

# Face Recognition using Principal Component Analysis (PCA), k-Nearest Neighbour (K-NN) and Convolutional Neural Network (CNN)

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# Outline

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# Introduction

## What is Face Recognition?

It is a kind of biometric technique which is used to identify individual's identity and authentication.

## 5 reasons to consider FRT as part of your authentication strategy

- Greater Accuracy: 3D mapping, deep learning and other advances make FRT more reliable and harder to trick.
- Better Security: Research shows a 1-in-50,000 chance of a phone with touch ID being unlocked with the wrong fingerprint. With 3D facial modeling, the probability drops to nearly [1-in-1,000,000](#).
- Convenient and Frictionless: FRT is easy. It can be used passively without a user's knowledge; or actively, such as having a person "smile for the camera."
- Smarter Integration: Face recognition tools are generally easy to integrate with existing security infrastructures, saving time and cost on software redevelopment.
- Automation: Automated and accurate 24/7 security eliminates the need for security guards to visually monitor entry points, perform security checks and view security cameras.

## Application Areas

This approach is gradually being applied to more industries, disrupting design, manufacturing, construction, law enforcement and healthcare. In this project face recognition is formulated as a classification task, where the inputs are given as images and the outputs are people's detail like name, gender etc.

# Problem statement

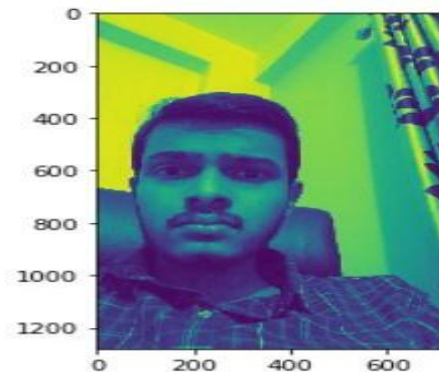
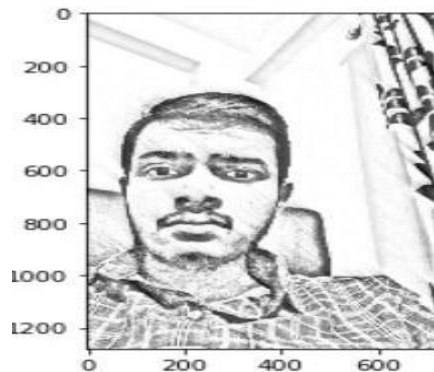
- In this project we have a large database of faces of different people with different expressions.
- Our aim is to detect correct face from given dataset
- A part of face recognition we also try to fetch the information like name and gender against a given image.
- We need to convert sketch images to RGB images
- We also have to produce correct label for correct expression like sad,happy,anger,surprise etc.

# Implemented Approaches

- Fetching corresponding RGB image from given sketch using **Principal Component Analysis(PCA)**
- Live face recognition using the **K-nearest neighbour (K-NN)** algorithm.
- Live emotion recognition using **Convolutional Neural Network(CNN)**
- Face Recognition and gender determination by training the **Convolutional Neural Network(CNN)** to achieve high accuracy in the given dataset

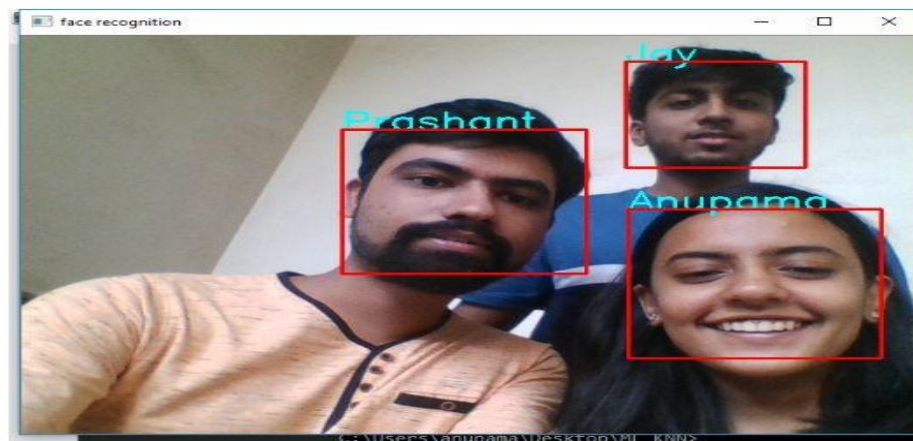
# RGB image transformation from sketch image using Principal Component Analysis(PCA)

