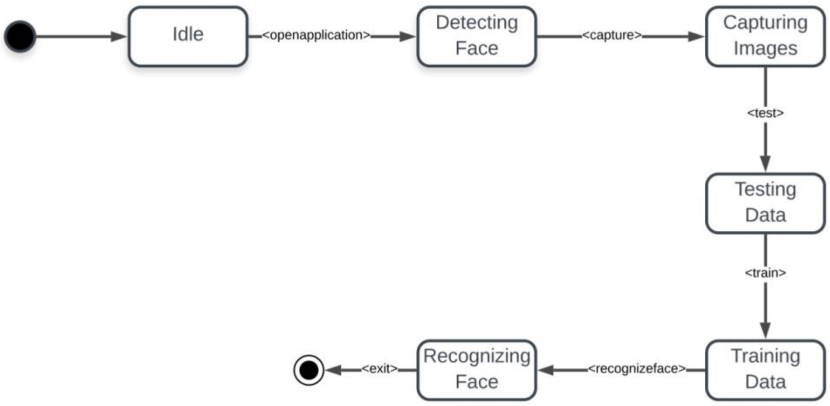

Fig. 3.4. State Chart

The state chart diagram shows the behaviour of classes in response to external stimuli. It describes the behaviour of a single object in response to a series of events in a system.

