FACE DETECTION USING MACHINE LEARNING

BY

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**ABSTRACT**

**Object detection** is a computer technology related to [computer vision](https://en.wikipedia.org/wiki/Computer_vision) and [image processing](https://en.wikipedia.org/wiki/Image_processing) that deals with detecting instances of semantic objects of a certain class (such as humans, buildings, or cars) in digital images and videos. Well-researched domains of object detection include [face detection](https://en.wikipedia.org/wiki/Face_detection) and [pedestrian detection](https://en.wikipedia.org/wiki/Pedestrian_detection). Object detection has applications in many areas of computer vision, including [image retrieval](https://en.wikipedia.org/wiki/Image_retrieval) and [video surveillance](https://en.wikipedia.org/wiki/Video_surveillance).

**Face detection** is an essential application of visual object detection, and it is one of the main components of face analysis and understanding with face localization and face recognition. Automatic face detection is a complex problem which consists in detecting one or many faces in an image. Faces are non-rigid objects. Face appearance may vary between two different persons but also between two photographs of the same person, depending on the lightning conditions, the emotional state of the subject and pose. That is why so many methods have been developed during last few years. Face Detection is a part of the **computational image research** field.

The main experiments that are to be carried out are to detect the presence of glasses, eyes, face, full body, hand, left eye, right eye, license plate, lower body, upper body, smile.

The significance to the field of research if the objective is reached in terms of fundamental understanding and or application is that it can implemented to solve many real-world problems like face recognition in mobile phones, proctoring in exams, security cameras at shops, cameras at airport for screening. 2D Face detection has a natural place in the present and the future environment because it’s unobtrusive and passive in nature. Our goal at the end of the project is to develop Human Face Detection software which works efficiently on input images that are taken either by webcam (real time) or from hard disk and which is also simple to understand.

The objective of this project is to provide a simpler and easy method in machine technology. With the help of such a technology one can easily detect the face by the help of dataset in similar matching appearance of a person. The method in which with the help of python and OpenCV in deep learning is the most efficient way to detect the face of the person. This method is useful in many fields such as the military, for security, schools, colleges and universities, airlines, banking, online web applications, gaming etc. this system uses powerful python algorithm through which the detection of face is very easy and efficient.

The objectives of face detection are:

• To design real time face detection system.

• To utilize the face detection system based on Haar Classifier.

• To develop face detection system using Python 3 edition.

• To implement real time face detection system using OpenCV.

• To design real time eyes, left eye, right eye, etc using haar cascades files (extra features)

**Introduction**

Face detection deals with the marking of an area of the image that may contain the human face and face recognition deals with the decidability of which person that face belongs to. Such kinds of systems have been largely used for the purpose of marking attendance in multiple educational and institutional organizations. Image processing is an integral part of Facial recognition systems. It basically deals with filtering, resizing, reshaping and enhancement of images which are further sent for detection to the actual system. Image enhancement methods to undo the effect of degradations of the image are a more sophisticated class of image processing. Interestingly this is another field in the growing research area. Machine learning is a concept that a computer program can learn and adapt to new data without any human interference. Machine learning is a field of artificial intelligence (AI) that keeps a computer’s built-in algorithms current regardless of changes in the worldwide economy.

The products, services or facilities that would result from the project activities are face recognition in mobile, proctoring in exams, security in shops, screening cameras at airport and the benefits that may happen from the project activities are that they can be used for Face recognition, sign language reading using vision based gesture recognition, **protects businesses against theft, reduces the number of touchpoints, makes shopping more efficient, strengthens security measures in banks and airports, improves photo organization.**

The importance to carry out at the end of the project is to create an application that has the ability of object detection (face, eyes, mouth, etc.) which can help in various field like:

* Facial motion capture
* Facial recognition
* Photography
* Marketing
* Emotional Inference
* Lip Reading

**Algorithm/Design flow**

Haar Cascade Classifier

It is a machine learning based approach where a cascade function is trained from a lot of positive (images with face) and negative images (images without face). The algorithm is proposed by Paul Viola and Michael Jones.

Diagram

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The algorithm has four stages:

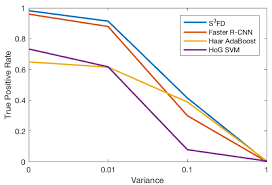
**Haar Feature Selection:** Haar features are calculated in the subsections of the input image. The difference between the sum of pixel intensities of adjacent rectangular regions is calculated to differentiate the subsections of the image. Many haar-like features are required for getting facial features.

