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Hybrid Compression based Stationary Wavelet Transforms

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Abstract:
In this paper, we introduce an approach to compressed the image by using Stationary Wavelet Transforms (SWT), Back Propagation Neural Network (BPNN) and Lempel-Ziv-Welch (LZW). Our approach consists of four phases are: (1) pre-processing, (2) Image transforms, (3) Vector Scan and (4) Hybrid compression. In preprocessing phase, resized the image into matrix 8x8 and converting to grey scale image. Image transformation phase, we use SWT to transform the image which remove the redundancy in image. In vector scan we convert from 2-dimensional matrix into 1- dimensional matrix by using zigzag scan. In hybrid compression we use Vector quantization by BPNN and LZW lossless techniques. Our Datasets collects from standard images in image compression. Our results give high compression ratio than other techniques used in image compressions with high elapsed time than other techniques, so we enhance the performance over elapsed time.

Keywords: - Hybrid Compression, Lossy Compression, Lossless Compression, Stationary Wavelet Transforms

I. INTRODUCTION

Compression is the art of representing the information in a compact form rather than its original or uncompressed form .In other words, using the data compression, the size of a particular file can be reduced. This is very useful when processing, storing or transferring a huge file, which needs lots of resources [1]. Lossy compression techniques is one in which compressing data and then decompressing it retrieves data that will be different from the original, but it is enough to be useful in some way. Lossy data compression is used frequently on the Internet and mostly in streaming media and telephony applications. In lossy data repeated compressing and decompressing a file will cause it to lose quality. Lossless when compared with lossy data compression will retain the original quality, an efficient and minimum hardware implementation for the data compression and decompression needs to be used even though there are so many compression techniques which is faster, memory efficient which suits the requirements of the user [2]. Stationary wavelet transform among the different tools of multi-scale signal processing, wavelet is a time-frequency analysis that has been widely used in the field of image processing [3].

The vector quantization is a classical quantization technique for signal processing and image compression, which allows the modelling of probability density functions by the distribution of prototype vectors. The main use of vector quantization (VQ) is for data compression [4] and [5]. It works by dividing a large set of values (vectors) into groups having approximately the same number of points

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closest to them. Each group is represented by its centroid value, as in BPNN algorithm and some other algorithms [6].

In this research a new and very expert scheme for hybrid compression of the researches images is suggested based on stationary wavelet transform and back propagation neural network vector quantization that results low computational complexity with no sacrifice in image quality. The execution of the suggested algorithm has been compared with some other common transforms which are lifting wavelet transform and discrete wavelet transform.

The rest of the paper is organized as follows. Section II describes stationary wavelet transform, section III describes the back propagation vector quantization, section IV describes the proposed approach, and section V shows the experimental results. Finally, section VI concludes the paper.

II. STATIONARY WAVELET TRANSFORMS

The Stationary wavelet transform (SWT) is a wavelet transform algorithm designed to overcome the lack of translation-invariance of the discrete wavelet transforms (DWT). Translation-invariance is achieved by removing the downsamplers and upsamplers in the DWT and upsampling the filter coefficients by a factor of in the th level of the algorithm. The SWT is an inherently redundant scheme as the output of each level of SWT contains the same number of samples as the input – so for a decomposition of N levels there is a redundancy of N in the wavelet coefficients[7].
In this figure (1) block diagram depicts the digital implementation of SWT.

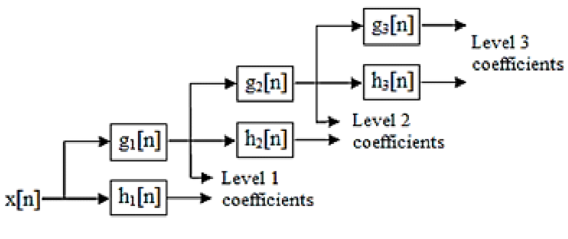

Figure 1: block diagram Stationary wavelet transform [7]

