Investigation of Image compression and Face recognition system using Multi wavelets and Back Propagation Neural Networks

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***Abstract*---In today's networked world, the need to maintain the security of information or physical property is becoming both increasingly important and increasingly difficult. Face recognition is one of the few biometric methods, which is very complicated system since the human faces change depending on their expression. There is no technique that provides a robust solution to all expressions for human face recognition. The proposed work presents a new technique for human face recognition. This technique uses an image-based approach towards artificial intelligence by removing redundant data from face images through image compression with higher PSNR using discrete wavelet transform (DWT). The DWT extracts image vectors, these vectors are given to the input of Back Propagation Neural networks(BPNN). A Back Propagation neural networks is used to classify DWT-based feature vectors into groups to indentify if the subject in the input image is "present" or "not present" in the image database (trained faces). The developed system provides better results for recognizing the face with various expressions. PSNR value is increased by 6dB and compression ratio is increased as 93% for compressed image.**

***Index terms*--- Back Propagation Neural Networks(BPNN), DWT, Face recognition, Image compression, PSNR**.

I. INTRODUCTION

In face recognition system, the database of images stored in the system. Whenever a new image, it is compared with the database of images already stored in the system. Neural Networks make use of new face image and the stored face images to determine if there is a match. It is a very interesting and challenging biometric technique of identifying individuals by facial features. Image compression is a process of efficiently coding digital image, to reduce the number of bits required in representing image. Its purpose is to reduce the storage space and transmission cost while maintaining good quality. Zyad Shaaban et.al [1] a new face recognition system based on Haar wavelet transform (HWT) and Principal Component Analysis (PCA) using Levenberg-Marquardt backpropagation (LMBP) neural network is presented. The image face is preprocessed and detected. The Haar wavelet is used to form the coefficient matrix for the detected face. The image feature vector is obtained by computing PCA for the coefficient matrix of DWT. Ronald .A.Devore et.al [2] proposed a new theory for analyzing Image compression methods that are based on compression of wavelet decompositions. Robert D et.al [3] ANN are suitable for image compression due to their massively parallel and distributed architecture. Multilayer perceptrons were used as nonlinear predictor replacing the known ARM linear predictor . Also ANN were used in transform coding to solve problems associated with the calculation of the basis vectors through eigen decomposition of the covariance estimate. These approaches require less storage overhead and can be more computationally efficient. Dimitras et.al [4] introduced a fast and high performance image subsampling method using backpropagation algorithm and showed that the proposed method outperforms the standard lowpass filtering and subsampling method. Sicuranzi G.L et.al [5] a different pattern matching technique to select the desired output values during the supervised training stage. In addition, the Al–Alaoui backpropagation (ALBP) will be implemented instead of the standard backpropagation approach.

By analyzing these papers the performance of proposed algorithm uses the combined technique of DWT and Back Propagation Neural Networks provides the better solution for image compression and face recognition system.

II. BACK PROPAGATION NEURAL NETWORKS

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. Compression is carried out for the following reasons:

- Reduce storage requirement
- Reduce processing time
- Reduce transmission duration

For still image compression, the 'Joint Photographic Experts Group' or JPEG standard has been established by

ISO (International Standards Organization) and IEC (International Electro-Technical Commission). The performance of these coders generally degrades at low bit-rates mainly because of the underlying block-based Discrete Cosine Transform (DCT) scheme.

The neural network structure can be illustrated in Fig 1. There are three layers, one input layer, one output layer and one hidden layer, are designed. Both input layer and output layer are fully connected to the hidden layer. Compression is achieved by designing the value of K, the number of neurons at the hidden layer, less than that of neurons at both input and output layers. The input image is split up into blocks or vectors of 8x8, 4x4 or 16x16 pixels. When the input vector is referred to as N-dimensional which connected to each neuron at the hidden layer can be represented by {w_{jb} j=1,2,… K and I=1,2.. N}, which can also be described by a matrix of K x N. From the hidden layer to the output layer, the connections can be represented by {w_{ij};: 1≤ \ ≤ N, 1≤ j≤ K} which is another weight matrix of N x K. Image compression is achieved by training the network in such a way that the coupling weights { w_{ij} }, scale the input vector of N-dimension into a narrow channel of K-dimension (K<N) at the hidden layer and produce the optimum output value which makes the quadratic error between input and output minimum.

