

Face Recognition Based on the Combination Method of Multiple Classifier

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Abstract

The study of human language comprehension machine has become a important research topic around the world. Face recognition has great potential application value in economic, security, social security, crime, military and other fields, especially in the occasions where need verification or identification of user identity. This paper presents improved Eigen face method and method for identification of multi-classifier fusion based on support vector machine. The combination of multi-classifiers method dose not only make full use of the support vector machine and high recognition rate and distance measurement, fast speed, the training and testing, but also use a distance metric results to guide the support vector machine. The experiments show that, the efficiency and the recognition accuracy of the multi-classifier combination method has higher efficiency and lower rate of error recognition.

Keywords: *Face recognition, Multiple classifier combination, Support vector machine*

1. Introduction

Face recognition is a technology to extract facial features by computer, and a technique for authentication according to the characteristics of these features. Other biological characteristics such as face and human body (fingerprint, iris *etc.*) are of inherent uniqueness. Their uniqueness and hard to copy provides the necessary prerequisite for authentication. Compared with other more mature human biological feature recognition methods (such as fingerprint, DNA detection *etc.*), face images are more accessible, especially in the occasions of not disturbing the detected human and non-contact environment, the superiority of face recognition is far more than other identification technology. Compared with other biometric authentication technology, face recognition technology has advantages of simple operation, intuitive result and good concealment. Therefore, face recognition has a widespread application prospect in the fields of information security, criminal detection and entrance control.

A variety of face recognition methods proposed currently have its own merits and drawbacks and restrictions .There is contradiction between efficiency and performance, algorithms which is better in accuracy, robustness and other aspects will often have to spend more time and system consumption. In some way, the performance and efficiency is essentially the opposite, having irreconcilable contradictions, but we should find a unification to the best of our ability at the opposite premise, namely to seeking the best combination of efficiency and performance, so the recognition system can achieve its overall optimal. Some scholars at home and abroad introduced and compared the face recognition methods, but with current technology, the general realization of face recognition method is not realistic. Solving the problem of face recognition with special constraints or certain application background will still remain a main research subject in this field. Now the key direction of research tend to those adapt to various complex

background technology such as face segmentation technology research, appropriate feature selection and extraction, various methods of synthesis, the identification process of the real-time implementation, dynamic face recognition research, multiple data fusion for face recognition, 3D face recognition research, automatic face recognition technology *etc.* For 3D face recognition technology at present still stays focused on theoretical method, the effect of research is not very desirable. But if there are somewhat technological breakthroughs, it will have great novelty and application value. This paper discussed the face recognition method based on the combination of support vector machine and improved eigenface method. In view of the limitations of existing face recognition method of eigenface, this paper firstly improves the eigenface method, and combined with the improved eigenface method and a hot research topic in statistical learning theory: support vector machine (SVM). This paper puts forward the new method of face recognition, combined the support vector machine and improved eigenface method, and completed all the work from feature extraction through the classifier design to face recognition. Experiments show that the combination of support vector machine and improved eigenface method improves the efficiency and accuracy of human face recognition.

2. Face Recognition Method Based on Multiple Classifier Combination

There are many issues in multi-classifier combination methods worthy of further study. Kittler put forward the theory framework of the multiple classifiers combination based on different feature representation. Some existing methods of multiple classifiers combination can be viewed as a special case of this framework. Recently, Lu Xiaoguang *et. al.*, combined 3 independent classifiers (PCA, ICA, LDA) in their method, and experimental results show that the combination classifier is better than any of the individual classifiers [1-3]. Aiming at the problem of face recognition, this paper presents a method combined with support vector machine and the distance metric, constituting two class classifier combination method. When using that method to classify, first use distance metrics to conduct front stage classification, if the condition is not met, then reject. Otherwise, switch to post stage classifiers, and then give the classification results. The front stage classifiers use improved eigenface method, and post stage classifiers use support vector machine method. The combination of multiple classifiers method not only make full use of the advantages of the support vector machine such as high recognition rate, distance measurement and fast speed but also use distance metric results to guide the support vector machine in tests and training. Experiments show that, the multiple classifier combination method has higher efficiency and accuracy lower rate of error recognition.