**Creating an Integral Image:** Too much computation will be done when operations are performed on all pixels, so an integral image is used that reduce the computation to only four pixels. This makes the algorithm quite fast.

**Adaboost:** All the computed features are not relevant for the classification purpose. Adaboost is used to classify the relevant features.

**Cascading Classifiers:** Now we can use the relevant features to classify a face from a non-face, but algorithm provides another improvement using the concept of cascades of classifiers. Every region of the image is not a facial region, so it is not useful to apply all the features on all the regions of the image. Instead of using all the features at a time, group the features into different stages of the classifier. Apply each stage one-by-one to find a facial region. If on any stage the classifier fails, that region will be discarded from further iterations. Only the facial region will pass all the stages of the classifier.

**HAAR Cascade vs CNN**

[True-positives and variance graph](https://arxiv.org/pdf/1804.07362.pdf)

Both the CNN and HAAR Cascade classifiers are state-of-the-art computer vision techniques but how are they different? Lets us see the comparison of HAAR Cascade vs CNN –

1. **Training Data –** HAAR Cascade requires comparatively fewer data to train whereas CNN requires thousands of images per [class](https://machinelearningknowledge.ai/glossary/class/) to achieve respectable accuracy.
2. **Training and Inference times –** The CNN has an upper hand when it comes to processing, training, and inference times. Since cascades are bulkier models, they take more time to train and provide an inference.
3. **SIFT –** Scale-invariant feature transform technique is applicable in the case of cascade classifiers but not in CNN. It lets the classify perform well in cases of different scenarios where the object could be present.
4. **Accuracy –** Both CNN and HAAR Cascade classifiers show reasonably good accuracies. But due to revolutionary ongoing research in [deep learning](https://machinelearningknowledge.ai/glossary/deep-learning/), the accuracy of CNN models is almost tending towards 100% now.
5. **Hyperparameter –** There is no experimentation of hyperparametric tuning is required in the case of HAAR cascades. Whereas in the case of CNN it is a painstaking process of tuning hyperparameters that will perform well with your data.

## ****HAAR Cascade File Download****

One can visit the official [Github repository](https://github.com/opencv/opencv/tree/master/data/haarcascades) and clone it to find the XML files for multiple classifiers that have been trained before. For example, pre-trained classifiers for cats, number plates, faces, eyes, and many more.

If you are interested in one classifier or don’t want to clone the entire repository you can simply open the XML file in raw form in another tab and then right-click and save it on your device.

All the cascade classifiers that are provided by the official OpenCV site are present in their repository.

You can also create your own custom HAAR cascade classifier according to your own needs and wants very easily. Unfortunately, that part is out of the scope of this article.

## ****HAAR Cascade Using OpenCV Python****

## **i) Installing dependencies**

We first need to install OpenCV since it provides the implementation of HAAR cascade classifier files in XML form using cv2.CascadeClassifier() function.

pip install opencv-python

**ii) Importing dependencies**

**import** cv2

**iii) Applying HAAR Cascades**

face\_cascade = cv2.CascadeClassifier('haarcascade\_frontalface\_default.xml')

eye\_cascade = cv2.CascadeClassifier('haarcascade\_eye.xml')

smile\_cascade = cv2.CascadeClassifier('haarcascade\_smile.xml')

cap = cv2.VideoCapture(0)

**while** 1:

ret, img = cap.read()

gray = cv2.cvtColor(img, cv2.COLOR\_BGR2GRAY)

faces = face\_cascade.detectMultiScale(gray, 1.3, 5)

**for** (x, y, w, h) **in** faces:

cv2.rectangle(img, (x, y), (x + w, y + h), (255, 255, 0), 2)

roi\_gray = gray[y:y + h, x:x + w]

roi\_color = img[y:y + h, x:x + w]

eyes = eye\_cascade.detectMultiScale(roi\_gray)

smile = smile\_cascade.detectMultiScale(roi\_gray)

**for** (ex, ey, ew, eh) **in** eyes:

cv2.rectangle(roi\_color, (ex, ey), (ex + ew, ey + eh), (0, 255, 255), 2)

**for** (sx,sy,sw,sh) **in** smile:

cv2.rectangle(roi\_color, (sx, sy), (sx + sw, sy + sh), (255, 0, 255), 2)

cv2.imshow('img', img)

**if** cv2.waitKey(1) & *0xFF* == 27:

**break**

cap.release()

cv2.destroyAllWindows()

Line 1-3: Initialize the cascades for detecting faces, eyes, and smile using the OpenCV CascadeClassifier() function by passing the XML file as an argument.