CLASS DIAGRAM

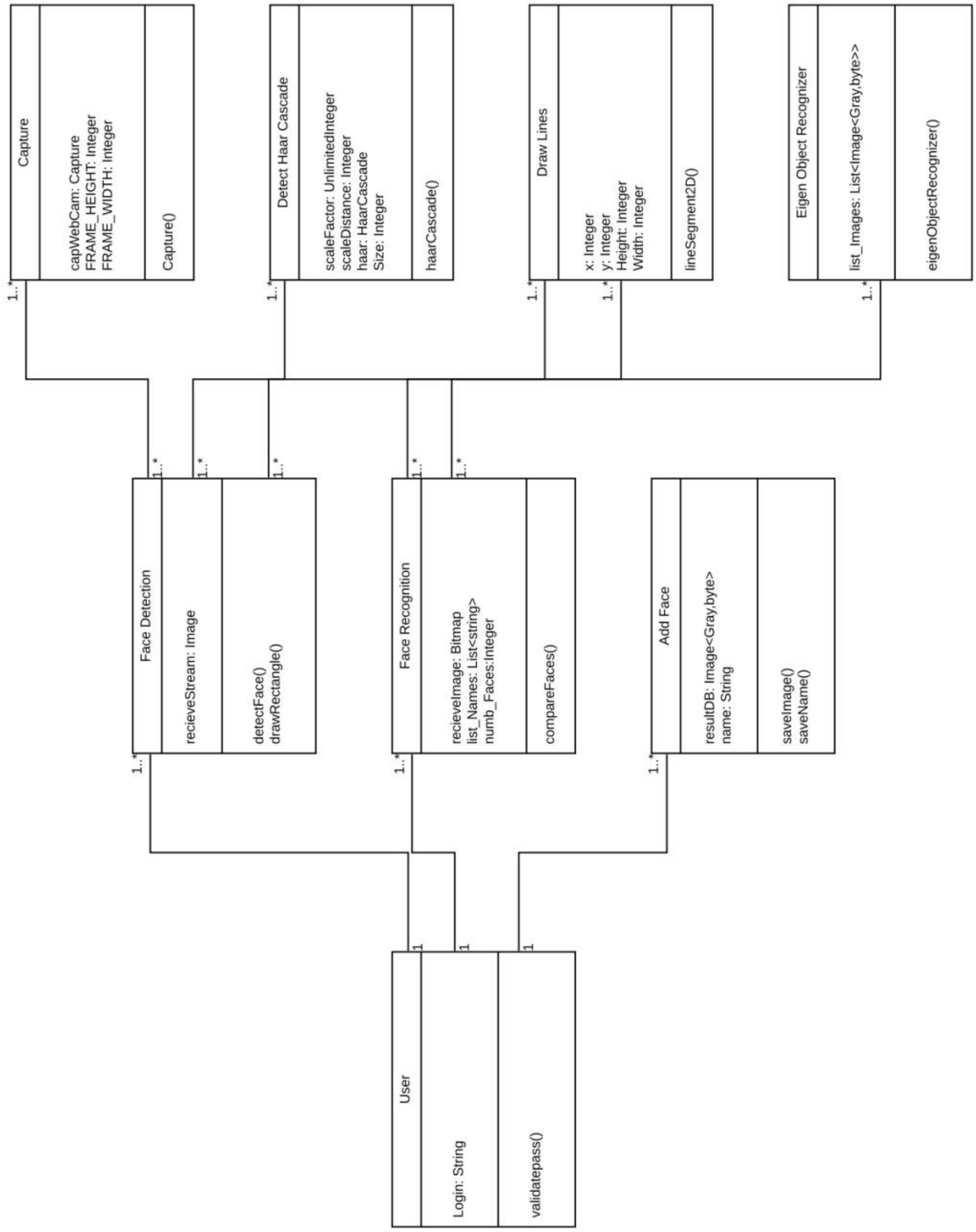

Fig. 3.5. Class Diagram

The class diagram is a type of static structure diagram that describes the structure of the system by showing the system's classes, their attributes, operations, methods and the relationship among the objects.

ACTIVITY DIAGRAM

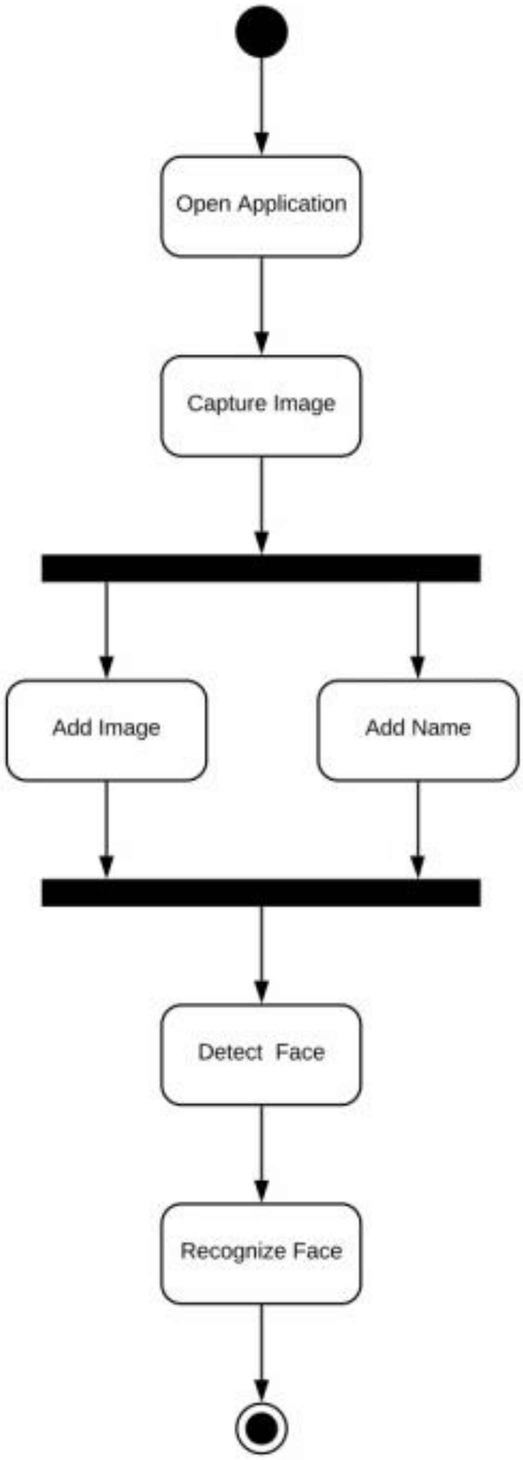

Fig. 3.6. Activity Diagram

The activity diagram visually presents a series of actions in the system, similar to a data flow diagram.