2.1 Improved Eigenface of face Recognition Method

Eigenface method has played an important part in numerous face recognition methods, and has also been widely developed and applied. Merely using this method, what we will obtain is the best features of face image representation, which for the classification is not optimal and therefore the recognition result is not very ideal. On the other hand, the linear discriminant analysis method in the process of feature extraction, due to the full use of the categories of information, so it can get the most favorable facial features for classification. This article from the perspective of combining the two methods and studied the face recognition algorithm based on improved eigenface.

The basic process of face recognition can be mainly divided into a training phase and recognition phase. Because there are various constitution of training sample size, the original image need to be normalized to a standard size and included in a training set,

which contains C classes. Each image can be set to Ψ_i ($i = 1, 2, \dots, N$), which is of a total of N training samples.

The training algorithm is as follows:

(1) Normalized image can be seen as a vector, and vectors can be set to x_i ($i = 1, 2, \dots, N$), vectors minus the average face, then we can get the difference between each facial image and average face;

(2) These difference constitute a covariance matrix, calculate feature vectors obtained before the K largest eigenvalues of this matrix, then these vectors are combined together to form a PCA projection matrix, which is set to W_{pca} , W_{pca} is the (U_1, U_2, \dots, U_n) ;

(3) Using the projection matrix to make all training samples projected into a K dimensional subspace, by equation:

$$\alpha_2 = \|x - (W_{pca} W_{lda} \eta + f)\| \quad (1)$$

$$f^T = [w_1, w_2, \dots, w_M] \quad (2)$$

can get w_i ;

(4) The best described characteristics w_i ($i = 1, 2, \dots, N$), which are obtained from step (3), respectively constitute the within class scatter matrix and discrete matrix between classes, computing eigenvector matrix $S_w^{-1} S_b$ of the first t of the maximum eigenvalue, constitute a projection matrix LDA by these vectors, denoted as W_{lda} ;

(5) Use methods similar to type (1) and (2), and adopt the matrix we get from step (4) to make all the samples are projected to a t dimensional subspace, and obtain the best classification feature η_i ($i = 1, 2, \dots, N$), and compose a class C face recognition database according to the characteristics;

(6) Calculate the maximum distance between two face class, and set the threshold T.

$$\beta = \frac{1}{2} \max_{i,j} \|\eta_i - \eta_j\|, (i, j = 1, 2, \dots, C) \quad (3)$$

The algorithm of improved eigenface face recognition is as followed:

The unidentified face images minus the average face, from which result in a difference vector, which can be set to s;

(2) Perform two projection transformations on the difference, and then get a best classification feature:

$$\eta = W_{lda}^T W_{pca}^T s \quad (4)$$

(3) Compare the unidentified face with every face in face database, conclude the minimum Euclidean distance:

$$\alpha_1 = \min_i \|\eta - \eta_i\|, (i = 1, 2, \dots, C) \quad (5)$$

(4) In order to distinguish whether the image is face image, the distance between unidentified face images and reconstruction face images needs to be calculated:

$$\alpha_2 = \|x - (W_{pca} W_{lda} \eta + f)\| \quad (6)$$

Where f is the average face.

(5) According to the classification rules, first we need to determine whether it is a face, if $a_2 > T$, then the image is in the non face database; if $a_2 \leq T$, then the image is a face in the database, moreover the unidentified image and the η_i which get a corresponding value to a_i is the facial image of the same person.

Firstly, according to the face image training samples, W_{pca} and W_{lda} can be calculated, and then select a representative images for each person in the face image database. After preprocessing and two times of projection transformation, the eigenvector of the person can be obtained, which can be regarded as the character of this people. For the test image input, after preprocessing and two times of projection transformation, the eigenvector of the test image can be obtained. And then, according to the preselected test image distance formula, the distance between the image eigenvector and each person's eigenvector can be calculated. The person's eigenvector is most close to the test image feature vector distance, can also be considered the corresponding person to this piece of test image.

