Available online at www.sciencedirect.com
SciVerse ScienceDirect
Physics Procedia 25 (2012) 1236 – 1240
Physics Procedia

2012 International Conference on Solid State Devices and Materials Science

Facial Expression Recognition Analysis with Muti-Scale Filter

Jun Ou

Department of Network Engineering,Hainan College of Software Technology ,QiongHai, Hainan, 571400, P.R.China

Abstract

The design of filters is the key step of facial expression extraction. Frequency and orientation of the filters can simulate those of the human visual system, and they have the characteristics of being particularly appropriate for texture representation and discrimination. The paper presents the wavelet filter provided with 3 frequencies, 8 orientations. In according to actual demand, it can extract the feature of low quality facial expression image target, and have good robust for automatic facial expression recognition. Experimental results show that the performance of the proposed filter achieved excellent average recognition rates, when it is applied to facial expression recognition system.

Keywords: Facial expression recognition; Muti-scale filters;Feature extraction

1. Introduction

In recent years, many researchers and experts show a growing interest in facial expression analysis. It is argued that the facial expressions play an important role in social interactions with other human beings. Facial expressions can contain a great deal of information and the desire to automatically extract this information has been continuously increasing. It is a visible and mutative manifestation of human cognitive activity and psychopathology. With the rapid development of computer vision and artificial intelligence, facial expression recognition becomes the key technology of advanced human computer interaction. More and more people have been paying attention to expression recognition. The research objective of facial expression recognition is how to automatically, reliably, efficaciously use its conveying information. It is a typical issue in model-identification that the automatic recognition system's property is decided by the represented facial expression feature. Detection of facial feature key-points is often the necessary step of facial expression recognition. The precise localization of the facial feature key-point detection highly affects the recognition system performance efficiency. In this study, it proposes here a robust, highly

 doi:10.1016/j.phpro.2012.03.226

accurate method for detecting 28 facial key-points in images. Of course, the feature extraction is also very important to the facial expressions recognition process. If inadequate features are provided, even the best classifier could fail to achieve accurate recognition. In most cases of facial expression classification, the process of feature extraction yields a definitively large number of features and subsequently a smaller subset of features needs to be selected according to some optimality criteria. Gabor filters have been proved to be effective for expression recognition because of its superior capability of multi-scale representation. Gabor wavelet can use very better description of biological visual neuron about receptive field, .According to the needs of special vision, it can adjust the spatial and frequency properties to face expression characteristic wanted, so Gabor filter wavelet is suitable for people face analysis and treatment of expression.

The remainder of this paper is organized as follows: Section 2 is composed of two parts: the first part describes the overall process of facial expression recognition; the second part presents the image capture and preprocessing. Section 3 introduces the filter's principle, property and the feature characterization in detail. Then the adaptation scheme for choosing the orientation and frequency of the filter to extract the facial expression feature will be performed. The convolution output of the original image is also presented in Section 3. In Section 4, some experimental results are shown and explained.

2. the process of facial expression recognition

A. The Process of Facial Expression Recognition

The recognition process is including the followed steps in Fig.1:

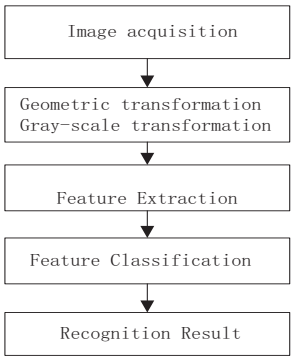

Figure.1 The process of facial expression recognition

The recognition process begins by first acquiring the image using an image acquisition device like a camera. Then, the image acquired must be pre-processed. Normally, the image pre-processing step comprises of operations like normalizing intensity, contrast, uniform size and shape. Two –dimensional Gabor wavelet can simulate the human visual system and has the appealing features. For example, such as it can provide optimal localization. We need to crop the face region using a rectangle according to face model and scale the face expression image at 90×100 pixels. To obtain the facial expression feature, each segmented image will be converted into 24 Gabor filters with three spatial frequencies and three orientations. The dimension of the Gabor feature vectors are 90×100×6=324000.Research in psychology has indicated that at least six emotions are universally associated with distinct facial expressions. The experiments is performed by using Cohn-Kanade AU-Coded Facial Expression Database[1]. Sample expressions of six expressers are in the database. Image data consist of approximately 500 image sequences

from 100 subjects. Subjects range in age from 18 to 30 years. Sixty-five percent were female; 15 percent were African-American and three percent Asian or Latino.

This database contains images of individual female subjects performing a variety of facial expressions. The number of images corresponding to each of the 6 categories of expression (anger, disgust, fear , sadness, smile, and surprise)is almost the same. Image sequences were digitized into 90 by 100 pixel arrays with 8-bit precision for grayscale values.

B. Image Preprocessing

The recognition process begins by first acquiring the

image using an image acquisition device like a digital camera or computer camera. Then, the image acquired at 236 × 236 pixels. It must be pre-processed. Normally, the image pre-processing step comprises of operations like normalizing intensity, contrast, uniform size and shape. We need to crop the face region using a rectangle according to face model and scale the face expression image at 90×100 pixels.