SEQUENCE DIAGRAM

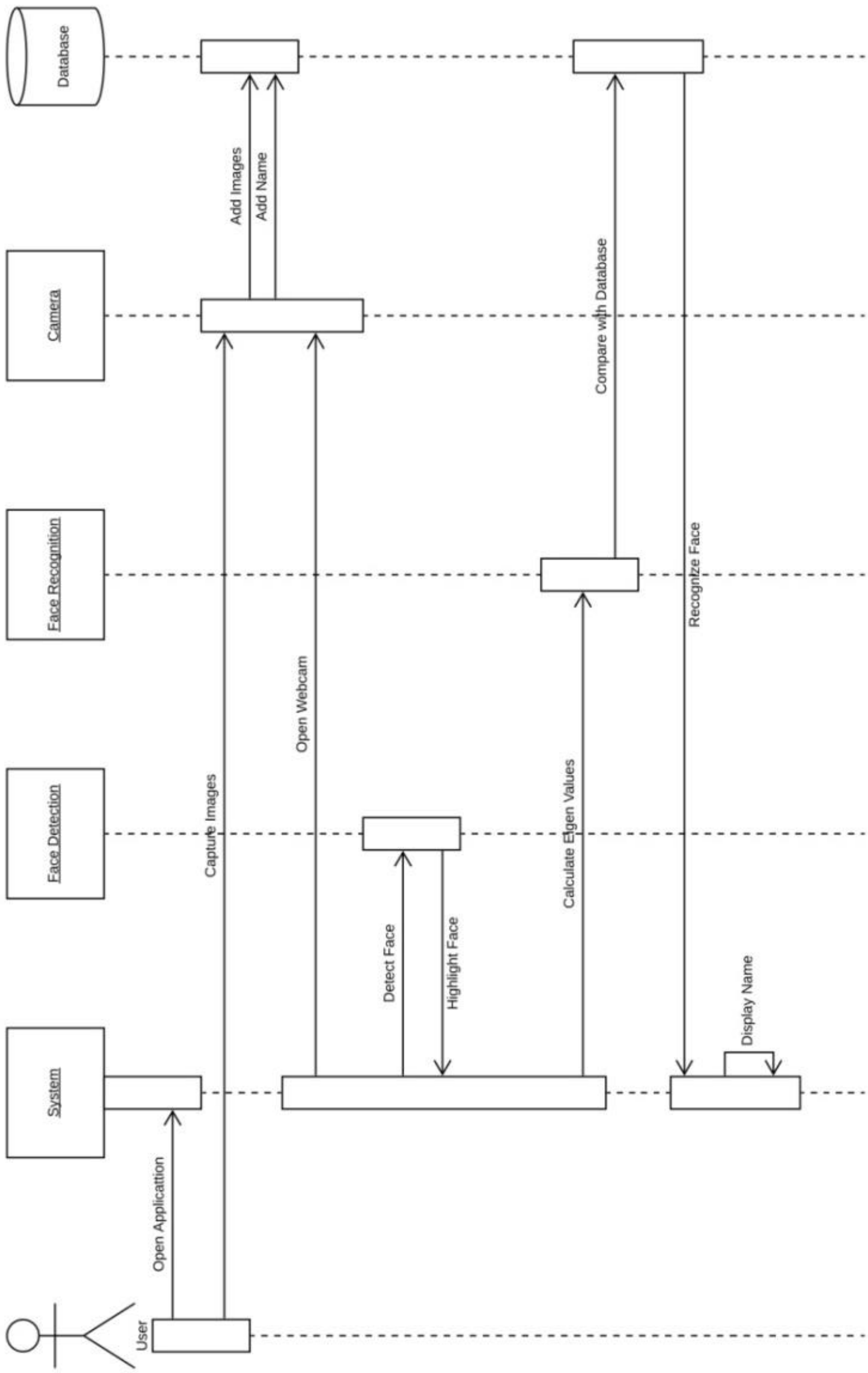

Fig. 3.7. Sequence Diagram

The sequence diagram describes interactions among classes in terms of exchange of messages over time.

