A Project Report

on

RECOGNIZING FACES WITH PYTHON

Submitted in partial fulfillment of the

requirement for the award of the degree of

Bachelor of Technology

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Under The Supervision of
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SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

GALGOTIAS UNIVERSITY, GREATER NOIDA, INDIA

MAY,2022

SCHOOL OF COMPUTING SCIENCE AND ENGINEERING
GALGOTIAS UNIVERSITY, GREATER NOIDA

CANDIDATE'S DECLARATION

I/We hereby certify that the work which is being presented in the project, entitled " **RECOGNISING FACES WITH PYTHON** " in partial fulfillment of the requirements for the award of the **BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND ENGINEERING** submitted in the School of Computing Science and Engineering of Galgotias University, Greater Noida, is an original work carried out during the period of **JANUARY-2022** to **MAY-2022**, under the supervision of **Dr. BASETTY MALLIKARJUNA**, Assistant Professor, Department of Computer Science and Engineering of School of Computing Science and Engineering , Galgotias University, Greater Noida

The matter presented in the project has not been submitted by us for the award of any other degree of this or any other places.

ADITI UNIYAL - 18SCSE1010685
SAMYAK JAIN - 18SCSE1010700

This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

(**Dr. Basetty Mallikarjuna)**

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GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

CERTIFICATE

The Final Thesis/Project/ Dissertation Viva-Voce examination of **ADITI UNIYAL (18SCSE1010685)**, **SAMYAK JAIN (18SCSE1010700)** has been held on __________________ and his/her work is recommended for the award of BACHELOR OF TECHNOLOGY.

Signature of Examiner(s) | **Signature of Supervisor(s)**

Signature of Project Coordinator | **Signature of Dean**

Date: May,2022

Place: Greater Noida

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I have taken efforts in this project. However, it would have not been possible without the kind support and help of many individuals and organization. I would like to extend my sincere thanks to all of them.

I am highly indebted to Dr. Basetty Mallikarjuna for his guidance and constant supervision as ell as for providing necessary information regarding the project and also for his support in completing the project.

I would like to express my gratitude towards my parents & member of Galgotias University for their kind co-operation and encouragement which help me in completion of this project.

I would like to express my special gratitude and thanks to industry persons for giving me such attention and time.

My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities.

ABSTRACT

How to accurately and effectively identify people has always been an interesting topic, both in research and in industry. With the rapid development of artificial intelligence in recent years, facial recognition gains more and more attention. Compared with the traditional card recognition, fingerprint recognition and iris recognition, face recognition has many advantages, including but limit to non-contact, high concurrency, and user friendly. It has high potential to be used in government, public facilities, security, e-commerce, retailing, education and many other fields. In the past framework face acknowledgment was done physically which required some investment and effort. Due to manual up keep there are numbers for hardships and obstructions exist in the framework. In the current circumstance this work is done by face affirmation structure. Various public places for the most part have perception cameras for video get and these cameras have their gigantic impetus for security reason. It is extensively perceived that the face affirmation has been accepted a huge part in perception outline work.

An unbelievable choice of libraries is one of the essential reasons Python is the most known programming language used for AI. A library is a module or a social affair of modules dispersed by different sources like PyPi which consolidate a pre-made piece out of code that licenses customers to show up at some value or perform different exercises.

The result would be a mechanized instrument for facial affirmation and separate movement message transported off mail close by various data. We draw a careful acknowledgment that people talk with structures that reflect humanlike outlooks unexpectedly, so they will interface with them in robot.

Keywords: Face recognition, biometric identification, OS Module, Numpy, Computer Vision

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CHAPTER-1
Introduction

Artificial intelligence is arguably the most exciting field in robotics. It's certainly the most controversial: Everybody agrees that a robot can work in an assembly line, but there's no consensus on whether a robot can ever be intelligent. artificial intelligence is hard to define. Ultimate AI would be a recreation of the human thought process a man-made machine with our intellectual abilities. This would include the ability to learn just about anything, the ability to reason, the ability to use language and the ability to formulate original ideas. Roboticists are nowhere near achieving this level of artificial intelligence, but they have made a lot of progress with more limited AI. Today's AI machines can replicate some specific elements of intellectual ability. So, if we talk about robotic dogs it can be very useful in real life also as of now in army they are using dogs for that they have to train them for years but if they use robotics dogs they do work on sudden commands there is no need to train them. we can use parallax sensor for gas leakage.

1.1 Biometrics

A biometric is a unique, measurable characteristic of a human being that canbe used to automatically recognize an individual or verify an individual‟s identity.

Biometrics can measure both physiological and behavioural characteristics. Physiological biometrics (based on measurements and data derived from direct measurement of a part of the human body) include:

Types Of Biometrics:-

- PHYSIOLOGICAL**-** This biometrics is based on measurements and data derived from direct measurement of a part of the human body.

a. Facial Recognition
b. Iris-scan
c. Finger-scan
d. Retina-scan
e. Hand-scan

- BEHAVIORAL**-** this biometrics is based on measurements and data derived from an action.

a. Voice-scan

b. Signature-scan

c. Keystroke-scan

Why we use face recognition?

There are number reasons to choose face recognition. This includes thefollowing :

- It requires no physical interaction on behalf of the user.
- It is accurate and allows for high enrolment and verification rates.
- It does not require an expert to interpret the comparison result.
- It can use your existing hardware infrastructure, existing camaras and imagecapture Devices will work with no problems
- It is the only biometric that allow you to perform passive identification in a oneto. Many environments (e.g.: identifying a terrorist in a busy Airport terminal

1.2 Face detection

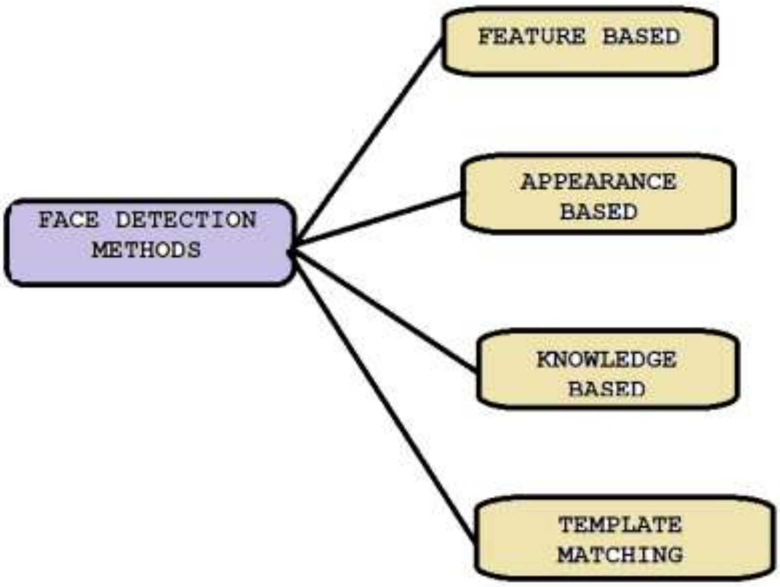
Face detection is a computer technology being used in a variety of applications that identifies human faces in digital images. Face detection also refers to the psychological process by which humans locate and attend to faces in a visual scene.
Face detection can be regarded as a specific case of object-class detection. In object-class detection, the task is to find the locations and sizes of all objects in an image that belong to a given class. Examples include upper torsos, pedestrians, and cars.

It is a component of Facial Recognition systems – the first stage of facial recognition is detecting the presence of a human face in the first place. Face detection can also be used in cameras to help with auto-focus – you will have noticed that on some digital cameras and phones, a small box will appear around the faces of people detected within the image, allowing the camera to prioritise focus on those faces.

1.2.1. Face Detection Methods

Yan, Kriegman, and Ahuja presented a classification for face detection methods. These methods divided into four categories, and the face detection algorithms could belong to two or more groups. These categories are as followsFace Detection Methods:-

Yan, Kriegman, and Ahuja presented a classification for face detection methods. These methods divided into four categories, and the face detection algorithms could belong to two or more groups. These categories are as follows



Different types of face detection method

i.Knowledge-Based -

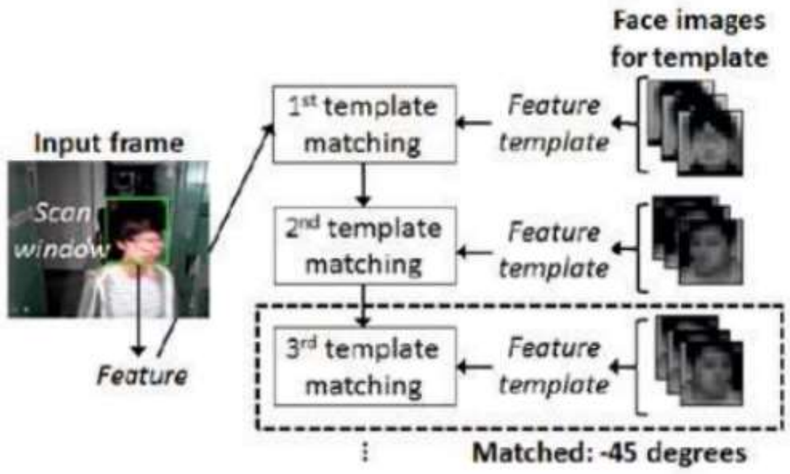
The knowledge-based method depends on the set of rules, and it is based on human knowledge to detect the faces. Ex- A face must have a nose, eyes, and mouth within certain distances and positions with each other. The big problem with these methods is the difficulty in building an appropriate set of rules. There could be many false positive if the rules were too general or too detailed. This approach alone is insufficient and unable to find many faces in multiple images.

ii.Feature-Based -

The feature-based method is to locate faces by extracting structural features of the face. It is first trained as a classifier and then used to differentiate between facial and non-facial regions. The idea is to overcome the limits of our instinctive knowledge of faces. This approach divided into several steps and even photos with many faces they report a success rate of 94%.

iii. Template Matching -

Template Matching method uses pre-defined or parameterised face templates to locate or detect the faces by the correlation between the templates and input images. Ex- a human face can be divided into eyes, face contour, nose, and mouth. Also, a face model can be built by edges just by using edge detection method. This approach is simple to implement, but it is inadequate for face detection. However, deformable templates have been proposed to deal with these problems.



