

Comparative Research of PCA+AdaBoost and PCA+LDA for Face Recognition Technology

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Abstract. Despite of the development of face recognition technology; face recognition rate is not high, which brings some inconvenience in our application. This paper carry on a simple introduction of PCA+AdaBoost algorithm and PCA+LDA algorithm and makes a simple comparison at the end. PCA+AdaBoost algorithm and PCA+LDA algorithm are both relevant to the feature space, so it can be better to compare.

Introduction

The development of science and technology not only promotes the development of other industries but also promotes its own development. With the development of society, because of the production of a technological product, the corresponding requirement arises on the basis of the product. For example, face recognition technology[1] is based on camera, video camera, computer technology, and social worries about the method for identifying the identity of people, which promoted the emergence and development of face recognition technology itself. The face recognition technology is a hot technology including face image acquisition, face location, faces preprocessing, identity verification, identity search and many other links. With the continuous development of society, the functional demand for face recognition technology increases continuously and the target functions vary in various fields. The advantages of face recognition technology based on of all kinds of algorithms are different, so it is particularly important to choose a good algorithm. PCA+AdaBoost[2] and PCA+LDA[3] are two such algorithms and this paper will carry on the comparative study of the two algorithms and compare their advantages and disadvantages.

The Technology of Face Recognition based on PCA+AdaBoostAlgorithm

The algorithm based on the PCA+AdaBoost is achieved through a combination of PCA [4] and AdaBoost[5] algorithms. The following is the simple introduction of the PCA and AdaBoost.

PCA is a method for data analysis in statistics, now for the optimal representation of face images. Optimal representation is totighten the face image. The face images are achieved tightness by PCA, which any images can be through the characteristics of face of the linear weighting and approximate reconstruction of the face, weight coefficient is obtained by characteristic face project in characteristic face space, then by project to the coefficients of basis function on the low dimensional space to represent face and make face recognition.

The relevant formula of achieving face recognition by using PCA:

$$X = (X - \bar{X})/\sqrt{D}(1)$$

Type X is the training sample image collection, the size of N * P, N is the sample, P is image size of, and P=Width * Height, Y3 is average image for the sample collection, D is variance.

$$U^T(XX^T)U = \Lambda(2)$$

In the equation, Λ is a diagonal matrix composing by characteristic value, U is a orthogonal matrix composing by characteristic value corresponding characteristic vectors, X is the sample image collection. Characteristic value is λ_i ($i=1,2,\dots, N$), $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_N$, feature vector is the U_i ($i=1,2,\dots, N$).

$$W = U^m X(3)$$

Type U^m is a former m ($m \ll N$) a large eigenvalue eigenvector components, W is feature face that before m .

$$P = WX^T(4)$$

Type P is a projection image collection in the feature space of X . Comparing the cosine formula and sample collection in the feature subspace projection on, can realize the face recognition.

$$P_{\text{test}} = W(X_{\text{test}} - \bar{X})^T(5)$$

$$d(P, P_{\text{test}}) = \frac{P * P_{\text{test}}}{\|P\| * \|P_{\text{test}}\|}(6)$$

AdaBoost is an effective method for target classification by a lot of function through weighted voting mechanism. And AdaBoost makes the simple classifier to generate strong classifier to make the error of each classifier irrelevant to each other and improve the generalization ability, the details are listed as follows:

Assuming that there are M simple classifiers which generate M strong classifiers, and those M strong classifiers combine to a strong classifier. The specific steps can be listed is $\chi_t = \frac{\epsilon_t/T}{1-\epsilon_t/T}$, weight is $\log(1/\alpha_t)$, normalized weighting is $\frac{\log(1/\alpha_t)}{\sum_{i=1}^M \log(1/\alpha_t)}$, the strong classifier

$$\text{generated } h_f(x) = \arg \max_{y \in Y} \sum_{i=1}^M \frac{\log(\frac{1}{\alpha_t})}{\sum_{i=1}^M \log(\frac{1}{\alpha_t})} \sum_{t=1}^T (\log \frac{1}{\beta_t}) h_t(x, y), \text{ while } \epsilon_t \text{ equal to } \epsilon = \frac{1}{2} \sum_{i=1}^N D_t(j)(1 - h_t(x_i, y_i)) + \sum_{y=1}^T q_t(i, y) h_t(x_i, y).$$

PCA+AdaBoost algorithm. Compile the PCA program (use SVD method to solve the eigenvalue and eigenvector, reduce the amount of calculation; Set separately retain 85%, 95%, 82%, 92%, 82% energy feature vector) to produce 5 different feature subspace and generate 5 simple classifier.

Then get 5 improved strong classifiers and the weight parameters of each classifier through writing AdaBoost program (for each simple classifiers respectively using AdaBoost algorithm, and for T iteration) weight parameters obtained strong classifier and each classifier 5 after the lifting of the.

Different projection space corresponding to different strong classifier, and the weight of different classifier parameter α , generating the final strong classifier.

On the test sample, the first is to project, then given by the classifier the classification results.