- The dataset comprises of all the RGB images which were imported and resized to an image size of 1280 X 720.
- A matrix 'A' which contains all the images, each in one column
- Using Principal Component Analysis(PCA) approach, we found out the eigenfaces and the basis vectors, thereby extracting the feature faces from the given data set.
- The test image was converted first into a grayscale image and its corresponding weights in terms of PCA were found.
- The Euclidean difference of the test image with every RGB face of a dataset was taken and the one with the minimum difference was declared as an appropriate RGB image match to the corresponding sketch image.
- The code has been successfully implemented in Colab by importing libraries like pandas, numpy, matplotlib and a few others achieving an accuracy of 73%.



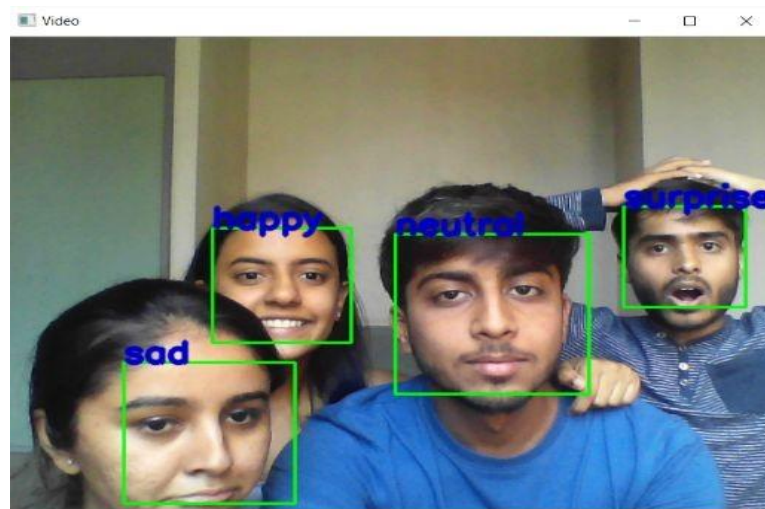
# Live face recognition using the K-nearest neighbour (K-NN) algorithm

- We first recorded the faces who desire to use this live face recognition application using webcam and for each face, a python file is generated.
- We have used OpenCV to instantiate a camera object to capture images, applied the haar cascade which is a xml file for encoding and is used to detect faces in the current frame
- Extracted the face component from the image. We have converted the captured data to a numpy format and then saved the data as a numpy matrix in an encoded format.
- For the recognition part, We first detected the face, flatten it into a linear array and then pass to KNN function along with all the data.
- As a result of the simulation, a rectangular frame is generated with the name of the person labelled accurately.



# Live emotion recognition using Convolutional Neural Network(CNN)

- Under this an attempt is made to to recognize user emotion using a convolutional neural network (CNN).
- The neural net can recognize 7 emotions with relatively high accuracy: (1) Anger, (2) Disgust, (3) Fear, (4) Happy, (5) Sad, (6) Surprise and (7) Neutral.
- We have used dependencies like OpenCV, TensorFlow and Keras to implement this.
- The algorithm is able to detect different expressions of captured images and display the expression of an individual.
- However sometimes,the expressions mislead and the program at times do not accurately detect the expression which is a scope of improvement.
- We have implemented the code under Spyder IDE



