Face Detection and Recognition

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Abstract- ***There normally exist many styles of versions in face picture taken beneath out of control conditions, including adjustments of pose, illumination, expression, etc. Most beyond face reputation (FR) studies has targeted on precise versions and has assumed the dearth of others. With the increase of video and image databases, there may be a extra want for wise structures to routinely understand and have a look at data, as doing so manually is turning into more and more more tough. People, or faces, are one of the maximum awesome gadgets that can be traced withinside the pictures while narrowing it right all the way down to one precise area. Face detection is turning into greater tough because the range of packages that rent it grows. It is first step withinside the approach of face identification, analysis, and detection of different facial traits. In this paper, Face detection, reputation set of rules are discussed***

I. INTRODUCTION

Facial reputation era is now a staple of smartphone security, at the side of the agree with antique PIN and an increasing number of tricky fingerprint scanners. While now no longer always greater stable than a fingerprint scanner, biometric thoughts like facial reputation have a tendency to be quicker and greater handy to use. Almost all smartphones put into effect this era today, as an opportunity to unlocking your smartphone with a PIN or fingerprint. This isn't secured. It best relies upon on the front going through digital digicam and a 2D facial reputation set of rules. We can without difficulty idiot the gadget with the aid of using the usage of the easy picture and we are able to release the smartphone. We need to use sturdy set of rules in detecting the face of a person. Different clever telephones paintings on distinct era which will release the mobile. The era within the Samsung Galaxy S8 is IRIS Scanning era. Samsung's Iris scanning era works with the aid of using figuring out the styles in iris the usage of infrared scanner. Just like fingerprints, Iris are particular to every person. Apple makes use of its new face ID era as a part of its Iphone X launch. A top first-class photograph offers higher reputation price than noisy snap shots. It is greater tough to extract capabilities from such noisy snap shots which in-flip reduces face reputation price. To triumph over issues happened because of low first-class photograph, pre-processing is carried out earlier than extracting capabilities from the photograph

II. USES

A. Unlock phones

Latest phones are coming with facial recognition. It is easy to unlock the phone using this feature. In case of mobile is stolen it is difficult for thief to stole the data.

B. Find Missing Persons

Face recognition may be used to discover lacking kids and sufferers of human trafficking. When lacking people are introduced to a database, regulation enforcement can come to be alerted as quickly as they may be identified via way of means of face reputation. More than 3000 kids have been identified in only four days in India the use of face reputation.

C. Help the blind

Listerine has created a pioneering facial popularity app that aids the visually impaired. This detects while others are smiling and vibrates the blind folks.

D. Identify People on social Media platform

When Facebook members appear in images, employs face recognition technology to instantly recognise them. This makes it easier for people to find photos in which they appear, and it also allows them to propose when certain persons should be tagged in photographs.

E. Protect schools from threat

When expelled kids, risky parents, drug dealers, or different folks that constitute a danger to high school protection input faculty grounds, face reputation surveillance structures can immediately pick out them.

F. Track School Attendance

Face recognition has the ability to grab kids' attendance in addition to create safe environment. In the past, attendance slips allowed college students to sign another kid in who turned into skipping class. Face reputation is already utilized in China to save your infant from skipping class. Their faces are scanned and as compared to their databases to affirm their Identity

III. MACHINE LEARNING

A proper begin for this paper is to realize approximately the gadget mastering. Machine mastering is a form of synthetic intelligence that makes use of software program programs to emerge as greater correct in predicting outcomes. Machine mastering algorithms use ancient statistics to expect the bran new outcomes

There are three kinds of learning in machine learning

1) Supervised learning: describes a class of problems that involves using a model to learn a mapping between input examples and the target variables.

There are two kinds of supervised learning problems

a) Classification: Supervised learning problems that involves predicting a class label
b) Regression: Supervised learning problems that involves predicting a numerical label

One or more input variables may be used in both classification and regression problems, and input variables can be of any data type, such as numerical or categorical.

2) Unsupervised learning: describes a class of problems that involves using a model to describe or extract relationships in data.

There are many types of unsupervised learning, although there are two main problems

a) Clustering: Unsupervised learning problem that involve finding groups in data.
b) Density Estimation: Unsupervised learning problem that involves summarizing the distribution of data.

3) Reinforcement learning: describes a class of problems where an agent operates in an environment and must learn to operate using feedback

When an environment is used, there is no preset training dataset; instead, an agent is given a goal or set of goals to attain, actions to take, and feedback on how well they are doing toward the goal.

