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ANALYSIS OF GABOR WAVELET TRANSFORM FEATURE EXTRACTION METHOD FOR FACIAL EMOTION RECOGNITION

Shweta Sharma*
Surendra Yadav**

ABSTRACT

Analysis and recognition of facial expression is an important aspect in the field of research and so it is required to achieve optimum recognition rate. Currently research issues are to pay emphasis to increase the recognition rate which can be done by refining the pre-processing of datasets, the method for extracting the features and using the best classifier for emotion recognition. Recognition rate for facial emotion recognition depends on the important step of feature extraction. To improve the recognition rate, if features are extracted using different ways or forecast then most likely the laying-off will rise which may result in fall in the recognition rate. The main issue with Gabor filter is high dimension and high redundancy although it has extreme alteration of features. Dimension and redundancy should be reduced using some method. The dimension reduction method for Gabor is called filtering so this whole system is called Gabor filter. These filtering method are sampling, averaging and PCA etc. In the projected Gabor feature removal method, wavelet transformation is used for filtering the Gabor features and it obtains finest features from facial Gabor matrices.

Keywords: *DWT, Expression, Facial Emotion Recognition, Gesture, Gabor Filter.*

Introduction

Facial expressions can contain an excessive agreement of information and the longing to mechanically extract this information has been nonstop growing. The mode of human-computer communication includes language, text, gestures, facial expressions, speech, symbols, or a mixture of these [1]. The performance of the Facial Emotion Recognition System depends on good image quality and large training set. There are seven basic expressions: Neutral, Anger, Fear, Disgust, Happiness, Sadness, and Surprise which have to be recognized in facial expression analysis [2]. In feature extraction the original image is converted into a more compact and separable representation by using reduced dimensionality or absorbing the features which is similar to reducing dimensions. [3]. Feature selection is a universal problem in machine learning, which decreases the number of features, unrelated, noisy and redundant data, and outcomes in suitable recognition accuracy [4]. The expression classification is achieved by classifiers, casing parametric as well as non-parametric systems, which have been functional to the automatic expression recognition unruly [5]. Meihua Wang, Hong Jiang and Ying Li [6] proposed a scheme of feature extraction method for facial gesture recognition depended on DWT and DCT. Low frequency coefficients of DWT have significant characteristics of a facial gesture of digital copy of picture.

And noise does not affect the low frequency sub band. Result and analysis have proven that the proposed scheme has higher recognition rate compared to normal Pixel Component Analysis method. Linin Shen and Li Bai [7] have proposed a Gabor and Kernel based face recognition method. Gabor wavelets and Kernel methods are mutual in order to achieve vastly discriminative features for recognition.

G Research Scholar, Department of CSE, CP University, Kota, Rajasthan, India.
** Professor, Department of CSE, CP University, Kota, Rajasthan, India.

Quan-You Zhao et. al. [8] take the nearby newly engaged person-independent facial expression recognition algorithm grounded on fusion of Gabor and LBP Structures with OLPP. A new Gabor feature extraction method is projected, pointing at the deficiency of joint Gabor feature extraction method, Each Gabor wavelet representation of an image is divided into small sub blocks, after that the mean value and standard deviation in each sub block are calculated. The indicators of all Gabor wavelet demonstrations are connected as the feature vector.

Related Work

- **Gabor Filter Feature Extraction Technique**

Gabor filters can be applied to images to extract features aligned at particular angles. Gabor filters acquire optimal localization properties in both spatial and frequency domains. The most substantial parameters of a Gabor filter are angle and frequency.

Assured features that share similar angle or frequency can be selected and used to individualize between different facial emotions depicted in pictures. Gabor filter is well-defined as a complex exponential modulated by a Gaussian function in the spatial domain [9]. Gabor filter is also called Gabor wavelet.

A Gabor filter equation is as follows:

$$\psi(a, b, \lambda, \Theta) = \frac{1}{2\pi D_x D_y} e^{-\frac{1}{2}\left(\frac{a_1^2}{D_x^2}+\frac{b_1^2}{D_y^2}\right)} e^{j\frac{2\pi a_1}{\lambda}} \quad (4)$$

(a, b), Spatial domain pixel position.

λ, Wavelength or a Reciprocal of frequency of pixels.

θ, Gabor filters orientation.

D_x, D_y, Standard deviation of the x and y directions.