Line 4: Initialize the webcam feed.

Line 6: Next, initialize a while loop that runs indefinitely or until all the frames are iterated through. The code enclosed inside is executed for each frame that comes from the webcam. Loop can also be broken if the user presses the ‘escape’ key (Line 23-25).

Line 7-9: Use the ‘read ()’ function to fetch consecutive frames from the webcam feed. This is preprocessed by converting it to grayscale (using cv2.cvtColor) and then sent to our face classifier object for [classification](https://machinelearningknowledge.ai/glossary/classification/) using the ‘detectMultiScale’ function which returns the coordinates(x,y,w,h) of faces that are detected by the classifier.

Line 11: Begin a for loop that loops through all the detected faces (and use the ‘cv2rectangle’ function to put a bounding box around it). For the convenience of detection of eyes and smiles (both smaller in size), we define a sub-area in the grayscale-video frame (which is the area that was returned to us by the face cascade). This can be done only because eyes or a smile will only be detected inside a face. (Line 13-14)

Line 16-21: Pass the sub-area defined in the previous step to the ‘eye’ and ‘smile’ cascades so that an array of coordinates of detected eyes and smiles is returned. Next, initialize ‘for’ loops for each of these arrays (Line 18 & 20) and put bounding boxes around each of the detected objects (Line 21).

Line 27: Finally, release the webcam video feed loaded into memory.

Line 28: Close all windows (If any are left open and running).

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**Circuit diagram / Model information**

Diagram, schematic

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**Results (Comparative analysis)**