Template Matching

iv.Appearance-Based -
The appearance-based method depends on a set of delegate training face images to find out face models. The appearance-based approach is better than other ways of performance. In general appearance-based method rely on techniques from statistical analysis and machine learning to find the relevant characteristics of face images. This method also used in feature extraction for face recognition.

The appearance-based model further divided into sub-methods for the use of face detection which are as follows-

- ***Eigenface-Based:-***
  Eigenface based algorithm used for Face Recognition, and it is a method for efficiently representing faces using Principal Component Analysis.

- ***Distribution-Based:-***
  The algorithms like PCA and Fisher's Discriminant can be used to define the subspace representing facial patterns. There is a trained classifier, which correctly identifies instances of the target pattern class from the background image patterns.

- ***Neural-Networks:-***
  Many detection problems like object detection, face detection, emotion detection, and face recognition, etc. have been faced successfully by Neural Networks.

- ***Support Vector Machine:-***
  Support Vector Machines are linear classifiers that maximise the margin between the decision hyperplane and the examples in the training set. Osuna et al. first applied this classifier to face detection.

- ***Sparse Network of Winnows:-***
  They defined a sparse network of two linear units or target nodes; one representsface patterns and other for the non-face patterns. It is less time consuming and efficient.

- ***Naive Bayes Classifiers:-***
  They computed the probability of a face to be present in the picture by counting thefrequency of occurrence of a series of the pattern over the training images. The classifier captured the joint statistics of local appearance and position of the faces.

- ***Hidden Markov Model:-***
  The states of the model would be the facial features, which usually described as strips of pixels. HMM's commonly used along with other methods to build detectionalgorithms.

- ***Information Theoretical Approach:-***
  Markov Random Fields (MRF) can use for face pattern and correlated features. The Markov process maximises the discrimination between classes using Kullback-Leiblerdivergence. Therefore this method can be used in Face Detection.

- ***Inductive Learning:-***

This approach has been used to detect faces. Algorithms like Quinlan's C4.5 orMitchell's FIND-S used for this purpose.

1.2.2. Application

- Facial recognition

Face detection is used in biometrics, often as a part of (or together with) a facial recognition system. It is also used in video surveillance, human computer interface and image database management.

- Photography

Some recent digital cameras use face detection for autofocus. Face detection is also useful for selecting regions of interest in photo slideshows that use a pan-and-scale Ken Burns effect. Modern appliances also use smile detection to take a photograph at an appropriate time.

- Marketing

Face detection is gaining the interest of marketers. A webcam can be integrated into a television and detect any face that walks by. The system then calculates the race, gender, and age range of the face. Once the information is collected, a series of advertisements can be played that is specific toward the detected race/gender/age. An example of such a system is OptimEyes and is integrated into the Amscreen digital signage system.

- Emotional Inference

Face detection can be used as part of a software implementation of emotional inference.Emotional inference can be used to help people with autism under stand the feelings of people around them.

- Lip Reading

Face detection is essential for the process of language inference from visual cues. Automated lip reading has applications to help computers determine who is speaking which is needed when security is important.

1.3. Face recognition

PIN gains access, but the user of the PIN is not verified. When credit and ATM cards are lost or stolen, an unauthorized user can often come up with the correct personal codes. Despite warning, many people continue to choose easily guessed PIN’s and passwords: birthdays, phone numbers andsocial security numbers. Recent cases of identity theft have highten the need for methods to prove that someone is truly who he/she claims to be.

Face recognition technology may solve this. The information age is quickly revolutionizing the way transactions are completed. Everyday actions are increasingly being handled electronically, instead of with pencil and paper or face to face. This growth in electronic transactions has resulted in a greater demand for fast and accurate user identification and authentication. Access codes for buildings, banks accounts and computer systems often use PIN's for identification and security clearences.

Using the proper s problem since a face is undeniably connected to its owner expect in the case of identical twins. Its nontransferable. The system can thencompare scans to records stored in a central or local database or even on a smart card.

WHY Facial Recognition ???

- It requires no physical interaction on behalf of the user.
- It is accurate and allows for high enrolment and verification rates.
- It can use your existing hardware infrastructure, existing camara and images capture device will work without any problem.

1.3.1 History:-

In 1960s, the first semi-automated system for facial recognition to locate the features(such as eyes, ears, nose and mouth) on the photographs.

In 1970s, Goldstein and Harmon used 21 specific subjective markers such as hair colour and lip thickness to automate the recognition.

In 1988, Kirby and Sirovich used standard linear algebra technique, tothe face recognition

1.3.2. Facial Recognition Processes

In Facial recognition there are two types of comparisons:-

1. VERIFICATION- The system compares the given individual with who theysay they are and gives a yes or no decision.
2. IDENTIFICATION- The system compares the given individual to all the Other individuals in the database and gives a ranked list of matches.

Implementation

The implementation of face recognition technology includes the following four stages:

a) Image acquisition

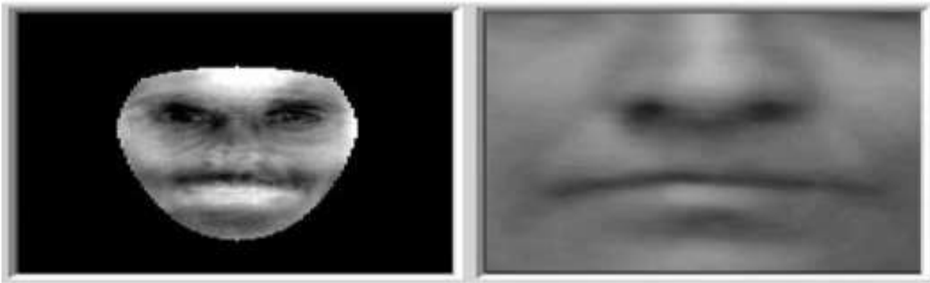
b) Image processing

c) Distinctive characteristic location

d) Template creation

e) Template matching

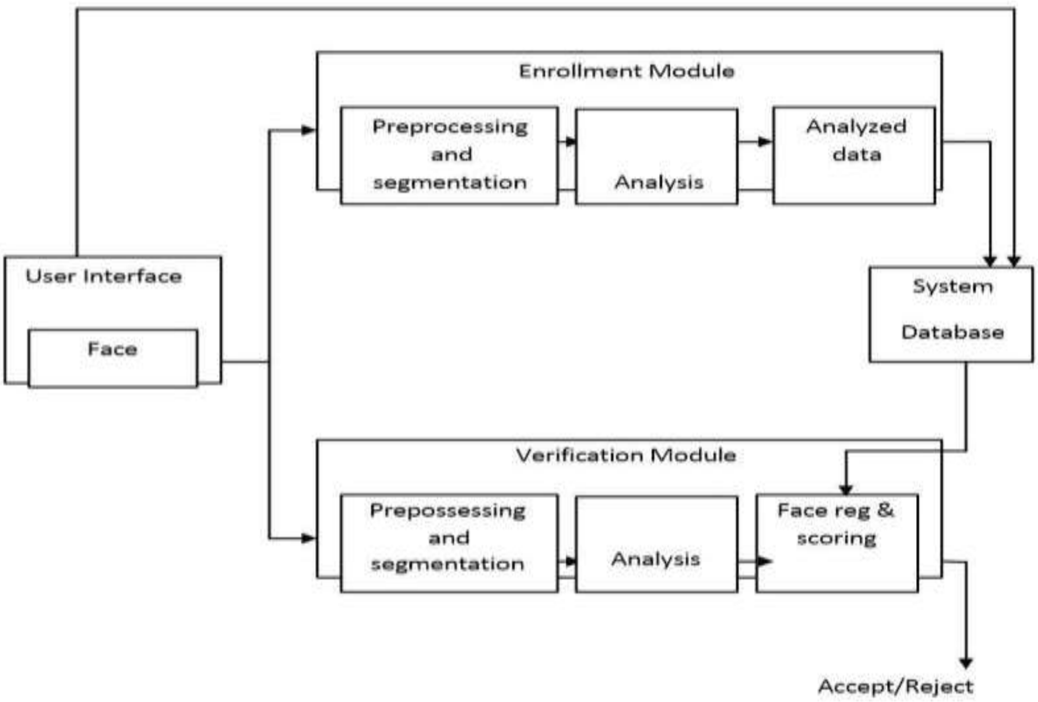

High-Quality Enrollment Image

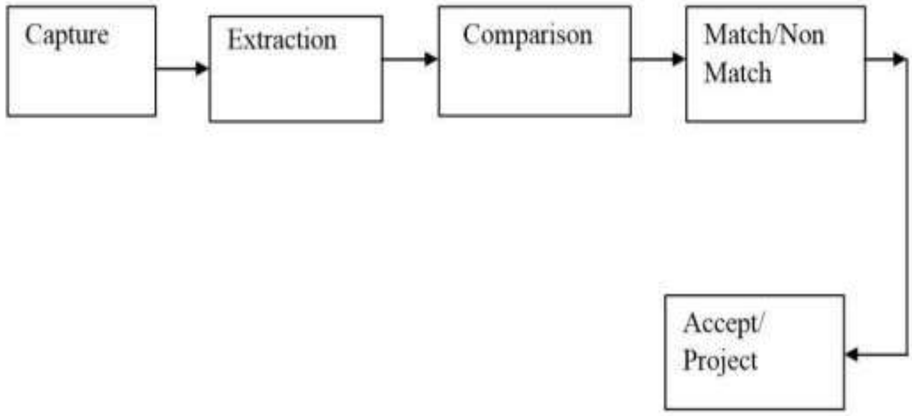

Low Quality Enrollment Image

1.3.3. How Facial Recognition System Works

Facial recognition software is based on the ability to first recognize faces, which is atechnological feat in itself. If you look at the mirror, you can see that your face has certain distinguishable landmarks. These are the peaks and valleys that make up the different facial features.