3. Feature representAtion

The filter is a good model of simple cell receptive fields in cat striate cortex [2] and it can be used for object recognition and face expression recognition. In this study, the filters have been applied to various image recognition problems for feature extraction due to its optimal localization properties in both spatial and frequency domain. A Gabor filter can be formulated by the following equation:

$$\Psi_{u,v} = \frac{\|k_{u,v}\|^2}{\sigma^2}\exp\left\{-\left(\frac{\|k_{u,v}\|^2\|z\|^2}{2\sigma^2}\right)\right\}\left[\exp\left(izk_{u,v}\right)-\exp\left\{-\left(\frac{\sigma^2}{2}\right)\right\}\right] \tag{1}$$

Where $k_{u,v} = \left(k_v \cos\phi_u / k_v \sin\phi_u\right), \quad \phi_u = \pi u / k,$

$$k_v = 2^{-\left(\frac{v+2}{2}\right)}\pi$$

where z=(x, y) is the pixel position in the spatial domain, k_v and ϕ_u are separately modulating frequency and modulating orientation. U is the orientation of a Gabor filter and v is the scale of a Gabor filter. The wavelength is decided by v. Further more, the second term of the Gabor filter($\exp\{-(\sigma^2/2)\}$) compensates for the direct current component value because the cosine component has nonzero mean while the sine component has zero mean. Gabor filter has good resolution both in spatial field and frequency field. It also have obvious speciality of orientation selection and frequency selection.

Feature extraction is the key step of facial expression recognition. In order to extract exact facial expression feature, each facial image was convolved with a multiple spatial resolution, multiple orientation set of two-dimensional Gabor filter..Provided input image I(x, y), The Characterization of the image can be written as below formula(2): a convolution of the image I(x, y) with the Gabor kernel $\Psi_{u,v}$ (x,y)[3][4][5][6].

$$O_{u,v}(x,y) = I(x,y) * \Psi_{u,v}(x,y) \tag{2}$$

In this study, suppose a discrete set of Gabor kernels is used that comprises of 3 spatial frequencies and 8 distinct orientations. Then, there are 3×8=24 Gabor wavelet kernel filters. As can be seen from the data result, they presents the output location of Gabor filter is mainly in eyebrow, eye, nose, mouth. Then the

characterization direction's information is obtained by a series of different angle. Gabor filters is greatly different. The Gabor filters($\phi = \pi$)extract sensitively the characteristics of the horizontal component, Such as eyes, mouth region is especially obvious. The Gabor filters($\phi = \frac{\pi}{2}$)extract sensitively the characteristics of the vertical component, Such as nose, face region is specially significant. Characteristic vectors($G_{0,0}, G_{0,1}, \ldots\ldots, G_{2,7}$)are provided by 24 Gabor kernels. They compose the Gabor feature vector.

$$X = (G_{0,0}, G_{0,1} \ldots\ldots, G_{2,7})^T \tag{3}$$

T stands for matrix transposition. The significant key points' Gabor vector mode $\|X\|$ is higher.

4. Experimental results

In order to further verify the effectiveness of the proposed method, we selected a set of 300 images from Cohn-Kanade AU-Coded Facial Expression Database to perform the experiments. The recognition results with and without the method are given by Table1.

As can be seen from the table，the recognition performance is better than the others, G(3×8) filter is nearly 2 percentage points higher than G(1×8). Considering from the recognition rate of the single test samples, the recognition performance of the samples in lower recognition rate is improved more: as shown in the ninth data increased from 72.33% to 75.21%.

Table 1. Recognition Rates with Different Scales

Test Case	Six Experimental Basic Emotions		
	G(1×8)	*G(2×8)*	*G(3×8)*
1	0.8929	0.9196	0.9228
2	0.8924	0.9020	0.9124
3	0.8434	0.8594	0.8663
4	0.9132	0.9228	0.9278
5	0.8754	0.8924	0.9020
6	0.9670	0.9715	0.9752
7	0.8170	0.8290	0.8357
8	0.8820	0.9302	0.9345
9	0.7233	0.7372	0.7521
10	0.8477	0.8613	0.8754
Average Recognition Rate (%)	0.8654	0.8825	0.8904

but the higher recognition rate increased little, as shown in the fourth and sixth data group. From Table1 it is obvious to see that the proposed method is effective for achieving high performance. Its average recognition rate is 89.04%, and it improves 2% or so than the average recognition rate with the other filters.

References

[1] Cohn-Kanade AU-Coded Facial Expression Database. Available: http://vasc.ri.cmu.edu/idb/html/face/facial_expression/ A. Mehrabian, Communication without words, Psychology Today, Vol 2, No.4,pp53-56.1968

[2] J. G. Daugman, "Complete Discrete 2-D Gabor Transforms by Neural Networks for Image Analysis and Compression", IEEE Trans. Acoustic, speech and signal processing, Vol. 36 1988, pp.1169-1179

[3] P. Ekman and W. V. Friesen. Facial Action Coding System: Investigator's Guide. Palo Alto, CA: Consulting Psychologists Press,

[4] 1978.

[5] Y.Yacoob and L.S. Davis. Recognizing human facial expressions from long image sequences using optical flow. IEEE Trans. Patt. Anal.

[6] Machine Intell., Vol 18, No.6, pp. 636–642, 1996.

[7] I.A. Essa, A.P. Pentland, Coding analysis interpretation and recognition of facial expressions, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol19 ,No.7,pp. 757–763, 1997

[8] N. Sebe, I. Cohen, A. Garg, M. Lew, and T. Huang. Emotion recognition using a Cauchy Naive Bayes classifier. ICPR2002.Vol.4: 3732-3737, Aug. 2002