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Wavelet Based Feature Extraction for Facial Expression Recognition

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Abstract

Facial expression recognition has become a vital part of the face analysis research in human computer interaction (HCI). The facial expressions are playing a key role in behavioral studies. The current study is to find a better way for automatic facial expression recognition based on facial images. In image processing, wavelets become very popular tools for various applications. In this paper, facial features are extracted using log Gabor wavelet filters as the wavelet-based feature extraction techniques are insensitive to large change in light direction and pose variations. Then the classification based on support vector machine (SVM). The JAFFE standard database was used for testing expression recognition system.

***Key Words*:**Facial expression recognition; Feature extraction; Log Gabor wavelet filter; Classification; Support vector machine.

1 INTRODUCTION

Facial expressions convey the emotional states of the individuals to observers. Generally, the facial feature extraction and classification of emotions from detected original face images are the major factors in accurate facial expression recognition systems. There are different face detection algorithms (feature based, knowledge based, appearance based and template matching) focus on the detection of frontal human faces. Automatic facial feature extraction categorized [5] as geometric based approaches [6] and appearance-based approaches [7]. Geometric based approaches based on the location and shape of facial components and appearance-based approaches are based on appearance changes of the face when applying filters to face regions. As the geometric based features are sensitive to noises, appearance-based methods are preferred for feature extraction. Gabor wavelets are more useful to exemplify local features of the human face. The major problems with wavelets are low resolution in orientation and aliasing. To avoid aliasing effects and for the improved resolution, Multi-resolution transformations are used. The log Gabor filters are proposed for localization of spatial and frequency information of images. Finally, support vector machines are chosen for machine learning and classification of extracted facial features. The various applications of real time facial expression recognition are include customer satisfaction analysis through facial expressions, patient health monitoring, video conferencing, facial emotion analysis, cognitive sciences and more.

The next chapter of this paper is literature review then the third chapter about the image database used and the image preprocessing. The fourth chapter about the feature extraction technique followed with the experimental results given as chapter five. Finally, the chapter seven covered the conclusions.

2 LITERATURE REVIEW

Pinky Rai, Manish Dixit [1] used a hybrid method of recognizing facial expression based on Bezier curve of mouth interest points and eye interest points using mussels movements. But problem was having a single query image for the measurement and considered three facial expressions smile, sad and surprised. Reda Shbib,

Shikun Zhou [8] developed a system for facial expression analysis based on Active Shape Model (ASM). ASMs are statistical models of the shape of the objects which tries to match the model to new image. The concept of active appearance model (AAM) is implemented for classification of emotional sates. In that work, AAM is experimented based on still images to identify the six universal emotions. FACS systems was used for guidance in land mark selection process of AMMs in capturing the important facial structures for finding face expression. In order to reduce the fitting error J. Sung [9] introduced an approach, which integrates AAM with ASMs. Jagdish Lal Raheja, Umesh Kumar [10] presented a simple architecture for human facial expression recognition in color images based on simple token finding and matching using back propagation neural networks. The problem involved with this architecture was setting threshold values manually for the detection of tokens to recognize the human gesture. similarly, some of the methods are proposed a method to recognize the facial expression based on neural networks.

Facial expression classification using local binary patterns was implemented in [2]. C. Shan, S. Gong, P.W. McOwan [3] recognized facial expression based on LBP, statistical local features. They used Boosted-LBP to extract LBP features and support vector machine classifiers to achieve better classification. Similarly, Liao, W. Fan, C.S. Chung, D.-Y. Yeung [4] presented an extended LBP operator to extract features for facial expression recognition. The log-Gabor wavelets are implemented by Sylvain Fischer, Filip Sroubek, Laurent Perrinet [11] and attained best results for representing features of images and to segregate the natural images from in-coherent noise. Lajevardi S.M., Lech M. [12] considered averaged features by using Gabor filters for facial expression recognition.

3 IMAGE DATABASE AND PRE-PROCESSING

Initially the images are taken from standard JAFFE database. It consisting of 213 static images of 10 different persons with seven facial expressions (neutral, sadness, surprise, happiness, fear, anger & disgust). The images in Fig.1 show the six basic expressions of a single person. Among the seven facial expressions, six expressions

are considered for the further face processing.

Fig. 1. Basic face expressions from JAFFE database

In the pre-processing step the image intensities are normalized and then resized. After pre-processing the resultant image consisting only a face expressing the emotion.

