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Performance Analysis of Feature Extraction Technique for Facial Expression Recognition

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Abstract

Facial Expression Recognition has been a very important topic for research in computer pattern recognition and currently there is no method of facial Expression recognition system that have 100% recognition rate. The purpose of this research paper is to analysis of performance of Gabor filter and average Gabor filter. Feature extraction is the key step on which recognition rate depends for facial gesture recognition. For increasing the recognition rate using different ways or projection should be extract but there is probability of increasing of redundancy which can be responsible of reducing the recognition rate. High dimension and high redundancy is a problem issue for Gabor while it has maximum variance of features.

Index term: Gabor Filter, Facial Expression, Recognition rate

Introduction

Computer-Aided facial expression Recognition System, which can identify the emotions or expression of a person by comparing the person's face to the face stored in database set, has wide range of application. Facial expressions are the facial changes in response to a person's internal emotional states, intensions, or social communications. Facial expression recognition has challenged many researchers not only from the field of pathology but also computer science. It can match verbal communication, or can convey complete thoughts by itself. Thus, to make use of the information afford by facial expressions, automated reliable, valid, and efficient methods of measurement are important [1]. Facial expressions have been studied by cognitive psychologists, social psychologist, neurophysiologists, cognitive scientist and computer scientists. There are seven basic expressions: neutral, anger, fear, disgust, happiness, sadness, and surprise which have to recognise in facial expression analysis.

Due to its important practical application it has become attractive field of research in the last few decades with significant progress. Despite of advancement in the algorithm of Face recognition, it is still very challenging field due to the various variations such as pose, illumination, occlusion and expression. Nonetheless, pose variation was identified as one of the prominent unsolved problems in the research of gesture recognition [2].

Feature Extraction Method

Gabor Filter

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 considerable parameters of a Gabor filter are angle and frequency. Certain features that share similar angle or frequency can be chosen and used to individualize between different facial expressions depicted in images.

A Gabor filter is a complex exponential transmogrified by a Gaussian function in the spatial domain.

A Gabor filter can be represented by the following equation 1 [15]

$$\Psi(x, y, \lambda, \theta) = \frac{1}{2\Pi SxSy} e^{-1/2\left(\frac{x'^2}{Sx*Sx}+\frac{y'^2}{Sy*Sy}\right)} e^{j2\,\Pi x'/\lambda} \quad \ldots 1$$

where (x,y) is the pixel position in the spatial domain, λ is the wavelength (a reciprocal of frequency) in pixels, θ is the angle of a Gabor filter, and S_x, S_y are the standard deviation along the x and y directions consequently. The parameters x' and y' are given as equation

$x' = x\cos\theta + y\sin\theta$

$y' = -x\cos\theta + y\sin\theta$ …2

The amplitude and phases of Gabor filter bank both contribute valuable cues about specific pattern present in images. The amplitude consists of directional frequency spectrum information and a phase contains information about the location of edges and image details.

The feature extraction method converts the pixel data into a higher-level representation 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(x, y) is a grey-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(x, y) with the Gabor filter u,v(x, y) of size u and angle v are given as equation 3.

$$G_{u,v}(x,y) = I(x,y) * \Psi(x,y) \quad \ldots 3$$

In Gabor feature extraction method if Holistic approach is used than features are extracted from the entire image. Gabor filters are applied on images to extract features fix at particular angle (orientation) than the Gabor feature representation $|o(x,y)|_{m,n}$ of an image I(x,y), for x=1,2,.....N, y=1,2,....M, m=1,2...N_L , n=1,2,....No, is computed as the convolution of the input image I(x,y) with Gabor filter bank function $\Psi(x,y,\lambda_m,\theta_n)$.The convolution operation is performed separately for real and imaginary part are given as equation 4.