COLLABORATION DIAGRAM

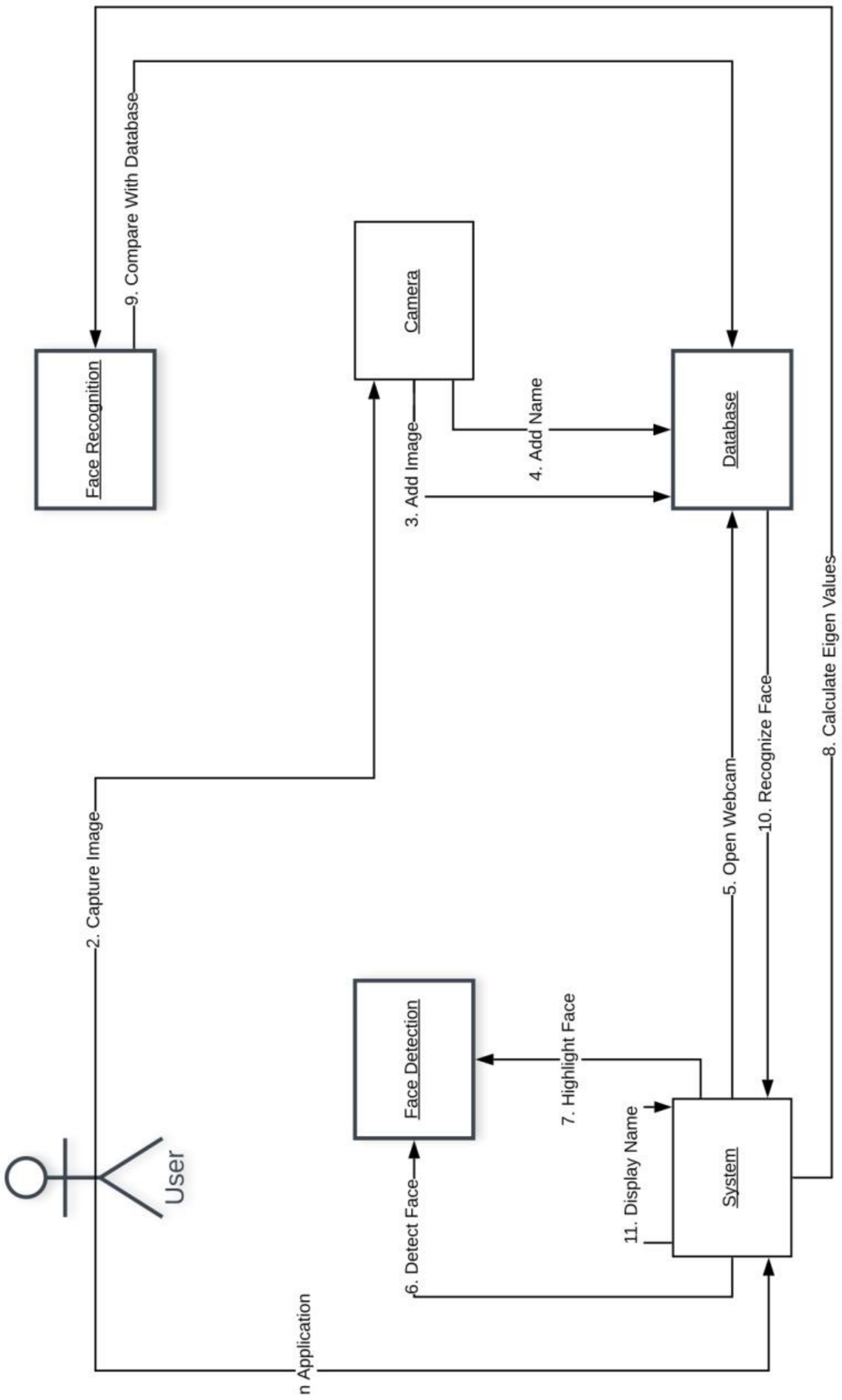

Fig. 3.8. Collaboration Diagram

The collaboration diagram is also an interaction diagram. It conveys the same information as the sequence diagram but focuses on the object roles instead of the times that messages are sent.

3.2. TECHNIQUES USED

Haar-Cascade

A Haar wavelet is a mathematical fiction that produces square-shaped waves with a beginning and an end and used to create box shaped patterns to recognise signals with sudden transformations. By combining several wavelets, a cascade can be created that can identify edges, lines and circles with different colour intensities. These sets are used in Viola Jones face detection technique in 2001 and since then more patterns are introduced for object detection. To analyse an image using Haar cascades, a scale is selected smaller than the target image. It is then placed on the image, and the average of the values of pixels in each section is taken. If the difference between two values pass a given threshold, it is considered a match. Face detection on a human face is performed by matching a combination of different Haar-like-features. For example, forehead, eyebrows and eyes contrast as well as the nose with eyes.

In this project, a similar method is used effectively to by identifying faces and eyes in combination resulting better face detection. Similarly, in viola Jones method, several classifies were combined to create stronger classifiers. ADA boost is a machine learning algorithm that tests out several week classifiers on a selected location and choose the most suitable. It can also reverse the direction of the classifier and get better results if necessary. Furthermore, Weight-update-steps can be updated only on misses to get better performance. The cascade is scaled by 1.25 and re-iterated in order to find different sized faces. Running the cascade on an image using conventional loops takes a large amount of computing power and time. Viola Jones used a summed area table (an integral image) to compute the matches fast. First developed in 1984, it became popular after 2001 when Viola Jones implemented Haar-cascades for face detection. Using an integral image enables matching features with a single pass over the image.