III. BACK PROPAGATION NEURAL NETWORK

BPNN algorithm helps to increase the performance of the system and to decrease the convergence time for the training of the neural network [8]. BPNN architecture is used for both image compression and also for improving VQ of images. A BPNN consists of three layers: input layer, hidden layer and output layer as shown in figure2. The number of neurons in the input layer is equal to the number of neurons in the output layer. The number of neurons in the hidden layer should be less than that of the number of neurons in the input layer. Input layer neurons represent the original image block pixels and output layer neuron represents the pixels of reconstructed image block. The assumption in hidden layer neurons is that the arrangement is in one-dimensional array of neurons which represents the element of codeword. This process produces an optimal VQ codebook. The source image is divided into non-overlapping blocks of pixels such that block size equals the number of input layer neurons and the number of hidden layer neurons equals the codeword length. In the BP algorithm, to design the codebook, the codebook is divided into rows and columns in which rows represent the number of patterns of all images and columns represents the number of hidden layer units [7].

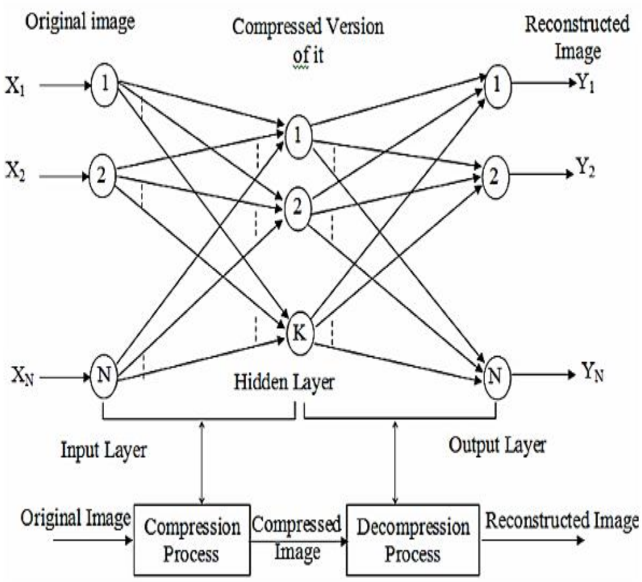

Figure 2: Back Probagation Neural Network [8]

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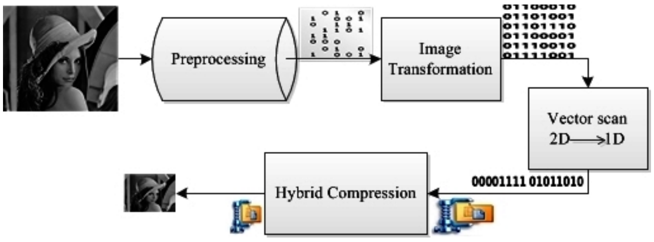
IV. PROPOSED APPROACH



Step 1 Preprocessing

Input image
RGB to Gray (image_matrix)
For Each Pixel in Image_matrix {
Red = Pixel. Red Green = Pixel. Green Blue = Pixel.Blue
Gray = (Red + Green + Blue) / 3
Pixel. Red = Gray
Pixel. Green = Gray
Pixel.Blue = Gray
}
Return image gray_matrix
Output image

Step 2 Image Transformation

Image transformation phase received the resizable gray scale images and produced transformed images. This phase used the three types of wavelet transforms such as DWT, LWT, and SWT.

Step 3 Vector scan

Zigzag scans phase takes as an input the transformed images in 2D matrix and produced images in 1D matrix, so that the frequency (horizontal + vertical) increases in this order, and the coefficient variance decreases in this order [9].

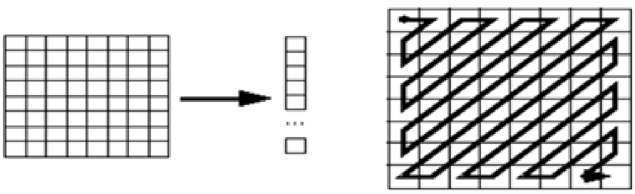


Figure 3: Zigzag scan [9]

Step 4 Hybrid Compression

In this step we use lossy and lossless compression to get high compression ratio, in lossy compression use vector quantization by (BPNN) and lossless compression using Run Length and Lemple Ziv Welch (LZW).

