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Introduction to FERET Database and Facial Recognition using Local Binary Patterns

[1]Jagbir Singh
M.Tech Scholar,
Department of Computer Engineering,
Punjabi University, Patiala

[2]Er. Rakesh Singh
Assistant Professor,
Department of Computer Engineering,
Punjabi University, Patiala

1. Introduction to FERET database

Face recognition includes two basic testing procedures. It includes both facial identification and verification. Face identification involves the process of giving the unknown fresh face to the system and ask it if it can recognize the person from already available database (of multiple images) in the system. For verification purposes, biometric signatures are stored on smart card in advance before delivering those to the authenticated masses. These persons swipe their biometric card in the card reader and give system their fresh signature. Now, the system, in turn, will compare both the newly given signature by the claimed person with the signature stored in the biometric card. On the basis of the compared result, either the claimed person is considered authenticated or not.

Before FERET, people were dependent on limited database which was even less than 50 persons. Consequently, they tend to show more than 95% accuracy in their work. Till date, three different versions of FERET are introduced, the most recent among is SEPT, 1996 FERET database whose database was collected in 15 sessions right from 1993 to July 1996. It include images database with different forms, versions, and algorithms. FERET have made the research work implementation of the various researches in the face recognition fields. Different sets are used to make the identification and verification accurate by dealing with challenging situation[1].

fa: Set of images containing the frontal images

fb: Set of images containing the frontal images with different facial expression this time

fc: Set of images captured with the help of another camera and different lightning conditions

Duplicate I and II: Set of images usually captured at later times (generally an year); variance in scale, illumination of face, different facial expressions, Glasses on the eyes, by pulling the hair back,

By July 1996, a total of 14126 images were totally collected with 1196 individuals along with 365 duplicate sets of images. It contains two different sets i.e. Query Sets(denoted by qi) and Target Set(denoted by tk). Query set contains 3816 images of set fa, fb, fc along with some rotated and modified images to check the illumination and scale whereas target set contains 3323 images having set fa and fb only.

There exist two different kinds of algorithms for the images accepting method:

- Partial automatic algorithms: In these kinds of images, co-ordinates of the centre of eyes i.e. Iris part of the eye is given.
- Fully automatic algorithms: Only facial images are given.

FERET stands for Face Recognition Technology. Neglecting the results of facial identification which were summarized in previous papers; In another paper[2], the verification performance is reported. Result finally produced is based on images taken on same day, images taken on different days, images taken atleast after one year and images taken under different lighting conditions

For Verification, Image p claims to be image g in the gallery set (gallery is the collection of images of known images, probe is the unknown image that claimed to be image g and collection of such images is called probe set); which further will either get accepted or rejected. One image per person is there in the Gallery set nevertheless there can be more than one images of single person in probe set.

There exists two performance statistics; First is the verification probability (denoted by P_v) which is also called as hit rate and the second is False-alarm Rate (P_f) which is incorrectly verifying the claimed image. The verification is

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done on the basis of $S_i(k)$ i.e. if $S_i(k)<= c$, then the image is accepted otherwise it will be rejected.

Three steps have been followed for the verification by using 12 different algorithms to obtain the verification scoring procedure on four different categories as similar to SEPT 96 FERET identification. In the first step, there exists generation of set of partitions of the probe set which are further divided into two different sets i.e. D_i having verified images and F_i having non verified images. In the second step, computation of verification and false alarm rates for each gallery image g_i for a given cut off value c, is done. In the last step, computation of overall verification and false alarm rates is done.

It is checked that the FERET having great importance for recognition procedure. Even, the individual performance increase is demonstrated by the performance improvement of U.Maryland algorithm.

