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IMPLEMENTATION OF ARTIFICIAL NEURAL NETWORK FOR FACE RECOGNITION USING GABOR FEATURE EXTRACTION

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Abstract

Face detection and recognition is the first step for many applications in various fields such as identification and is used as a key to enter into the various electronic devices, video surveillance, and human computer interface and image database management. This paper focuses on feature extraction in an image using Gabor filter and the extracted image feature vector is then given as an input to the neural network. The neural network is trained with the input data. The Gabor wavelet concentrates on the important components of the face including eye, mouth, nose, cheeks. The main requirement of this technique is the threshold, which gives privileged sensitivity. The threshold values are the feature vectors taken from the faces. These feature vectors are given into the feed forward neural network to train the network. Using the feed forward neural network as a classifier, the recognized and unrecognized faces are classified. This classifier attains a higher face deduction rate. By training more input vectors the system proves to be effective. The effectiveness of the proposed method is demonstrated by the experimental results.

Keywords:

Face Detection, Gabor Wavelet, Feed Forward Neural Network Classifier

1. INTRODUCTION

Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary images. It detects facial features and ignores anything else, such as buildings, trees and bodies. Face detection can be regarded as a more general case of face localization. In face localization, the task is to find the locations and sizes of a known number of faces. In face detection, one does not have this additional information. It is also used in some recent digital cameras use face detection for autofocus.

The first step of face processing is detection of face location in the given photo. In spite of that, in many of the researches in face identification, it's supposed that the location and dimensions of face is clear in photo and because of that a deep attention has not been paid to face identification area and conducted researcher are related to recent years. Face detection includes determining existence or lack of all human faces in photo and also their locations and limits [1],[5]. For example it's possible that the aim is just detection of full faces or there are some presuppositions regarding size and angle of face, wearing or not wearing hat, glasses or using artificial tools environmental light and noise in photo. It's clear that providing a method that detects faces in every condition is not a simple task. Finding the location of the face in the image is the first step in the system [15]. Pattern localization and classification is the step, which is used to classify face and non- face patterns.. The most difficult type of face detection is related to the fixed photo with gray surface in which input is the intensity of the reflex light. In this paper we are interested to determine the face location on the gray background image. This paper is organized as follows: In section III Proposed method, section A Feature extraction from the gabor Wavelet, in section B neural network structure and training order to achieve image classification.

2. LITERATURE REVIEW

The major human face recognition techniques that apply mostly to frontal faces, This are the several methods used for the face recognition are eigenfaces, neural networks, dynamic link architecture, hidden Markov model, elastic graph matching, and template matching. In which two methods are taken into account are eigenfaces and elastic graph matching. These methods have reached relatively high detection rates. Eigenfaces algorithm has some shortcomings due to the use of image pixel gray values. As a result system becomes sensitive to illumination changes, scaling, etc. When a new face attends to the database system needs to run from the beginning, unless a universal database exists. Unlike the eigenfaces method, elastic graph matching method is more robust to illumination changes, since Gabor wavelet transforms of images is being used, instead of directly using pixel gray values [7]. Although detection performance of elastic graph matching method is reported higher than the eigenfaces method, due to its computational complexity and execution time, the elastic graph matching approach is less attractive for commercial systems. Although using 2- D Gabor wavelet transform seems to be well suited to the problem, graph matching makes algorithm bulky. Moreover, as the local information is extracted from the nodes of a predefined graph, some details on a face, which are the special characteristics of that face and could be very useful in detection task, might be lost. In the proposed method input vectors are taken from the Gabor wavelet characteristics, deleting the non face areas in the image to reduce the time for the classification of faces and non face in an image [15].

3. PROPOSED METHOD

Face detection is the important and very first step in the face recognition. It is necessary to localize the face in an image. Our system detects the faces in the photo.

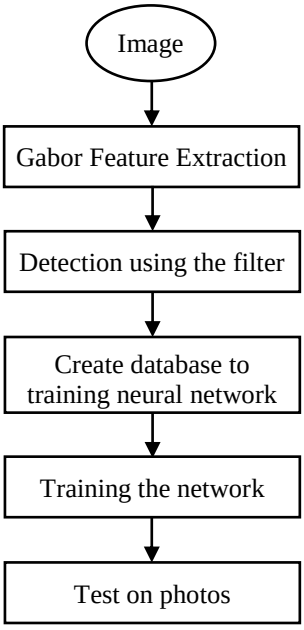

Fig.1. Flowchart for the Face Detection

In this process Gabor wavelet is used for feature extraction which is in vector form are extracted from points with high information content on the face image. In most feature-based methods, facial features are assumed to be the eyes, nose and mouth. However, we do not fix the locations and also the number of feature points in this work. The characteristics vector which goes to neural network for presence or absence of face.