IV. FACE DETECTION VS FACE RECOGNITION

Both the words sound similar. But both are different in their way. Face detection isn't like face recognition. Let us see how they both are different from each other.

Face detection is a process of detecting faces from an image or video or from a group of people that doesn't matter. Face detection doesn't do anything other than detecting faces. But Face recognition tells that whose face belongs to who. In other words, it will recognize faces and tells the names of persons.

To create an algorithm that identifies faces, we'll need some training data. We'll need to teach our machine how to detect faces and who they belong to. In this project we are going to teach our systems how to detect and recognize the faces using code. There are two types of learnings in machine learning they are supervised learning and non-supervised learning.

There are two steps in recognition of a face. They are Face detection and recognition a face. Face recognition comes after detecting a face

V. FACE DETECTION

Computer vision technologies are deeply integrated to lifestyles of many people via Instagram filters and snapchat filters. They detect the face of a human first and it apply the filter regarding the face it detected.

One important application of computer vision technology is ability to have a computer detects the objects in the image. Among the objects detected

detecting human face receives more preference since it is used in security and entertainment.

We have to use algorithm to detect the face. In this paper we are going to see about the Viola-jones object detection framework.

A. Concept

It is developed by Paul Viola and Michael jones in 2001. The viola-jones object detection framework quickly and accurately detects the objects in image and works well with the human face. Despite its antiquity, the framework, like many of its CNN counterparts, is still a major player in face detection. To produce a quick and accurate object recognition system, the Viola-Jones Object Detection Framework incorporates the principles of Haar-like Features, Integral Images, the AdaBoost Algorithm, and the Cascade Classifier. To comprehend the framework, we must first comprehend each of these notions separately, then figure out how they interact to make the framework. Despite being an obsolete framework, Viola-Jones is highly effective, and its application in real-time face identification has proven to be particularly noteworthy.

There are two stages in viola-jones algorithm.

They are Training and detection.

- Detection

Viola-jones was designed for the faces which are facing front. So, it is able to detect the faces which are facing in front way rather than looking in sideways or upwards or downwards. The image is transformed to grayscale before detecting a face since it is easier to work with and there is less data to process. The Viola-Jones algorithm discovers the position on the coloured image after detecting the face on the grayscale image. This first outlines a box and searches for face. This box moves in a image from the left corner first and then it moves in every block.

B. Haar-Like Features

Haar-Like Features named after a Hungarian mathematician Alfred Haar in 19th century. These Haar-Like functions capabilities suggest a field with mild and darkish aspect, that is how gadget determines what the characteristic is. As withinside the fringe of a eyebrow, one aspect can be lighter than the alternative at times. The center area of the box may be shinier than the surrounding boxes, which can be mistaken for a nose. Rather than simply using their intensities (RGB values, etc.) in Computer Vision, features are frequently retrieved from input images. Haar-Like features are one such example. These Haar-Like features produce a single value by taking the sum of the intensities of lighter region and subtract by the sum of intensities of dark region. There are 3 different Haar-Like features

- Edge-features
- Line-features
- Four-sided features

These features help the machine to detect the what the image is. Consider how a black-and-white representation of a table's edge would seem. As you can see in the image above, one side will be lighter than the other, giving it a b&w effect.

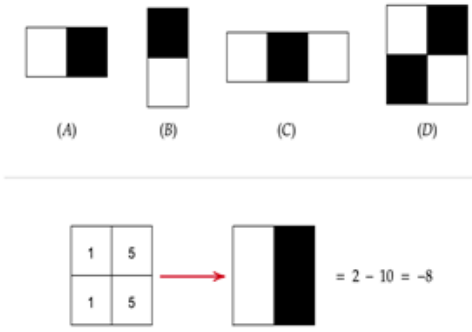


Fig 1: Haar-like features (top) and how to calculate them (bottom)

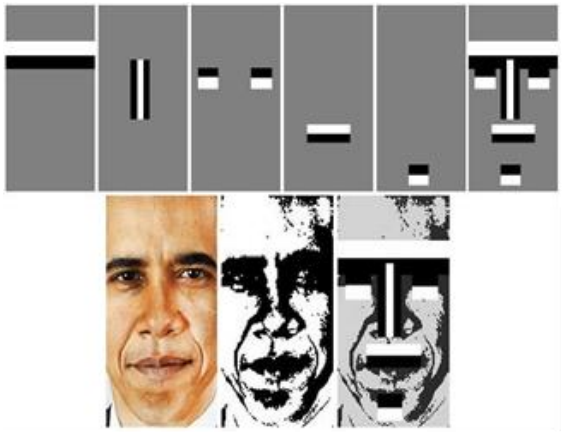


Fig 2: Haar-like features seeing in black and white

C. Integral Image

Computing rectangular features in a convolution kernel style can be long, very long. So Viola and jones proposed an intermediate representation of an image: the integral image. The integral image's purpose is to make it easy to compute any rectangular sum using only four values.

