Comparing Face Recognition Technologies

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Abstract
An automated system for human face recognition in a real time background world for a large homemade dataset of persons face. There is overview and different steps of face recognition. Because the face system is totally non-intrusive, thus without bothering the user in any way it can therefore make an existing security system more effective. To detect real time human face AdaBoost is used and a 2DFLD is used to recognize the faces detected. The 2DFLD is used to select an optimal subset of features that gives a better accuracy results in solving the face recognition problem. This approach is compared with the AdaBoost plus standard PCA.

Key words:
Face recognition, Eigenface, AdaBoost, Haar Cascade Classifier, Principal Component Analysis (PCA), two-dimensional fisher's linear discriminate (2DFLD).

1. Introduction

Face recognition is an important and active topic in pattern recognition. That is also a key technology widely applied in computer vision. In traditional, face recognition is treated as a supervised learning, i.e., classifiers are trained by a set of prepared face images associated with Persons and then new face images are recognized by use of the classifiers. Real time face recognition for video and complex real-world environments has garnered tremendous attention for student to attend class daily means online attendance system as well as security system based on face recognition. Automated face recognition system is a big challenging problem and has gained much attention from last few decades. In this field there are many approaches. There are many proposed algorithms to recognize and identify human being face form given dataset. The fast processing capacity and high accuracy are the recent development in this field. To include learning techniques in this complex computer vision technology the efforts are also going in that direction. There are many existing systems to identify faces and recognized them. But the automated system of face detection, identification and recognition are not that much perfect. To increase the visual power of computer a lot of research work is going in this direction. Hence, in the development of visual and vision system there is a lot of scope. Development of efficient visual feature extracting algorithms and high processing power for retrieval from a huge image database are the difficulties in the path.

Face recognition systems are a perfect enhancement to existing security systems because the face system is totally non-intrusive. In many special aspects and cases of security requirements, face recognition affords significant advantages over traditional key based systems. In the case of carjacking, the car will have a system for automatically recognizing the identity of its owner and other drivers which are designated to drive the car [1]. The face system will instantly recognize the new driver as an unauthorized driver and can then disengage the transmission of the car. Face systems can also recognize a wide range of other security issues including anything that a normal camera system would be used for, even when it is in motion [4].

As image is a complex processing matrix and high dimension matrix operation is not so perfect and fast. Hence, this direction us to handle with a focus on the new algorithms and huge image database which are more efficient with maximum percentage of accuracy and real-time. Effective and Efficient recognition of human face is now a requirement from image databases. For identifying individuals by their features of face, face recognition is a biometric method. In areas such as criminal identification, security system, image and film processing the applications of face recognition are widely spreading [2] [3]. From the sequence of image captured by the capturing device, in our case camera, the goal is to find the best match in the database. It can identify or verify one or more identities in the scene using pre-storage database. The face recognition system is having three main blocks, the first is face detection, second is face extraction and the third face recognition.

2. Face Recognition Systems

The goal of face recognition is to determine the identity of a person based on a video sequence of his or her face. Figure 1 shows the block diagrams of face recognition system. The block diagrams assume that there is a single face in the given video sequence. Our face system consists of a face detection block, an eye localization block, a face normalization block, a face feature extraction block and a face classification block[7]. It can give a short description of our face recognition system as follows: Face detection is

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to determine whether exists human faces in real-time video. If exists, then return to the face's spatial location. AdaBoost algorithm is used for face detection. After Face detection, eyes are detected by same algorithm as face detection. The algorithm is developing, since eyes are not symmetrical as faces, one classifier for each eye is trained. Searching the right eye in the right and searching the left eye in the left. The goal of eyes localization is to select a suitable face frame automatically from the video according to the criteria, which the right and left eyes is horizontal, the image is registered. The registered image is normalized, and then 2DFLD is used for image feature extraction. A nearest neighbor classification algorithm determines the identity of the person.