The algorithm for the proposed scheme as follows:

Step 1: Feature extraction using Gabor filter.

Step 2: Face detection in the image using the output vectors from the filter.

Step 3: Create image database for training the neural network.

Step 4: Initialize the network.

Step 5: Train the network using the feature vectors obtained from the Gabor filter.

Step 6: Test on photos.

These are extracted characteristics which make face detection resistance against variation of environment light.

In each of examined parts, just one center is selected as the center of window that includes face and this center has the greatest amount which is returned from neural network and is greater than threshold amount too.

3.1 GABOR FEATURE EXTRACTION OF FACE

Gabor wavelet alteration like other different wavelets alterations is used in areas of photo processing and machine vision because of its unique features [15]. These wavelets have provided a ground for understanding photo frequency and their analysis in the area of place and their greatest advantage is slow variations in frequency area. If L(z) be input photo with values of light intensity of gray surface, when photo wavelet alteration is calculated according to relation (1) from convolution of one of wavelet family members with input photo[3].

$$O_{\mu,v}(Z)I(Z)*\varphi_{u,v} \qquad (1)$$

Wavelet to ψ, the result of O alteration in which * indicates operator of convolution. Equation of v magnification applied in alteration of Gabor direction in face indicates a plate simple wave with specified frequency and direction which is trapped under a Gaussian function. This equation can be defined in various forms according to the type of coordinate's system wether Cartesian or polar and the following form is the most general form its illustration in various articles.

$$\varphi_{\mu,v}(Z)=\frac{K_{\mu,v^2}}{\delta^2}\exp\left(-\frac{K_{\mu,v^2,z^2}}{\delta^2}\right)\left(e^{i}K_{\mu,v^2}-e^{\frac{\delta^2}{2}}\right) \qquad (2)$$

In this relation, k indicates the length and direction of wave and is calculated by following relations:

$$K_{\mu,v}=K_v e^{i\varphi\mu},\quad K_v=\frac{K_{mu}}{f^v},\quad \varphi_v=\mu\frac{\pi}{8} \qquad (3)$$

As it can be seen from above relation, μ is multiplied in $\pi/8$ and has produced number phase of k so it will have a integer value from zero to seven. Greater values produce waves with repetitive directions. v can have values between zero and four and 40 wavelets with different directions and sizes are obtained from above relation. For analytical understanding of this wavelet, we show one of the members of this better family with dimensions of 128 * 128 and following parameters,

$$v=4,\ \mu=7,\ f=\sqrt{2}\ ,\ K_{mu}=\pi,\ \delta=2\pi$$

After introducing Gabor wavelets here the method of characteristic extraction from human face photo is discussed [5]. Windows of photo which is supposed to be decided about its being a face is balanced considering their gray surface histogram. In the next step-Fourier transform- in Fourier transforms, Gabor wavelets are multiplied then reversed Fourier transform from to obtained photos are placed by each other and in fact produce matrix of specified window characteristic.

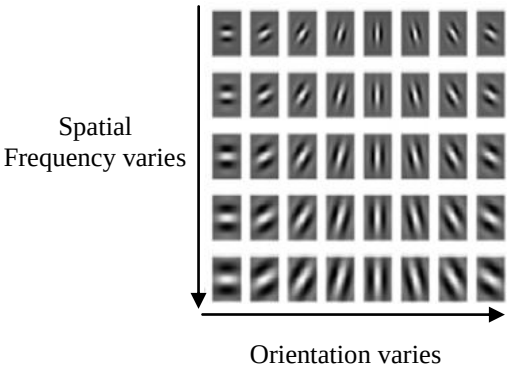

Fig.2. Gabor Filter Correspond to Spatial Frequency and Orientation

It's clear that this number of process characteristics in each classificatory is large and causes slow down in detection process. Here algorithms of space reduction. So by considering process time, here reduction in dimensions of characteristics matrix is done by averaging blocks and instead of 3 * 3 block. By doing so, characteristics matrix is reduced to 48 * 45.