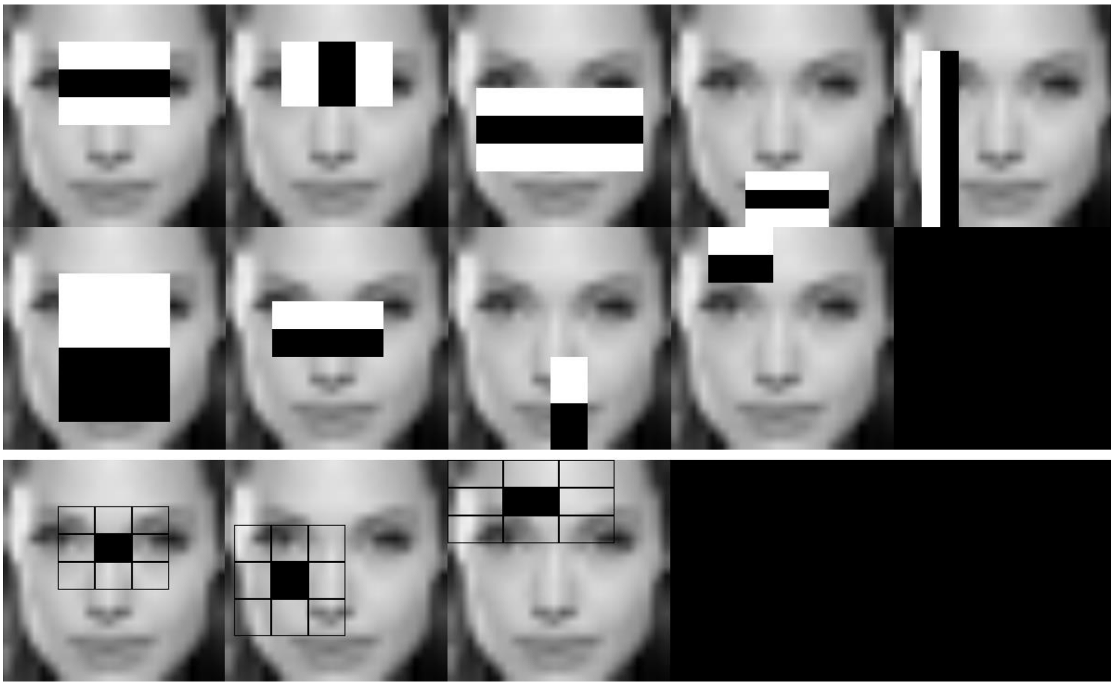

Fig. 3.9. Several Haar-like-features matched to the features of authors face

Eigenface

Eigenface is based on PCA that classify images to extract features using a set of images. It is important that the images are in the same lighting condition and the eyes match in each image. Also, images used in this method must contain the same number of pixels and in grayscale. For this example, consider an image with n x n pixels. Each raw is concatenated to create a vector, resulting a 1×n2 matrix. All the images in the dataset are stored in a single matrix resulting a matrix with columns corresponding the number of images. The matrix is averaged (normalised) to get an average human face. By subtracting the average face from each image vector unique features to each face are computed. In the resulting matrix, each column is a representation of the difference each face has to the average human face.

The next step is computing the covariance matrix from the result. To obtain the Eigen vectors from the data, Eigen analysis is performed using principal component analysis. From the result, where covariance matrix is diagonal, where it has the highest variance is considered the 1st Eigen vector. 2nd Eigen vector is the direction of the next highest variance, and it is in 90 degrees to the 1st vector. 3rd will be the next highest variation, and so on. Each column is considered an image and visualised, resembles a face and called Eigenfaces. When a face is required to be recognised, the image is imported, resized to match the same dimensions of the test data as mentioned above. By projecting extracted features on to each of the Eigenfaces, weights can be calculated. These weights correspond to the similarity of the features extracted from the different image sets in the dataset to the features extracted from the input image. The input image can be identified as a face by comparing with the whole dataset. By comparing with each subset, the image can be identified as to which person it belongs to. By applying a threshold detection and identification can be controlled to eliminate false detection and recognition. PCA is sensitive to large numbers and assumes that the subspace is linear. If the same face is analysed under different lighting conditions, it will mix the values when distribution is calculated and cannot be effectively classified. This makes to different lighting conditions poses a problem in matching the features as they can change dramatically.

