

# Facial Emotion Detection using Deep Learning

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## Abstract

Face recognition is been studied by several investigators for cosmetic surgery, home automation, detect face and give suggestions, focus adjustment, etc. Face recognition is incredibly very important thanks to the security purpose. Everyone wants their phone, many of the other things like flats secure which is possible by using face recognition. So it plays a major role in the field of security. In this paper, a facial recognition system has been proposed which detects of mainly 1) emotion 2) age 3) gender and 4) race of a person. It has ability of detect faces in any form of input like image and webcam and give classifications. It is used to identify important people in many applications. Algorithms of deep learning can detect age, race, gender, expressions. The comparison between many of the existing algorithms like ConvNet and future algorithm on database like DeepFace shows that proposed algorithm completes these important tasks of identifying people and many features of their face significantly.

**Keywords:** Artificial intelligence, Deep Learning, Deepface, Face detection, Face recognition , Machine learning.

## 1. Introduction:

Human beings display their feelings and emotions through their facial expressions. Facial Expression Recognition allows the user to communicate with their emotions in the form of expressions. Another features which can be recognized are age, gender and race. This makes it one of the very powerful software for communication purposes. Automatic emotion recognition along with the IOT and smart environments has received a lot of attention in smart homes, hospitals, etc. With the introduction of IOT, the automatic emotion recognition

has received a lot of attention. IOT has There are other software like Siri, Alexa, etc. which communicate with humans by the use of natural language processing which is speech. The level of communication can be increased if the emotion recognition is augmented with the intelligent personal assistants[1].

Emotion recognition is a method of identifying and distinguishing the emotions according to the facial expressions. In this, the age, gender and race of a human can also be identified according to the facial muscles and expressions. The computational methodologies and databases related to the information about facial recognition have also been developed. The interaction between human and a machine communication can be done by extracting and understanding of expressions which has a great importance to it. Deep learning can be used in some huge applications with facial data detection being one of them. Some security based applications where facial detection and recognition is used are: Prevent Retail Crime, Unlock Phones, Find Missing Persons, etc.

## **2. Literature Survey**

Face detection and facial features extraction is employed in biometrics, frequently together with a facial recognition structure. Some smart cameras and also mobile phone use this software at backend for autofocus and face detection in particular frame. Face detection is additionally beneficial for analyzing center attraction and in photo. This feature attracts many of the big marketers and big software companies. Webcam maybe utilized into an online streaming platform and may detect any face that walks by. After detection it can compute the age range, gender and race of the face detected on webcam. When the data is composed, some of the announcements can be interpreted which will be specifically targeted for the detected race/gender/age. Our research manifests backend process of this sort of work with the utilization of webcam and image as input.

1. In [Sarala A. D. & Mrunal S. B., 2012] the theoretical method for coding and decoding of the face image is discussed in the support of facial recognition. There are two stages stated which are: Face is detected by using Haar like cascade classifier along with Principle Component analysis for recognition purpose[2].
2. In the [Faizan Ahmad et al., 2013] in the field of face recognition which has associated conjointly answer for image identification and recognition which is proposed as a first step for CCTV system[3].

3. In [Hussein R., 2011] is the execution for facial recognition by using principal component analysis with four distance classifiers.[4]
4. There have been a lot of traditional computer vision techniques over the years. For example, the [Choi et al, 2001] paper has studied the classification of Gabor features.[7]
5. But now, deep Convnets has shown great results in the field of computer vision. For example, the Adience dataset was collected by Hassner and his team in 2014 in which they trained some models about gender and age. In the Gender\_net, Age\_net, the classification was done precisely.
6. A lot of results were shown in the age and gender recognition by Rothe and team in the year 2015 as they trained deep VGG-16 and huge dataset.[9]
7. This paper was further expended by [Antipov et al. (2017)] and had epitomized the transfer learning process along with the pre-trained face recognition by Rassadin and team from 2017 is suitable for face emotion recognition compared to the pretrained ImageNet dataset[5] and with transfer learning from face identification [12].

## **2.1 VGG:**

In many of the existing projects VGG and RESNET are used for the age, gender, emotion detection. VGG is a neural network architecture. It is Very Deep Convolutional Neural Networks for image processing and Large-Scale Image Recognition. In VGG the convolutional layers use a very small receptive field which is 3x3. There are three fully connected layers in VGG which are: 1st two layers having 4096 channels each and third having 1000 channels, one for each class[6].