**![A couple of men playing football

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confidence](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4T8oRXhpZgAATU0AKgAAAAgABgALAAIAAAAmAAAIYgESAAMAAAABAAEAAAExAAIAAAAmAAAIiAEyAAIAAAAUAAAIrodpAAQAAAABAAAIwuocAAcAAAgMAAAAVgAAEUYc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFdpbmRvd3MgUGhvdG8gRWRpdG9yIDEwLjAuMTAwMTEuMTYzODQAV2luZG93cyBQaG90byBFZGl0b3IgMTAuMC4xMDAxMS4xNjM4NAAyMDIxOjA5OjIzIDIyOjAzOjM2AAAGkAMAAgAAABQAABEckAQAAgAAABQAABEwkpEAAgAAAAM4NgAAkpIAAgAAAAM4NgAAoAEAAwAAAAEAAQAA6hwABwAACAwAAAkQAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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GTxTJHKxXjtVqBgy8inNajysiq8TeXwetFrhqtx90flGOBVbJ5x1qeZwy4AyafZW5kxnvQ/dQ0uZi28bMBu/lTbqGSP7oIrYW1UKOP1qXyAy4PIrH2hv7O+hzQyWJYZqSFgxwQMfStG5swuSorO2+Wx9a15uZGPLyyG3aDJxwKr28jRsOeKnmYletVs0kN9zRkk3JzzVYMN1JCxk+Unilki2ZIqouzJd5Ik8zFWrGRXurUHkiVce3zA/wBKyTLz61Y06Q/brbHA81f5inOVyYqweYx4Bp8UbbiT0qJcq2e1XY2BjzmqJBZNox3qRZMketVJD1Ip0LcAnrQBqp8y5PWqci/OcVaVvl/Cq+cuaBjo1Pl1SlJ+0itD7q8VUkjDTFsc0DuPjkxx3qaPDc1VMbbjjpU8e5FpiZJJheagd1qG4nY/So8kxnHFRJDT6EuQW4qO4LKeuOO/rTreORiDsJ7dD/hXosmi2ng+xgmmjiuLyWNXJbLYJGRxj3rOVWMHa47Rvqzh9MYxswKsrLwcqRV+WRZFBzxWrD4vuJDMsohJZsgm2HP47c0/UrKz1TT5Z4mW1v4xny0DFZePccfhWMq0b2bNFy9GjMgZQlZWryDPBpVmeNcsGC9/lP8AhVC6m85uuRW8GnsQ2pbEHrnrWpp+ltdkAVVt7USLk12PhmMK69M96u4kignht416VWvNEkiUtjivTFt1kQAAVka7FHHbldvakB5vu+ztg025uQ/Q0zUpP9II7ZqmGz9KY7kkSgyE1oxW42hvWs2P5WGK2bZQ0JzzgVLKirlC+UKMCs89a0LxqoMOeKroQ2kyxaybcCpLpvl46VBawl5D6VauIMR9Km47aFWCEyMac0Zt3GRxT7P5X5q1eKJI+BRcai9yBrzMeAcCqnmZ5pjIyk8cU0U0J7lu3/eSHJrQgxGSc1lQtsOatLIW4BpS1Q4uzN2GRZGCgZNa8GkmeM7VIPrWPokBkcHPINd1ZyJDb4OM4rGNK+5rKp2OOudLlXK9hWLfabJCxYjivR57eKQEg4JrD1q1RYOmfeuj2aS0Mue71OGaEtmqM0ZRq2D8pI96qXcWQTioW5UtiKzIWSrl1HujJHSs2FjGwNX2ug0eM07EX0sZyp83PNaFlEi3dqQMfvV7+4qhI3OR61bsZG+2Wozx5q/+hChiHzW5jUVFuxgA1ZupBJnjNVAu3BrQgtR2pdQexqJVMbFTVmG5AjAzyKhZtzEkZoAsLN8vWlU5yRVZTzz07VPF93FAFuKPep9Kq3GYj0q/bsfLNVrxdzEdqAK8NwM/NVkyo6nbxWbKm08U+BW3daegCyLyc803jg5x/wDqNWJlCrVJ+Mf57Gle2qGfYHgPxBc+F/hj8MbfSdL0iabXPtr3c99aCRv3TEg5PsR0r1fUI9cv9Ngv7Y+G42kX7txpG4LjgDP4V5N4L0W61L4YfCee2RmMFrqSbsZxI77V/lXp3jTxdofw3s7TTrmC71PU4YvMuwCiLHnkAbuvBFfm+HwOGxEJVKkLy5p/+lM8HIcjwOOoTr4qnduc9fSTRz9xD8WY7hPsmh+Cb2B8hX+w7O3XBrVh0z4jxabLdX+m+DoGhQu0cen7jwOmas6R8YfDt3oJ1eGOaOztwGl86IZU9MYxVmx+Jnhzx/C9pZRXlgJ4nRJpIQsTtz0INdMsuwr3pI+plwvlC09itfU8v+F/xm1Xxj8VtM8K6zoHh9bO7MsU3k6aFcgRs3BPToDkV8reL7WOHxTq8cQCot5MqgdAA5wPyr6D+Fmny2f7Uvh8vGygSzIsij5WxbsCRXz/AON22+LtaOeftsx/8fNell9Glh8xnCjGycIv53kfIYbCU8DmtWjRjyx5Iu3zkUrRcDk1sabqAtZMhsGueS4x1NO84bq+qsfT3PUbDWFkjBBJyKz/ABBdiSMhTziuSttRaEDDkfjUtxq3mJgvk07AzEuoGeRj3zVRozGAO9bUeyTLHrVeaBHYnFK4W0uVLaPew3c1sQ4VMYqjFH5eCBgdK29L0DU9YtpprO0kmSLhmUf0rKT1sdVO3Lcwr6LJJA4rO5yBmti+ilgDeZFIm04O5cc1nRw7pASaakjGa6lmzjIOR+NWbr5l4NTW1qSp29e9QXUfl9etJsvSxVSPbJz0qw2NuKjVxTnxt460FpKwwwrItZ80Zjb2q+uVFV7hGZie1aLU5pbkC+nap4cq3tUKqP1rUt7cNFnFDQR3NXQrpIQxYc/WtS71cR7QDiuP85oZCAeM1Za4aZQScjtSvYe7Osj1jcv3qZcXX2uIA8iuWa7eNQBVm1u3IHJrRSVjN7jLm0KyHHAzVW5hwlaU0ileaqSurKRU21KctDCkUrIc9KQyVLeL8xxVfHtQSBbpxV3TVLahbf3fNXj8RVVcccVo6Xta+teOfNX+YoGTSwKq8daqMhbvxUkk7N9KTaSoKrVkEezb061ct4VZBmoByoyKPPaNjzxQA+6jCYxTomJNRs5mx3pNzRtTA1IGxHUMxLNRDJ8opW60gK8lvuJ44qDaYznpWknzZFU7yFlGQfrQBG0m6Pk1WPJH+expfM4wBxTVPPTj/wCsadhSPu34JaxZWfwz+Ftjd3SwyTi5lghbAErJMeM9e9dT8QtH0PxxqVxFqOmQ3FyADJI/rnn6V82+J759P+EPwMuonMTRXd04ZTgj98M19R6o32NtfmEbDHzRvv7E8AevHrXwGCjy0pSXWc//AEuRrwrV58FKEl8M6n/pcjE0W+8BabYTaHdXkG2UeXJa+WxVeeOcc9q0NF8A+FPB9w89hC000z+ZC7zHYuR1CnpXk1l8TPG9v4ugx4Mtxo/mbGZ1VnK/3uld38U/GaaB4J1HVId0d1Has8Z/usSQK9Lkk2o33PseaKTk+hxGiajHN+1B4P06OSN5bZ7p5GjORloXP8iK+V/GUfmeLNZIH/L5