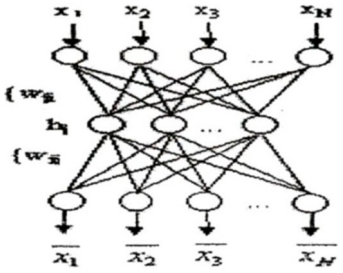

Fig.1 Back propagation neural networks

$$hj = \sum_{i=1}^{N} w_{ji}\, x_i \qquad 1 \le j \le K \qquad (1)$$

Where $x_i \in [0,1]$ denotes the normalized pixel values for grey scale images with grey levels [0,255]. The reason of using normalized pixel values is due to the fact that neural networks can Operate more efficiently when both their inputs and outputs are limited to a range of [0,1].Training of such a neural network can be designed as : (a) parallel training (b) serial training; and (c) activity based training;

A .The parallel training scheme applies the complete training set simultaneously to all neural networks and use S/N (signal-to-noise) ratio to roughly classify the image blocks into the same number of sub-sets as the of neural networks. After this initial coarse classification is completed, each neural network is then further trained by its corresponding refined sub-set of training blocks.

B. Serial training involves an adaptive searching process to build up the necessary number of neural networks to accommodate the different patterns embedded inside the training images. Starting with a neural network with predefined minimum number of hidden neurons, h_{min}, the neural network is roughly trained by all the image blocks. The S/N ratio, further training is started to the next neural network with the number of hidden neurons increased and the corresponding threshold readjusted for further classification. This process is repeated until the whole training set is classified into a maximum number of sub-sets corresponding to the same number of neural networks established.

$$z_i = \begin{cases} 1 & d(x,W_i(t)) = \min d(xW_j(t)) \\ 0 & otherwise \end{cases} \qquad (2)$$

Frequency sensitive competitive learning algorithm address the problem by keeping a record of how frequent each neuron is the winner to maintain that all neurons is the network are updated an approximately equal number of times.

III. DISCRETE WAVELETS TRANSFORM

Wavelet is a mathematical function that divides the data into different frequency components, and then fits each component with a resolution suitable for its scale. Wavelet is a waveform that effectively has a duration limit of zero mean value. The nature of wavelet is its infrequency. In fact, there are many coefficients in the representation of wavelet with very small or zero value. This characteristic gives the opportunity to perform image data compression. The application of wavelet transform in digital image processing uses the Discrete Wavelet Transform or DWT. Wavelet is a base, the wavelet base is derived from a scaling function which properties are assembled from a number of self copies that has been dilated, translated and scaled. This function is derived from the dilation equation, which is considered as the basis of wavelet theory. From the scaling equation of this function a wavelet equations of the first (known as mother wavelet) can be formed as follows:

$$\Psi(x) = 1/\sqrt{|a|}\ \psi\left(x-b\right)/a \qquad (3)$$

Ψ(x) is obtained by scaling the wavelet at time b and scale a, where represents the wavelet. The main properties of wavelet transform in still image compression is the occurrence of minimum distortion in the reconstructed image even when exercising removal transform coefficients are near zero. Wavelet transforms on an image results in many subfields images with very small magnitude. In determining non-negative threshold, the elements of image with very small

subfields can zeroed so as to produce a very rare matrix. The existence of the very rare matrix will make it easier to be transmitted and stored; even the result of image reconstruction with threshold (quantization) can provide visual results for bare eyes. In the wavelet transform process for 2-dimensional image, there are two ways to decompose the pixel values, the standard decomposition and nonstandard decomposition. Each method is obtained based on wavelet transform 1-dimensional. When the standard decomposition processes an image, the first is by using a wavelet transform 1-dimensional image on each row. This process will generate a mean value along with detail coefficients for each row. The second is by using wavelet transform 1-dimensional image on each column. The process results in the form of detail coefficients and one coefficient average. Nonstandard Decomposition transformation is obtained by combining pairs of rows and columns alternately transformation. In the first step wavelet transform 1-dimensional line is applied, then followed by a wavelet transform 1-dimensional column. In the decomposition level 1, the image will be divided into 4 sub bands; they are HH, HL, LH, and LL sub bands. HH sub band image gives details on the diagonal, HL sub band provides detailed images in the horizontal direction, the LH sub band provides detailed images in the vertical direction. While the LL sub band is a low-resolution residue that has low frequency components, which are often referred to as the average image. LL sub band is divided again at the time of decomposition at a higher level. The process is repeated according to the desired level. As a technique of 2-dimensional discrete signal analysis, for example in analyzing images, wavelet decomposes signal into signal average, details of vertical, horizontal and diagonal at some desired level. In addition, wavelet decomposes the original signal into signals in some frequency bands (called multi-resolution analysis.) The analysis can be done by applying the Discrete Wavelet Transform or standard decomposition techniques and non-standard Haar with wavelet. The feature (signature) image generated by wavelet is taken from a wavelet coefficient at a certain level (3, 4 or 5) and can be transformed to a much smaller than the original image.

