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Algorithms of Feature Based and Image Based Face Recognition

KEYWORDS: Face recognition, Eigenface, PCA, Eigen vector.

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ABSTRACT *The face recognition algorithms can be divided in two main categories, feature based and image based. Feature based algorithms consider only few important fiducial points to recognize face image. Image based algorithm consider full face as an input to recognize face image. One algorithm from each type is discussed in this paper. Elastic bunch graph algorithm for feature based category and PCA algorithm for image based category are given. Purpose of PCA is to reduce the large dimensionality of the data space to the smaller intrinsic dimensionality of feature space, independent variable.*

1. INTRODUCTION

Face Recognition in complex scenarios is still remain unsolved. The research in the face recognition area dates back to the 1960's. It is still an area of active research, the reason behind this is the power full application of face recognition in identifying terrorists and criminals, minimizing cyber-crimes, law enforcement ext. The face recognition algorithms can be divided in two main categories, feature based and image based. In this paper two basic face recognition techniques from each of the category are proposed, the Principal Component Analysis (PCA) and Elastic Bunch Graph. Face recognition has two basic phases, **Face Detection and Face Recognition.**

Face detection is reliably finding a face in an image. This is essentially a segmentation problem and most effort goes in this step/task.

2. TYPES OF FACE DETECTION

Two types of face detection are their

1. Face detection in image
2. Real-time face detection

2.1 Face Detection In Image:

Face detection system attempt to extract a fraction of the whole face, there by eliminating most of the background and other areas of an individual's head such as hair that are not necessary for the face recognition task.

With static image, this is done by running a 'window' across the image. The face detection system then judges if a face is present inside the window. In example based learning approach classifiers are trained using supervised learning with 'face' and 'non-face' examples, thereby enabling it to classify an image as a 'face' or 'non-face'. This approach needs thousands of images for effective training. Different techniques are developed to achieve good face detection result.

Fig 1: classifying face and non-face

2.2 Real Time Face Detection:

Real-time face detection involve detection of a face from a series of frames from a video capturing device. By using filters ,the area of the frame that has changed can be identified and the individual is detected.

3. FACE RECOGNITION ALGORITHM CATEGORIES

Face recognition algorithms can be divided in to two main categories.

1) Feature Based Algorithms
2) Image Based Algorithms

3.1 Feature Based Algorithms

Feature-based approaches first process the input image to identify and extract (and measure) distinctive facial features such as the eyes, mouth, nose, etc., as well as other fiducial marks, and then compute the geometric relationships among those facial points, thus reducing the input facial image to a vector of geometric features. Standard statistical pattern recognition techniques are then employed to match faces using these measurement.

Early work carried out on automated face recognition was mostly based on these techniques. One of the earliest such attempt was by Kanade, who employed simple image processing methods to extract a vector of 16 facial parameters. Brunelli and Poggio, building upon kanade's approach, computed a vector of 35 geometric features from a database of 43 people and reported 90% recognition rate.

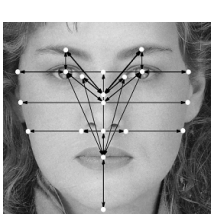

Fig 2: selecting fiducial

Locating the Facial Feature Points

Locating facial features is an important step in human face recognition. We need to locate different pointes on the face. These points are chosen based on their significance in representing a face, and the reliability of extracting them automatically. In the detection procedure, we first locate the face boundary Then approximate regions of the different facial features can be located. Among the decided feature points

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few are located on the face boundary, few for the eye corners, mouth corners, eyebrows and one for the nose.

The extraction of the face boundary is performed as the first step in our feature extraction system.. After the face boundary is located and measured, the approximate position of the mouth can be estimated. A searching window is then established for it. The reason for locating the mouth first among all the other facial features is that it can be detected and located reliably under wide perspective variations. Based on the face boundary and mouth position, other feature points can also be located reliably.

These approaches are generally invariant to illumination changes, but need proper normalisation. These algorithms do not perform well for variations such as pose and expression because in these variations, we do not get the original shape and size of the features. In the case of expression variation, feature dimensions change with the change in expressions.

3.2 Elastic Bunch Graph: Feature Based Algorithm
Elastic bunch graph matching method proposed by wiskott. This technique is based on dynamic link structures. A graph for an individual face is generated as follows:

A set of fiducial points on the face are chosen. Each fiducial point is a node of a full connected graph, and is labelled with the Gabor filters responses applied to a window around the fiducial point. Each arch is labelled with the distance between the correspondent fiducial point. A representative set of such graph is combined in to a stack like structure, called a face bunch graph. Once the system has a face bunch graph, graph for new face image can then be generated automatically by Elastic Bunch Graph Matching. Recognition of a new face image is performed by comparing its image graph to those of all the known face images and picking the one with the highest similarity value.