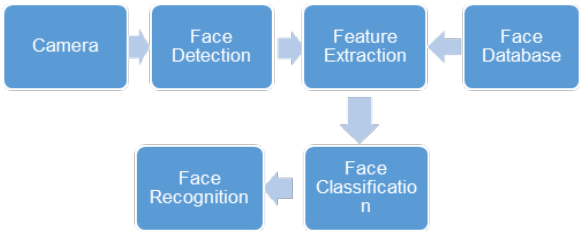

Figure 1.Face Recognition system Block Diagram

3. Face Detection Using The Adaboost Classification Technique

The AdaBoost algorithm for visual object detection, which is capable of processing images extremely rapidly and achieving high detection rates. AdaBoost algorithm is one kind of self-adaptation boosting algorithm, using this algorithm, the multi weak learner is boosted into a strong one, and its basic philosophy is that when the classifier distributes certain sample correctly, the weight of these samples will be reduced; when misclassification, then increases these samples' weight, makes the learning algorithm to concentrate to carrying on the quite difficult training sample to learn in the following study, according to the weighted voting's way, merging the weak rule which produces each wheel to be a strong one finally[10].

In general face detection algorithm based on AdaBoost may divided into three major parts:

- First of all using "the integral image" to extract face's rectangle feature [9].

  ii1 = sum (A)

  ii2 = sum (A) + sum (B)

  ii3 = sum (A) + sum (C)

ii4 = sum (A) + sum (B) + sum (C) + sum (D)

SUM (D) = i4 + i1 – i2 – i3

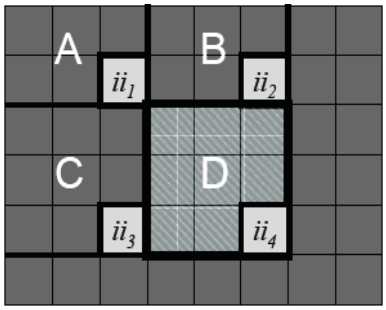

Figure 2.Integral image representation and rectangle computation

Second is formed weak classifier, which is based on single rectangle feature, and using AdaBoost algorithm to trained the weak classifier, then combined some accurate feature to forming a strong classifier that is more accurately in distinguish between "face" And "nonface" mode.

The third is in accordance with the principle of "first heavy after the light" cascade multiple strong classifiers, which maybe achieves increased detection performance while radically reducing computation time. in other words, it is put these strong classifier in the front which is formed by important features and have more simple structure, it can be filtering out numerous "non-face" sub window, so it will put the detection focus on these regions which have lager possibility of exist human face, it greatly enhanced face detection speed.

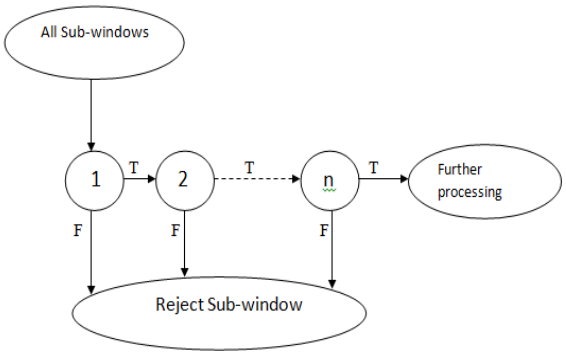

Figure 3.Schematic depiction of the detection cascade

4. Image Feature Extraction

4.1 PCA (Principal Component Analysis)

Face recognition is one of the nonintrusive biometric techniques commonly used for verification and authentication. Techniques are available for face recognition for local and global features based extraction. Auto-correlation matrix is computed in local features technique whereas Global features extraction technique calculates co-variance matrix of inter images. PCA is a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components [6] [17]. PCA can be expressed in general as "a linear transformation of the image vector to the projection feature vector" as given below:

$$Y = W^T X \quad \ldots\ldots\ldots (1)$$

Where, W is the transformation matrix having dimension K x 1, Y is the K x N feature vector matrix and X is the higher dimension face vector obtained by representing all the face images into a single vector[26]

$$X = \{x_1, x_2, \ldots, x_N\}$$

4.2 2DFLD(Two Dimentional Fisher's Linear Discriminant)

The 2DFLD feature extraction scheme outperforms the conventional PCA schemes not only in terms of the computational efficiency, but also in terms of the performance for face recognition [24].