IV. IMAGE COMPRESSION USING DWT AND BPNN

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. Wavelets are useful for compressing signals but they also have far more extensive uses. They can be used to process and improve signals, in fields such as grayscale image. They can be used to remove noise in an image, for example if it is of very fine scales, wavelets can be used to cut out this fine scale, effectively removing the noise. Compute the BPNN technique to the compressed image (Approximation block) by DWT for efficient compression.

V. PROPOSED FACE RECOGNITION ALGORITHM

A. Preprocessing:

Preprocessing of faces images prior to face detection and classification is essential. The RGB face image is converted into grayscale image and then resized into 100 by 100 pixels.

B. DWT feature extraction:

This stage is extracting DWT features from the input image obtained by applying Haar DWT on this image.

C. Recognition process:

This stage has two parts: The training part and the retrieving part. In the training BPNN neural network nodes is trained using the training features vectors. The optimal weights are obtained to be used in the recognition part. In this part, a new face is classified using the trained BPNN neural network.

VI. DISTORTION ANALYSIS

The images can be distorted in embedding process because of changing pixel bits. Distortion is measured by means of three parameters namely, Compression ratio(τ), Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

Compression ratio τ can be calculated by

$$\tau = (1-T_c/T_o)*100 \qquad (4)$$

Where Tc and To are the size of compressed & original image.

MSE can be calculated by

$$MSE = 1/MN \sum_{i=1}^{M} \sum_{j=1}^{N} (X_{ij} - Y_{ij})^2 \qquad (5)$$

Where x*ij* and y*ij* are the pixel intensities for the original and the reconstructed image.

The PSNR can be calculated by

$$PSNR=10 \log_{10} [I^2 max/MSE] \; dB \qquad (6)$$

Imax is the maximum intensity value of each pixel which is equal to 255 for 8 bit gray scale images. Higher value of PSNR leads to better image quality.

VII. RESULT AND DISCUSSION:

Fig 2: Simulation result of compressed image

Table 1: PSNR Analysis of DWT vs. DWT+BPNN

PSNR VALUE in dB		
Tech/levels	2 Level Decomposition	3 Level Decomposition
DWT	25.7	23.03
DWT+BPNN	26.78	30.02

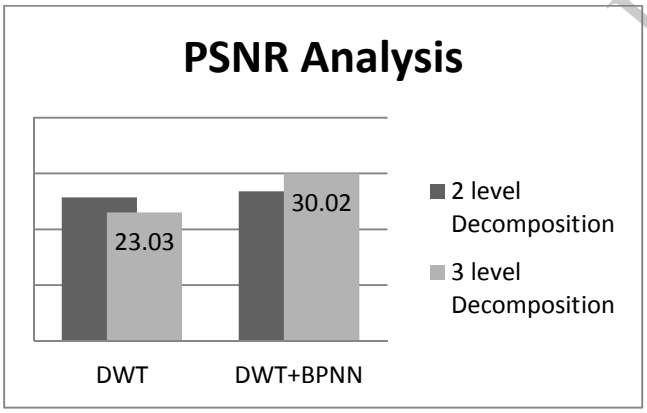

Fig 3: PSNR analysis of proposed algorithm

The simulation result shows that the PSNR value is increasing while BPNN technique is used along with DWT.

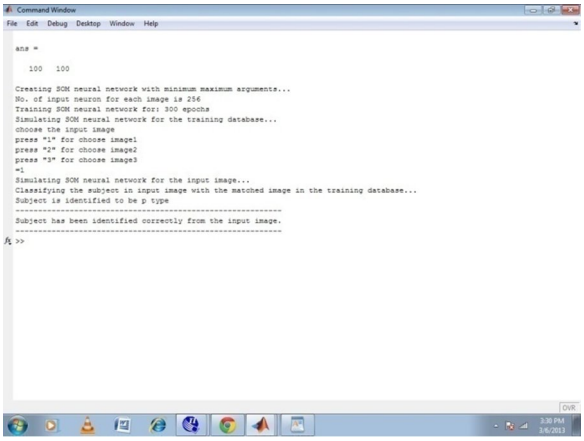

Fig 5: Simulated output of face recognition system

Fig.5 shows the Sampled simulated output of face recognition system. Here the given input image has been identified that it belongs to r type of trained data base among various trained face groups.

VIII. CONCLUSION & FUTURE SCOPE

Main goal of this project is achieved by designing of an efficient high-speed face recognition system. The DWT and the Back propagation neural network are the heart for the design on, which are the final algorithms used for the design of an efficient high-speed face recognition system. The main limitation of the present work is it recognizes only the facial expressions. Hence the future works consider the face illumination and tilt angles.

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