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

$$Im(O(x,y))_{m,n} = I(x,y) * Im(\psi(x,y,\lambda_m,\theta_n)) \quad \ldots 4$$

This is followed by the amplitude calculation is given as equation 5

$$|O(x,y)|_{m,n} = ((Re(O(x,y))_{m,n})^2 + (Im(O(x,y))_{m,n})^2)^{1/2} \quad \ldots 5$$

Average Gabor Filter

If average Gabor Filter technique is used then averaging of 5 gabor feature matrix of size 25x25 pixels is performed and converted to a single average feature matrix of size 25x25 pixels. Using Same averaging, 5 gabor matrix of size 51x51, 5 gabor matrix of size 76x76, 5 gabor matrix of size 102x102, 5 gabor matrix of size 128x128 are converted into a single matrix of size 51x51, 76x76, 102x102, 128x128 or average feature vector of size 35790.These matrix is called average gabor matrix and feature vector is called average gabor feature vector. Which is further reduced using down sampling process with a factor of 25 would further reduce it to a single feature vector of dimension 1431 and down sampling of 125 would reduce it to single feature vector of dimension 286 only. This vectors is called average gabor filter vector.

Algorithm

Gabor Filter Feature Extraction Technique

Input : Gray scale Image Img

Step 1: Loop scale =[0.1,0.2,0.3,0.4,0.5]

Img_{resize}= image Img is resized with scale.

Step2: Loop theta=[0,30,60,90,120,150,180]

Apply Gabor equations

Step3: End Loop

Stp4: End Loop

Step 5: for reducing the dimensions use sampling filtering by 25.

Step 6: for reducing the more dimensions use sampling filtering by 25 again.

Step6: Features is given to classifier.

Average Gabor Filter Feature Extraction Technique

Input : Gray scale Image Img

Step 1: Loop scale =[0.1,0.2,0.3,0.4,0.5]

Img_{resize}= image Img is resized with scale.

Step2: Loop theta=[0,30,60,90,120,150,180]

Apply Gabor equations

Step3: End Inner Loop

Step 4: for reducing the dimensions:

Arithmetic Average is calculated for corresponding features of all 7 Gabor matrixes. It is a reduced matix by factor of 7 which is converted in feature vector.

Step 5: for reducing the dimensions use sampling filtering by 25 and merged into a feature vector F.

Stp6: End Outer Loop

Step7: Features is given to classifier

Experiments and Result

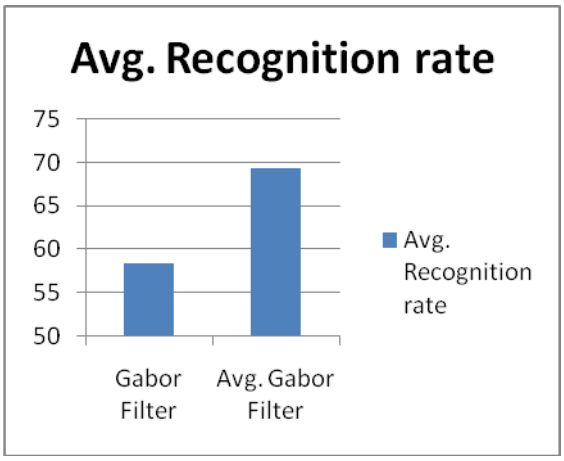
We have implemented the facial expression analysis using facial expression recognition by average Gabor filter method and simple Gabor filter.

The Result of average recognition rate of facial expression recognition using Gabor sampling Filter Feature Extraction Algorithm is 58.33 in the iteration no. 12.

The average recognition rate of facial expression recognition using Average Gabor Filter Feature Extraction Algorithm is 69.3 in the iteration no. 12.

Table 1: Comparative Analysis of Gabor Sampling Filtering and Average Gabor Filter for Facial Expression Recognition

Methods	Gabor Filter	Avg. Gabor Filter
avg. Recognition rate (%)	58.33	69.3



Graph of Results of recognition rate (in %) for Gabor Sampling Filter, and avg. Gabor Filter

Conclusion

Feature extraction is the key step on which recognition rate depends for facial gesture recognition. For increasing the recognition rate features using different ways or projection should be extract but there is probability of increasing of redundancy which can be responsible of reducing the recognition rate.

High dimension and high redundancy is a problem issue for Gabor while it has maximum variance of features. This high Dimension and redundancy should be reduced using some filtering technique. The dimension and redundancy reduction technique for Gabor is called filtering so this whole technique is called Gabor filter. These filtering technique are sampling, average filtering etc.

Algorithms are implemented in Matlab and JAFEE dataset are used for experiment with ratio 70/30 of training/testing with adaboost classifiers for seven different facial expressions.

The experiments result show that avg. Gabor filter has **69.3**% higher recognition rate compared to **58.33** % for Gabor Sampling Filter for facial expression recognition for JAFEE dataset with 70/30 training/testing ratio.

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