VISIONICS defines these landmarks as nodal points. There are about 80 nodal points ona human face.





1.3.4. Applications:-

A. Government Use:

a) Law Enforcement: Minimizing victim trauma verifying Identify for court records, and comparing schosurveillance camera images to know child molesters.

b) Security/Counterterrorism: Access control, comparing surveillance images to Know terrorist.

c) Immigration: Rapid progression through Customs.

d) Voter verification: Where eligible politicians are required to verify their identity during a voting process this is intended to stop "proxy" voting where the vote may not go as expected.

B. Commercial Use:

a) Residential Security: Alert homeowners of approaching personnel.

b) Banking using ATM: The software is able to quickly verify a customer's face.

c) Physical access control of buildings areas, doors, cars or net access.

1.3.5 Strengths and Weaknesses

Strengths:-

- It has the ability to leverage existing image acquisition equipment.
- It can search against static images such as driver's license photographs. It is the only biometric able to operate without user cooperation.
- There are many benefits to face recognition systems such as its convinence and Social acceptability. all you need is your picture taken for it to work.
- Face recognition is easy to use and in many cases it can be performed without a Person even knowing.
- Face recognition is also one of the most inexpensive biometric in the market and Its price should continue to go down.

Weaknesses:-

- Changes in acquisition environment reduce matching accuracy. Changes in physiological characteristics reduce matching accuracy.
- It has the potential for privacy abuse due to noncooperative enrolment and identification capabilities.
- Face recognition systems can't tell the difference between identical twins.

CHAPTER-2
Literature Survey

Research into human-robot interaction, the use of robots as tools, robots as guides and assistants, as well as the progress being made in the development of humanoid robots, are all examined. Finally, a variety of efforts to use robots in collaboration are examined and analysed in the context of the human-human model presented. The simplest way robots can be used is as tools to aid in the completion of physical tasks. Although there are many examples of robots used in this manner, a few examples are given that benefit from human-robot interaction. For example, to increase the success rate of harvesting, a human-robot collaborative system was implemented for testing by (Bechar and Edan 2003). Results indicated that a human operator working with a robotic system with varying levels of autonomy resulted in improved harvesting of melons. Depending on the complexity of the harvesting environment, varying the level of autonomy of the robotic harvester increased positive detection rates in the amount of 4.5% – 7% from the human operator alone and as much as 20% compared to autonomous robot detection alone. Robots are often used for hazardous tasks. For instance, the placement of radioactive waste in centralized intermediate storage is best completed by robots as opposed to humans (Tsoukalas and Bargiotas 1996). Robotic completion of this task in a totally autonomous fashion is desirable but not yet obtainable due to the dynamic operating conditions. Radiation surveys are completed initially through teleoperation, the learned task is then put into the robots repertoire so the next time the task is to be completed the robot will not need instruction. A dynamic control scheme is needed so that the operator can observe the robot as it completes its task and when the robot needs help the operator can intervene and assist with execution. In a similar manner, Ishikawa and Suzuki (Ishikawa and Suzuki 1997) developed a system to patrol a nuclear power plant. Under normal operation the robot is able to work autonomously, however in abnormal situations the human must intervene to make decisions on the robots behalf. In this manner the system has the ability to cope with unexpected events

Chapter-3
Working of project

Detection using Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones in their paper, “Rapid Object Detection using a Boosted Cascade of Simple Features” in 2001. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images.
Initially, the algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. Then we need to extract features from it. For this, haar features shown in below image are used. Each feature is a single value obtained by subtracting sum of pixels under white rectangle from sum of pixels under black rectangle.

It is a method of identifying or verifying the identity of an individual using their face. Face recognition systems can be used to identify people in photos, video, or in real-time. Law enforcement may also use mobile devices to identify people during police stops.
But face recognition data can be prone to error, which can implicate people for crimes they haven’t committed. Facial recognition software is particularly bad at recognizing African Americans and other ethnic minorities, women, and young people, often misidentifying or failing to identify them, disparately impacting certain groups.

Facial recognition software is becoming more prevalent in our day to day lives. Many mobile phones come standard with facial recognition technology as a way of unlocking the screen as well as authenticating logins to certain applications. Many businesses are embracing facial recognition as a way of managing access to buildings and secure areas and airports are using facial recognition at border control as an additional level of security and also for a frictionless
check-in and boarding experience.

There are number reasons to choose face recognition. This includes the following :

- It requires no physical interaction on behalf of the user.
- It is accurate and allows for high enrolment and verification rates.
- It does not require an expert to interpret the comparison result.
- It can use your existing hardware infrastructure, existing camaras and image capture. Devices will work with no problems
- It is the only biometric that allow you to perform passive identification in a one to. Many environments (e.g.: identifying a terrorist in a busy Airport terminal)

3.1. How the Face Detection Works:-

There are many techniques to detect faces, with the help of these techniques, we canidentify faces with higher accuracy. These techniques have an almost same procedure for Face Detection such as OpenCV, Neural Networks, Matlab, etc. The face detection work as to detect multiple faces in an image. Here we work on OpenCV for Face Detection, and there are some steps that how face detection operates, which are as follows-

Firstly the image is imported by providing the location of the image. Then the pictureis transformed from RGB to Grayscale because it is easy to detect faces in the grayscale.

Converting RGB image to Grayscale

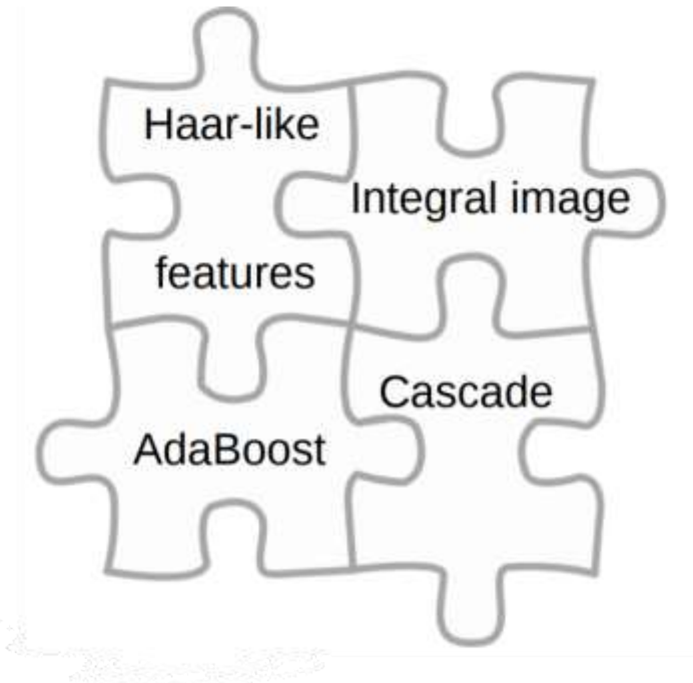
After that, the image manipulation used, in which the resizing, cropping, blurring and sharpening of the images done if needed. The next step is image segmentation, which is used for contour detection or segments the multiple objects in a single imageso that the classifier can quickly detect the objects and faces in the picture.

The next step is to use Haar-Like features algorithm, which is proposed by Voila andJones for face detection. This algorithm used for finding the location of the human faces in a frame or image. All human faces shares some universal properties of the human face like the eyes region is darker than its neighbour pixels and nose region isbrighter than eye region.

The haar-like algorithm is also used for feature selection or feature extraction for an object in an image, with the help of edge detection, line detection, centre detection fordetecting eyes, nose, mouth, etc. in the picture. It is used to select the essential features in an image and extract these features for face detection.

The next step is to give the coordinates of x, y, w, h which makes a rectangle box in thepicture to show the location of the face or we can say that to show the region of interest in the image. After this, it can make a rectangle box in the area of interest where it detects the face. There are also many other detection techniques that are used together for detection such as smile detection, eye detection, blink detection, etc.

Face Detection using Haar Cascades - Algorithm



Haar Feature Selection

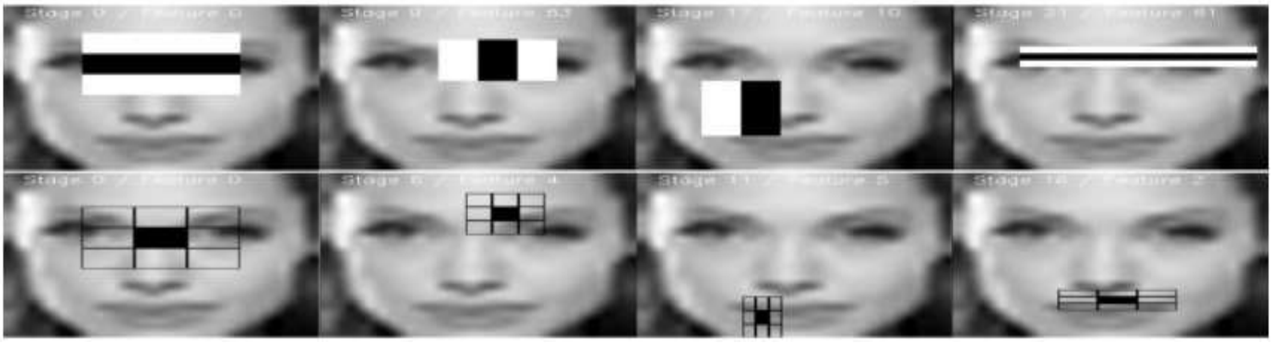
Dark eye region compared to upper-cheeks.

A bright nose bridge region compared to the eyes.

Some specific location of eyes, mouth, nose.
The two-rectangle feature is the difference between the sum of the pixels within two rectangular regions, used mainly for detecting edges (a,b).

The three-rectangle feature computes the sum within two outside rectangles subtracted from the sum in a center rectangle, used mainly for detecting lines (c,d).

The four-rectangle feature computes the difference between diagonal pairs of rectangle (e).