V. EXPERIMENTAL RESULTS AND DISCUSSION

5.1. Data Sets and its characteristics

Used in the proposed system 5 image (2 gray scale, 3 RBG)
1 - Lena.jpg, gray scale, Dimensions 512*512, Size 37.7 KB.
2 - Cameraman.jpg, gray scale, Dimensions 256*256, Size 40 KB.
3 - Tulips.jpg, RBG, Dimensions 1024*768, Size 606 KB.
4 - White flower.png, RBG, Dimensions 497*498, Size 198 KB.
5 - Fruits.png, RBG, Dimensions 512*512, Size 461 KB.
Work experiment in Matlab R2013a.

The next sections describe the performance of three types of wavelet transform (DWT, LWT, and SWT) and hybrid compression techniques are: vector quantization (BPNN) and lossless compression using Run Length and Lemple Ziv Welch (LZW).

5.2. Hybrid compression based DWT/LWT/SWT Experimental Results

Table1. showing results for the process lossy and lossless image compression of the five images uses the discrete wavelet transform with Run Length and Lemple Ziv Welch without the use of the BPNN, as well as with the use of the BPNN and that using three decomposition levels. We find that Zigzag BPNN & Lempel Ziv Welch has large value than other techniques in compression ration but has elapsed time more than other techniques, so the BPNN & LZW hybrid technique give good compression ratio but in large elapsed time.

Table1. Hybrid compression based DWT/LWT/SWT

Image	SWT & BPNN ZigZag Run Length Encoding		SWT & BPNN ZigZag Lempel Ziv Welch		LWT & BPNN ZigZag Run Length Encoding		LWT & BPNN ZigZag Lempel Ziv Welch		DWT & BPNN ZigZag Run Length Encoding		DWT & BPNN ZigZag Lempel Ziv Welch	
	C. Ratio	Elapsed time(SEC.)	C. Ratio	Elapsed time(SEC.)	C. Ratio	Elapsed time(SEC.)	C. Ratio	Elapsed time(SEC.)	C. Ratio	Elapsed time(SEC.)	C. Ratio	Elapsed time(SEC.)
Lena	32.24	5.6628	47.92	76.3675	17.43	5.7879	27.5	43.1375	12.06	5.9336	28.57	49.2547
Cameraman	34.94	4.0028	52.99	67.3841	18.73	5.7903	29.14	37.2786	12.07	5.6661	30.11	38.4843
Tulips	36.32	5.8652	53.46	65.8333	19.96	3.2802	28.46	31.6085	13.69	2.9463	26.41	33.3085
white flower	41.68	2.9504	71.09	36.7384	17.42	2.2406	33.22	22.4952	27.55	2.1519	33.6	28.1893
Fruits	37.73	3.4271	60.43	63.2316	19.27	2.9619	39.56	26.4468	17.9	2.7274	30.58	24.8021
AVERAGE	36.58	4.38166	57.18	61.91098	18.56	4.01218	31.58	32.19332	16.65	3.88506	29.85	34.80778

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5.3. Experimental Results Comparison Analysis (BPNN and LZW/Run length)
SWT, LWT, DWT

Average	SWT & BPNN ZigZag Run Length Encoding	SWT & BPNN ZigZag Lempel Ziv Welch	LWT & BPNN ZigZag Run Length Encoding	LWT & BPNN ZigZag Lempel Ziv Welch	DWT & BPNN ZigZag Run Length Encoding	DWT & BPNN ZigZag Lempel Ziv Welch
Compression ratio	*36.58*	*57.18*	*18.56*	*31.58*	*16.65*	*29.85*
Elapsed Time	*4.38166*	*61.91098*	*4.01218*	*32.19332*	*3.88506*	*34.80778*

In SWT & BPNN ZigZag Lempel Ziv Welch best compression ratio (57.18), but the longest elapsed time (61,91098) SEC. In DWT & BPNN ZigZag Run Length Encoding lower compression ratio (16.65), but shortest elapsed time (3.88506) SEC.

VI. Conclusion

Hybrid compression is combine two or more algorithms from lossy and lossless compression, so our approach applied back propagation neural network vector quantization (lossy compression), and run length, LZW (Lossless compression) based stationary wavelet transform. Hybrid compression based stationary wavelet approach conclude the hybrid between back propagation neural network vector quantization and LZW algorithm gives high compression ration with high elapsed time but acceptable compression ratio with accepted elapsed time can be occur when hybrid back propagation neural network with run length coding.

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