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Design of Face Recognition System by Using Neural Network with Discrete Cosine Transform and Principal Component Analysis

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Abstract

This research paper deals with the implementation of face recognition system using neural network Importance of face recognition system has speed up in the last few decades. A face recognition system is one of the biometric information processing. The developed algorithm for the face recognition system formulates an image-based approach, which uses the Two-Dimensional Discrete Cosine Transform (2D-DCT) for image compression and the Self-Organizing Map (SOM) Neural Network for recognition purpose, simulated in MATLAB. By using 2D-DCT we extract image vectors and these vectors becomes the input to neural network classifier, which uses self-organizing map, algorithm to recognize familiar faces (trained) and faces with variations in expressions, illumination changes, tilt of 5 to 10 degrees. Again face Recognition system is developed with principal component analysis (PCA) instead of Two Dimensional Discrete Cosine Transform (2D-DCT) and self-Organizing Map (SOM) Neural Network for recognition purpose. The crux of proposed algorithm is its beauty to use unsupervised single neural network as classifier.

Keywords

Artificial Neural Network, Self-Organizing map, Two dimensional discrete cosine transform, Principal component analysis, unsupervised.

1. Introduction

Machine recognition [1,2] of faces is gradually becoming very important due to its wide range of commercial and law enforcement applications, which include forensic identification, access control, border surveillance and human computer interactions. However recently it is only work on biological motivated approach for face recognition that deliver real solutions.

Many techniques are available which apply face recognition that work well in constrained environment. The most common approach for recognition is artificial neural networks. The proposed recognition system uses artificial neural network (ANN). One of the first artificial neural networks (ANN) techniques used for face recognition is a single layer adaptive network called WISARD which contains a separate network for each stored individual.

2. Literature Review

In [3], Face recognition has received considerable interest as a widely accepted biometric, because of the ease of collecting samples of a person, with or without subject's intension. This type of technology constitutes a wide group of technologies which all work with face but use different scanning techniques. Our visual performance is very robust against a variety of factors such as changes in facial expression, head posture or size, illumination, background, facial aging, or partial occlusion of a face. The work described by a face recognition system consisting of face image detection, normalization, pre-processing, trait extraction and input to neural network & matching that runs accurately and effectively on a personal computer platform.

Face recognition is a pattern recognition problem, so training/learning algorithm should be used to make comparison between the faces. For 2D recognition, Linear/Nonlinear Projection methods and Neural Networks are used. The Linear/Nonlinear Projection methods are Principal component analysis, Linear Discriminant Analysis (LDA), and Gabor and the Neural Network approaches are FFNN, RBNN.

2D Linear/Nonlinear Projection methods generate feature vector for each person, then classify the input person inside the database. Generating feature vector also has importance to reduce dimension of the input images. One approach applies image enhancement to suppress the bad lighting condition before

recognition process. Image enhancements are known as logarithm transform and normalization. Then in [4], feature extraction is done with Gabor Wavelets. Finally, using Fisher Face, input face is classified. Song et al. [4] apply a different approach on image pre-processing/enhancement. For pre-processing before feature extraction, calculates the illumination difference between right and left part of face. If there is a large amount of difference than take the mirror of average illuminated part. When face image is pre-processed, feature extraction is done with PCA. Classification of feature vector is completed with Euclidian Distance. Other implementation uses [5] Layered Linear Discriminate Analysis (LDA) to classify faces, and the benefit of Layered LDA is using small sample size database. Extending the feature extraction can improve the performance of the system i.e. applying Gabor wavelet, Principal Component Analysis and then, Independent Component Analysis (ICA) on face image. After feature extraction is applied, then cosine similarity measures and the nearest neighbour classification rule is used to recognize. Another approach for input vector uses facial distance.

Faces can be sent to NN as a vectored matrix image or feature-extracted image. The feature-extracted algorithm can have more performance because of using small dimension vector. As network, RBNN [6], and Multilayer Cluster NN are used and as feature extractor, Discrete Wavelet Transform, DCT, PCA are used. Wavelet NN uses transfer function which is made from wavelet function series and this series avoids the blindness in structure design of FFNN [7]. On the other hand, instead of using grayscale images, colour images can be used as input to the FFNN. R, G, B channels are inputs together and network feed with colour information for easy discrimination. Researchers also work on effects of using different type of networks and feature extractors.

3. Objectives

a. To design a model for an ideal facial recognition system.
b. To enhance the model for a high-speed facial Recognition system
c. To develop a program in MATLAB based on the designed model.
d. To compare a face recognition training time between 2D-DCT and PCA with neural network

4. Methodology

4.1 Two Dimensional Discrete Cosine Transform

In [8], Compression is a process by which the description of computerized information is modified so that the capacity required to store or the bit-rate required to transmit it is reduced.