Detection using Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones in their paper, “Rapid Object Detection using a Boosted Cascade of Simple Features” in 2001. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images.
Initially, the algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. Then we need to extract features from it. For this, haar features shown in below image are used. Each feature is a single value obtained by subtracting sum of pixels under white rectangle from sum of pixels under black rectangle.

A sample calculation of Haar value from a rectangular image section has been shown here. The darker areas in the haar feature are pixels with values 1, and the lighter areas are pixels with values 0. Each of these is responsible for finding out one particular feature in the image. Such as an edge, a line or any structure in the image where there is a sudden change of intensities. For ex. in the image above, the haar feature can detect a vertical edge with darker pixels at its right and lighter pixels at its left.

The objective here is to find out ***the sum of all the image pixels lying in the darker area of the haar feature*** and ***the sum of all the image pixels lying in the lighter area of the haar feature***. And then find out their difference. Now if the image has an edge separating dark pixels on the right and light pixels on the left, then the haar value will be closer to 1. That means, we say that there is an edge detected if the haar value is closer to 1. In the example above, there is no edge as the haar value is far from 1.

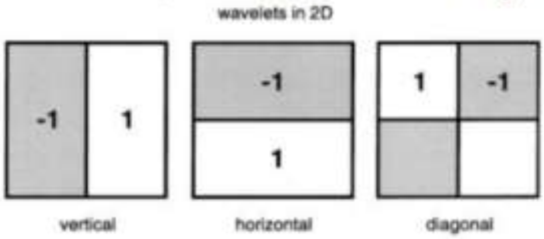
This is just one representation of a particular haar feature separating a vertical edge. Now there are other haar features as well, which will detect edges in other directions and any other image structures. To detect an edge anywhere in the image, the haar feature needs to traverse the whole image.

The haar feature continuously traverses from the top left of the image to the bottom right to search for the particular feature. This is just a representation of the whole concept of the haar feature traversal. In its actual work, the haar feature would traverse pixel by pixel in the image. Also all possible sizes of the haar features will be applied.

Depending on the feature each one is looking for, these are broadly classified into three categories. The first set of ***two rectangle features*** are responsible for finding out the edges in a horizontal or in a vertical direction (as shown above).

The second set of ***three rectangle features*** are responsible for finding out if there is a lighter region surrounded by darker regions on either side or vice-versa. The third set of ***four rectangle features*** are responsible for finding out change of pixel intensities across diagonals.

Haar-like features: local, oriented intensity differences

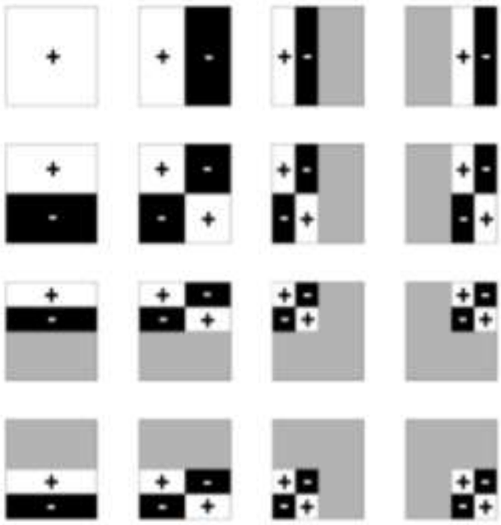


Haar wavelets

Original-Matrix

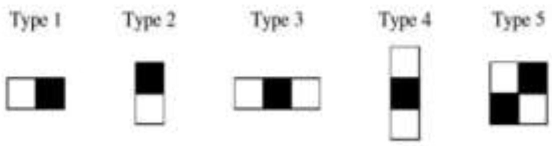
10	14	7	5
16	12	13	19
14	12	1	5
8	2	3	3

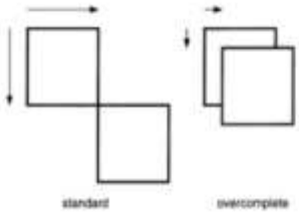
9	2	1	-1
3	-1	-1	0
-3	2	-2	2
2	2	-1	-1



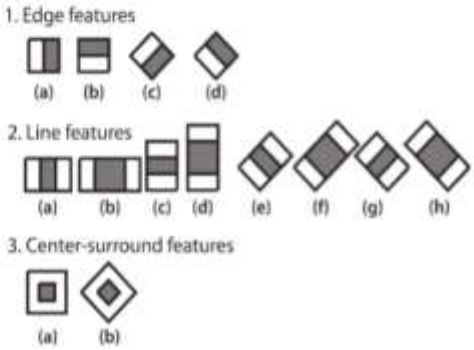
Zweidimensionale Basisfunktionen für ein 4×4-Bild

Haar-like features





→ 160.000 features per 24x24 px window



→ Features encode knowledge

→ Sensitive to edges, bars, simple structure

Integral Image

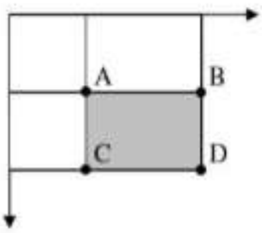
→ Very fast

1	1	1
1	1	1
1	1	1

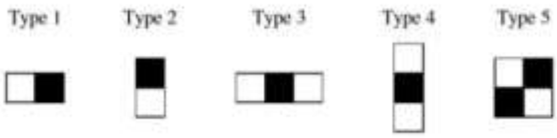
Input image

1	2	3
2	4	6
3	6	9

Integral image



Sum of grey rectangle = D - (B + C) + A



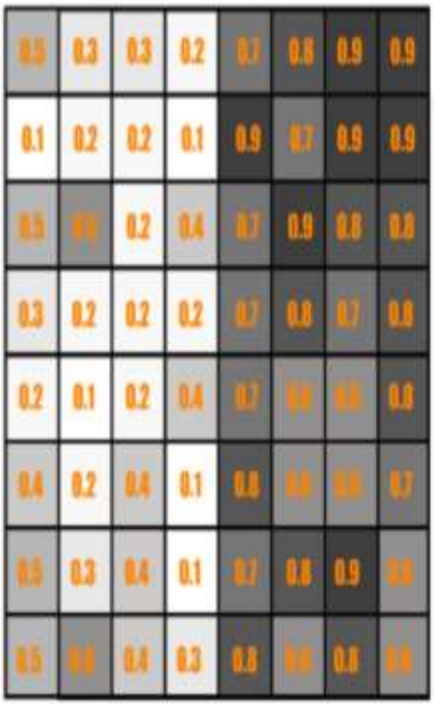
Number of array references: 6 8 9

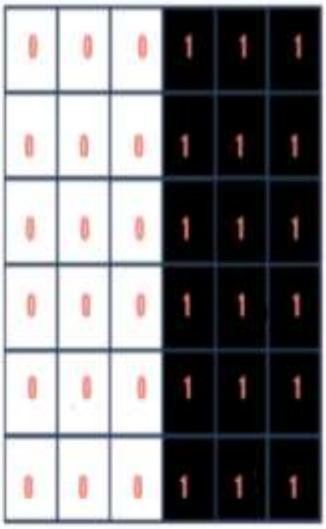
Now, the haar features traversal on an image would involve a lot of mathematical calculations. As we can see for a single rectangle on either side, it involves 18 pixel value additions (for a rectangle enclosing 18 pixels). Imagine doing this for the whole image with all sizes of the haar features. This would be a hectic operation even for a high performance machine.

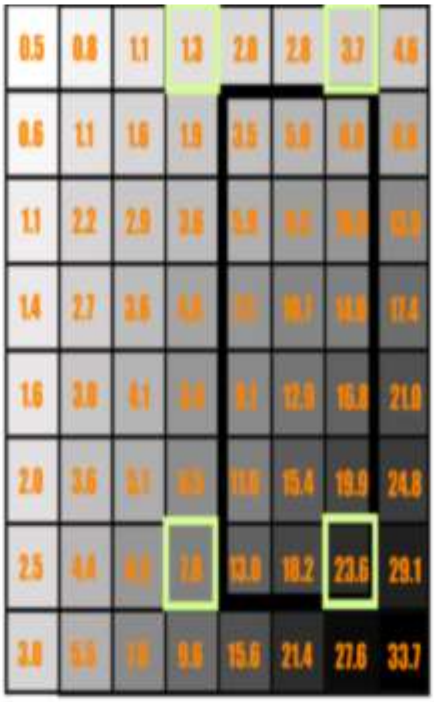
To tackle this, they introduced another concept known as ***The Integral Image*** to perform the same operation. An Integral Image is calculated from the Original Image in such a way that each pixel in this is the sum of all the pixels lying in its left and above in the Original Image. The calculation of a pixel in the Integral Image can be seen in the above GIF. The last pixel at the bottom right corner of the Integral Image will be the sum of all the pixels in the Original Image.

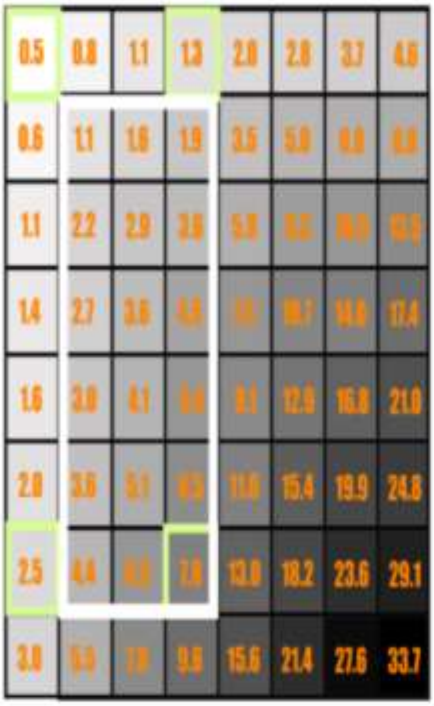
With the Integral Image, only 4 constant value additions are needed each time for any feature size (with respect to the 18 additions earlier). This reduces the time complexity of each addition gradually, as the number of additions does not depend on the number of pixels enclosed anymore.