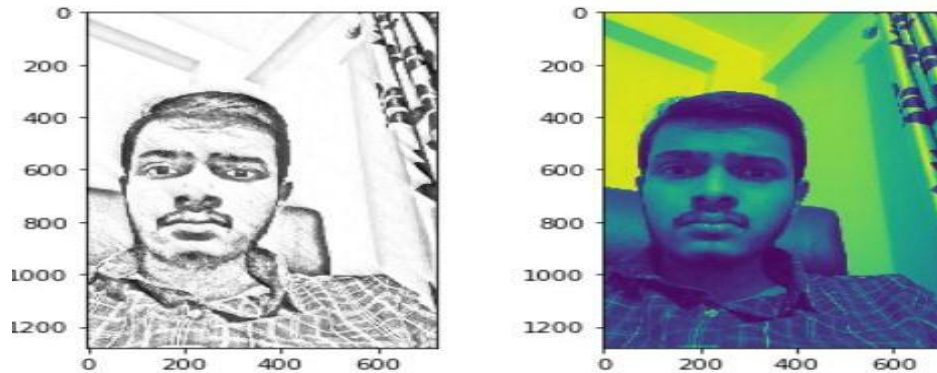


## *Face Recognition and gender determination by training the Convolutional Neural Network(CNN) to achieve high accuracy in the given dataset.*

- We have augmented the dataset to get higher accuracy rate during training of neural network.
- We have divided the data set into 85% training set and 15% test set and fed them into a CNN network.
- Graph of training accuracy Vs number of epochs and data loss Vs number of epochs generated to represent the accuracy details.
- We can observe that as the number of iterations (epochs) is increased, we can see that the accuracy on both training and test set improves.
- The loss goes down as epochs are increased.
- Out of 753 images, 740 of them were correctly identified along with their gender.
- The code has been successfully implemented in Jupyter Notebook achieving a significant accuracy rate of 95.3%

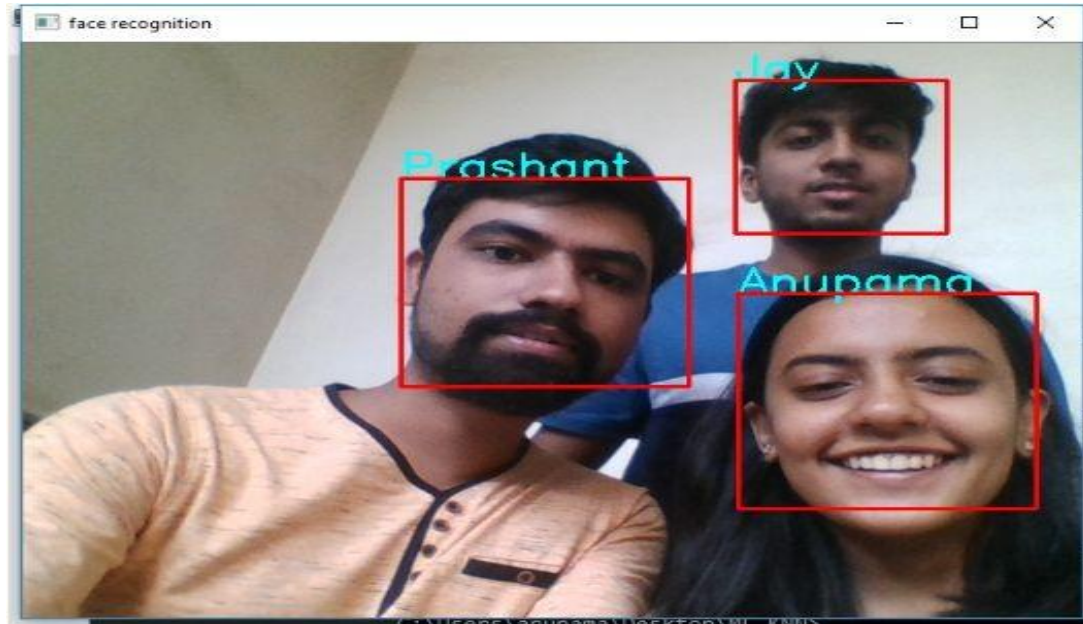
# Final Results

- **Given a sketch image, fetching its corresponding RGB image using Principal Component Analysis (PCA)**