The parameters a'and *b*' are given as equation

a'= acosθ + bsinθ y'= -acosθ + bsinθ (5)

The amplitude and phases of Gabor filter bank both contribute valuable information about specific pattern present in images. The amplitude contains of directional frequency spectrum information and a phase contains information about the location of edges and image details. The feature extraction technique transforms the pixel data into a higher-level demonstration of structure, movement, intensity, characteristic of surface, and spatial configuration of the face or its components. The Gabor features are computed by convolution of input image with Gabor filter bank. I (a, b) is a gray-scale face image of size M*N pixels. The feature extraction method can then be defined as a filtering operation of the given face image I (a, b) with the Gabor filter u, v (a, b) of size u and angle v are given as equation (6).

$G_{u,v}(a,b) = I(a,b) * \Psi(a,b)$ (6)

In Gabor feature extraction method if Holistic approach is used then features are extracted from the entire image. Gabor filters are applied on appearances to extract features fix at particular angle orientation then the Gabor feature representation $|O(a,b)|_{m,n}$ of an image I(a,b), for a=1,2,.....N, b=1,2,....M, m=1,2...N_L , n=1,2,....No, is computed as the convolution of the input image I(a,b) with Gabor filter bank function $\Psi(a,b, \lambda_m,\theta_n)$.The convolution process is performed separately for real and imaginary part are specified as equation (7).

$Re(O(a,b))_{m,n} = I(a,b) * Re(\psi(a,b,\lambda_m,\theta_n))$

$Im(O(a,b))_{m,n} = I(a,b) * Im(\psi(a,b,\lambda_m,\theta_n))$ (7)

This is followed by the amplitude calculation is given as equation (8).

$|O(a,b)|_{m,n} = ((Re(O(a,b))_{m,n})^2 + (Im(O(a,y))_{m,n})^2)^{1/2}$ (8)

- **Discrete Wavelet Transform Feature Selection Technique**

Wavelet transform signifies the signals with minor waves of limited interval which are termed as wavelets. A Wavelet transform of M*N pixel image produce M*N wavelet coefficients in transform matrix. If Ψ (t) $\in L_2(R)$, the Basic Wavelet Ψ (t) is defined as

$$C = \int_{-\infty}^{\infty} \frac{|\Psi(w)|^2}{w} dw \quad (9)$$

Where Ψ (w) is Elementary Wavelet's Fourier alteration and w is called circular rate. In the Wavelet transformation, the indication is decomposed into different sub-band which has high frequencies called detailed components. The sub-band which has low frequency coefficient is named Estimated Modules. Estimated coefficient contains dominant information about gesture and detailed coefficient represents disruption and noise in a signal. So we have to extract low frequency coefficient or approximate components from transformed wavelet coefficient matrix.

1-Dimensional Wavelet Transformation is functional to the rows and columns of the input block of image so that 2-Dimentional Wavelet Transformation can be implemented [10].

Proposed Work

In the Gabor Filter Feature Extraction technique, the dimension and redundancy is too large for performing feature extraction. To overcome this disadvantage of huge feature vector dimension we need to decrease the size of feature vector and for this down sampling is performed without losing any kind of information. In the Gabor filter feature extraction technique, the problem of feature extraction can be viewed as a dimensionality reduction problem. It refers to transforming the input data into a reduced representation set of features which encode the relevant information from the input data. In my proposed average Gabor wavelet filtering the wavelet transform is applied on each average Gabor matrix which converts it into four equal sub bands LL, LH, HL and HH in which LL sub band have most prominent information or characteristics features and HH sub band represent most redundancy. Using wavelet transform at one level a filtering of a factor of 4 is carried out on average Gabor feature matrix.

- **Algorithm of Proposed Gabor Filter**

The input image I is converted into gray scaled image Ig.

The Gabor features are calculated by convolution of Image Ig with Gabor filter bank using 5 different scales and 7 different orientations.

The Gabor matrices is transformed using Discrete Wavelet Transform on 3 iterative level and discrete wavelet coefficient values of LL block are kept in the feature vector Fgdwt. Finally features vector are passed into AdaBoost classifier and recognition rate is calculated.

Experiment and Results

MATLAB is used for implementation of proposed work and IAFEE dataset will be used with *.tiff image format of 256x256 pixel images for face expression images. All the facial expression classification algorithms described here were performed using publicly available Indian Child Facial Expression (JAFFE) dataset using AdaBoost classifier. The IAFFE dataset (Lyons et al., 1998; Zhang et al., 1998) used in experiment contains 213 images of female facial expression of 10 Indian female models. Among 215 images 172 (80 %) are training images and 86 (40%) are testing images. The images in the database are grayscale images in the tiff file format which have pixel depth is 8. The number of pictures for each of the seven categorization of expression (Neutral, Happy, Sad, Surprise, Anger, Disgust and Fear) is almost the same. For Expression classification, the multiclass AdaBoost classifier is applied. Facial Emotion Recognition based on Gabor Filter is implemented as mentioned in section 2.1 Result of Facial Emotion recognition obtained from above feature extraction methods on IAFFE dataset are shown in Table I. Comparative Graph of correct classification of each expression based on proposed technique and Gabor Filter method proposed method are shown in Figure 3.