Nj/vs16V+yzfTal+0D4YubmRpbiZp2kZ2JJJgYn9TXnvibaPFWs7v+f2b/0M1thafs8zmv8Ap3H/ANKkfmjqe2zqrL/p3H85HMPCyMSelJu9Kv3y/LxWfjbwa+mPXZKJWx1pNxznPNOt4/MbnpU01uqDgUAQrcMnANSJM7qRjA67j/IVWztbnpXq/wCzLpdhr3xq8N2OoWsd3aNLKWhnBZG2xMwyPqBXHi66wtCddq/Km/uObE4j6rQqV2rqKb+4xvh7ottHFd67q1rJcWVqP3MYmCo8vv3rs9P+IEMzSrG8MHmtvKRAIAAowOBzXoUXxi1vUtYi0fR/CnhK5nm1CS1S3m0vK5DlQxxweB6V7hN8MfFuk6gkWpaT4HUNGp/0fSGLKSoyOv4V85PHY2cef2On+L/gGFDEZnWipUsKmn/e/wCAfEWo+MIdU863v4I5oWfCyLgHr6gVz/iLw7FYMt1Yy+batyRuGV7elfc3inwX4ssbGWbR/D/gu8eJdzQz6SVY4Hsa8OT9oTWdL1ptH1vwd4UsZxwY/wCyzg5+pqqeMxrXNCh/5N/wDSpUzOK9/CL/AMD/AOAeA2c+xgM/MR93PNSTW6TAgtk1798Zmt/FHwO0HxHPoem6Zqv9sS2jvp9uIVMYBIGB19cnnn0r59huhxnk4GT+Ferl+L+u0nNx5Wm1a99h5fjnjqblOPK4txavfZ2KU1v5OaYhyoPerOoSbslRVBZSgwTXqJXO+UrEjMdx4ob5oxmnxujLk1BcTALgGmtxELAKeK0bZj5YFZ0eXcZ6VrW4WNRxRIcdyncRvuzjinIxVQDWjJsaPgVnOMtUbmvw6kifPjPIqdXWPOBg022tywqK4Rgx5oT6Ey1QTXBbJ61Xa4K55xUywlvpUFxbYZj2rRGLiyrNJv681GAGyaax2sRQG9OlIdhq/fNaujRhr63P/TVf5isdmKscVoaLK32635/5ar/MUDsSbW4z0rRgVfJHOKhvIWhxlcVWMp7ZAqlqZj7ghZGAqrId2PWrCReb701rfb1FMCeyVQgBpbrHbrUSsFXI4NCxmZj3oEPhZumasioI7d1qbaVxmgtLqT2ozJg9KW6hypIFOtVHmE4q1cRr5LHkbRkt2X/EnpigNzAMIz0p0NnJcTCKCJ55GGRHEhkbPPZeR+NfVXwB/YA8c/GK1t9d1pT4O8KSEMt1eL/pNwuf+WUf/wAVX6EfCP8AZ1+HvwV0+O18OaBbPfA4k1O9iEtxMe5JfOPoMcAU+W+xF7anwV4E+B118c/hH8O7K0vfsieH57k6knlkzwgykjC47he9e+eI/DClbtf7StVtsld1w4R9n8OeODjFfRPw78K23hn4mfEq3jgS2m1AWd5FsXaHQxkOBj/bBPFfLHx20vUdD1nU7C5jaMTOVBkGI3A6EH6Yr4PEZZiqMf3de0XKTty93cnCZTiMHUnSwWL5YN81nFPWTuzA0/4Y6MuqLdx+J4Hn7qNR3L7jbU/xR+D998RPBF9oul6rpy3Nw0bb3l+URp97JA4rgPBPw11C41RV0qz+26hM3ECruwT7/rX1DD8I/EPhvw/H4Rt44v8AhNvEURSXbhk0qzPEk0nox6AGsaeBzCU1KFfb+6d/1HMpPkqY21/7q2Pkb4R/AMfCLx7pHi7V/Gnho6fZSTBtt2ckmMjA456kV8x+KrqK68TarcQsHgku5XRlOQVLkg5r9a4/2APhxdeG00bUbrW7yZl+a4NwB+8x95UHSvir9pj9gHxp8G5JdV8Pw3Xizwt1+0W6hrm2H/TRQPr+GK+lwOBxFKtLE4mfNJpLa2ib/wAzyFl0MJipV1iHVbSV2lHRN9vU+V2kMjYJyKjkjGScVZS1KyNGTtlVtrKwIx9R1BpbiHy1OM/jXtnZZsqR5j5rSS3+0L17Vmrls+ma39Lby1I25GKYGJfWfl4Ir1P9kwH/AIX/AOFx/tTj8PIevOtYwzEgYFek/smL/wAX+8L/AO9cY/78PXkZv/yL6/8Ahl+R5GcaZdiH/cl+R2vwbuFb49aXE8Ui2cd/czeZ5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The haar cascade face detector is running in real-time without an issue. If you need to obtain real-time face detection, especially on embedded devices, then consider utilizing Haar cascade face detectors. Yes, they are not as accurate as more modern face detectors, and yes, they are prone to false-positive detections as well, but the benefit is that you’ll gain tremendous speed, and you’ll require less computational power. Otherwise, if you’re on a laptop/desktop, or you can use a coprocessor such as the Movidius NCS or Google Coral USB Accelerator, then use [**deep learning-based face detection**](https://www.pyimagesearch.com/2018/02/26/face-detection-with-opencv-and-deep-learning/). You’ll obtain far higher accuracy and still be able to apply face detection in real-time. The reson we used Haar Cascade Detection over convolutional neural networks (CNN) is one of the oldest yet powerful face detection algorithms invented. It has been there since long, long before Deep Learning became famous. Haar Features were not only used to detect faces, but also for eyes, lips, license number plates etc. The models are stored on GitHub, and we can access them with OpenCV methods another reson to use this algorithm was because it is given a lot of positive images consisting of faces, and a lot of negative images not consisting of any face to train on them. The algorithm is given a lot of positive images consisting of faces, and a lot of negative images not consisting of any face to train on them.