## **2.2 Resnet:**

Resnet compare to other architectures like AlexNet, VGG and OverFeat relies on the micro architecture module. It is in the form of exotic architecture. Resnet has deep networks which can be trained using residual networks.

But, Deepface compared to other ConvNet-based method is easier to detect the emotion, age, gender and race of a human being.

## 2.3 Deepface:

Deepface is facial recognition software which is used by FB. It identifies faces in digital images and is used for tagging images. There are four stages in a modern face recognition pipeline which are detect, align, represent and verify. These stages are handled by deepface in the background. Deepface program has an eight-layer neural network. Over four million images uploaded by the FB users have been trained by this network. There are over 120 million connection weights in this network. The program reaches an accuracy of 97.35% in the LFW dataset[8].

### 2.3.1 Deepface structure: -

Deepface model is eight layered convolutional neural network with each layer named with a letter and a number.

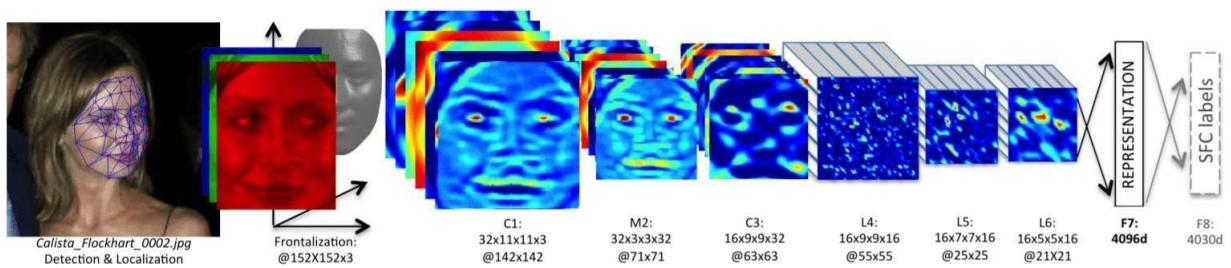


Fig 1: Deepface structure. (From FB research team)

The numbers refer to index from 1 to 8 and the letters state the type of layers.

The layers are:

- i. C refers to convolutional layer
- ii. M refers to max pooling
- iii. L refers to locally connected layer
- iv. F refers to fully connected layer `

### 3. Motivation

There are a limited number of layers in Deepface but its parameter size is huge. Deepface is six times wider than Facenet and 36 times wider than OpenFace whereas complexity of VGG-Face and DeepFace is close.

In many of the existing projects VGGFace , ResNet, ImageNet, FaceNet, OpenFace , OverFeat are used for the age[14], gender, emotion detection requires more memory consumption and computational complexity.

Model	No. of params	CNN Layers
VGG-Face	145,002,878	16 layers CNN
FaceNet	22,808,144	22 layers CNN
OpenFace	3,743,280	Uses FaceNet 22 layers CNN
DeepFace	137,774,071	8 layers CNN

Table no. 1 Comparison between some of the well-known models [16]

Comparative study shows DeepFace overcomes challenges faced by ConvNet. Multifold parameter recognition instead of one at a time.

The projects we referred are based on one particular modules, like how to, “detect face in image”, “Detect emotion”, “Detect age and gender”, “Detect Race” meanwhile our module can give output with key classification including “Dominant Emotion”, “Dominant Race”, “Gender” and “age” all together. Also, the input can be given with Image or Real time webcam[13] to make it even more effective for industrial applications.

### 4. Proposed Work:

This project mainly focuses on detection of emotions, age, gender and race of a person of given input of image or real time webcam frame. With the help of python, OpenCV we are making modules. It uses DeepFace to analyze and give output. Proposed scheme uses age differences and FERET database for face recognition using 3 main techniques:

1. Viola Jones: Viola Jones algorithm outlines a box which is seen on the input given. It searches for a face by using haar like features and outlines the face in the input picture given[10].
2. CNN classifier: CNN is convolutional neural network. It is a multi-layered neural network which detects complex features in the data. This algorithm was proposed by Lecun in 1989. In CNN the input image can be directly taken and the final classification result can be achieved without the data processing[11].
3. Local Binary Patterns (LBP): LBP is used for texture classification. By combining LBP with histograms, the face images can be represented with a data vector. LBP can be used for face recognition tasks as can also be used as a visual descriptor.

Our project works on these following steps:

Step 1: Take the input from user in the form of image or with the help of webcam using OpenCV python.