In the above image, there is no edge in the vertical direction as the haar value is -0.02, which is very far from 1. Let’s see one more example, where there might be an edge present in the image.Again repeating the same calculation done above, but this time just to see what haar value is calculated when there is a sudden change of intensities moving from left to right in a vertical direction. The haar value here is 0.54, which is closer to 1 in comparison.









AdaBoost

→ narrowing down number of features to only a few useful ones

- Weak classifier: perform at least better than random:

$$h(x, f, p, \theta) = \begin{cases} 1 & \text{if } pf(x) > p\theta \\ 0 & \text{otherwise} \end{cases}$$

- Combining weak classifiers in a weighted sum to form a strong classifier:

$$C(x) = \begin{cases} 1 & \text{if } \sum_{t=1}^{T} \alpha_t h_t(x) \geq \frac{1}{2} \sum_{t=1}^{T} \alpha_t \\ 0 & \text{otherwise} \end{cases}$$

- Given examples images $(x_1,y_1),\ldots,(x_n,y_n)$ where y_1=0,1 for negative and positive examples.
- Initialize weights $w_{1,i} = \frac{1}{2m}, \frac{1}{2l}$ for y_1=0,1, where m and l are the numbers of positive and negative examples.
- For t=1,...,T:

1) Normalize the weights, $w_{t,i} \leftarrow \frac{w_{t,i}}{\sum_{j=1}^{n} w_{t,j}}$

2) Select the best weak classifier with respect to the weighted error:

$$\varepsilon_t = \min_{f,p,\theta} \sum_i w_i \left| h(x_i, f, p, \theta) - y_i \right|$$

3) Define $h_t(x) = h(x, f_t, p_t, \theta_t)$ where f_t, p_t and θ_t are the minimizers of ε_t.

4) Update the weights:

$$w_{t+1,i} = w_{t,i} \beta^{1-e_i}$$

where $e_i = 0$ if example x_i is classified correctly and $e_i = 1$ otherwise, and $\beta_t = \frac{\varepsilon_t}{1-\varepsilon_t}$

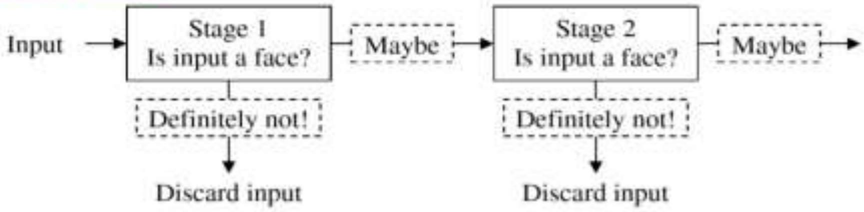
- The final strong classifier is:

$$C(x) = \begin{cases} 1 & \text{if } \sum_{t=1}^{T} \alpha_t h_t(x) \geq \frac{1}{2} \sum_{t=1}^{T} \alpha_t \\ 0 & \text{otherwise} \end{cases}$$

where $\alpha_t = \log \frac{1}{\beta_t}$

The cascade

→ Focus of attention



Training the cascade

- AdaBoost

  → minimize false negative

- Parameters:

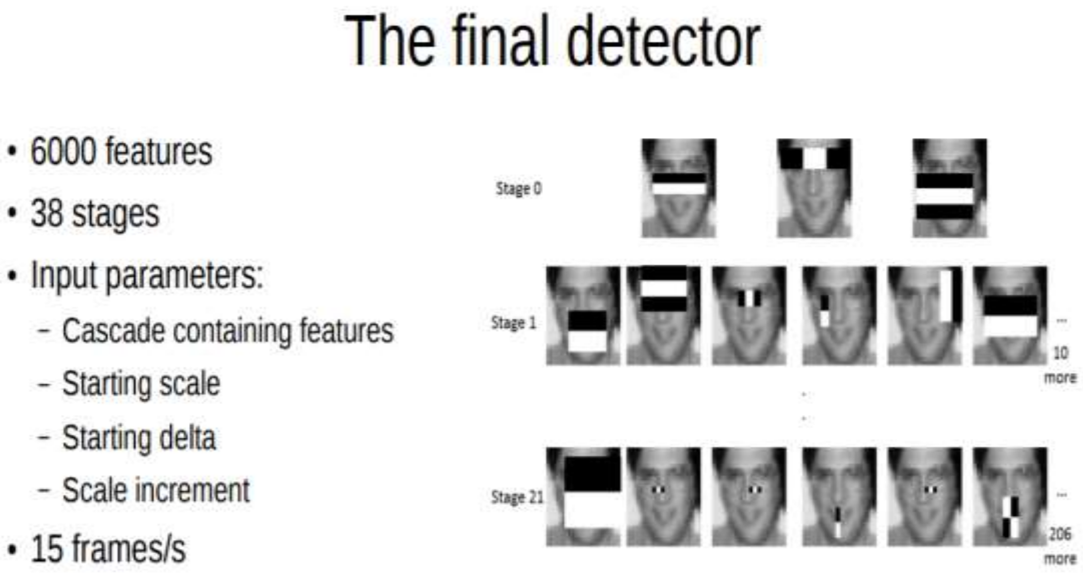
  - # stages
  - # features per stage
  - Threshold of each stage

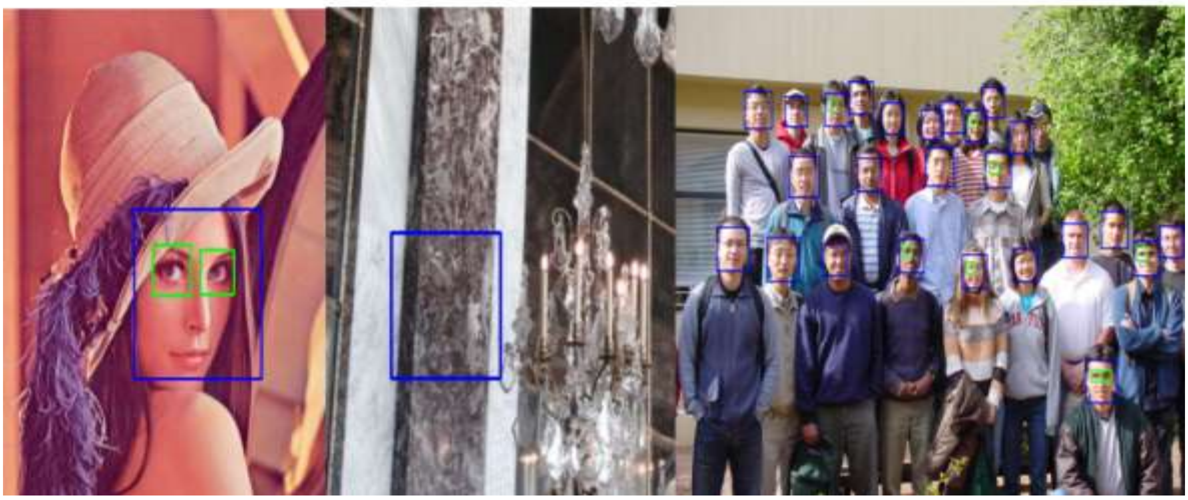
Select:

- Max. false positive / stage
- Min. true positive / stage
- Target overall false positive

Training the Cascade

- User selects values for f, the maximum acceptable false positive rate per layer and d, the minimum acceptable detection rate per layer.
- User selects target overall false positive rate, F_{target}.
- P = set of positive examples
- N = set of negative examples
- $F_0 = 1.0$; $D_0 = 1.0$
- $i = 0$
- while $F_i > F_{target}$
  - $i \leftarrow i + 1$
  - $n_i = 0$; $F_i = F_{i-1}$
  - while $F_i > f \times F_{i-1}$
    - $n_i \leftarrow n_i + 1$
    - Use P and N to train a classifier with n_i features using AdaBoost
    - Evaluate current cascaded classifier on validation set to determine F_i and D_i.
    - Decrease threshold for the ith classifier until the current cascaded classifier has a detection rate of at least $d \times D_{i-1}$ (this also affects F_i)
  - $N \leftarrow \emptyset$
  - If $F_i > F_{target}$ then evaluate the current cascaded detector on the set of non-face images and put any false detections into the set N





3.2. code: Harr-cascade Detection in OpenCV

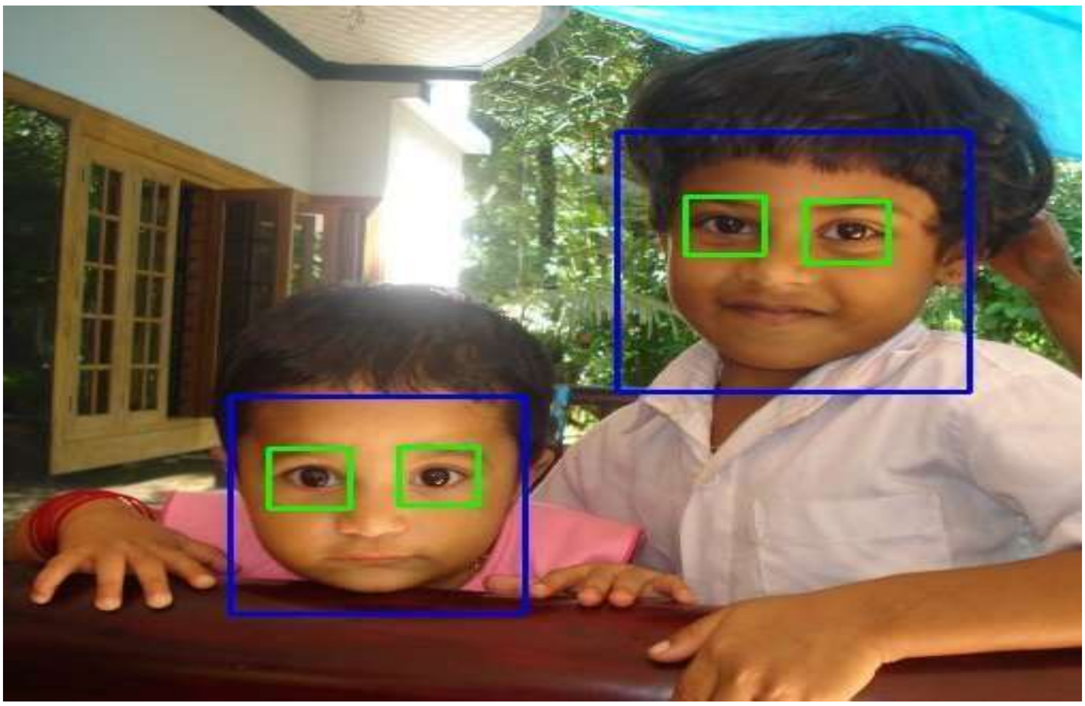
First we need to load the required XML classifiers. Then load our input image(or video) in grayscale mode.