Seeing above, because the final recognition judgment of this method is by means of distance, the calculated distance can be set as a threshold which can achieve refuse judgment.

Parts of the images in ORL face image database, which is often used by scholars at home and abroad, were adopted in the experiment. Some examples of face images and 6 face images of a same person in ORL face database were shown respectively in Figure 1 and Figure 2.



Figure 1. Part of the Face Images in the ORL Face Database

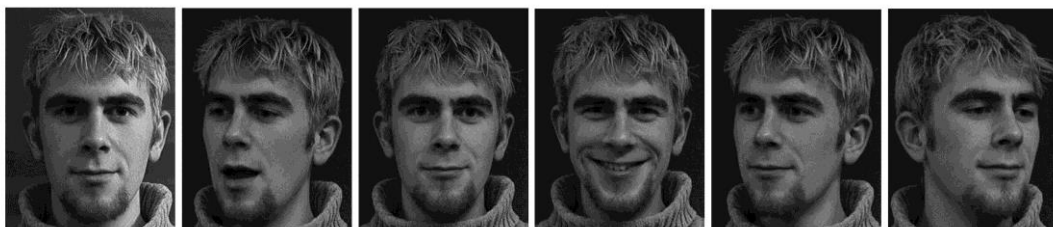


Figure 2. 6 Face Images of a Same Person in ORL Face Database

The ORL database contains face images of 40 different ages, different gender and different race, each have 6 images of different attitude, different expressions and different appearance with resolution ratio 112*92 and grayscale 256. While the establishment of database, we conducted a arbitrary choice of 38 people's face image in the ORL face

database. The training is between the two images of each person and another image is for testing, while the training samples and testing samples is without coincidence. The judgment standard is on the basis of Euclidean distance and the test results are shown in Table 1.

Table 1. Test Results

Face Image sets	Total number	Error number	Rejection number	Correct identification number	Recognition rate
The first training set	38	0	1	37	97.37%
The second training set	38	1	0	37	97.3%
Test set	38	5	1	32	84.21%

Table 1. is the result of using PCA projection matrix to reduce the original image dimension to 38 dimensions, and then uses the LDA projection matrix to reduce the 38 dimensional images to 37 dimensions. It can be seen from the table 1, using that method, the recognition rate of the first and second training set can reach 97.37% and the test set can also amount to 84.21%.The literature suggests, Wan Feng, Du Minghui *et. al.* adopt the eigenface recognition method to identify the face data in ORL face database and the average recognition rate is 73.05%. It can be seen from Table 1, considering the class information of samples, using improved eigenface method for face recognition is much more effective than merely use the eigenface method, and the recognition rate rises from 73.05% to 84.21%. The low face image recognition rate of Eigenface method is blamed on it's highly influenced by illumination, expression and pose, while LDA less affected by illumination, expression *etc.*

2.2 Face Recognition Method Based on Support Vector Machine

Support vector machine (SVM) is developed from the two class pattern recognition problem and the method which is based on SVM is more suitable for two class pattern recognition problem. However, the face recognition problem is not a two class pattern recognition problem, but a typical problem of multi class pattern recognition .While using the SVM method for face recognition ,it must be considered that how to expand the two class pattern recognition problem to multi class pattern recognition problem.

The first one who made it possible that the SVM is used for face recognition is Phillips [4]. He separated all kinds of face by differences between categories and within class into two kind of pattern, transforming the face multi-class recognition problem into two class pattern recognition problem, and then through the SVM to learn and classify .This is actually a two class pattern recognition problem, which is mainly used for authentication of face. That is to say, if one class face is known, given a face image, determine whether the face image belonging to the class. This is in fact a two class pattern recognition problem, and not to solve multi-class face recognition problem. Document [5-6] also studied using SVM for face authentication problem, but still did not consider how to use the SVM for multi-class face recognition. Using SVM for the two class pattern recognition problem has already done much research and has many successful applications. In the latest few years, using SVM for the multi-class pattern recognition problem have been emphasized much attention, and there are already exist some SVM method for multi-class pattern recognition.