And then test the samples through ORL face database or YaleB face database [6]. And the face recognition rate using PCA+AdaBoost can be get. AdaBoost can greatly improve the recognition rate of PCA algorithm; therefore, it has great feasibility and practical significance to combine the two methods.

Face recognition algorithm based on PCA+LDA

Face recognition algorithm based on PCA+LDA is the combination of PCA and LDA[7] two kinds of algorithms. Through the algorithm combination, the two make up the defects of each other and make full use of the advantages of both to a certain extent. PCA algorithm has been mentioned in the above. The following is brief introduction of the LDA algorithm.

LDA is to extract the low dimensional feature with discrimination ability from high dimensional feature space, the low dimensional features can help to select a characteristic that make a Max ratio between samples of discrete rate between classes SB and samples in the class of discrete rate SW. The sample of discrete rate between classes SB definition and samples in the class of discrete rate SW definition as follows:

$$S_B = \sum_{t=1}^C N_t (m_t - m) (m_t - m)^T(7)$$

$$S_W = \sum_{t=1}^C \sum_{x \in X_t} (x - m_i)(x - m_i)^T(8)$$

In the formula, C is the number of categories. N_i is the prior probability. m_i is the mean value of C_i class samples. X is the sample belonging to I class.

According to the projection in the low dimensional space, samples should be separated as far as possible. At the same time, within each category, the more intense the better. So, if S is a nonsingular

matrix, the best projection direction W is the eigenvector of the largest ratio between samples of discrete degree between classes S_B and samples in the class of discrete degree S_W . The best projection function is listed as follows:

$$W_{opt} = \arg \max \frac{|W^T S_B W|}{|W^T S_W W|} \quad (9)$$

By projecting the image onto W_{opt} space, we can get the global face features based on LDA algorithm.

PCA+LDA has the advantages of PCA and LDA, which makes LDA+PCA higher than LDA and PCA in face recognition rate. Here introduces PCA+LDA calculation process:

First put all centralized images as a column vector and array them in order for a data matrix;

Then calculate the feature subspace of LDA algorithm;

Then work out feature vector value and eigenvector and combine a best classifying space;

Then fuse PCA and LDA feature subspace to obtain PCA+LDA fusion feature space;

Finally, in order to get the recognition feature, Project training samples and testing samples respectively and fuse feature space. Then complete identification by using the nearest neighbor rule.

Then as same as PCA+AdaBoost algorithm, test samples by using ORL face database or YaleB face database and Malta and face recognition rate curve can be obtained by PCA+LDA algorithm. This method can greatly compare face recognition rate of PCA+AdaBoost algorithm and PCA+LDA algorithm by facial recognition curve. PCA+LDA algorithm not only achieves feature extraction of PCA algorithm but also solves small sample sets problems of LDA algorithm.

Comparison of PCA+AdaBoost algorithm and PCA+LDA algorithm

First of all, for PCA+AdaBoost algorithm and PCA+LDA algorithm are both involved in PCA algorithm, both of them need to generate face image matrix, the feature space and the feature vector and so on. And both of them need projection and linear weighted sum to reconstruct approximately. Its weight coefficient can be obtained by projecting face image in characteristic face space.

PCA+LDA algorithm projects original image onto the fusion feature space constituting by PCA+LDA algorithm, and removes a large number of redundant information of the image. At the same time, it retains the useful information of the image. With good adaptability, PCA+AdaBoost algorithm is not sensitive to light; form a strong classifier has a good feasibility and practical significance in improving the accuracy of face recognition.

The difference between PCA+AdaBoost algorithm and PCA+LDA algorithm in achieving face recognition mainly exists in AdaBoost and LDA algorithm. AdaBoost algorithm mainly gives big weight to the classification with good effect and smaller weight to the classification with poor effect. LDA algorithm is aimed at feature space, samples of discrete rate between classes S_B and samples in the class of discrete rate S_W . The two algorithms differ, the difference between AdaBoost algorithm and LDA algorithm led to face recognition degree difference of PCA+AdaBoost algorithm and PCA+LDA algorithm.

PCA+AdaBoost algorithm flow chart in Figure 1, and the flow chart of PCA+LDA algorithm in Figure 2.