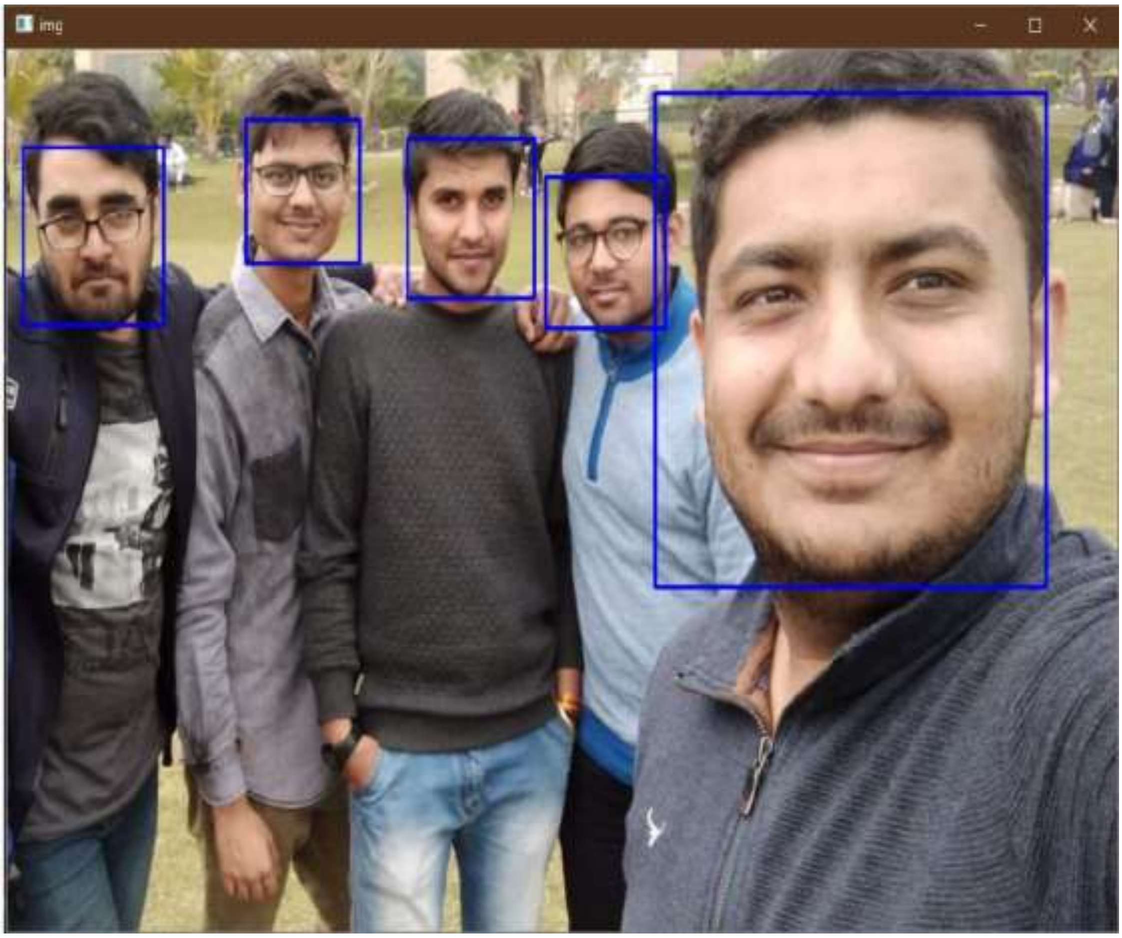
```
import numpy as np
import cv2

face_cascade = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')
eye_cascade = cv2.CascadeClassifier('haarcascade_eye.xml')

img = cv2.imread('sachin.jpg')
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
```

Now we find the faces in the image. If faces are found, it returns the positionsof detected faces as Rect(x,y,w,h). Once we get these locations, we can create a ROI for the face and apply eye detection on this ROI (since eyes arealways on the face !!!).

```
faces = face_cascade.detectMultiScale(gray, 1.3, 5)
for (x,y,w,h) in faces:
img = cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),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)
for (ex,ey,ew,eh) in eyes:
cv2.rectangle(roi_color,(ex,ey),(ex+ew,ey+eh),(0,255,0),2)

cv2.imshow('img',img)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

Result




img

3.3 CODE : FACE RECOGNITION

CODE

```
import face_recognition as fr
import os
import cv2
import face_recognition
import numpy as np
from time import sleep


def get_encoded_faces():
    """
    looks through the faces folder and encodes all
    the faces

    :return: dict of (name, image encoded)
    """
    encoded = {}

    for dirpath, dnames, fnames in os.walk("./faces"):
        for f in fnames:
            if f.endswith(".jpg") or f.endswith(".png"):
                face = fr.load_image_file("faces/" + f)
                encoding = fr.face_encodings(face)[0]
                encoded[f.split(".")[0]] = encoding

    return encoded


def unknown_image_encoded(img):
    """
    encode a face given the file name
    """
    face = fr.load_image_file("faces/" + img)
    encoding = fr.face_encodings(face)[0]

    return encoding


def classify_face(im):
    """
    will find all of the faces in a given image and label
    them if it knows what they are

    :param im: str of file path
    :return: list of face names
    """
```

```
    faces = get_encoded_faces()
    faces_encoded = list(faces.values())
    known_face_names = list(faces.keys())

    img = cv2.imread(im, 1)
    # img = cv2.resize(img, (0, 0), fx=0.5, fy=0.5)
    # img = img[:,:,::-1]

    face_locations = face_recognition.face_locations(img)
    unknown_face_encodings = face_recognition.face_encodings(img, face_locations)

    face_names = []
    for face_encoding in unknown_face_encodings:
        # See if the face is a match for the known face(s)
        matches = face_recognition.compare_faces(faces_encoded, face_encoding)
        name = "Unknown"

        # use the known face with the smallest distance to the new face
        face_distances = face_recognition.face_distance(faces_encoded, face_encoding)
        best_match_index = np.argmin(face_distances)
        if matches[best_match_index]:
            name = known_face_names[best_match_index]

        face_names.append(name)

        for (top, right, bottom, left), name in zip(face_locations, face_names):
            # Draw a box around the face
            cv2.rectangle(img, (left - 20, top - 20), (right + 20, bottom + 20), (255, 0, 0), 2)

            # Draw a label with a name below the face
            cv2.rectangle(img, (left - 20, bottom - 15), (right + 20, bottom + 20), (255, 0, 0),
cv2.FILLED)
            font = cv2.FONT_HERSHEY_DUPLEX
            cv2.putText(img, name, (left - 20, bottom + 15), font, 1.0, (255, 255, 255), 2)

    # Display the resulting image
    while True:

        cv2.imshow('Video', img)
        if cv2.waitKey(1) & 0xFF == ord('q'):
            return face_names


print(classify_face("test2.jpg"))
```

DATA BASE:-

```
var blockList =
 [];var waitList
 = [];
 var list1 = []; //test list
app.post('/postUid', function
(req, res) {var uid1 =
req.body.uid1;
var uid2 =
 req.body.uid2;var
 uid3 = req.body.uid3;
 var value1 =
req.body.value1;var
value2 =
req.body.value2;
var value3 = req.body.value3;

function
timeOutBlockList(listElement){setTimeout(fu
nction(){
var listPos = blockList.indexOf(listElement);

console.log(new Date(),'BlockList: To be removed From block list:',li stElement);

 // blockList[listElement] = 'False'; // to set value to this eleme
nt. blockList.splice(listPos,1); // to remove this element.
//console.log(new Date(),'New block list',blockList);
}, blockTime);

}

function
 timeOutDisplayList(listPos,uid,waitTime){ set
 Timeout(function(){
console.log(new Date(),'DisplayList: To be emptyed:
position: ', listPos);
  if (displayList[listPos].uid === uid ) {

 if (displayList[listPos].stat ===
 'Replaceable')
 {displayList[listPos].stat = 'Empty';
 } request.post({url:'http://localhost:3000/postUinfo', form: {slot:di
splayList[listPos].slot,uid:'',
imgSrc:displayList[listPos].imgSrc,username:
displayList[listPos].username, title:displayList[listPos].title}}, function (e
rr,response, body)
{

if (err) {

 return console.error(err);
```

```
} else {
 console.log(new Date(),"Timeout DL, post to SSE sucesss",listPo s,uid); } });

 // to set value to this element.
 //displayList.splice(listPos,1);
 // to remove this element.