|  |  |
| --- | --- |
| Haar Cascade | Convolusional Neural Network |
| Haar cascades are a classical (non deep learning) approach that uses hand-engineered features | CNN is a deep learning approach which learns features automatically |
| The advantage of Haar Cascade is that it has a detection time of 2 fps which can be used in a real-time face recognition system. | The advantage of Deep learning is that we don’t need to do feature extraction from data as compared to machine learning. |
| Haar cascades are faster at inference, but less accurate | CNNs are slower at inference, but more accurate. |
| Haar Cascade gain tremendous speed, and require less computational power. | CNN sometimes are slow in training and require more computational power. |

Basically, if you have a large training dataset, it would be good to use CNNs, and otherwise you could try to use a predefined Haar cascade model or try to engineer your own features.

**Conclusion**

Face detection systems are currently associated with many top technological companies and industries making the work of face recognition easier. The use of python programming and OpenCV makes it an easier and handy tool or system which can be made by anyone according to their requirement. The proposed system discussed in this project will be helpful for many as it is user friendly and a cost-efficient system. Hence using python and OpenCV the face detection system can be designed for various purposes.

**Future scope Reference**

This project is face detection system. This gives accurate output while we give the neat and clean images to the system and using the appropriate algorithm for this. In this project we focused on the image and background should be neat and clean for the system. These are key point by which we can increase the accuracy and we must use good algorithm for this nowadays may algorithms are coming so

we must check and implement in the project. We can increase the accuracy. There are using other method and algorithm to build the face detection system applications examples are face lock in mobile which is working on this. Nowadays everyone wants to secure his document and personal information and his system. It will work in security system because everyone has unique face point and his dimensions. It’s working all other fields like as medical and defences etc.

**Bibliography**

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