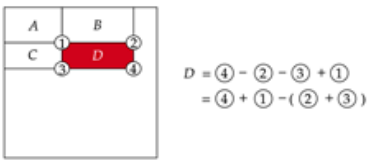


Fig3: How to calculate a rectangle region using an integral picture (top) and how to convert an original image to an integral image (bottom) (bottom)

An integral image is a representation of an image in which the value for location (x, y) on the integral image equals the sum of the pixels above and to the left (inclusive) of the original image's (x, y) location (Viola & Jones, 2001). This representation is essential because it allows calculation of rectangular region.

D. The AdaBoost Algorithm

Figure4: The AdaBoost algorithm's purpose is to extract the best features from a set of n features.

It is used to pick the capabilities from the available features. Algorithm output is a classifier called “Strong Classifier”. A Strong Classifier is made up of a series of “Weak Classifiers” that are connected in a linear fashion. On a high level, the algorithm runs for T iterations in order to find these weak classifiers, where T is the number of weak classifiers to find, which you set. It finds the error rate in each iteration and feature with low error is selected for that iteration.

E. The Cascade classifier

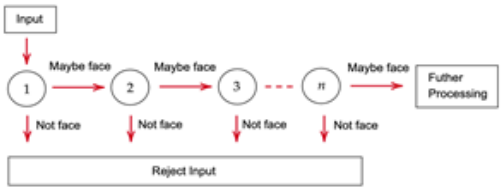


Figure 5: The cascade classifier

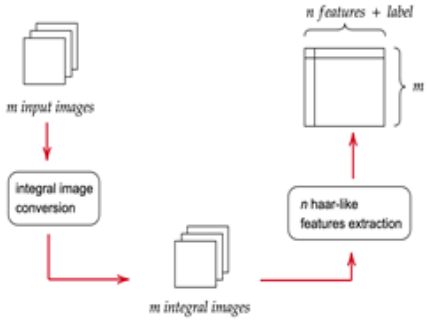
It is multi stage classifier. It performs detection quickly and accurately. Each stage consists of strong classifier. From one stage to another number of week classifiers in strong classifier increases. If a classifier for a particular step returns a negative result, the input is immediately rejected. If output is positive then it is transformed to next stage.

- Training

The purpose of this step is to create a face Cascade Classifier that can accurately categorise a face while swiftly excluding non-faces. To do so, you must first prepare your training data, and then use a modified AdaBoost Algorithm on that data to build a Cascade Classifier.

1) Data preparation

Concepts: Integral features + Haar-like features

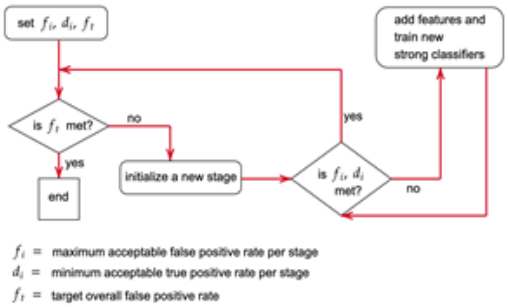


assuming you have a training set of positive samples (faces) and negative samples (non-faces), is to extract features from those sample images. Over 160,000 Haar-like features can be extracted in a 24 × 24 window since each sort of Haar-like feature might

have varied sizes and placements. Nonetheless, all 160,000+ Haar-like features must be estimated at this point. Thankfully, the development of Integral Images has aided in the speeding up of this process. The full data preparation procedure is depicted in above picture.

2) Constructing a cascade classifier with a modified AdaBoost algorithm

Concepts: AdaBoost algorithm + the cascade classifier



Using all 1,60,000+ features directly is computationally difficult. Viola and jones proposed two solutions to solve this difficulty. Firstly, reduce features to handful of useful features. Second, Divide the remaining features into stages and assess each input one by one (in a cascade) method.

VI. FACE RECOGNITION

For human beings finding faces is very simple task and there is no effort in doing this. It is simple task for us but it is difficult for computer, as it has many variables that can damage the accuracy.