 //console.log(new
Date(), 'New display
list',displayList); }
 else { console.log(new Date(),uid," no longer on the display list") } },
 waitTime );

}
function
 addToDL(listPos,uid){ display
 List[listPos].stat = 'OnScreen';
 displayList[listPos].uid = uid;
// query the user info with UID
 var sqlStmt = 'SELECT uid, username, title from client_users where uid =
 \"' + uid + '\";';
//console.log(new Date(),sqlStmt);
connection.query(sqlStmt, function
(err, rows) {if (err) {
// throw err;
console.log(new
Date(),err);
} else { if (rows.length > 0) {
console.log(new Date(),'DB query result: ',
 rows[0].uid, rows[0].username, rows[0].title);
 displayList[i]
=
{uid:rows[0].ui
d, slot : i+1,
 imgSrc:'userimg/'+rows[0].uid +
'.jpg',
username:rows[0].username,
title:rows[0].title
};

request.post({url:'http://localhost:3000/postUinfo', form: {slot:di
splayList[i].slot,uid:displayList[i].uid, imgSrc:displayList[i].imgSrc,userna
me:displayList[i].username, title:displayList[i].title}}, function (err,respo nse,
body)
```

```
{ if (err) { return console.error(err);
} else {
console.log(new Date(),"Add to DL: Post to SSE sucesss",listPo s,uid); } });
// below is the one without handle exception where sse is down.
//request.post('http://localhost:3000/postUinfo').form({slot:displa
yList[i].slot,uid:displayList[i].uid, imgSrc:displayList[i].imgSrc,username:d
isplayList[i].username, title:displayList[i].title}); }
else { console.log(new Date(),'User not in database: ', uid1);
}
}
});
oneSecFunc(listPos,uid);
}
function oneSecFunc(listPos,uid)
{setTimeout(function(){
if (waitList.length >
0) { var wl1 =
waitList.shift();
console.log(new Date(),listPos, " is picking from waitlist for ",wl 1);

// play out animation, about 500
displayList[listPos].stat =
'pickedUpfromWL';
timeOutDisplayList(listPos,uid,0);
//-- wrong --
setTimeout(addToDL(listPos,wl1),500);
console.log(new Date(),wl1,' will be added
to DL'); setTimeout(function
(){addToDL(listPos,wl1);},500);
} else {
displayList[listPos].stat = 'Replaceable';
timeOutDisplayList(listPos,uid,displayTime -
1000);
}

} , 1000);

}

// blockList.push(uid1);
//test if (value1 > yz1) {
if (blockList.includes(uid1)) {
```

```
console.log(new Date(),"Uid1 already in BlockList. Uid1 is: ", uid1);
} else {
console.log(new Date(),"Uid1 not in BlockList. Uid1 is: ", uid1);
// add this user to
block list
blockList.push(uid1);
timeOutBlockList(uid1);
// add this user to display list var
displayed = false; for (var i=0;
i<displayList.length; i++)
{ if(displayList[i].stat ===’Empty’){
console.log(new Date(),”Display on Display
list index:”,i); addToDL(i,uid1);
displayed =
true; break;
}
}
// Add a waitDisplayList to handle
displayed = false console.log(new
Date(),'Displayed?: ', displayed); if
( displayed == false ) {
var pushed = false;
for (var i=0; i<displayList.length; i++) {
if (displayList[i].stat === 'Replaceable')
{ console.log(new Date(),"Push to Display
list index: ",i);
timeOutDisplayList(i,displayList[i].uid,0);
displayList[i].stat = "waitForPush"
setTimeout(function
(){addToDL(i,uid1);},500); pushed = true;
break;
}
}
console.log(new Date(),'Pushed?: ',
pushed); if ( pushed == false ) {
waitList.push(uid1);
console.log(new Date(),'Current wait list',waitList);
}
}
```

```
//console.log(new Date(),displayList)
}
} else {
console.log(new Date(),"Largest value lower than ",yz1);
}
res.send('Got a POST request:: ' + JSON.stringify(req.body) );
})
app.get('/getUinfo', (req, res) => res.send(JSON.stringify(displayList)))
```

Output:-

```
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 390.48                 Driver Version: 390.48                    |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|===============================+======================+======================|
|   0  GeForce GTX 1050    Off  | 00000000:01:00.0 Off |                  N/A |
| N/A   59C    P0    N/A /  N/A |   1972MiB /  4042MiB |     99%      Default |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                       GPU Memory |
|  GPU       PID   Type   Process name                             Usage      |
|=============================================================================|
|    0      1037      G   /usr/lib/xorg/Xorg                            78MiB |
|    0      1223      G   /usr/bin/gnome-shell                          68MiB |
|    0      2206      C   /home/u18/anaconda3/envs/fastai/bin/python  1815MiB |
+-----------------------------------------------------------------------------+
```