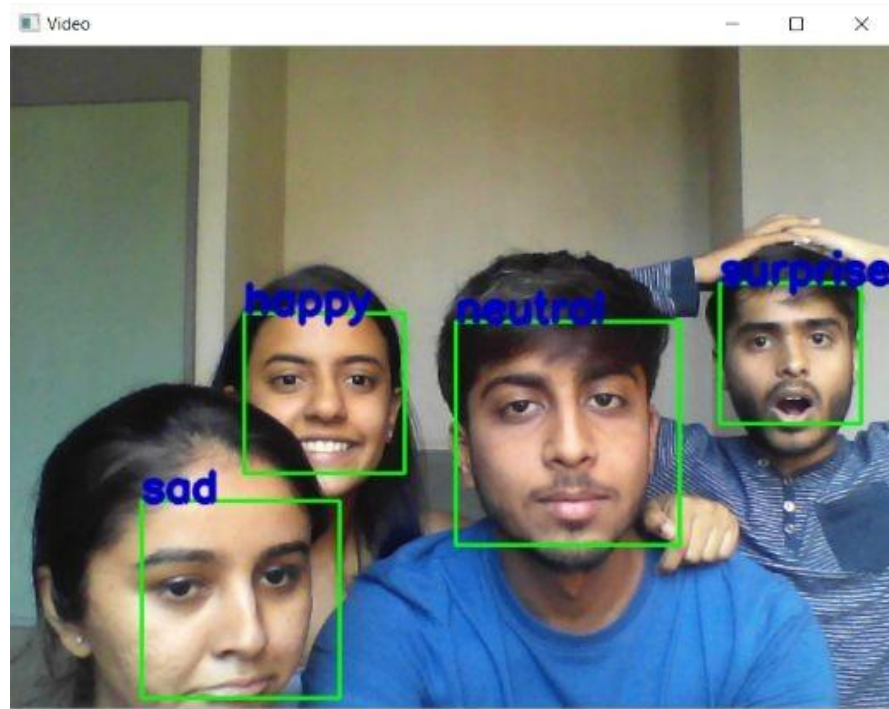
Left image is an input test image and the right image is its corresponding RGB matched generated

# *Live face recognition using the K-nearest neighbor (k-NN) algorithm.*



Webcam capturing live stream and detecting and recognizing faces accurately.

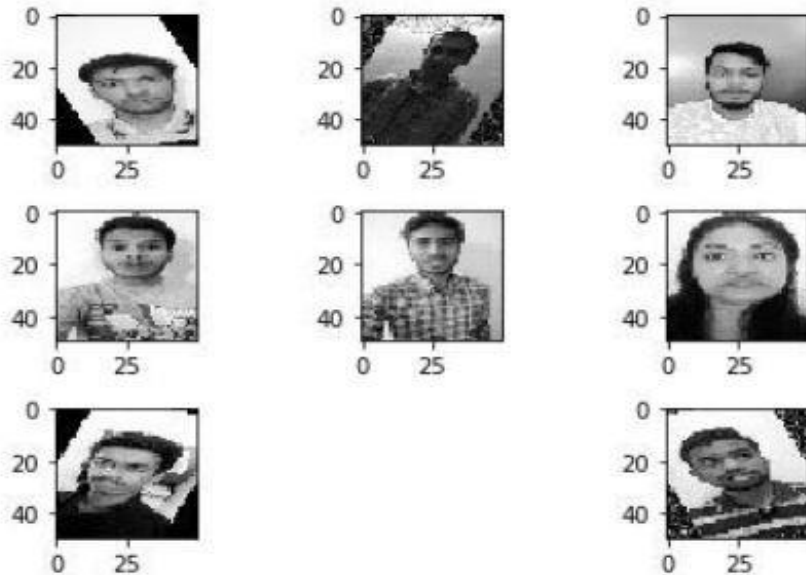
# *Live emotion recognition using Convolutional Neural Network(CNN)*