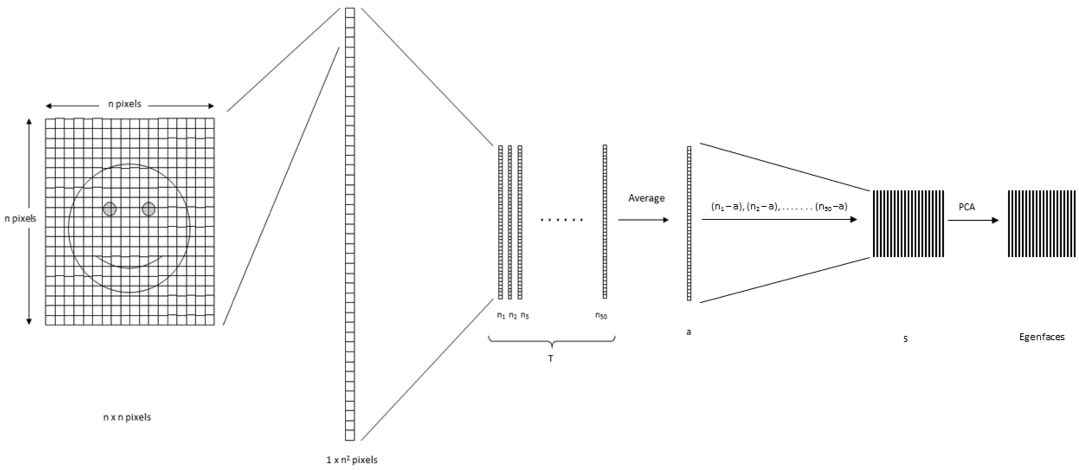

Fig. 3.10. Pixels of the image are reordered to perform calculations for Eigenface

3.3. SOFTWARE REQUIREMENT

- The system is on server, so it requires any scripting language like JavaScript, PHP, etc.
- The system may also require a database to store any transaction of the system like MYSQL, etc.
- The system also requires DNS and for the user to have an active internet connection for browsing.

3.4. HARDWARE REQUIREMENT

- High megapixel camera is required.
- The system will use the standard hardware and data communication resources.

3.5. FUNCTIONAL REQUIREMENT

The functional requirements for this software are:

- Accept User Pictures: The website will accept the user’s pictures and store it in the dataset.
- Recognition: The program will search the image in the dataset and if there is a match than print the name.
- Feedback: The website will follow up with the User once they have used to improve and update the performance of the prediction model.

IMPLEMENTATION

4.1. IMPLEMENTATION

We started off by detecting the face which is run using the Haar-Cascade algorithm.