Step 2: Default image taken by OpenCV is of BGR format and it is converted to RGB format by module using cv2 color converter.

Step 3: Plot the image on the graph with the help of matplotlib.pyplot .

Step 4: Face detection in the image or in the webcam frame is done by haarcascade algorithm with the help of voila jones algorithm.

Step 5: Analyzing the image or webcam frame by using Deepface.

Step 6: Customizes output to give particular dominant features given by analyzer.

Step 7: With the help of OpenCV rectangle around the detected face is drawn and the dominant emotion, dominant race and gender is displayed on the screen along with image or real time frame.

Step 8: Gives exceptions or errors runtime if there are any.

## **5. Architecture:**

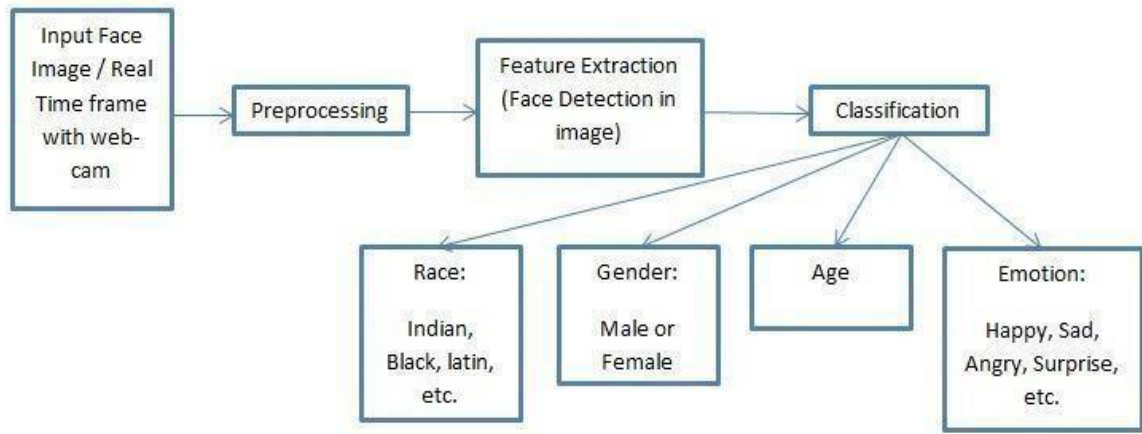


Fig. 2: Architecture of the project

## 6. Testing, Results & Discussion

The code has been tested with many of the input with varying conditions and got promising results. Some of outputs of implementation are mentioned below.

- Input image:



Fig. 3: Hillary Clinton Image input.

We could get this console-based output with “dominant emotion, dominant race, age and gender.”