4 FEATURE EXTRACTION

The feature extraction is the important step in facial expression recognition process. In this current work the face features are extracted based on log Gabor filters. The proposed logs Gabor wavelet transforms permit exact reconstruction and intensify the finest mathematical properties of the Gabor filters. The Gabor wavelet have many applications such as image fusion, image compression, edge detection and image de-noising. The log Gabor wavelets are good at representing important features of human faces. The log-Gabor filter does not depend on the mean value of the signal i.e., this filter does not exhibit a non-zero DC component like Gabor filters. As the DC component becomes zero, the filter is designed in frequency domain and the spatial domain representation can be obtained by applying inverse Fourier transform.

The 2-dimensional log-Gabor filter is designed, not only for frequency component but also for particular orientation. The orientation component is a Gaussian function of distance in terms of polar co-ordinates. The polar form of 2D log-Gabor filter can be represented mathematically as in (1)

$$H_{lg}(f,\theta) = exp\{\frac{-|\ln\frac{f}{f_c}|^2}{2|\ln\frac{\sigma_f}{f_c}|^2}\}exp\{\frac{-(\theta-\theta_0)^2}{2\sigma_\theta^2}\} \quad (1)$$

Where, is the filters center frequency and the direction of the filter is denoted by .

The constant , defines the radial bandwidth in octaves as in (2),

$$B_w = 2\sqrt{\frac{2}{\ln 2}|\ln(\frac{\sigma_f}{f_c})|} \quad (2)$$

The component , defines the angular bandwidth in radians and it is represented as in (3),

$$\Delta\Omega = 2\sigma_\theta\sqrt{\frac{2}{\ln 2}} \quad (3)$$

Here in this work four scales and six orientations were implemented to extract facial features from images.

5 EXPERIMENTAL RESULTS

In this work, the facial expression recognition system was trained and tested using JAFFE database. Log-Gabor filters are used for feature extraction. From the database considered 100 images for feature extraction including six facial expressions: Happiness, fear, sad, anger, surprise, disgust. Half of the 100 images are considered for training and the remaining half is used for testing. By using SVM classifier 17 images with the expression happiness are classified correctly out of 20 images. The MATLAB is used for obtaining the results. Once the data base trained, test image is classified using the SVM classifier. The result for the recognition of happiness expression is shown in Fig.2.which showing the small window that shows The recognized emotion is happy. That is, the performance of the classifier for the expression happiness is 85%. For the expression fear the performance is 84.6%, and for the expression surprise it is 83.3%. Similarly, the performance of the classifier at different expression is tabulated in Table I.

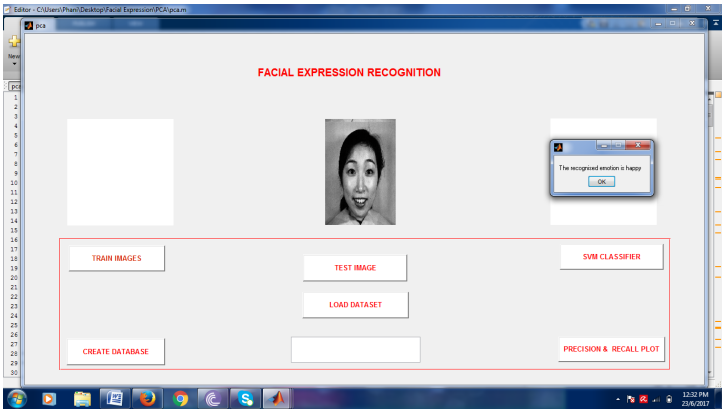

Fig. 2. Recognition of expression Happy

TABLE I. PERFORMANCE OF FACIAL EXPRESSION CLASSIFICATION USING LOG GABOR FILTER AND SVM

	Happy	Fear	Sad	Disgust	Surprise	Anger
Happy	**85%**	5%	0	0	10%	0
Fear	7.7%	**84.6%**	7.7%	0	0	0
Sad	0	0	**76.5%**	0	17.6%	5.9%
Disgust	0	0	16.6%	**75%**	0	8.3%
Surprise	16.7%	0	0	0	**83.3%**	0
Anger	18.7%	0	0	0	0	**81.3%**

6 CONCLUSION

In this paper, we studied feature extraction method for facial expression recognition system using the log-Gabor filters. The results showed that the log-Gabor method produced total accuracy of 80.95% with support vector machine classifier. Here it is concluded that the log Gabor filter results with better performance with four scales and six orientations and also the SVM classifier is one of the good classifiers.

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