The existing multi-classification methods include: one to many method, one to one method, DDAGSVM method (Decision Directed Acyclic Graph Support Vector machine) and the SVM decision tree method [7-8].

Following is a brief introduction of the several methods:

(1) One to many method

One to many method is to consider a kind of sample as a category and the rest of the sample as a separate category. Then it becomes a two class classification problem. Then, repeat the above steps in the remaining samples. This method requires constructing the N SVM model, in which N is the number of samples that need to be classified. The first i SVM use the i class in the training samples as positive training samples, and the other sample as negative training samples. The final output is the largest category in the two class classifier output. (At this point, the decision function of two class classifier does not take the sign function SGN).

The advantage of this method: it only need to train N two class classification support vector machine, the number of the classification function obtained is (N) small and the classification is of relatively fast speed.

The main disadvantage of this approach is: each classifier training is all of the samples as training samples, this requires solving quadratic programming problems of n variables the number of the N. Because each support vector machine training speed slowed sharply along with the increasing number of training samples, this method is of relatively long training time. Another drawback is that, if there is more than one output result is 1, and then the sample will not be able to classify. At the same time, this method only builds N classification surface, because the classification plane not complicated enough, that all categories may not be separated from each other well, that is to say, the generalization ability is not good.

(2) One to one method

One is put forward by Knerr [9], although it mainly deal with neural network, it can also be applied to the SVM multi-class classification problem [10]. Its approach is to construct the N-class training samples in all possible types two class classifiers. In each class, training only in the N class of 2 types of training samples, resulting in the structure

$$\frac{N(N-1)}{2}$$

of classifiers. Naturally the combination of these two types of classifier used the voting method; the class with the largest number of votes is the class where the new point belongs.

The advantage of this method is its training speed is faster than one to many methods [11].

The main drawback is: ①if a single two class classifier is not standardized, then the whole class N classifiers will tend to over learning. ②the generalization error unbounded.

$$\frac{N(N-1)}{2}$$

③the number of classifier increases sharply with N, resulting in the slowly decision [12-13].

Because this method adopts a voting method in the decision process, there may exist several classes vote a same situation, which means there may exist a sample belongs to several multi-class cases, makes this method cannot be good for decision making.

(3) The DDAGSVM method

The DDAGSVM method was put forward by Plantt *et. al.*, decision directed acyclic graph (Decision Directed Acyclic Graph, DDAG [14-15]) method, which is to combine a plurality of two class classifiers into a multi-class classifier. In the training stage, the method is same as one to one method, for N class problem, DDAG contains N (N-1) /2 two class classifiers. However, in the decision-making stage, starting from the root node

using the guide acyclic graph (DAG), having $N(N-1)/2$ internal nodes and N leaf nodes, each internal node is a binary classification. A leaf node is the final class values. Given a test sample, start from the root node to determine its path to go left or right, and so far has come to a leaf node, get the value of the sample belongs to the class based on the output value of the classifier. The DDAGSVMS method schematic diagram is shown in figure 3.