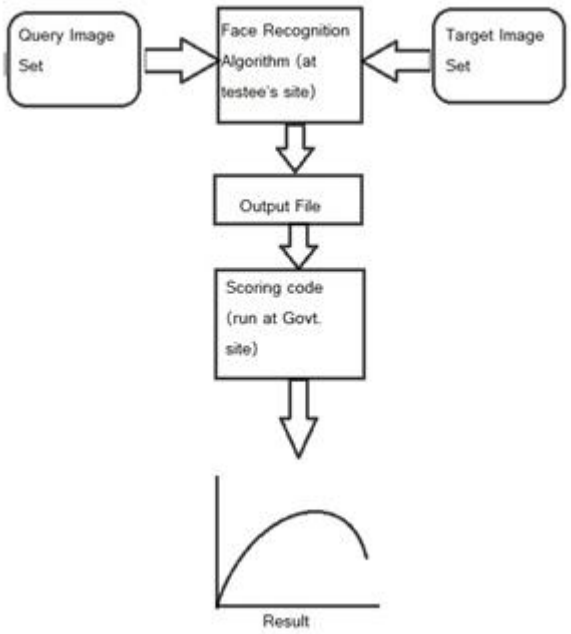

Fig. 1: Process of face recognition on FERET

2. Importance of face recognition

Face recognition has been growing rapidly in the past few years for its numerous uses in the areas of Law Enforcement, Biometrics, Security, and other commercial uses. Face recognition is the task of identifying an already detected object as a KNOWN or UNKNOWN face, and in more advanced cases, telling EXACTLY WHO'S face it is!. Automatic face recognition is all about extracting those meaningful features from an image, putting them into a useful representation and performing some kind of classification on them.

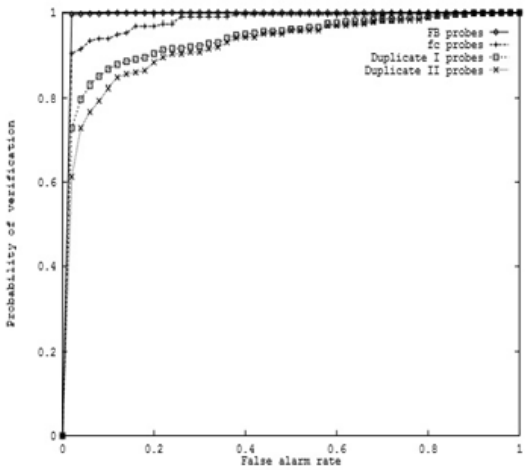

Fig. 7. Current upper bound on algorithm performance for each probe category.

Face recognition is an easy task for humans. To recognize an object certain steps must be taken. Information is received through the retina in the form of light. Visual processing occurs to organize the data by determining size, shape, contoured edges, and surface so that the information can be compared to other representations of objects in memory until recognition occurs. While first-order relational information is used in object recognition, second-order relational information is needed for facial recognition. If an individual only applied first-order relational information to facial recognition it would give him or her basic idea of what features were there and where they were located in relationship to each other. This would not be enough to distinguish one person from another as everyone has the same basic features. Second-order relational information takes the information from first-order relational information and compares it to an average face based on information each individual has accumulated on faces.

The ability to recognize faces is very important to many aspects of life. It not only helps us to recognize those close to us but also allows us to identify individuals we do not know so that we can be more aware of possible dangers. Facial recognition is a complex process that involves using knowledge and experience to set an average face to compare other faces too. The security of information is becoming very significant and difficult. Security cameras are presently common in airports, Offices, University, ATM, and Bank and in any locations with a security system. Face recognition is a biometric system used to identify or verify a person from a digital image. Face Recognition system is used in security. Face recognition system should be able to automatically detect a face in an image.

3. Introduction to Face recognition

Face recognition by a computer system is the most exciting and even interesting application of the image analysis. Face

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is the most distinct body part of human and is the most widely used part for the biometric classification too. Each and every person in the world is having different face with distinct expression on it from others. Face recognition can be done for verification i.e. the proposed image is observed with the original stored image. Obviously it moves to some threshold value in order to give the desired result (in most ideal case). On the other hand, it can also be used for recognizing a single particular face from a bulk of faces which may be for security purpose or for identification purposes. The system returns a value which is a measure for the similarity between the images.

Face is one of the most important biometric features of the human beings. Recognizing the face of a particular person by another person is not a difficult task but it is in real a difficult task for a system to recognize someone's face. This might be the reason why face recognition area is most widely used in various applications of security and surveillance. There are three phases into which the process of identification lies and these are:-

1. **Registration and normalization**: In this phase the original image is transformed i.e., scaled and rotated till the accurate position as the images from the stored database. For example; the nose tip position should be at the same place in each pixel to compare them perfectly. Even in this case, there exists certain problem factors like illumination differences.
2. **Feature Extraction:** In the feature extraction Phase, some distinct features are extracted from the image in order to store them in the database for future reference. These features include shape, colour, texture, size , position and spatial configuration of the face or its components
3. **Classification:** By the help of these obtained features, the image is compared with the stored images from the database and this is done in the classification phase. The output of the classification phase is the highest matching score of both the images. There assigned a threshold value too for determining whether the differences are small. Expression categorisation is performed by the classifier.