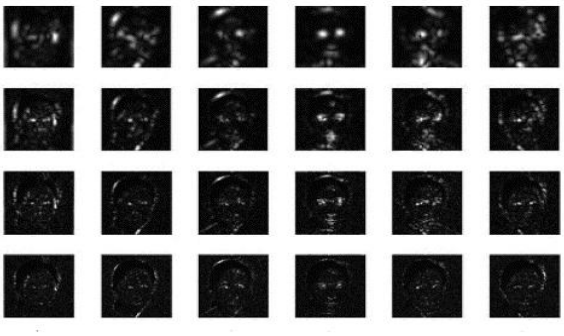

Fig.3. Facial image response to the Gabor filter

This operation is done because the maximum and minimum value obtained from output of wavelet transformation is not a determined and clear number and in designing neural network, there is a need limit arrays between two specified value. In this phase, vector of characteristics of examined photo window is ready to refer to neural network.

Gabor wavelet is a plate wave with decreasing range. After introducing Gabor wavelets here the method of characteristic extraction from human face photo is discussed. Here if input window is a rectangular with dimensions of 27 * 18, then matrix of characteristics will be 144 * 135.

The black and gray areas are the parts which have returned amounts higher and lower than the threshold by network respectively. Thus, the figure gives the localization of faces in an image.

The Table.1 illustrates the threshold values of the features extracted from the face using the Gabor feature filters. These extracted values from the eye, mouth, nose and cheeks are given as inputs to the neural network structure. The dimension of the images that are given to the database for training is taken as 27×18. The dimension of the image is directly proportional to the time taken to train the database. Thus, we have chosen such a smaller value as the dimension so as to reduce the training time.

Table.1. Threshold Values of the Features Extracted from the Face

IMAGE	EYE	MOUTH	NOSE	CHEEKS
1	65	95	157	162
2	73	93	119	138
3	85	92	139	164
4	100	111	128	155

3.2 NEURAL NETWORK STRUCTURE AND TRAINING

The neural network has feed forward architecture within input layer, a hidden layer, and an output layer. To select and design the structure of neural networks, various factors should be considered. Three main factors are calculation volume, responding time and generalization capability. Generalization capability means that network is trained with limited number and little training data which is face and non face vectors here and it's expected that network can provide desirable responses against vectors which have observed. To improve network response, the network structure, training data and extracted characteristics play on important role. As it was observed, after extracting characteristic from windows referred to network, data will be transformed into the form of a vector with 2160 elements. It will adjust the histogram of the image for better contrast. Then the image will be convolved with Gabor filters by multiplying the image by Gabor filters in frequency domain.

To save time they have been saved in frequency domain. The input layer of this network has N units for an N dimensional input vector. The input units are fully connected to the '*I'* hidden layer units, which are in turn, connected to the '*J'* output layers units, where *J* is the number of output classes.

Neural network are divided to two class of monitored and unmonitored considering training [12]. Applied network in this research is monitored type. A number of photos including face no face and also their desirable responses are displayed for the network. Then network by aid of algorithm after error dispersion.

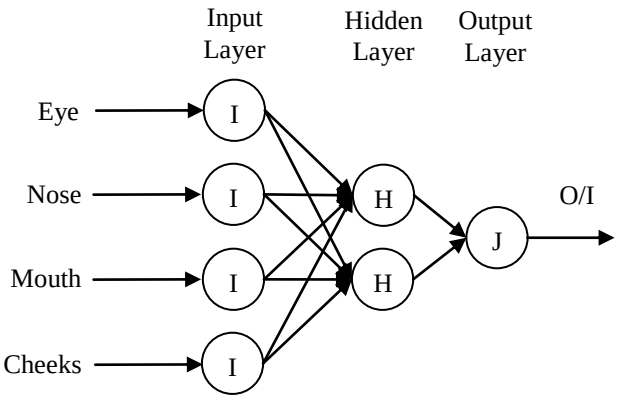

Fig.4. Applied Neural Network Structure

Face photos are providable easily. The main problem is selection of non face photos [1]. It's clear that these photos can be selected optionally but the point is the dependency of network efficiency to selected photos. So it's possible to add windows which wrongly detect face in the network testing process to the set of training non face photos and repeat training process. In this research 70 face photos and 60 non face photos are used in training phase. Also for every human face photo, its mirror photo and with the angle of 5,10,15 degrees in positive and negative directions and photos with one pixel shift in every four directions are placed in training set for reducing network sensitivity [2]. For no face photos also, their mirror and their 180 degrees transformation is placed in training data.