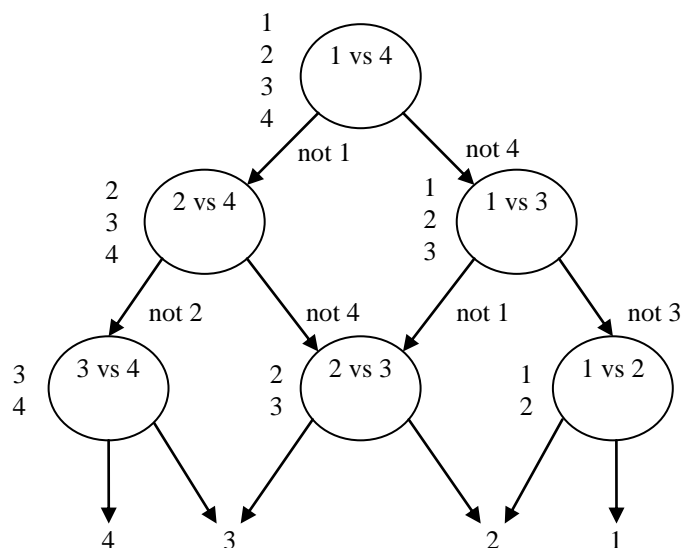


Figure 3. DDAGSVMS Method Schematic Diagram

The advantage of DDAGSVM method is its decision speed is faster than the one to many method or one to one method's voting methods. The shortcoming is the root node selection directly affect the result of classification, different classifier as the root node, the classification results may be different, resulting in the classification results of uncertainty.

(4) The SVM decision tree method

SVM and binary decision tree method is usually combined to form multi-class identifier. SVM classifier is a classifier categories, so it must be improved in order to be able to handle many types of cases face recognition. We know that the problem exists between the N classification ($N > 2$) and two classification certain relationship, if a classification problem can be divided into N classes, this class of N must be divided between any two categories; on the contrary, in a N classification problems, if any twenty-two known to be divided, through some combination of law, may be divided to the ultimate realization twenty-two N class separability. So the basic idea can support vector machine and binary decision tree are combined to form a multi-class identifier, this method is called SVM decision tree.

Sample set of N class structure of a binary tree, each leaf node of the tree corresponds to a category for each of the two non-leaf node corresponds to a sub-SVM classifier. So the decision tree is of $2N-1$ nodes, the number of leaf nodes is N and the sub-SVM classifier number is $N-1$. Specific implementations SVM decision tree method is different because, by definition binary tree is constructed with strict binary tree leaf nodes of N . There are many different options, for example, four-class classification problem, you can have in Figure 2.4 three binary forms below.

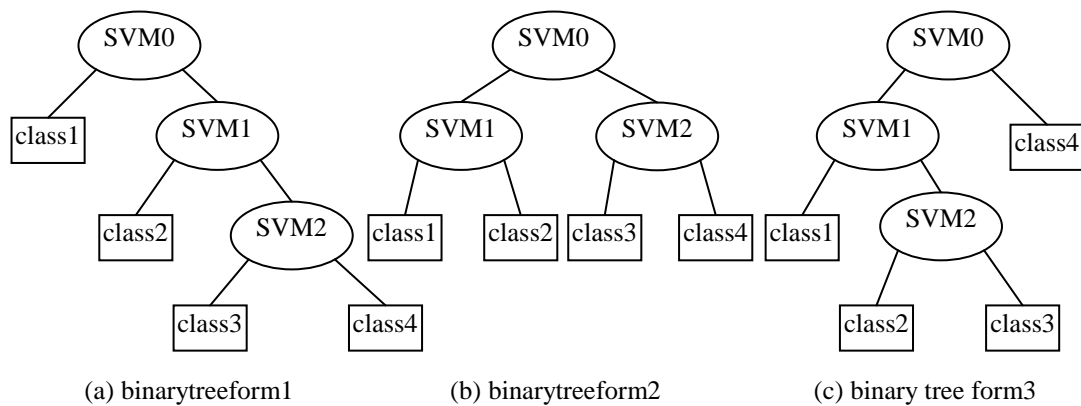


Figure 4. Binary Tree Form

Considering the simplicity of the algorithm and the recognition time, we used the figure 4 (a) of the binary way of combining support vector machines in the experiment. First set SVM1 as binary tree root, and make the decision to separate the test samples belong to the first category and separate the test samples which does not belong to the first category to classify the samples by SVM2, until SVM (N-1) to make decision to separate N-type out of the sample. In DAG SVM method, all the test samples must undergo classification N -1 times to get the class to which they belong. In this scenario, the class just after the first sample of a classification, you can get the class to which it belongs, Class 2 samples only after two classified can get class to which they belong, and so has been the first N-1 and N-type samples, subject to N-1 times to get the class to which they belong classification. Therefore, from the overall point of view, its decisions need to go through a classifier to be considerably less than the number of DDAGSVM methods.