The DCT is a transform which transforms a signal or image from the spatial domain to the elementary frequency domain. Lower frequencies are more obvious in an image than higher frequencies an image is transferred into its frequency components and higher frequency coefficients are discarded, the amount of data needed to describe the image without sacrificing too much image quality will reduce.

4.2 Principal Component Analysis

In [9], PCA is a useful statistical technique that has found application in fields such as face recognition and image compression, and is a common technique for finding patterns in data of high dimension.
It is a way of identifying patterns in data, and expressing the data in such a way as to highlight their similarities and differences. The other main advantage of PCA is that once you have found these patterns in the data, and you compress the data, i.e. by reducing the number of dimensions, without much loss of information.

4.3 Self Organizing Map

In [10], the principal goal of self-organizing maps is to transform an incoming signal pattern of arbitrary dimension into a one or two-dimensional discrete map, and to perform this transformation adaptively in a topologically ordered fashion. Self-organizing maps learn to recognize groups of similar input vectors in such a way that neurons physically near each other in the neuron layer respond to similar input vectors. They provide a quantization of the image samples into a topological space where inputs that are nearby in the original space are also nearby in the output space, thereby providing dimensionality reduction and invariance to minor changes in the image sample.

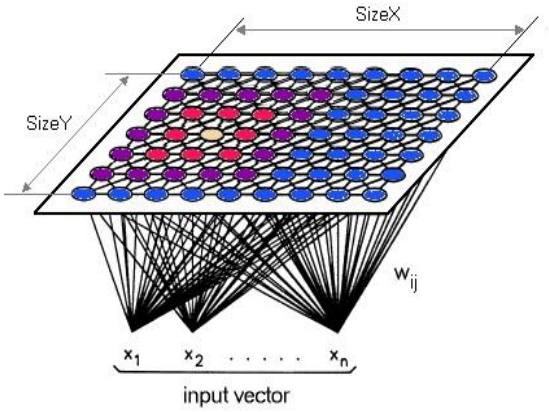

Figure.1: Self-Organizing map

5. Procedure

Step [1] Collect all dates of face images.
Step [2] Pre-process all face images in Adobe Photoshop.
Step [3] Import all face images into MATLAB.
Step [4] Compressed all face images by using discrete cosine transform.
Step [5] Design a Self-Organizing Map (SOM) neural network in MATLAB.
Step [6] Input all face images into SOM Neural network.
Step [7]Give training to the neural network and simulating it for different input face images.
Step [8] The same procedure mentioned above is applied on all face images with principal component analysis instead of two dimensional discrete cosine transform.
Step [9]At last compare the training time of both the methods and analysis the results.

6. Results and Discussion

The face images are shown in figure 2.

Figure.2: Face images of individual subjects

Similarly, three additional pictures of each individual subject were taken. They are trained with the SOM network

Figure.3: Face images of each subject with different facial expression

The untrained face image is shown in figure 4.

Figure.4: Untrained face image

The untrained input matched with the closest image of the same subject in the training database, generating a correct answer. The output is shown in fig. 5.

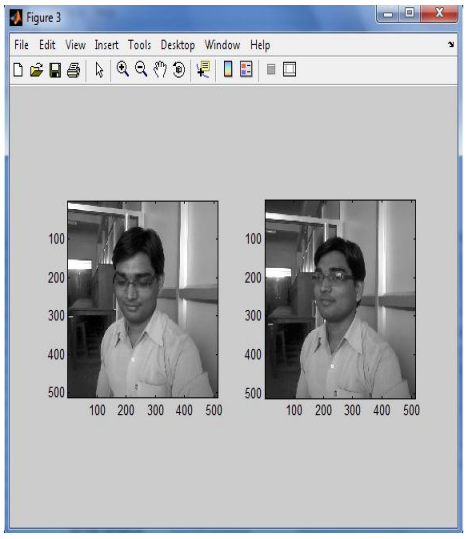

Figure.5: Output-closest image

Table 6.1: Comparison B/w Training Time of Images with 2D-DCT and Principal Component Analysis

No. of epochs	No. of images	Training time with 2D-DCT (sec.)	Training time with PCA (sec.)
100	9	1.7277	1.1710
300	9	3.5705	3.1796
500	9	5.7956	5.0664
1000	9	11.3543	10.0418

Table 6.1 compares the training time of face images with 2D-DCT and PCA. As shown from the table we took 9 images with different facial expression. We have got different training time for different no. of epochs. From the Table 5.1 it can be shown that training time of images with PCA is less than 2DDCT so PCA is better technique for facial feature extraction than 2D-DCT.

7. Conclusion

Main goal of this research paper is achieved by designing of an efficient high-speed face recognition system. The PCA and the SOM neural network are the heart for the design and implementation, which are the final algorithms used for the design of an efficient high-speed face recognition system. PCA with SOM is the better technique than 2D-DCT with SOM.

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