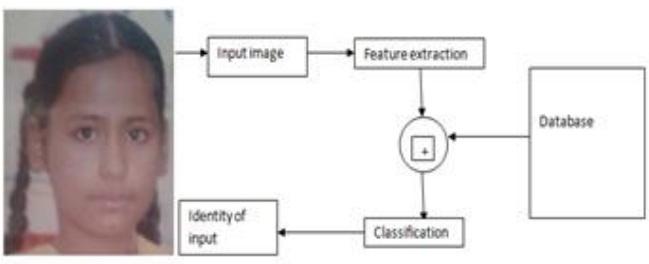

Figure. 7 Process involves in Recognition of an image from the database

Face recognition is used for two basic tasks:

1. **Verification:** it is a one to one matching showing whether the claimed image is having similarity to the original image based on colour , textual, position and so on
2. **Identification:** A Particular image is matched from the database having a bulk of image and an attempt to recognize the image from that bulk of image have been made.

4. Face recognition algorithms

In the Recent years, a lot of attention had been given to facial image analysis while talking about the area of computer vision and image processing that generally contain face detection, face recognition. There involves two crucial aspects in computer recognition of face images: Facial feature representation and classifier design.

It is important to extract the distinguish feature from the original face for further recognition. If the features extracted from the face are adequate, even the best classifier will remain fail to accurately recognize that particular face further. Therefore, discriminative facial features should be extracted from the original face and focus should also be given to extract the low dimension part of the image to avoid computationally expensive classifiers.

Many algorithms have been applied to describe the face recognition process that include PCA(Principal Component Analysis), LDA(Linear Discriminate Analysis). Recently Gabor Filters based representations have been introduced for outstanding performance for facial image analysis. Nevertheless, it is computationally excessive to convolve the facial images with the usage of Gabor filters. The new operator i.e. Linary Binary Pattern have overcome these drawbacks up to several extent. LBP was originally introduced for the texture description and has been used widely for various fields.

a) PCA

PCA is a useful statistical technique that is helpful in the area of face recognition and image compression, and it a very useful technique for finding patterns of the high dimensional image.[3] The basic process under PCA is to minimize the large dimensionality of the data space(observed variables) to the smaller intrinsic dimensionality of feature space (independent variables). PCA includes following steps:

1. Calculate the Variance , Calculate and form covariance matrix

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2. Calculate Eigenvectors and Eigen values and choose feature vector.

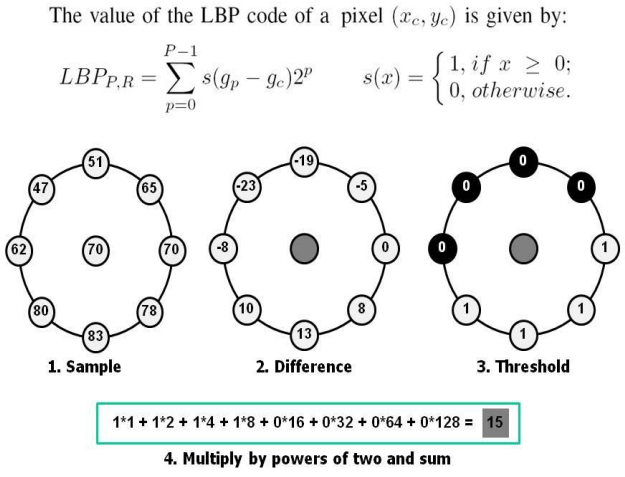
b) LDA

LDA seeks to reduce dimensionality while preserving possible discriminatory information as possible. It is the enhancement of PCA but still effect from varying lighting condition still exists here along with the accuracy problem.

c) LBP

In order to overcome the limitations of both PCA and LDA, another technique i.e. LBP was introduced that is having less computations and doesn't get effected by varying lighting conditions unlike PCA and even provides more accurate results

In Image processing, Local Binary pattern is the texture operator or descriptor that is exactly helpful in the detection performance for image by thresholding the nearby pixels of a centre pixel of an image. Generally, pixels having matrix of 3*3(Most Optimal) are used for this computational task. It means that 2^8 =256 different LBPs value will be accessed. Depending upon whether the intensity of the neighbourhood pixels is more than the centered pixel, the pixel value is forced to set either on or off. Thus the result contains the binary value i.e. 0 or 1. This can be computed in anti-clockwise direction. Like first we'll check the pixel if I(x+1,y) is brighter than I(x,y) and then I(x+1,y-1) will be compared to I(x,y) and the process goes on. The Following figure 4 shows the computation formulae and an example for it.