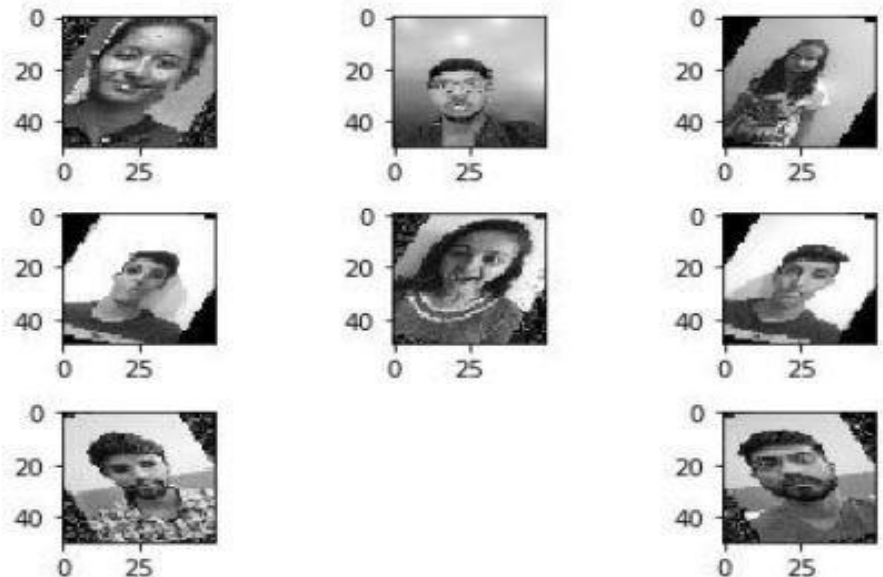
Webcam capturing faces live and recognizing the expressions as per the mood appropriately.

*Face Recognition and gender determination by training the Convolutional Neural Network(CNN) to achieve high accuracy in the given dataset.*

