Gender Recognition using Adaboosted Feature

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Abstract

In this paper, a novel approach for gender recognition combining the ellipse face images, Gabor filters, Adaboost learning and SVM classifier is proposed. Face representation based on Harr-like feature、Gabor feature or ICA is an effective method to extract facial appearance information. So we compare these three kinds of features selected by adaboost method using FERET database. In the first experiment, several different preprocessing methods (face detector, warp face images and ellipse face images) have been compared, meanwhile comparing different feature extraction methods (Gabor wavelets, Haar-like wavelets, PCA, ICA).The experimental results show that our proposed approach (combination of ellipse face images, Gabor wavelets and Ada+SVM classifier) achieves better performance. The second experiment is tested on PCA and ICA feature extraction method with different explanation. It is shown that ICA is much steadier than PCA method when the explanation changed.

1. Introduction

This paper addresses the problem of classifying gender from facial images. Gender classification is one of the focuses of face retrieve problem and has many potential applications. When we communicate directly with other people, visual information plays an important role. When we look at a person's face, not only we discern who it is, but also process other information about the person, such as the expression, gender, ethnicity and age. We also hope the computer can comprehend automatically these messages from facial images.Then human-machine communication could flow more freely. The problem of human computer interaction has obtained a high degree of interest, with the development of computer and robots technology. The earliest was based on neural networks attempting to use computer vision techniques for gender classification. Moghaddam etal [1] investigated to apply the Support Vector Machine to classify gender with low-resolution 21*12 "thumbnail" faces. And Wu etal [3] introduced an automatic real-time gender classification system based on LUT-Adaboost method.

The approach presented in this paper consists of three modules, Feature extraction, Adaboost learning and SVM classifier. Figure.1 shows the system flowchart based on our method. In the recent years, Gabor filter bank, Haar wavelets, Adboost and SVMs have been successfully applied to various tasks in computational face-processing. These include face detection[6], face expression recognition[4]et al. In this paper, we compared different preprocessing methods and different feature extraction methods, and the results with different combination methods were showed.

The rest of this paper is organized as follow: In section II, the three methods of facial images preprocessing are introduced briefly. Section III introduces and compares the two feature extraction methods. And the experiments and results based on our approach are shown in the Section IV. Final Section is the conclusion based on the experiments and results.

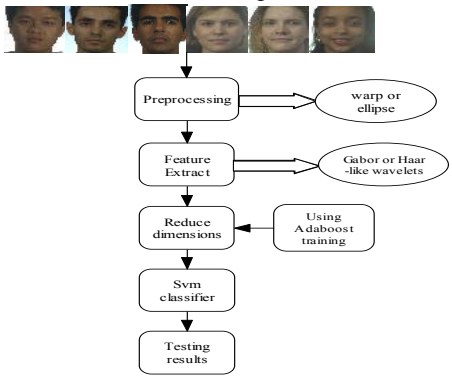

Fig 1. **Flowchart of the gender recognition system**

2. Three different Preprocessing of Facial Images

We used three different image preprocessing methods (face detector, warp face images and ellipse

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face images). One is simple geometry normalization (face detector), which includes the scaling and rotation. The other two methods are warp and ellipse processing, which can align all the training and testing images to the same size. The disadvantage of geometry normalization is that the key Gabor features' or Haar-like features' positions are quite different for different training and testing samples. Before the feature extract process we must obtain the face region of human face image. Because the methods used in our experiments are all features, which have a strong relationship with the face area position (Fig 2). The face's normalization is much more necessary. We need to know three points of the face to obtain the face region by the face detector, two eye centers and one nose center. 71 label points is needed in the face to obtain the warp image. But for the ellipse images, two eye centers is only to be estimated. This is the reason we choose the ellipse face images in the final experiments. The training sample images (face detector face images, ellipse face images and warp face images) are showed in Fig4, 5, 6.

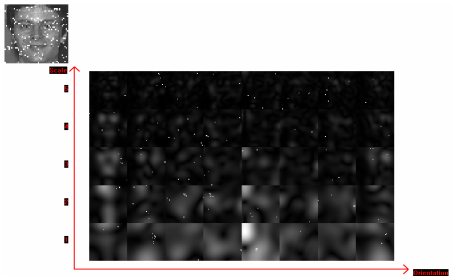

Fig 2. **Gabor features according to pixel position**

3 Compare the different Feature Extraction Methods

In order to obtain the discriminatory features of gender from face images, we implemented several different methods, which include PCA, ICA, Gabor and Haar-like features. In our experiment, the results show that the Gabor features is more effective.