Results and Analysis

Table 1: Comparison of Recognition Rate for Different Technique on IAFEE Dataset using AdaBoost Classifier

	Expression	Gabor Filter	Gabor Average method	Proposed Gabor Method
1	Anger	70	80	90
2	Disgust	70	80	85
3	Fear	50	60	70
4	Happy	70	80	90
5	Neutral	80	80	90
6	Sad	80	85	90
7	Surprise	80	90	90
8	Recognition rate (%)	73.5%	81.5%	86.5%

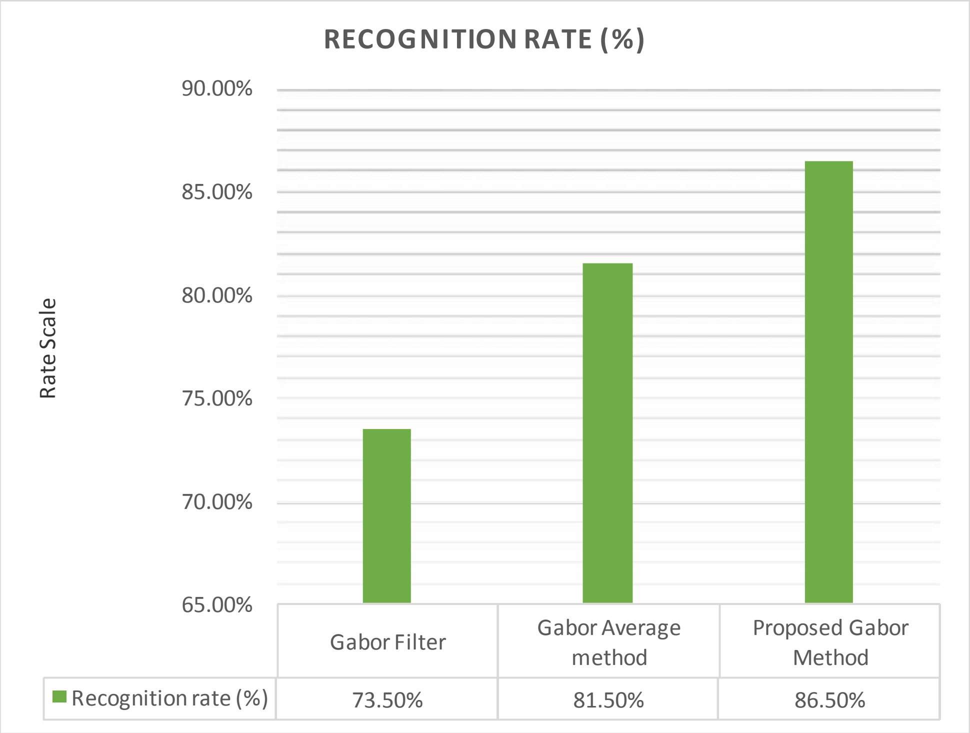

Figure 3: Relative Recognition rate of Proposed Method with Gabor Filter and Gabor Average Filter Feature Extraction Technique for Facial Expression Recognition

Conclusion

The Proposed algorithms are implemented in MATLAB and IAFEE dataset are used for experiment with ratio 80/40 of training/testing with AdaBoost classifiers for seven different facial expressions: Anger, Disgust, Fear, Happy, Neutral, Sad and Surprise. The results show that the recognition rate based on Gabor Selection Filter Feature Extraction technique is 73.5% while the recognition rate based on Gabor Average filtering is 81.5%. The Proposed Average Gabor Wavelet Transform Feature Extraction Method achieves 86.5 % average recognition rate. Thus, it shows that the Proposed Method extracts better Feature Extraction compared to above techniques and it reduces generalized error.

Future Scope

Facial Emotion Recognition has not reached up to 100% recognition rate because every progression has some generalization error in feature extraction. There is wide future scope in Facial Emotion Recognition such as to present new feature space in facial expression and improvement of existing methods reducing their disadvantage. The proposed concept of combined feature vector can be implemented with more techniques and feature reduction can be done using Pixel component analysis feature extraction.

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