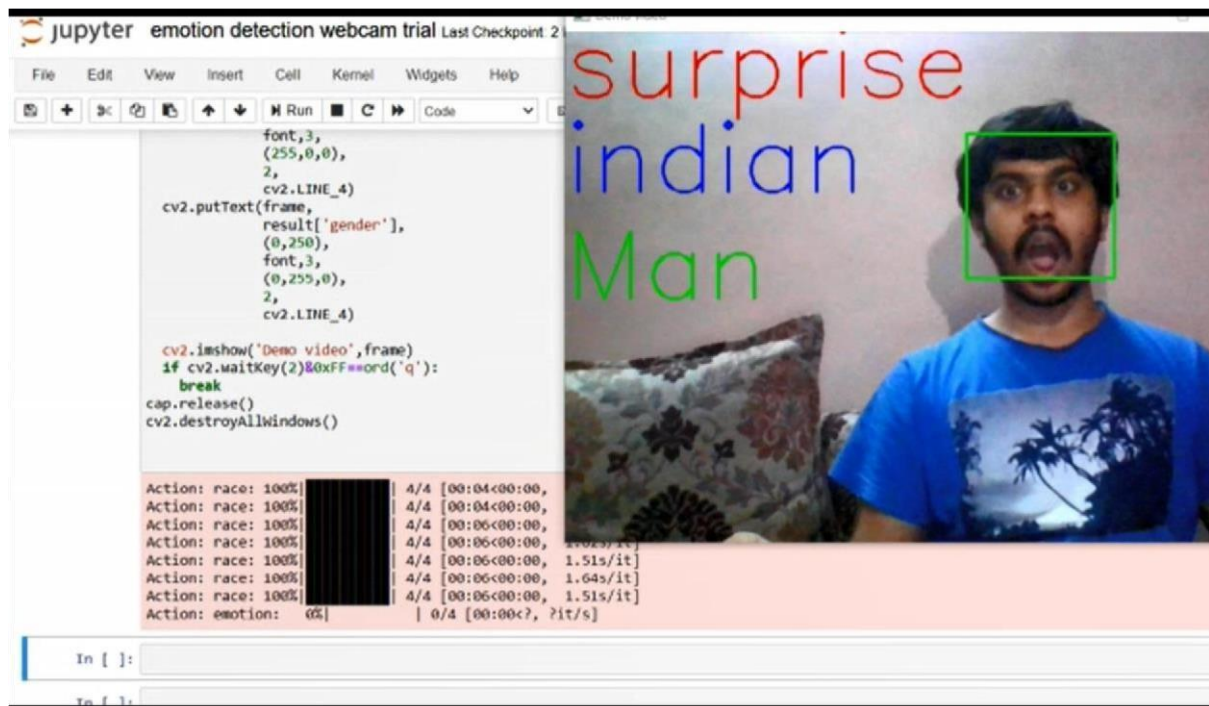


Fig. 6 Webcam output ii.

## 7. Applications:

This project can be used in many fields and has many applications. First and foremost, it can be used to detect the mood of the person. According to the mood different suggestion such as music and movies can be suggested to person to lighten up their mood. One of the most useful applications of our project would be to suggest a person skincare product according to his/her/their age, gender and race. This project can also be used in workplaces as in if installed in system it can detect the mood of the employee working on that system and further aid can be provided to the employee which can help in decreasing the number of suicidal cases and also help depressed ones. Criminal casing is another useful application of this project, it can be used to detect whether a person is bluffing based on the percent of fear and anger detected by the project. This project can also be used to suggest user different apps to calm the person if detected to be stressed. Last but not the least this project can be used in home automation and IOT. Lights and music can be changed according to the mood of the person to then feel better.

## **8. Conclusion**

In our project we have used Deepface library to perform gender, mood and race detection with OpenCV and Deep learning. Our input image will be in the form of BGR and with the help of Viola Jones algorithm it will be converted to RGB and it will be analysed with the help of Deepface. The model is useful in many fields and gives reasonably accurate predictions. It can be used to suggest user music, movies, skincare, etc based on their age, race and gender.

Age, Gender and emotions detection will help in various ways. However, it needs some improvements on training dataset w.r.t various age groups, various ethnicity and human emotions as well for the same.

## **9. Future scope**

Some points to be taken in consideration that not all algorithms are universally successful, the accuracy of the algorithm lowers with women or black individuals. Algorithms are usually trained with white men due to which the system sometimes falsely identifies black and Asian people. Once databases are exposed to diverse faces and trained to identify them, they will be more successful. So, the future aim will be to take the above points in consideration and try to fix them.

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## Appendix A: Code snippets

Using google colab for execution of image as input. Following code snippet shows the requirement Environment setting.

```
[3] pip install deepface  
  
[4] from deepface import DeepFace  
  
[5] import cv2  
    import matplotlib.pyplot as plt
```

Input taken from the user .

```
[9] img = cv2.imread('/content/drive/MyDrive/Input images/Trump.jpg')
```

Default image taken by OpenCV is of BGR format and it is converted to RGB format by module using cv2 color converter.

Using matplotlib image is shown in graph format.

```
[11] plt.imshow(img) ##Default BGR  
  
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB)) ##Conversion from BGR TO RGB
```

Face detected in the image with Haar like features

```
[ ] faceCascade = cv2.CascadeClassifier(cv2.data.harcascades+'haarcascade_frontalface_default.xml')
```

Analzyation done by deepface

```
[13] predictions = DeepFace.analyze(img)
```

Customized prediction shown.

```
[ ] predictions['dominant_emotion']
```

Rectangle around face is drawn and the customized output is shown on the image with OpenCV

```
[ ] gray=cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    faces=faceCascade.detectMultiScale (gray,1.1,4)
    #draw rectangle
    for(x,y,w,h) in faces:
        cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),2)
```

```
[ ] plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
```

```
[ ] font =cv2.FONT_HERSHEY_SIMPLEX
    cv2.putText(img,
                predictions['dominant_emotion'],
                (0,200),
                font,3,
                (0,0,255),
                2,
                cv2.LINE_4)
```

```
[ ] plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
```