3.1 Gabor filters

A two dimensional form of Gabor wavelet [2] consists of a planer sinusoid multiplied by a two dimensional Gaussian. Using the 2D Gabor wavelet highlights and extracts local features from an image, and the advantage is the high tolerance of changes in location, shape, scale and light. Here is the formula of Gabor wavelet in space domain:

$$g(x,y)=(\frac{1}{2\pi\sigma_x\sigma_y})\exp[-\frac{1}{2}(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2})+j2\pi\omega x] \quad (1)$$

The formula in frequency domain is defined as follows:

$$G(u,v)=\exp\{-\frac{1}{2}[\frac{(u-\omega)^2}{\sigma_u^2}+\frac{v^2}{\sigma_v^2}]\} \quad (2)$$

The Gabor wavelet transform adopted in our system is:

$$\begin{aligned} &F(x,y)=a^{scale-scaleindex}g(x',y') \\ &x'=(x\cos\theta+y\sin\theta) \\ &y'=(-x\sin\theta+y\cos\theta) \end{aligned} \quad (3)$$

(x,y) represents the pixel in an image, $scale$ is the parameter of spatial frequency, θ is the orientation angle , $\theta=\frac{(n\pi)}{k}$, $(n=0,\cdots,k-1)$, where k is the number of orientations. This wavelet can be used in 8 orientations $(n=0,\cdots,7)$ and 5 spatial frequencies $(scale=1,...,5)$.

After that, an image is converted into 40 images with different scales and orientations, and the individual Gabor filters coefficients is the features needed. The operation is very complex and slow in spatial domain, so we use FFT in frequency domain firstly, and then employ IFFT to obtain the output in spatial domain. In this paper, the original images are 48*48 resolutions. So the Gabor wavelet coefficient is 92,160 dimensions.

3.2 Haar-like wavelets

Recently, Paula Viola and Michael J. Jones[6] constructed a fast face detection system using Haar-like rectangle features. Sung Uk Jung[10] established more analysis and innovative rectangle features for facial expression analysis system. In our gender recognition system the Haar-like wavelets rectangle features proposed in [10] are used. Meanwhile we employed all possible Haar-like wavelets rectangle features to represent each face image as a high dimension feature vector. Because the dimension of Haar-like feature vector is higher, we have to use lower resolution original face images. When 24*24 face images is used, the dimension of Haar-like feature vector is 136,656. Then the Adaboost algorithm is used to reduce the dimension of feature

vector. There are totle 316 rectangle feature types for each pattern. Each rectangle feature type was selected by the Adaboost training algorithm. Figure 3 shows all possible style of Haar-like rectangle features.

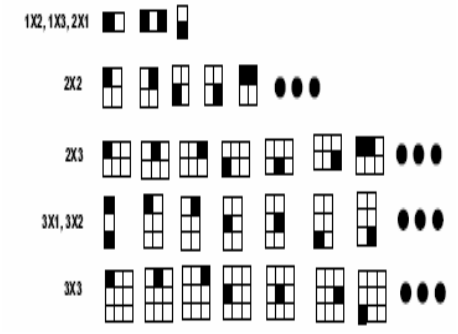

Fig.3 **All possible Haar-like rectangle features types up to the 3*3 structure size used in our experiment training**

4. Experiments and Results

The approach presented in this paper was trained and tested on frontal face images collected from FERET dataset. The training set consists of 300 images with 256 gray levels, 150 of male subjects and 150 of female subjects, and the test set includes the other 518 images. In preprocessing, we used the three methods mentioned above to obtain the face area. The training sample images (face detector face images, ellipse face images and warp face images) are showed in Fig4,5,6. Based on the approach we proposed, several experiments are done below.