Found 740 correct labels

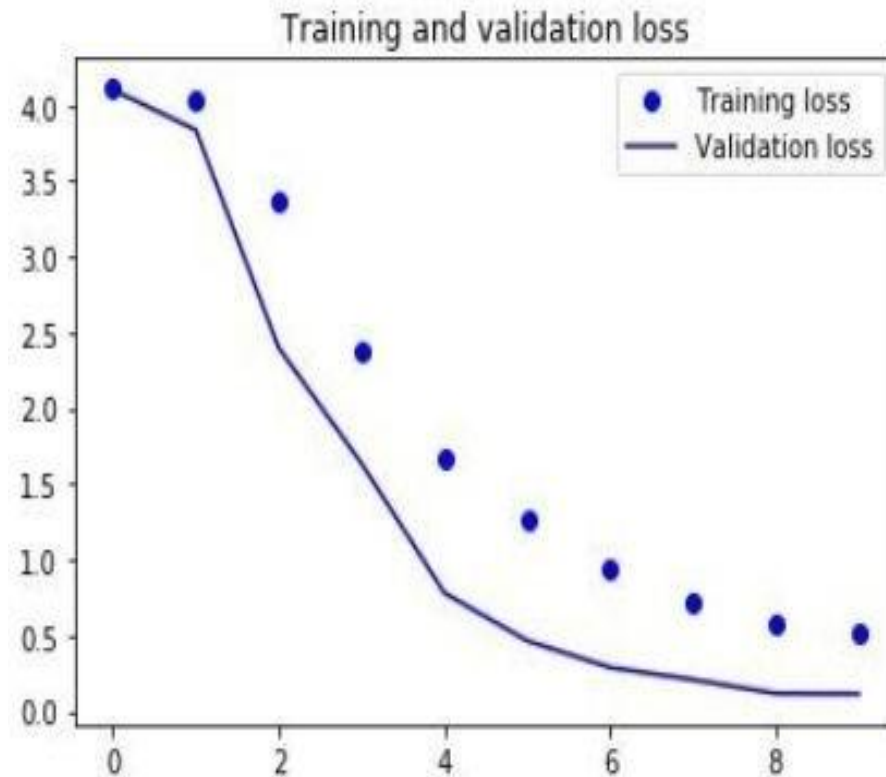


Found 13 incorrect labels

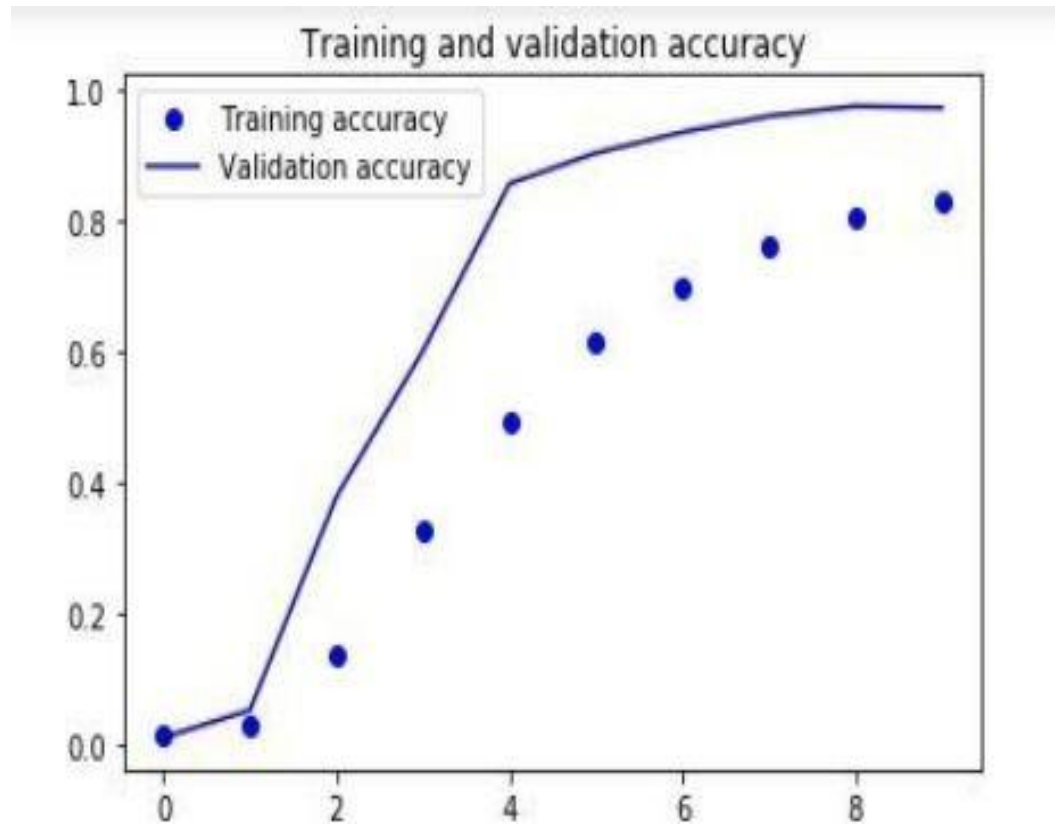


**Total 740 images were recognized correctly      113 images were labeled as incorrect**

# Accuracy Details



**Graph of training and validation loss Vs number of epochs. As the number of epochs increases, loss has been significantly reduced.**



**Graph of training accuracy Vs number of epochs. Accuracy received is 95.3%**

# Conclusion

- There are various methods for face recognition which have been incorporated in our work like Principal Component Analysis(PCA),K-nearest neighbour (k-NN) algorithm and Convolutional Neural Network(CNN).
- The use of PCA to fetch the RGB image corresponding to its sketch image achieved an accuracy of 73% which is not so efficient in real-time projects.
- In terms of improvement we implemented k-NN algorithm in real time face recognition which produced satisfactory results comparatively.
- however many a times, it wasn't able to classify the faces correctly.So finally implemented the convolutional neural network in our face recognition project using which We were able to recognize the test images with an accuracy of 95.3%
- However sometimes,the expressions mislead and the program at times do not accurately detect the expression which is a scope of improvement.



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