4. EXPERIMENTAL RESULTS AND DISCUSSION

In this paper, a new approach to face detection with Gabor wavelets & feed forward neural network is presented. The method uses Gabor wavelet transform& feed forward neural network for both finding feature points and extracting feature vectors. From the experimental results, it is seen that proposed method achieves better results.

The black and gray areas are the parts which have returned amounts higher and lower than the threshold by network respectively.

In this system the error rate is calculated by giving more test images to the system. And the elapsed times for all the images are calculated.

Gabor wavelet will provide a complete representation of any image. So that Gabor wavelet is used in this system. For the automatic face recognition Gabor feature extraction vectors are used as an input.

Fig.5. Finding Face in Test Image1

Here the faces are recognized by the white dots and the gray dots are used to indicate the surrounding region of the face in the given test Image1. In this image one face is not detected and this is the unrecognized face in an image.

Fig.6. Finding Face in Test Image2

Similarly, white dots indicate the faces of the given Image2, a test image with the resolution of 150 × 180. This testing image having 8 faces in which 6 faces are detected. When compared to test Image1 with test Image2, it is more complicate to recognize the face in test Image2.

Table.2. Performance Analysis of Detection Rate

Resolution of image	Recognized faces	Unrecognized faces
Image1 150 × 150	4 from 5	1
Image2 150 × 180	6 from 8	2
Image3 150 × 190	6 from 7	1
Image4 600 × 254	55 from 63	8
Average	85.36%	14.63%

The above table shows the recognized and unrecognized faces in the image. The first Image1 gives the recognized rate very high and the second Image2 recognize the 5 faces from 7 in the photo.

In this experiment more testing image are tested and the corresponding recognized faces and unrecognized faces are observed. In this analysis the average recognized rate is 85.36% and the unrecognized rate or the error rate is 14.63%.

Table.3. Performance Analysis of Various Testing Images

Testing Images (Resolution)	Time (seconds)
Image1 (150 × 150)	22.573891
Image2 (150 × 180)	10.607918
Image3 (150 × 190)	3.986369
Image4 (600 × 254)	148.219303
Image5 (150 × 130)	2.675362
Image6 (120 × 140)	1.8758463
Image7 (130 × 145)	1.986875
Image8 (200 × 160)	2.587673
Image9 (140 × 120)	1.866595
Image10 (265 × 145)	2.957546
Average Elapsed Time	19.93373

The performance analysis is done by comparing two other techniques. The eigen face detection and template based methods. The error rate is found to be lesser in Gabor wavelet technique when compared to the former methods.

It's obvious that these errors are due to neural network inability to classify correctly and for its resolving, network configuration or training process can be corrected.

Table.4. Comparision of Performance Analysis with Various Methods

Methods	Error Rate
Eigen face detection	17.28%
Gabor Wavelet	14.63%
Template Based	19.98%

The face recognition using the Gabor wavelet gives the better result. It is clearly seen from the above error rate which is 14.63%. This error will say that our system performance is better than several methods

5. CONCLUSION

In this experiment Gabor wavelet for feature extraction and neural network for classification are used. In which recognition of face presence in the image is fine. The faces which are not detected by this system is due to lag of training data sets in neural scheme, it will be reduced by training more number of face image to the neural network. Reduction in dimension gives more support to reduce the execution time and also it will reduce the memory space. This method is also robust to illumination changes as a property of Gabor wavelets, which is the main problem in many systems. when the number of training non-face photos are high, the number of output neurons reduces and results in that even for face photos, output be less than threshold value. The characteristics selection can help network by improving training process and reducing input vector size. In future this system can be enhanced with small modification such as, considering the face boundaries, the distance between eyes and nose, length of eyebrows, the distance between mouth and ears, the colour of the face. In order to further speed up the algorithm, number of Gabor filters could be decreased with an acceptable level of decrease in detection performance. It must be noted that performance of detection systems is highly application dependent and suggestions for improvements on the proposed algorithm must be directed to a specific purpose of the face detection application.

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