We construct a support vector machine classifier N-1 (N is the number of categories, face) before the N-2 classifier will be before the N-2 class their classification, finally the N-1 classifier to class N-1 and class N separately, which can deal with multi class classification situation. First support vector machine with first class samples as positive training samples, second, 3,..., N class of training samples as negative training samples to train SVM1, section I, a support vector machine to class I samples as positive training samples, the article i+1, i+2,..., N class training samples as negative training samples to train SVM_i, until the N-1 support vector machine to class N-1 samples as positive samples, with N sample class as negative samples to train SVM (N-1).

This sample selection scheme solves the following three problems:

- ① The number of two class support vector machine required training is small, for a N class classification problem, there only need to train the N-1 two class support vector machine.
- ② Eliminate the existence of multi-class belong or do not belong to any one class area when making decisions.
- ③ The first two types of support vector machine training on the entire sample, the second two types of support vector machines in addition to first class on other samples outside the training sample, until the N-1 in the first two categories of support vector machine N-1 training class on the sample and the N-type samples, so as the training progresses, total training samples compared with the many ways to reduce a lot. If there are N classes of samples, the number of samples per class is n, the total number of training samples as many methods N²n, the total number of training samples of one method for N (N-1) n. The decision tree method SVM training sample program for the

total number of training samples $[N(N + 1) / 2 - 1] n$, so if a few more classes, the program total number of training samples is approximately one to many methods and a pair of half a method.

The use of SVM face recognition, you need to face image preprocessing. Pretreatment methods see "3.2.1 face image normalization." Because the human face images are generally larger, and relatively small number of samples of face recognition, we use PCA method to extract the sample set is the main element to achieve dimensionality reduction of the sample will be sent after the feature reduction SVM learning, identification phase will be recognized after the same face image is transformed into learning good SVM model, and then using SVM decision tree method to determine and improve the training speed and testing speed.

Experiments using the database for the ORL database, the experiment uses a different kernel function, learning for the first three samples of each type of face images, the test sample after three images, the experimental results as shown in Table 2, enter the PCA for 40 transform coefficients.

PCA-based SVM method has increased over the face alone support vector machine speed and recognition rate stability. SVM constructed mainly depends on the choice of kernel function. Experimental results show that the use of different kernel functions have little effect on the recognition rate, When the kernel function parameters, the recognition rate will be slightly different, so the need to experiment to select the appropriate parameters. From Table 2 Taken together, the Gaussian radial basis function (Radial Basis Function, RBF) has the best performance, to obtain a higher recognition rate. In order to improve recognition speed of the system, we chose the parameters $\sigma^2=0.3$ of radial basis function as kernel function. Since the feature dimensionality reduction, the learning time is reduced to about 58 seconds, the recognition time reduced to 70 milliseconds.

Table 2. Different Kernel Function SVM Classifier Recognition Results in ORL Database

Support vector machine types	The recognition rate
Polynomial kernel (d=3)	88%
Radial basis function ($\sigma^2=0.3$)	94.5%
S-Layer Neural Network Kernel	91%

Select the kernel function is important, but so far, there is not a better choice recognized standards. Can determine what kernel trained by the experimental results, and how to determine the appropriate kernel function and its parameters should be further studied.

In this paper, a Gaussian radial basis function RBF kernel function as the main reason there are the following:

First, RBF function can be non-linear planning to sample higher dimensional space, in order to address inter-class tags and attributes nonlinear relationship, which is linear kernel can not be solved. Further, the linear kernel function is a special case of RBF kernel function. In addition, sigmoid kernel functions when taking certain performance parameters and the same RBF.