```
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 390.48                 Driver Version: 390.48                    |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|===============================+======================+======================|
|   0  GeForce GTX 1050    Off  | 00000000:01:00.0 Off |                  N/A |
| N/A   35C    P8    N/A /  N/A |    147MiB /  4042MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                       GPU Memory |
|  GPU       PID   Type   Process name                             Usage      |
|=============================================================================|
|    0      1037      G   /usr/lib/xorg/Xorg                            78MiB |
|    0      1223      G   /usr/bin/gnome-shell                          68MiB |
+-----------------------------------------------------------------------------+
```

3.4 Tool and Technology Used

PYTHON

Python is most popular language with wide library. Python is an interpreted high-level general-purpose programming language. Its design philosophy emphasizes code readability with its use of significant indentation. Its language constructs as well as its object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.

SMTP LIBRARY

The smtplib module defines an SMTP client session object that can be used to send mail to any Internet machine with an SMTP or ESMTP listener daemon. An SMTP instance encapsulates an SMTP connection. It has methods that support a full repertoire of SMTP and ESMTP operations.

COMPUTER VISION

Computer vision is a field of artificial intelligence that trains computers to interpret and understand the visual world. Using digital images from cameras and videos and deep learning models, machines can accurately identify and classify objects — and then react to what they “see.”

Chapter-4
Planning and Problem formulation

4.1Complete Work Plan Layout

We applied a four-step research approach. We

Step 1: Identified relevant publications.

Step 2: We then analyzed the identified publications

Step 3: Grouping benefits as well as disadvantages

Step 4: Mapping the related studies

- **Data Collection**

For the identification of publications addressing in educational environments , we searched potentially relevant papers to match the following search pattern in title, abstract, or keywords. The publications were analyzed with regard to our inclusion and exclusion criteria .

We limited the results to empirical works since we aimed to gain insights into benefits of applied systems and benefits in real-world scenarios. Additionally, we aimed to ensure, that the benefits we found were not only results of theoretical thoughts, but proved in real-world scenarios.

- **Data Analysis**

We collected information about the mentioned benefits and merged similar benefits into a single one. To improve clarity and to find semantically coherent groups, the benefits were clustered into categories if they were logically related to the sa

4.2.Formulation of Problem

- Power and Energy

Like all electric systems, power sources are one of the major limitations for robotics. In practice, the usefulness of a mobile, autonomous robot is largely dictated by its battery's power, size and weight. A battery with long longevity will be large and heavy, but a small battery will have a limited lifespan.

- Higher Maintenance and Installation Costs

  Unlike digital and software-based automation which may be setup with minimal overhead, making the switch from a conventional workforce to a robotic one often entails considerable expense. While commercial and industrial-grade equipment will no doubt fall in price as it becomes more commonplace, the total costs needed to bring automation into a working environment continues to create obstacles for smaller organizations and those that have only limited financial resources. Purchase,installation and long-term upkeep costs are all something that employers and business owners would do well to consider carefully prior to investing in the resources needed to automate even small-scale workflow processes.

- Enhanced Risk of Data Breach and Other Cybersecurity Issues

  Replacing conventional workers with software applications or equipment that may be accessed wirelessly may result in an increased risk of a data breach. Enhanced automation is not without risk and businesses that utilize smart-devices and computer controlled equipment to manage or perform the bulk of their operations and workflow can often become an inviting target. While new digital technologies thatwill be able to address security concerns will continue to be developed, businesses that elect to automate without addressing safety concerns and those who fail to make digital security a top priority could be making a costly misstep.

- Reduced Flexibility

  While a robotic workforce may have vastly improved efficiency, enhanced productivity is not without its cost. Automated equipment is often very limited in termsof its scope of use and businesses that need to quickly respond to changing circumstances or new developments may find themselves at a real disadvantage.
  While employees may be able to shift their focus and attention without issue, an automated workflow process may be little more than a liability should change occurtoo quickly.

- Navigation and exploration
  Robotics has moved ahead in leaps and bounds in navigation and exploration, with autonomous robots advancing rapidly thanks to developments in path planning, obstacle avoidance and environment mapping. However, the challenges will only increase as we use robots more and more to explore hostile places. In the future, robots will be required to operate in environments that are not only undiscovered, but that the very nature of the environment is not well understood.

- Social interaction
  Social interaction is one of the most complex of human behaviours. However, it is one that because we're so adept at recognising and interpreting social behaviour and norms, we underestimate its actual complexity. There is so much nuance, rapid changes and unconscious social cues that we innately pick up, that it is argued our understanding of human social interaction is less understood than Newtonian mechanics or even human visual perception.

- Accuracy
  It is how closely a robot can reach a commanded position. Robotic inaccuracy is attributed to several error sources, which are divided into three main categories: Active joint errors, kinematic errors and non-kinematic errors. By active joints, we refer to the articulated and actuated joints of a robot, since some joints are articulated but not actuated, for example in parallel robots, these are called passive joints.

- Enhanced Risk of Data Breach and Other Cybersecurity Issues
  Replacing conventional workers with software applications or equipment that may be accessed wirelessly may result in an increased risk of a data breach. Enhanced automation is not without risk and businesses that utilize smart-devices and computer controlled equipment to manage or perform the bulk of their operations and workflow can often become an inviting target. While new digital technologies that will be able to address security concerns will continue to be developed, businesses that elect to automate without addressing safety concerns and those who fail to make digital security a top priority could be making a costly misstep.

- Reduced Flexibility
  While a robotic workforce may have vastly improved efficiency, enhanced productivity is not without its cost. Automated equipment is often very limited in terms of its scope of use and businesses that need to quickly respond to changing circumstances or new developments may find themselves at a real disadvantage. While employees may be able to shift their focus and attention without issue, an automated workflow process may be little more than a liability should change occur too quickly

Chapter-5
Result and Discussion

1. Is facial recognition racially biased?
Demographic differences in facial recognition accuracy rates have been well-documented, but the evidence suggests that this problem will disappear as the technology improves.

The most thorough investigation of the demographic effects of facial recognition was conducted by the National Institute of Standards and Technology (NIST) in 2019. NIST found that a majority of algorithms exhibited significant demographic differences in accuracy rates. However, NIST also came to several encouraging conclusions. The first is that differences between demographic groups were far lower for algorithms that were more accurate overall. This means that as facial recognition systems continue to improve, the effects of bias will be reduced. Even more promising was that some algorithms demonstrated no discernible bias whatsoever, indicating that bias can be eliminated entirely with the right algorithms and development processes.

One of the most important factors in reducing bias appears to be the selection of training data used to build algorithmic models. If facial recognition algorithms are trained on datasets that contain very few examples of a particular demographic group, the resulting model will be worse at accurately recognizing members of that group. This may be why NIST found that some algorithms developed in China performed better on Asian faces. EU proposals for regulatory frameworks for facial recognition include requirements that training data reflect "all relevant dimensions of gender, ethnicity and other possible grounds of prohibited discrimination." This is a useful precedent for the United States.

In addition to better training data, demographic differences can also be reduced by improving the quality of the images being captured. An assessment of 11 commercial facial recognition systems by the Department of Homeland Security (DHS) found that the skin reflectance was a better predictor of accuracy differences than the self-reported race of the subjects. This indicates that higher-quality cameras and better image capture could make a difference in eliminating bias. Like NIST, DHS found that the most accurate algorithms had an almost negligible demographic effect, further supporting the conclusion that improvements in algorithm and hardware quality will reduce bias in these systems.

2. Does the use of facial recognition increase the risk of false arrest?
To date, there have been three reported instances of false arrests that were based in part on facial recognition out of roughly 10 million arrests annually. In these cases, facial recognition was used to analyze footage of a crime and generate a suspect or list of suspects based on a comparison with criminal databases or ID registries. The results of this analysis were then turned over to investigators, who asked witnesses to corroborate the matches. In the cases of Robert Williams, Michael Oliver, and Nijeer Parks, both the facial recognition analysis and subsequent witness corroborations were incorrect and led to their arrests.

These instances are obviously regrettable, and more should be done to prevent similar errors from occurring in the future. But critics citing these cases often gloss over the role that human operators and witnesses had in confirming the findings of the facial recognition systems and seem to imply that the alternative—identification by humans alone—is a superior and less biased way to achieve the same results. This does not seem to be the case, because there are thousands of false arrests not based on facial recognition.

U.S. jurisdictions using the technology do not consider a positive match in a facial recognition system as sufficient to justify an arrest. Police only use facial recognition to generate leads on potential suspects. These leads have to be followed up on with additional evidence gathering and corroboration with witnesses before they can be used to justify taking someone into custody. The New York Police Department, for example, stated that in its investigations, “No one has ever been arrested based solely on a positive facial recognition—it is a lead, not probable cause.” Similarly, the Department of Justice declared that “the FBI uses the technology to produce investigative leads, but nothing more.”

The most valuable lesson to be learned from the three known instances of false arrests is how important better training and procedures are for human investigators to reduce the risk of misidentification from low-quality searches or “automation bias,” which is the propensity for humans to prefer information from automated systems and ignore contradictory information. In the case of Robert Williams, for example, police used an extremely low-quality image to identify potential suspects, and the arrest was made after Mr. Williams was identified in a line-up by a contractor who had only seen the grainy security camera footage of the crime.

3. Is facial recognition accurate enough for law enforcement use?

The answer to this question depends on what kind of use is envisioned and whether there are clear rules governing that particular use of facial recognition.

Facial recognition technology has improved rapidly over the past several years. In ideal conditions, facial recognition systems have extremely high accuracy. As of December 2020, the best face identification algorithm has an error rate of just 0.1 percent. This degree of accuracy requires consistency in the images’ lighting and positioning and ensuring that the facial features of the subjects are clearly visible and not obscured.

In real-world deployments, accuracy rates can be much lower. NIST’s 2017 Face in Video Evaluation (FIVE) tested algorithms’ performance when applied to video captured in settings like airport boarding gates and sports venues. The test found that when using footage of individuals walking through a sporting venue—a challenging environment where it is difficult to capture clear images of the subjects—the algorithms being tested had accuracies ranging between 36 percent and 87 percent, depending on camera placement.

The NIST results demonstrate a major issue with facial recognition accuracy—the wide variation between vendors. The top algorithm achieved 87 percent accuracy at the sporting venue, but the median algorithm achieved just 40 percent accuracy, with both algorithms using imagery from the same camera. NIST’s more recent tests have found that some facial recognition providers on the market may have error rates orders of magnitude higher than the leaders.

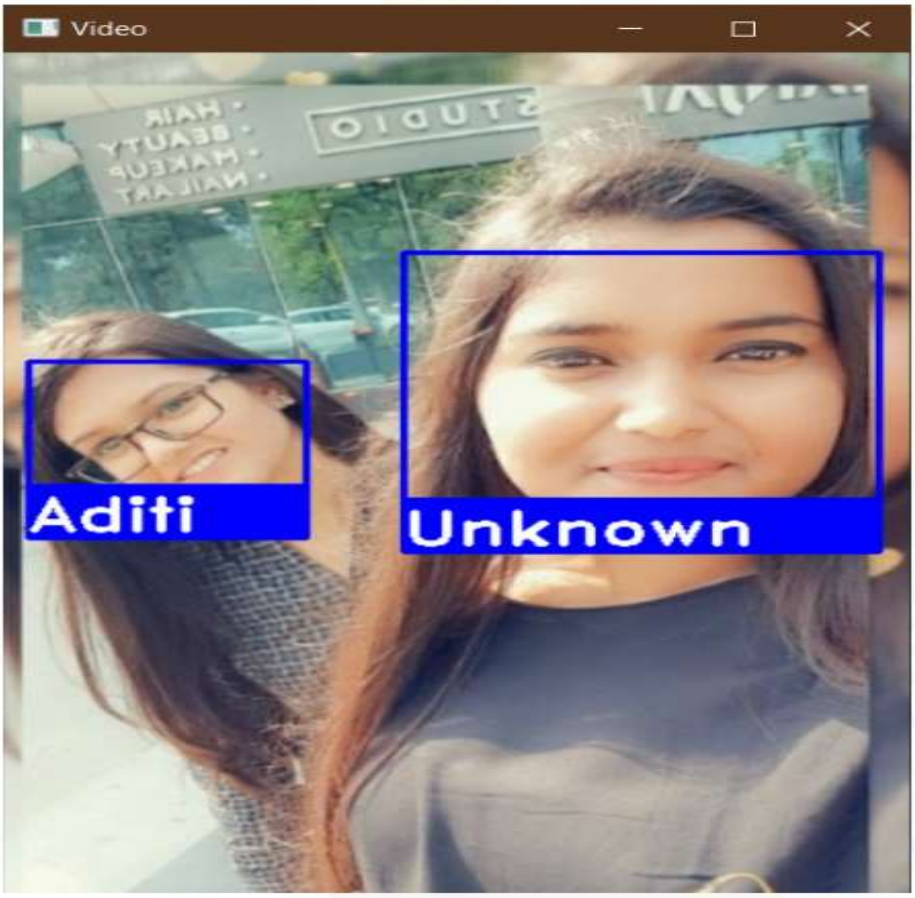
While a few leading vendors have developed powerful, highly accurate facial recognition algorithms, the average provider still struggles to achieve similar reliability. This makes it difficult to come to general conclusions—either positive or negative—about the accuracy of facial recognition. Given the differences among systems, policymakers need to consider the circumstances of deployment and the algorithm being used to fully understand risk.

Stronger safeguards on facial recognition use are necessary. Legislation can clarify the standards required for different law enforcement use cases, including real-time monitoring, retroactive identification, and recognition based on body cams or images taken using mobile devices. Guidelines on when different sources of images, including arrest photo databases or state or federal identification databases, can be used for criminal investigations are needed.

Results:-

Face Detection:-

Face Recognition:-



Chapter 6
Conclusion

Face recognition technology is often associated with high- end secure applications. Today the basic technology has evolved and the cost of equipment has dropped dramatically due to the deviation and growing processing power. Some face recognition applications are now more expensive, reliable, and more accurate. As a result there are no technical or financial constraints to go down from the pilot project to the general deployment.

Face recognition technology has come a long way in the last twenty years. Today, machines are able to automatically verify identity information for secure transactions, for surveillance and security tasks, and for access control to buildings etc. These applications usually work in controlled environments and recognition algorithms can take advantage of the environmental constraints to obtain high recognition accuracy. However, next generation face recognition systems are going to have widespread application in smart environments -- where computers and machines are more like helpful assistants.

To achieve this goal computers must be able to reliably identify nearby people in a manner that fits naturally within the pattern of normal human interactions. They must not require special interactions and must conform to human intuitions about when recognition is likely. This implies that future smart environments should use the same modalities as humans, and have approximately the same limitations. These goals now appear in reach -- however, substantial research remains to be done in making person recognition technology work reliably, in widely varying conditions using information from single or multiple modalities.

REFERENCES

[2]. www.biometricgroup.com/wiley
[3]Biometrics- identify verification in a networked world by Samir Nanavati, Micheal Thieme and Raj Nanavati.
[2]History- www.biometrics.gov.
[4]www.facereg.com
[4]www.Imagestechnology.com
[2]. Intelligent Biometric Techniques in Fingerprint and Face Recognition 1999
By I. Hayashi, Lakhmi C. Jain, S.B. Lee, Shigeyoshi Tsutsui, Ugur Halici
[5]. Face Recognition from Theory to Applictions 2012
By Francoise Fogelman Soulie, Harry Wechsler, Jonathon P.Phillips, Thomas S. Huang, Vicki Bruce
[5] Face Recognition Semisupervised Classification, Subspace Projection and Evaluation Methods 2016
By S. Ramakrishnan
[5] Face Recognition: A Literature Review January 2005
By Ahmad TolbaMansoura University,
Ali El-BazDamietta University,
Ahmed A El-HarbyDamietta University
[4]. Face Recognition: A Literature Review
A.S. Tolba, A.H. El-Baz, and A.A. El-Harby