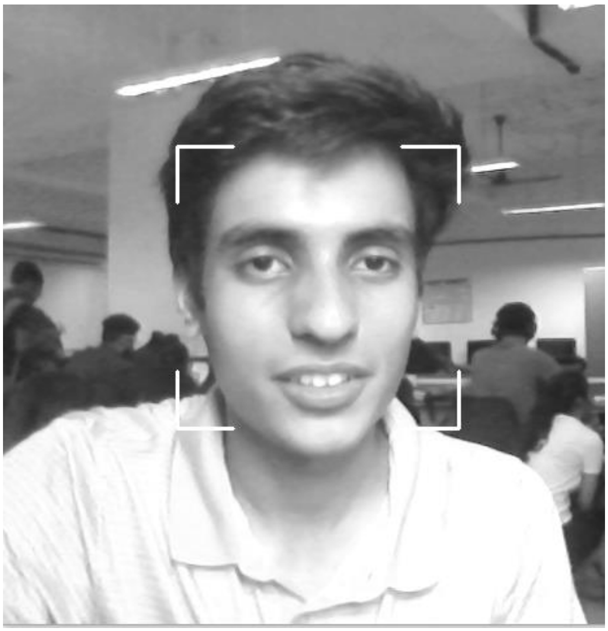

Fig. 4.1. Face Detection

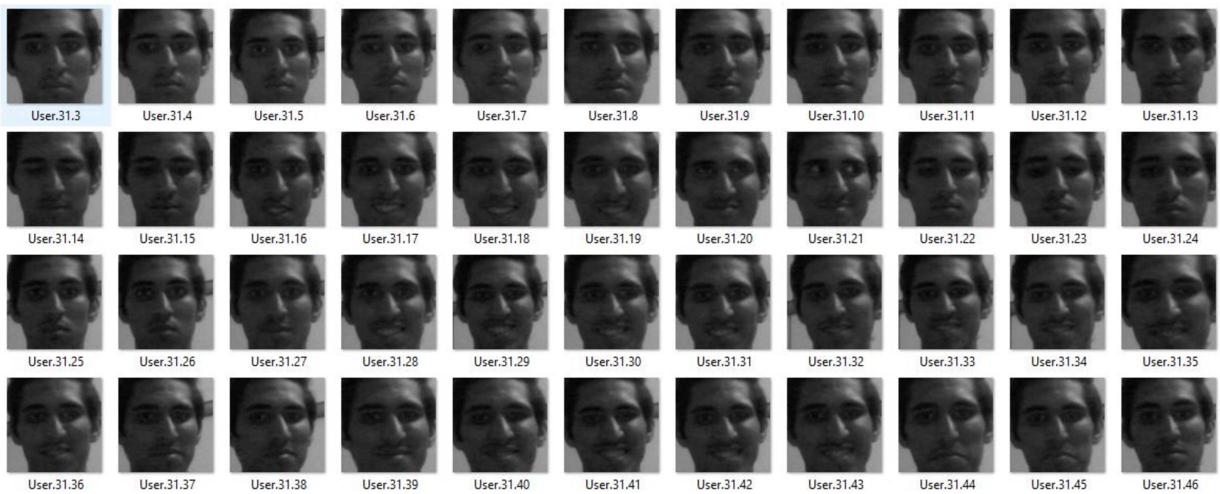

Fig. 4.2. Dataset

Then we run the face capture file which records images of the user and store it in the database along with rest of the images. The Dataset which contains set of image is stored in a folder.

The Database is then trained using the Eigenface algorithms.

```
In [5]: runfile('C:/Users/Asad Charolia/Desktop/Face Detection and
Recognition/SpikeSL-vision-systems-1fb3fcebe6d0/Python/Trainer_All.py'
wdir='C:/Users/Asad Charolia/Desktop/Face Detection and Recognition/
SpikeSL-vision-systems-1fb3fcebe6d0/Python')
Reloaded modules: NameFind
TRAINING......
EIGEN FACE RECOGNISER COMPLETE...
FILE SAVED..
```

Fig. 4.3. Training Output

Then it is tested on a picture.

```
EIGEN FACE RECOGNISER TRAINED
FOR 90 COMPONENTS ID: 21 CONFIDENT: 4620.671218719648
TRAINING FOR  91 COMPONENTS
EIGEN FACE RECOGNISER TRAINED
FOR 91 COMPONENTS ID: 21 CONFIDENT: 4633.039767085727
TRAINING FOR  92 COMPONENTS
EIGEN FACE RECOGNISER TRAINED
FOR 92 COMPONENTS ID: 21 CONFIDENT: 4638.02466249413
TRAINING FOR  93 COMPONENTS
EIGEN FACE RECOGNISER TRAINED
FOR 93 COMPONENTS ID: 20 CONFIDENT: 4723.120124377917
TRAINING FOR  94 COMPONENTS
EIGEN FACE RECOGNISER TRAINED
FOR 94 COMPONENTS ID: 20 CONFIDENT: 4723.575822829077
TRAINING FOR  95 COMPONENTS
EIGEN FACE RECOGNISER TRAINED
FOR 95 COMPONENTS ID: 20 CONFIDENT: 4733.973015215602
TRAINING FOR  96 COMPONENTS
EIGEN FACE RECOGNISER TRAINED
FOR 96 COMPONENTS ID: 20 CONFIDENT: 4736.489043054683
TRAINING FOR  97 COMPONENTS
```