Secondly, the impact of the number of kernel functions to select the model complexity. Polynomial number of kernels are more than RBF kernel function, so the model selection more miscellaneous summer.

Finally, a numerical limit RBF function is less condition. Because k is limited to between 0 and 1, and the value of the polynomial kernel function may become indefinite value or a value of zero and a higher power; sigmoid kernel function in taking some parameter values may be invalid.

From the experiment also found that the results of the use of support vector machines for image recognition is not only concerned with the quality of the image, select the parameters of the algorithm is also critical, distribution relationship test sample set and the training set is also worth considering that these are the future work to further explore the issue.

By Table 1 and Table 2 can be seen, the use of SVM method is a better recognition of the effect, can get a higher ratio improved features face recognition method of recognition rate. However, a problem exists SVM method, that is, if given a face image does not belong to any of the categories in the database images, face recognition method based on SVM is difficult to judge, that is not easy to judge rejection, and this in practice is likely to occur. SVM method in order to solve this shortcoming, we propose a face recognition method based on the combination of multiple classifiers.

2.3 Face Recognition Method Based on Multiple Classifier Combination

Architecture has multiple classifier fusion series and parallel two forms [16-18]. In tandem structure, the previous level classifiers provide classification information for classification after stage after stage classifier to external input and output level classifiers as input before making decisions. Parallel structure classifier is individually designed, each given a separate classification decision results, and then some kind of fusion rules by combining the results of individual decisions in order to get the decision-making fusion system.

Killter systematic study of multiple classifier fusion [19-20], gives the theoretical framework of multi-classifier fusion, and got two basic rules classifier fusion in this framework: Quadrature rules and sum rules. the majority voting rules, such as minimum rules, can be derived from the fusion of these two basic rules.

Minimum rules in order to plot a rule-based, all kinds of other overall posterior probability for each classification after the minimum posterior probability of this category.

Majority voting rules is a very common combination method [21], it is also a sum rule of evolution, just ignore the message posterior probability. Category to get the most votes is the ultimate recognition categories.

Face recognition problem is a small sample, so the use of support vector machine method compared to traditional identification methods has obvious advantages.

SVM-based face recognition method because it is based on a statistical model identification method, in the case of determining the given face is a certain class of people in the database face can be obtained relatively high recognition rate. However, due to a statistical model based on SVM basis, this method has a problem in that if given a face image in the database does not belong to any class of images, face recognition method based on SVM is difficult to judge, That is not easy to judge the rejection. In theory, if you want to achieve rejection, then the database will not require a face model as a class to learn and discrimination, but because it is not the kind of face image too much, you should choose what kind of sample as a counter-example the most appropriate sample, there is no unified criteria. Which in turn is likely to occur in practical applications, such as identity authentication system, must be able to identify the sample does not appear to be in the database need to be removed. This requires the use of other methods first part of the database will not be ruled out face recognition, guarantee to be fed into the SVM face recognition database certainly face, we can solve this problem. From the point of view of pattern recognition, the use of multiple correlation is not strong classifier combination can

improve the ability of the recognition system, although it can not improve the recognition rate, but can use a combination of multiple classifiers reduce the error rate, which is in recognition accuracy demanding situations is very necessary.

This paper considers the improved features of the face recognition method for rejection judgment, will face into recognizable images already in the database in the future does not belong to the category of people face to exclude, and then those who belong to certain types of human faces in the database images into better identify the effect of SVM recognizer to identify, so you can easily determine the rejection, thereby avoiding SVM face recognition method based on rejection of the problem is difficult to judge.

Because of improved features face recognition method using distance determination, if the input image and a database of all known types of distance are very far away, we can determine that the image does not belong to any category in the database, it is determined that rejection. If the input image and the database of a class of persons face very close distance, we can also determine if the human face images belong to the category of people face. Due to improved methods of face recognition feature speed faster, can reduce the part into the SVM method to identify the facial image, it is easy to improve the efficiency of the whole system.