Fig 4**. Training images after face detector**

Fig 5. **The training ellipse face images**

Fig 6. The training warp face images

4.1 Experiment -1

The purpose of this experiment is to examine the effects of different preprocessing methods and different feature extraction methods on the face gender recognition results. Firstly, we compared the Gabor wavelets and Haar wavelets at low resolution face image (24*24), and the results are shown in Table 1. The accuracy is lower with low image resolution, In the next experiments the 48*48 images are used, and it also can real-timely recognizing in FERET dataset. M. S. Bartlett[6] suggested that it was better to set the high and low frequency to 0.4 and 0.1 in facial expression analysis problem. But in our experiments we set the high and low frequency to 1.0 and 0.1. And it has a better performance than before. When using the Haar-like wavelets method, we calculate all the possible Haar-like rectangle features [10] to represent one gender face image, and the experimental results are shown in Table2.

Table1. **results with different resolution**

Preprocess	Feature Extraction	Classifier	resolution	Accuracy
Face detector	Haar-like Feature	Adaboost +SVM	24*24	80%
Face detector	Gabor Feature	Adaboost +SVM	24*24	83%
Face detector	Gabor Feature	Adaboost +SVM	48*48	85%

Table2. **Results with different preprocessing**

Preprocess	Feature Extraction	Classifier	resolution	Accuracy
Face detector	Gabor Feature	Adaboost +SVM	48*48	85%
Warp images	Gabor Feature	Adaboost +SVM	48*48	86%
Ellipse images	Gabor Feature	Adaboost +SVM	48*48	90%

4.2 Experiment -2

In another experiment, the PCA and ICA feature extraction methods have been compared. These two methods are used to extracted features from ellipse face images. And the SVM classifier is used to classify the PCA and ICA face features. The experimental results are shown in Table [3, 4]. The goal of this experiment is to understand the effects of the explanation on PCA and ICA performance.

Table3. **PCA results with different explained**

Feature Extraction	Feature dimension	Explained	Accuracy
PCA	50	80%	86%
PCA	79	85%	87%
PCA	134	90%	79%
PCA	261	95%	68%

Table4. **ICA results with different explained**

Feature Extraction	Feature dimension	Explained	Accuracy
ICA	50	80%	86%
ICA	79	85%	87%
ICA	134	90%	88%
ICA	261	95%	87%

4.3 Experiment -3

When the PCA+ICA method is used as feature extraction method, we find that the PCA+ICA features have some negative components which affect the gender recognition performance. So the ICA+Adaboost method to extract the key features is implemented, and in our experiment the results show that the ICA+Adaboost method is better than only using ICA method. The original ICA feature dimension is 134, we use the Adaboost learning method to reduce the dimension from 10 to 130, the gender recognition results are shown in Fig7. From the results, we find that when the ICA dimension is from 60 to 120 the recognition performance is better than the 134 dimension. The green point in Fig7 shows the original ICA features performance。

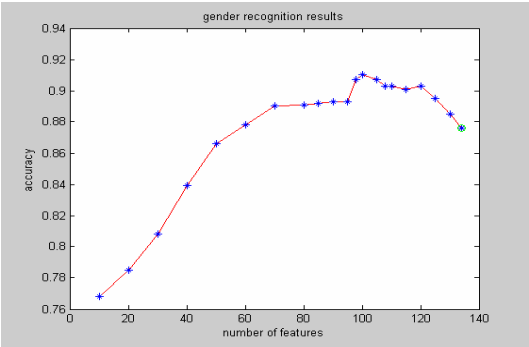

Fig 7. **ICA+Adaboost gender recognition results**

5. Conclusion

In this paper we have proposed a novel approach for gender recognition problem, and compared the different preprocessing methods and different feature extraction methods, meanwhile have shown the performances of different combinations. Experimental results on FERET database of frontal facial images show that the Gabor features of ellipse face images method have achieved the best performance. Because the Gabor filters can extract the face features with different orientations and scales, it has strong representation ability. Though the accuracy is lower using the method, which combines Haar-like wavelets with Ada+SVM classifier, the Haar-like feature method has a higher speed when recognizing the gender from face images based on fast calculation algorithm. From the other experiments, it is shown that ICA feature extraction method is much steadier than PCA when the explanation changed. And we also implement the Adaboost learning process to improve the ICA features extraction performance. Through the Adaboost process we can reduce the influence of noises especially illumination. The experiment result proves that the ICA features extracted by the proposed method (ICA+Adaboost) is much more appropriate to facial gender recognition than original ICA method.

6 Acknowledgment

Portions of the research in this paper use the FERET database of facial images collected under the FERET program.

7 References

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