1) An alternative Fisher criterion:

Project an m*n image matrix X onto an m-dimensional vector space through the transformation y=Xα, where α is an n-dimensional vector, and y the m-dimensional projected vector. Goal is to find the optimal projection direction α so that the projected vector in the m-dimensional pace reaches its maximum class separability. Suppose $\{X_i\}_{i=1}^{N}$ are the training images, which contain C classes (subjects), and the ith class ci has ni samples. The images, all m*n matrices, are projected into m-dimensional vector space yi = Xiα. In the projection space, the measure of the class separability of the projected images is calculated by

$$J(\alpha) = \frac{\alpha^T G_b \alpha}{\alpha^T G_w \alpha} \quad \ldots\ldots\ldots (2)$$

Where the measure J in Eq. (2) is also a well-known Fisher scalar for measuring class separability.

$$G_b = \frac{1}{N}\sum_{i=1}^{c} n_i (\overline{X}i - \overline{X})^T (\overline{X}i - \overline{X})$$

$$G_w = \frac{1}{N}\sum_{i=1}^{c}\sum_{j=c} (X_j - \overline{X}_i)^T (X_j - \overline{X}_i)$$

Where X and $\overline{X}_i$ respectively, represent the global and the ith class mean images.

2) Two-dimensional FLD feature extraction:

The goal of our 2DFLD scheme is to find the optimal projection direction α in order to maximize (2).

Obviously, the optimal projection direction α opt is the eigenvector corresponding to the maximum eigenvalue of the eigenstructure:

$$G_b \alpha = \lambda G_w \ldots\ldots\ldots (3)$$

In practice, one optimal projective direction is not enough to extract sufficient discriminatory features. It is usually need to project the image data onto a set of orthogonal directions, namely, α1, α2… α k, which maximize the criterion. These projection directions can be selected as the k eigenvectors corresponding to the first k largest eigenvalues of the eigenstructure (3).

Suppose $(\alpha_i)_{i=1}^{k}$ are the optimal projective directions. Given an image X, all the projections of the image matrix in the k directions make up an mk-dimensional vector y, which is our 2DFLD feature vector.

$$Y^T = (Y_1^T, Y_2^T, \ldots., Y_K^T) = (\alpha_1^T, \alpha_2^T, \ldots., \alpha_K^T) X^T$$

5. Nearest Neighbor Rule For Faces Classification

The nearest neighbor (NN) rule, first by Fix and Hodges (1951), is one of the oldest and simples pattern classification algorithms. To identify the nearest neighbor of a query pattern, a distance function has to be defined to measure the similarity between two patterns [27] [30]. In the absence of prior knowledge, the Euclidean and Manhattan distance functions have conventionally been used as similarity measures for computational convenience. Here, the distance between two matrices $Y = [Y_1, Y_2, \ldots, Y_d]$ and $B_i = [Y_1^{(i)}, Y_2^{(i)}, \ldots, Y_d^{(i)}]$ is defined by

$$d(Y, B_i) = \sum_{k=1}^{d} \left\| Y_k - Y_k^{(i)} \right\|_2$$

Where $\|Y_k - Y_k^{(i)}\|$ 2 denotes the Euclidean distance between the two vectors Y_k and $Y_k^{(i)}$.

The Similarity Measure between two matrices, Y= [Y1, Y2,…,Yd] and $B_i = [Y_1^{(i)}, Y_2^{(i)}, \ldots, Y_d^{(i)}]$ is defined by

$$s(Y, B_i) = \frac{\sum_{k=1}^{d} Y_k^T B_k^{(i)}}{\sqrt{\sum_{k=1}^{d} Y_k^T Y_k} \sqrt{\sum_{k=1}^{d} B_k^{(i)} \left(B_k^{(i)}\right)^T}}$$

Suppose that the training samples are B1, B2… BM (where M is the total number of training samples), and that each of these samples is assigned a given identity (class) ω_k, given a test sample Y.

6. Conclution

Face recognition technology is applied to automotive security. Because the face system is totally nonintrusive, it can therefore make an existing security system more effective without bothering the user in any way. And the core algorithm is studied, which is aiming at developing a robust and practical face recognition system for auto security. AdaBoost face detection algorithm is presented, which is extremely rapid face detection. And 2DFLD for image feature extraction is also presented, which outperform the features extracted by the PCA.

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