Analyzing rejection threshold T and determines whether or not fed to the next classifier threshold value T_1 is determined by experiment. For very small distance, directly determine the characteristics of the face recognition based on improved methods through experiments, directly determine the distance threshold we set for 2100. Rejection threshold T is set to 2900, you can not ORL face image database excluded to ensure recognition of human faces into the next image in the database is a certain class of people face. Thus, by adjusting the threshold of reasonable, can ensure that the system of recognition rate, but also ensures the identification of efficiency.

Improved features and face recognition method using support vector machine face recognition method based on the series in the form of architecture, we use "and" determine the relationship between the two classifiers identify their results, so you can ensure the accuracy of the recognition result, this is in applications requiring high accuracy is more important. Recognition results of this approach is likely to reduce the recognition rate, but reduced the error rate, which is to improve the rejection rate of the price. However, because of the recognition rate of SVM face recognition method is relatively high, therefore, relatively speaking, the price is not great.

3. The Experimental Results

We used the ORL face image database to validate the effectiveness of the method of face recognition based on multiple classifier combination. In the verification, we selected a total of 200 samples, each person have 5 samples. And we also selected other 200 samples for testing. The training samples and testing samples is without coincidence.

We selected a higher recognition rate of the Gauss radial basis kernel function, parameter $\sigma^2=0.3$. In order to validate reliability of refuse judgment of the improved eigenface recognition method, we set the general threshold with different value. The experimental results are shown in table 3. As can be seen from Table 3, if the rejection threshold value of the improved eigenface method is set too small, then there will be some image ought to belong to the database face classes are eliminated, increasing the rejection, but not increase the error rate. But the rejection threshold is set too high, and then some image which originally does not belong to the category of face image database will be sent into SVM recognizer, which led to the increase of error rate.

Table 3. Face Recognition Method Based on Multiple Classifier Combination

the rejection threshold	multi-classifier recognition rate	multi-classifier error rate	multi-classifier rejection rate
2900	90.87%	0.0%	9.13%
2700	80.23%	0.0%	19.77%
3000	89.45%	0.93%	9.62%

It can be seen from Table 3, when the rejection threshold value T is set to 2900, face recognition with the combination of method the based on support vector machine and improved eigenface, the recognition rate is 90.87%, while in the table 2.2 which use the Gauss radial basis kernel function, the recognition rate is 94.5%. Although the face recognition method of multi-classifiers combination reduces the recognition rate, it reduces the error rate as well, which has an effective impact on the actual application for face recognition method. Because the application for higher level security, the recognition rate can be lower and cannot produce error recognition. Therefore the face recognition method based on multi-classifiers combination is reasonable and has a strong practical value.

4. Conclusion

Classifier combination technology, as an important part of pattern recognition, is paid more and more attention and widely used. It can fuse the information of different classifier and effectively complement and play the advantage of each classifier.

Considering the characteristics of SVM, we have done experiments on face recognition with support vector machine; the experiments show that the effect of this recognition method is fairly good. But there still remains a problem, that is if you want to determine the rejection, the need for adequate counter-examples sample is representative does not belong to the training samples needed to identify the human face model, to find enough negative samples is difficult, which is based on support vector machine the method is not easy to determine the existence of a problem of rejection. Therefore, we propose a face recognition method based on improved eigenface and SVM classifier combination of multi-use features improved face recognition method to determine the rejection, first determine whether a given face image if it is part of a database humanoid face, if it is part of a database of face, and then into the SVM recognizer to identify, so you can avoid SVM face recognition method based on rejection of the problem is difficult to judge. The combination of multiple classifiers method not only make full use of the advantages of the support vector machine such as high recognition rate, distance measurement and fast speed but also use distance metric results to guide the support vector machine in tests and training. Experiments show that, the multiple classifier combination method has higher efficiency and recognition accuracy and lower rate of error recognition.

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