Fig. 4.4. Testing Output

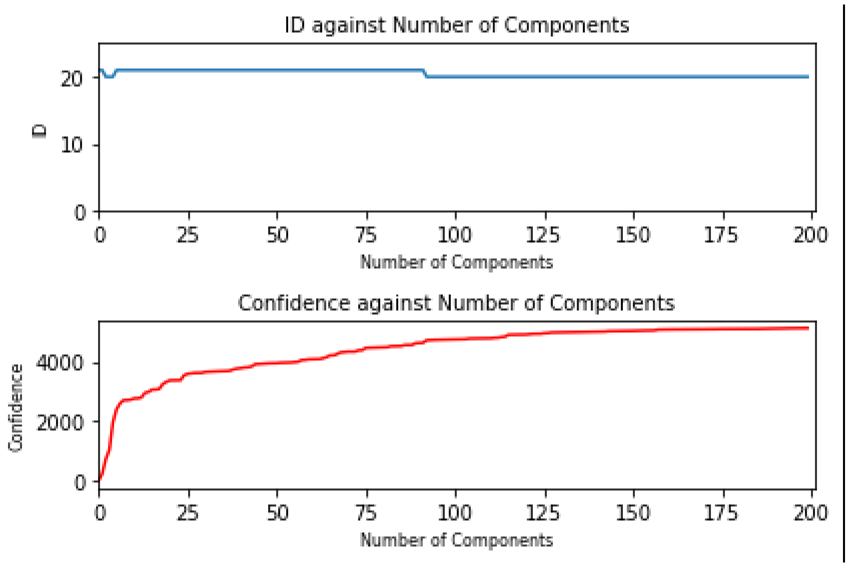

Fig. 4.5. Confidence Graph

The program than opens the camera and if the face of the user is stored in the database, it prints his name on the top else it prints face not recognized.

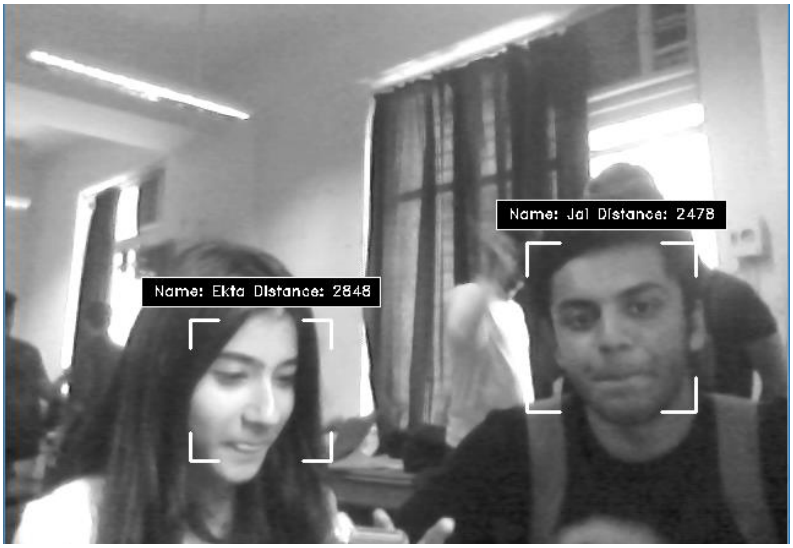

Fig. 4.6. Face recognition

CONCLUSION

5.1. CONCLUSION

This report describes the mini-project for face detection and face recognition. Next, it explains the technologies used in the project and the methodology used. Finally, it shows the results, discuss the challenges and how they were resolved followed by a discussion. Using Haar-cascades for face detection worked extremely well even when subjects wore spectacles. Real time video speed was satisfactory as well devoid of noticeable frame lag. Considering all factors, Eigenface combined with Haar-cascades can be implemented as a cost effective face recognition platform. An example is a system to identify known troublemakers in a mall or a supermarket to provide the owner a warning to keep him alert or for automatic attendance taking in a class.

5.2. FUTURE SCOPE

Today, one of the fields that use facial recognition the most is security. Facial recognition is very effective tools that can help law enforcers recognize criminals and software companies are leveraging the technology to help users access their technology. This technology can be further developed to be used in other avenues such as ATMs, accessing confidential files, or other sensitive materials. This can make other security measures such as passwords and keys obsolete.

Another way that innovators are looking to implement facial recognition is within subways and other transportation outlets. They are looking to leverage this technology to use faces as credit cards to pay for your transportation fee. Instead of having to go to a booth to buy a ticket for a fare, the face recognition would take your face, run it through a system, and charge the account that you've previously created. This could potentially streamline the process and optimize the flow of traffic drastically. The future is here.

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