There are different types of facial recognition algorithms. They are

1. Eigenfaces
2. Local Binary Patterns Histograms
3. Fisher faces
4. Scale invariant feature transform
5. Speedup robust features

From the above types of algorithms, we will discuss about Eigenfaces algorithm as it is easy to implement and it is less expensive. In order to use this, the face my be a centered face and this algorithm is lightining, shadow, scale of image sensitive.

A. Eigenface using OpenCv

In this we will discuss about Eigenface. It is an application of Principal Component analysis (PCA) For human faces

Eigenfaces are photos that may be introduced to a mean (average) face to create new facial photos.

We can mathematically write as:

$$F = F_m + \sum_{i=1}^{n} \alpha_i F_i$$

F is a new face
Fm is the mean
Fi is an eigenface

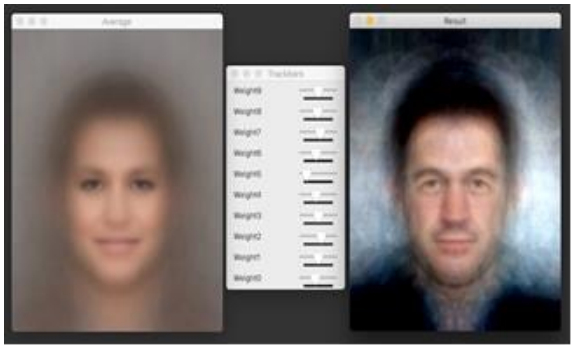


Figure 5: left is the mean image and in the right side a new face produced by adding 10 Eigenface with different weights

Eigenfaces are calculated through estimating the predominant additives of the dataset of facial images. They are used in Face Recognition and Facial Landmark Detection.

B. An image as a vector

If we had collection of 2D or 3D data points, we can find the principal components. But how will we constitute a picture as a factor in a better dimensional space? Let us take an example

A color image of 100 **x** 100 is nothing but array of 100 **x** 100 **x** 3 numbers. usually, we call it as 3D array but we can think it as 1D array consisting of 30,000

elements. We can imagine an array of 3 numbers (x, y, z) as a3D space point

C. Steps to calculate Eigen faces

There are steps to calculate the Eigenfaces

1) Obtain a facial image dataset:
   In this step we have to collect different faces
2) Align and resize Images:
   Next we want to align and resize pictures so the middle of the eyes are aligned in all pictures. This may be accomplished through first locating facial landmarks. In the dataset all the images are of same size.
3) Create a data matrix:
   Create a data matrix that consists of all photos as a row vector.
4) Calculate mean vector:
   Before performing PCA we need to remove the mean vector. In our case mean vector is 30k x 1 row vector calculated by averaging all the rows of data matrix.
5) Calculate Principal components:
   The most important additives of this information matrix are calculated through locating the Eigenvectors of the covariance matrix. Fortunately, the PCA elegance in OpenCV handles this calculation for us. We simply want to deliver the data matrix, and out comes a matrix containing the Eigenvectors
6) Reshape Eigenvectors to obtain Eigenface:
   The obtained eigenvector will have length of 30K when our dataset contained images of size 100 X 100 X 3. To obtain Eigenfaces we can reshape these Eigenvectors into 100 X 100 X 3 images.

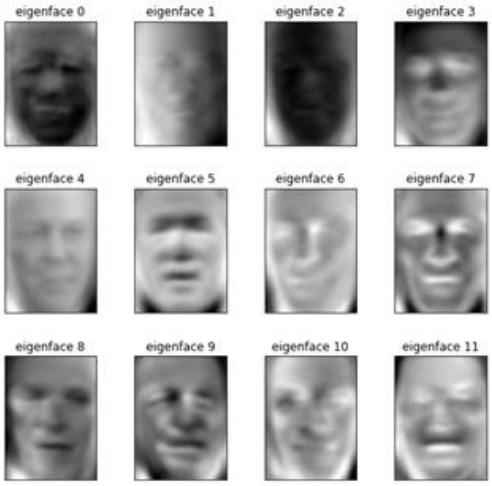


Figure 6: Eigenfaces

CONCLUSION

In this paper we learn about face detection algorithm and face recognition algorithm. In face detection algorithm there are 2 stages involved and face is detected by using Haar-like features, integral image, AdaBoost algorithm and cascade classifier. By using all above we will detect face but it will not recognize face. In order to recognize face, we will have another algorithm. By using Eigenface algorithm we will recognize who's face belong to who.

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