Age Classification and Face Recognition Using Neural Network and Fusion of Wavelet and Curvelet Transform

1E. Gomathi and 2K. Baskaran

1Karpagam College of Engineering, Coimbatore, Tamil Nadu, India
2Government College of Technology, Coimbatore, Tamil Nadu, India

ABSTRACT

Face recognition is the process of comparing an image with the database images. It is used in many applications such as video surveillance, criminal investigation, etc. When compared to other biometric techniques, it has the advantage that it can be done without the active participation of the person. Here we proposed a new algorithm to recognize the input face image and to classify the age effectively. Due to high ability of curvelet transform in representing the edges, a fusion technique based on wavelet and curvelet transform is used. Wavelet transform is applied to the query image thus producing four subbands. For each subband, fast discrete curvelet transform is applied to get curvelet coefficients. Then energy and entropy features are calculated for each coefficient. The resultant features are reduced by PCA. The PCA approach is used to reduce the dimension of the data by means of data compression, and reveals the most effective low dimensional structure of facial patterns. This reduction in dimensions removes information that is not useful and precisely decomposes the face structure features into orthogonal components. These reduced features are compared to database and if the person is authorized, then age classification is done using neural network. The classifier classifies the age into four categories: child, young, middle age and old.

Key words: Face recognition, Curvelet transform, Wavelet transform, Age classification, Neural network

Introduction

Face recognition is used to identify an individual in international traffic points, in access control and in many other fields. Biometric techniques include fingerprint, speech, palmprint and face recognition. Compared to other techniques face recognition is user friendly and performs without the cooperation of participants. In recognition of faces using machine, still or video images are given. Using stored database of faces, one or more persons are identified. Face recognition process involves three stages. i) Face Detection ii) Feature Extraction iii) Face Identification/Verification. In face recognition process, face detection is very important. The general face recognition process is depicted in Figure 1.

Fig. 1: Face Recognition Process.

In (Mohammod Abul Kashem, 2011), they proposed face recognition system based on PCA with back propagation neural network. Using PCA, the dimensionality of face image is reduced and the recognition is performed by BPNN.

In (Steve Lawrence, ), they presented a fast automatic system for face recognition system by combining SOM network and a convolutional network. The SOM provides a quantization of image samples into a topological space which gives invariance to minor changes in image samples. The convolutional neural network provides for partial invariance to translation, rotation scale and deformation.

In (Yu Su, 2009), faces are recognized on both global and local facial features. In this method, the global features are extracted from the whole face images by using Fourier transform, and by using Gabor wavelets, the
local features are emphasized. The position and size of the patches are learned from a training data via greedy search.

In (Mayank Agarwal, 2010), they analyzed by varying the number of eigenfaces used for feature extraction. Since eigenface method is very sensitive to head orientations, it is used. The dimension is reduced by choosing PCA as a feature selection technique.

In (Mohammed Alwakeel, 2010), they presented face recognition based on Haar Wavelet transform and PCA via LMBP. Here for the detected face, Haar wavelet is used to form the coefficient matrix. Then PCA is computed to obtain the image feature vector. To recognize face, LMBP neural network is used as a classifier.

In (Xin Geng, 2007), they proposed automatic age estimation based on facial aging patterns. Here aging pattern is modeled as a sequence of particular individual’s face images by means of subspace.

In (Stollnitz, E.J., 1995), they presented four age groups for classification system. Sobal edge operator and region labeling are applied to locate position of eyes, noses and mouths. Wrinkle and geometric features are obtained from a facial image. For classification, two BPNN are constructed.

Wavelet Transform:

In discrete wavelet transform (Jiulong Zhang, 2011), the original image is high pass filtered thus yields three detail images Vertical, Horizontal and Diagonal direction of image. The image is then low pass filtered to obtain approximate image. This image is filtered again to generate high and low frequency subbands. This procedure is repeated until whole image is processed. Wavelet transform can handle point discontinuities well then STFT. But many wavelet coefficients are needed to account for edges. Since it does not handle curve discontinuities well. Curvelet transform was introduced as an alternative to wavelet transform. Wavelets (Amira, A., 2005) can be represented mathematically using the equations (1) and (2)

\[
d_{j,k} = \sum x(n)h_{j}^*(n - 2^j k) \tag{1}
\]

\[
a_{j,k} = \sum x(n)g_{j}^*(n - 2^j k) \tag{2}
\]

The coefficients \(d_{j,k}\) and \(a_{j,k}\) are detailed and approximation components. The functions \(h(n)\) and \(g(n)\)

Curvelet Transform:

Curvelet transform is a multiscale representation suitable for objects with curves. In 1999, ridgelet transform was proposed by Candes and Donoho. For curve singularities, first generation curvelet transform was proposed by Candes and Donaho in (2000). Later, second generation curvelet transform was proposed by Candes et al (2005). It is faster and simpler than first generation curvelet transform. It is an efficient tool to describe edge using few coefficients. Curvelets handle curve discontinuities well. Therefore curvelet transform performs better than wavelet transform. Second generation curvelet transform can be implemented using unequally spaced FFT and curvelets via wrapping. Wrapping method (Candes, E.J., 2006) is very fast and easy to implement. The architecture of wrapping based FDCT is as follows (Mohammad Saleh Miri, 2011).