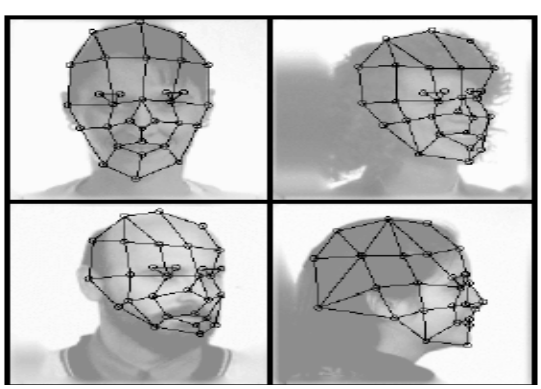

Fig 3: Grids for face recognition

3.3 Principal Component Analysis(PCA): Image Based Algorithm
PCA was invented in 1901 by Karl Pearson. Used to reveal the internal structure of the data in a way which depicts the major features/directions in the data and it is used to convert a set of 'X' face images in to a set of 'Y' uncorrelated variables called "eigenfaces". Purpose of PCA is to reduce the large dimensionality of the data space to the smaller intrinsic dimensionality of feature space, independent variable. This is the case when there is a strong correlation between observed variables. PCA can do prediction, redundancy removal, feature extraction, data compression, etc. PCA express the large 1-Dimension vector of pixels constructed from 2-Dimension facial image in to the compact principal components of the feature space.

Sirovich and Kirby were the first to utilize Principal Component Analysis(PCA) to economically represent face images. Turk and pentland realized, based on Sirovich and Kirby's findings that projections along eigenpictures could be used as classification features to recognize faces. They employed this reasoning to develop a face recognition system that builds eigenfaces which correspond to the eigenvectors. The eigenfaces define a feature space that drastically reduce the dimensionality of the original space and face identification is carried out in this reduced space.

To find exact match of the given face image to that of face database one way is comparing the image pixel by pixel. It is not necessary that each pixel of the image holds valuable information. This point makes the image distance larger or smaller.

Steps of PCA Eigenface for Face Recognition
Given training set of 'X' images and an unknow face all of same size.

Step 1: Represent face image as a linear combination of a set of eigenvectors because PCA eigenface does not works on image directly.

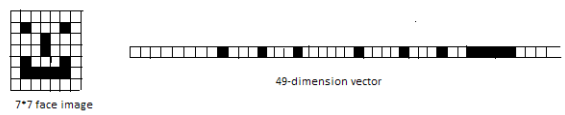

Fig: A 7*7 face image transformed in to a 49 dimension vector

These eigenfaces(eigenvectors) are in fact the principle components of the training set of face images generated after reducing the dimensionality of the training set.

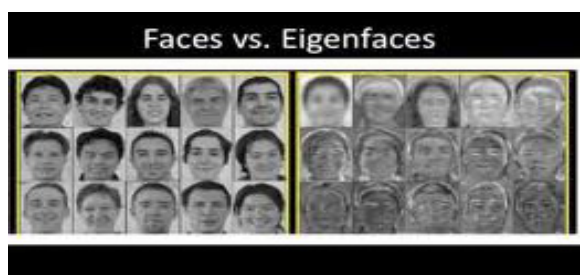

Fig 5: Faces vs Eigenfaces

Step 2: Compute the average face by removing all common features of all faces. Once eigenfaces are selected, each training set image is represented in terms of these eigenfaces. First eigenface will represent the most significant difference between all images and average image and last one the least significant difference.

Now when we have the average image and the eigen faces each image in the database can be represented as composition of these. Let's say:

Image1=average image+10% eigenface1 + 5% eigenface2 +----------+1% eigenface5

This basically means that we are able to express each image as a vector of percentages. The image becomes to vector [0.10,0.5-------0.1].

Step 3: When an unknown face comes for recognition it is also represented in terms of the selected eigenface.

Step 4: The eigenface representation of unknown face is computed with that of each training set face image. The 'Distance' between them is calculated.

Step 5: If the distance is above a specified threshold then recognize it is a known face.

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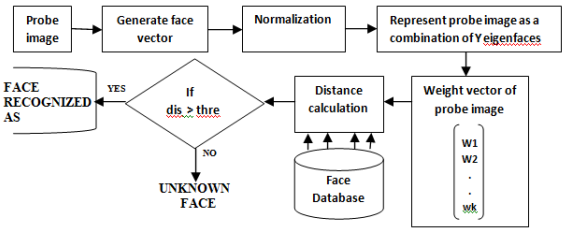

Fig 6: Face Recognition Steps diagram

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