In order to use it in different scales, the extension of LBP operator was done to its neighbour. It is usually imagine that the pixel on which the LBP operation is going to perform lies in the centre and all the neighbourhood pixels are used to compute the value, but in some cases when the sampling point is not at the centre, then that particular process to find the LBP comes under the heading of Linear Interpolation.

There is another extension to original operator and that is the definition of uniform patterns. A Local Binary Pattern is called uniform if it has utmost two bitwise transitions i.e. 0 to 1 or vice versa when the bit pattern is considered circular.

For example . The pattern 00001111 have 1 transition, 00110000 have 2 transition are uniform whereas the patterns 01010100 have 6 transition which is not uniform pattern. While computing the LBP, uniform pattern are used while all the non uniform patterns are assigned a single bin.

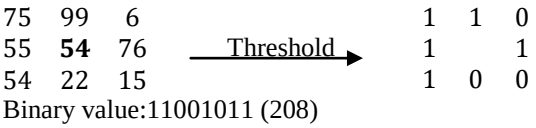


Fig. 5. The Basic LBP Operator

For the faces, the process of retaining the spatial information is very important. It is difficult to work with the image and extracting the texture description. For ease of access, the original image is divided into blocks and then from each block the needed distinguished texture description is extracted independently. These descriptions are then combined for global description of the image. Have a look at the following figure in which the image is divided into rectangular blocks.

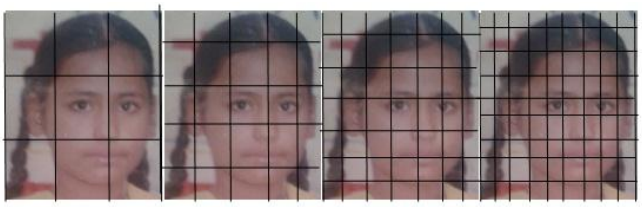


Fig. 6 A Facial image divided into 3×3,5×5,7×7,9×9 rectangular regions

The idea of spatial enhanced histogram can be exploited further. An important and most interesting method in enhanced histogram corresponds to small area of the original picture (ex. Eye). The distance between these small parts and their location is used in the whole process. It is expected that in this according to some psychological method, some facial features are used and played the most significant part for recognization of the area of the image.

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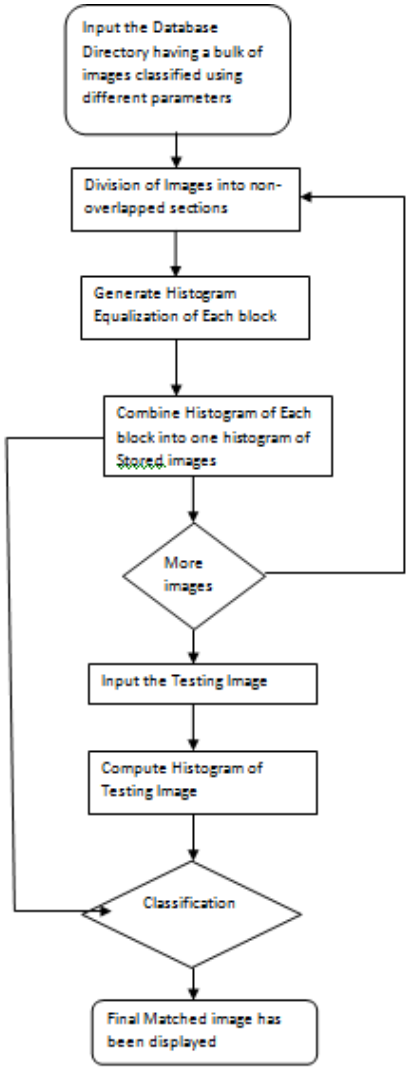
METHODOLOGY OF WHOLE PROCESS



CONCLUSION:

In this paper, introduction of FERET database is given and face recognition process has been clearly demonstrated along with the steps. Local binary Pattern clears out the limitations of previous operators i.e. LDA, PCA etc. It is having less complexity and another most important feature is its robustness. Face recognition is becoming a popular topic in various applications like security, surveillance etc. In LBP, the whole image is divided into number of blocks having equal size. Then local binary pattern is computed for each pixel in all blocks by comparing the centre pixel with neighbouring pixels. This will give us a binary pattern for each image.

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