1. Apply 2D-FFT to obtain fourier samples.
2. For each scale and angle, form the product.
3. Wrap the product around the origin.
4. Take inverse 2D-FFT and obtain discrete curvelet coefficients.

![Curvelet Transform Diagram](image)

Fig. 2: Curvelet Transform
Artificial neural networks emulate the human brain's ability to learn and recognize patterns. Neural network is mainly used for classification problems. It is made up of number of highly interconnected elements. The information is processed by their dynamic state response to external inputs. It has the capability to acquire knowledge from its surroundings and produces response by applying external stimulus. Artificial neural network consists of input, output and hidden neurons. The activation values are propagated to the output units and the actual network output is compared with the desired output values thus producing error. The error signal is passed to each unit and weight changes are calculated. The Back propagation algorithm was first proposed by Paul Werbos in the 1970. Back propagation is the most common neural network learning algorithm. Input signals propagate in the forward direction and ards through the network, and error signals propagate backwards. Weight adjustments are made to reduce error.

**Proposed Work:**

In this section, the proposed method is illustrated and the algorithm is described. Since wavelet transform cannot handle curve discontinuities well and limited orientation, the fusion algorithm (Yan Sun, 2010) based on wavelet and second generation curvelet transform is used. Preprocessing is done in two stages. First histogram equalization of the input image is performed. Afterwards normalization of image is done. Then face is detected from the input image using Viola-Jones algorithm.

Wavelet transform is applied to the above detected face thus producing four subbands: LL, LH, HL, HH bands. Since wrapping based fast discrete curvelet transform is more efficient and provides better results, it is applied for LL band. Here curvelet with scale-3 and orientation-8 are selected. Thus we obtain a set of subbands or wedges at each level. These wedges are called discrete wavelet coefficients. Then energy and entropy features are calculated for each coefficient. The resultant features are reduced by PCA. The PCA approach is used to reduce the dimension of the data. These reduced features are compared to database and if the person is authorized, then age classification is done using neural network. The classifier classifies the age into four categories: child. Young, middle age and old using neural network. The figure [4] shows the proposed face recognition system.

**Experimental Results:**

**A. Database:**

We applied our method to Iranian database. The figure [5] shows sample face images from Iranian database.
Fig. 4: Flowchart of proposed face recognition system.

Fig. 5: Sample of Face images.
B. Implementation:

We implemented our proposed method by MATLAB version 9. The algorithm explained in the proposed method was implemented by applying the images of ORL database. Initially preprocessing of the input image is performed. Then face is detected from the preprocessed image using Viola-Jones algorithm. Wavelet transform is applied to the above detected face thus producing four subbands: LL, LH, HL, HH bands. FDCT is applied for LL band with scale-3 and orientation-8 respectively. Thus we obtain a set of subbands or wedges. For each coefficient, energy and entropy features are calculated. Then PCA is applied to reduce the resultant features. These reduced features are compared to database and if the person is authorized, then age classification is done using neural network which classifies the age into four categories: child, young, middle age and old. The results are shown in figure [6].

Specifications of the neural network:

Type = Feed Forward Back propagation Network  
Number of Layers = 3 (Input layer, Hidden Layer, Output Layer)  
Activation Functions = Log-Sigmoid and Tan-Sigmoid  
Number of Epochs = 1000-3000  
Training Algorithm = Levelberg – Marquardt  
Number of Validation Checks = 5  
Learning Rate = 0.7  
Momentum = 0.6  
Number of Neurons in the Hidden Layer = 2732

OUTPUT

Query Image

Preprocessed Image

Face Detection

Wavelet coefficients

Curvelet Coefficients for LL band
Fig. 6: Results of proposed system.

Comparative Analysis:

The recognition rate of the three methods is shown in the table 1. (Mandal, T., 2009).

<table>
<thead>
<tr>
<th>Method</th>
<th>Recognition Accuracy(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard eigenface</td>
<td>92.2%</td>
</tr>
<tr>
<td>Waveletface</td>
<td>93.5%</td>
</tr>
<tr>
<td>Curveletface</td>
<td>94.5%</td>
</tr>
<tr>
<td>Proposed Method</td>
<td>95.6%</td>
</tr>
</tbody>
</table>
Comparative analysis

Conclusion:

In this paper, a new method for face recognition with age classification has been presented. Using fast discrete curvelet transform, curved edge information can be captured effectively. So wavelet and curvelet transform are used. The energy and entropy features are calculated for each coefficient obtained by applying curvelet transform. The resultant features are reduced by PCA. The PCA approach is used to reduce the dimension of the data. These reduced features are compared to database and age classification is performed if the person is authorized. The classifier classifies the age into four categories: child, young, middle age, and old.

References

Mohammad Saleh Miri and Ali Mahloojifar, 2011. “Retinal image analysis using curvelet transform and multistructure elements morphology by reconstruction,” IEEE transactions on biomedical engineering, 58(5).