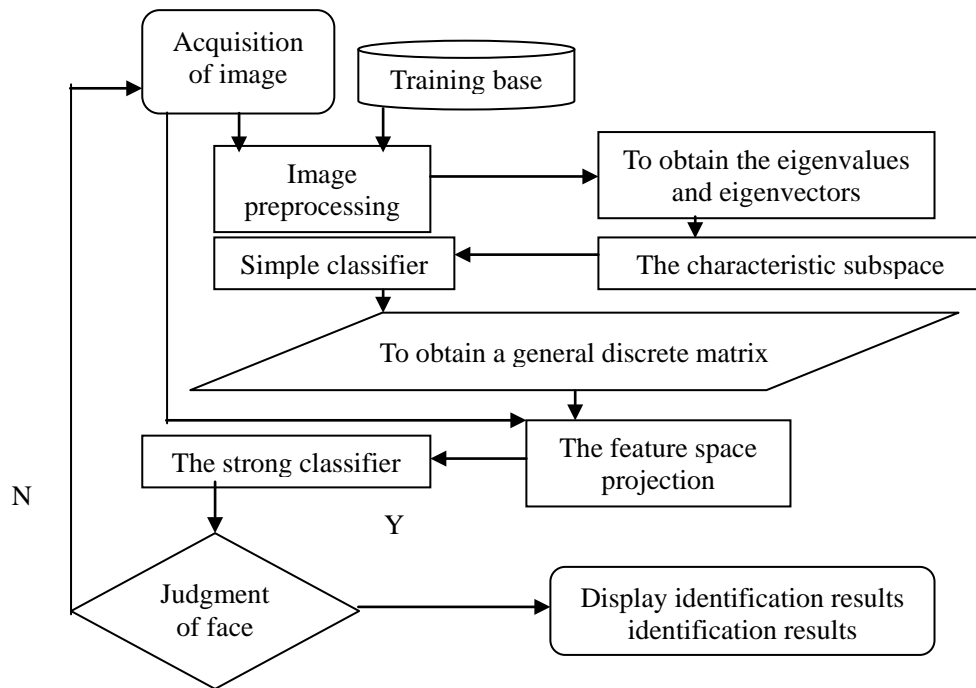


Fig. 1 Flow Chart of PCA+AdaBoostAlgorithm

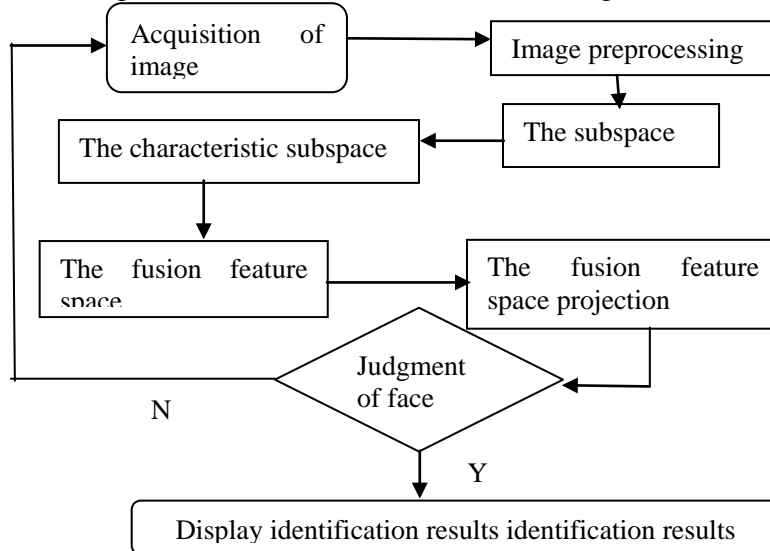
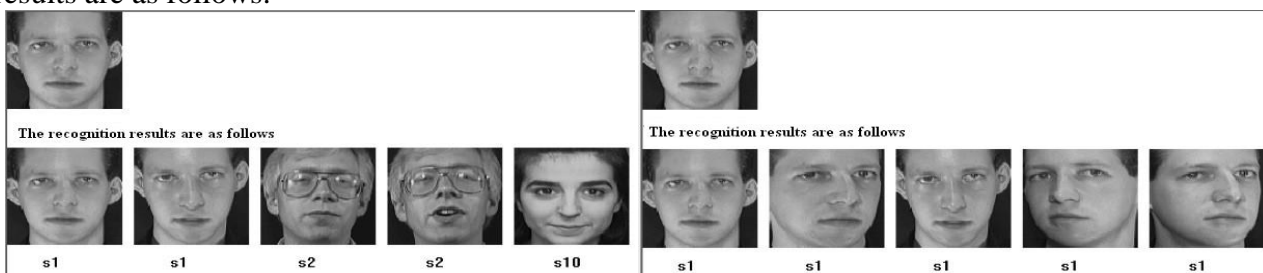


Fig. 2 Flow Chart of PCA+AdaBoostAlgorithm

Experimental Analysis

To set up a portrait gallery, the gallery contains some portraits, and named as S1, S2... and Sn, but also each one contains a variety of different postures and expressions; in this case, respectively to simulation compare with PCA and LDA, which we combine the training feature dimension of PCA and LDA is set to 1. Now, opening a personal portrait, respectively for identification, the results are as follows:



(a).PCA recognition results (b).LDARECognition results

Fig. 3 Recognition Results

From the above results it can be seen, after PCA identifying the person in full is the name for this S1 person's portrait, and after LDA recognition results are not entirely S1's portrait, which exist in error. This error is due to the advantages and disadvantages of the algorithm, the algorithm will directly affect the results. Here, we can see that compared with the LDA algorithm, PCA algorithm is more desirable, good reliability.

Conclusion

This paper briefly introduces PCA, LDA, PCA+AdaBoost and PCA+LDA algorithm and compare PCA+AdaBoost and PCA+LDA algorithm. PCA+AdaBoost and PCA+LDA algorithm have their own advantages and disadvantages, but PCA+AdaBoost algorithm is better than PCA+LDA algorithm in comparison. We believe that with the progress of science and technology, the technology aiming at the face recognition will be more mature and its function will be more powerful.

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