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The Application of Color Image Compression Based on Discrete Wavelet Transform

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ABSTRACT

The rapid progress in technology has been the use of color images that contain very large data and to transfer large information without loss of image information led to the creation of an important tool used to compress the color image, which is the modern wavelengths derived from polynomials, depending on the influencers (s,r) responsible for expansion, contraction and compensation in The parent function for obtaining the functions at each point depends on the influences responsible for the formation of the wavelet functions from which we derive the appropriate filter responsible for analyzing the color image and divide it into parameters that divide into two parts Approach and Details. In this work, new wavelets were used in order to find the exact solution to a number of important numerical problems in the field of mathematics. These methods are tested in the field of multi resolution analysis (MRA) for using in the field of image processing where it was used in the analysis and compression of the color image, calculating the most important image quality Mean Square Error (MSE) and Peak signal-to-noise ratio (PSNR). Standards and comparing the results with the results obtained using standard wavelets used in the Matlab program that was used in this work. In physics, the images of atoms were taken, random images were designed and designed with a size (256 x256) that were processed using modern wavelets.

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1. Introduction

The image is a group of numbers represented by a very large group of rows and columns that take up a large space so that they cause problems when transporting them, which led to the need to reduce the space occupied by these large numbers, which calls for the use of many mathematical equations and the extraction of new filters that

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improve the compression of images using a new technology in mathematics [1-30]. Researchers used several numerical techniques in order to find the useful parameters [31-40]. In this work, the Matlab language and its role in image processing that proved to be a high technology in the world of computing and creating programs to be used in programming mathematical equations and using them in image processing such as compressing the image and raising the noise from the image to be processed. Physical samples of the atoms were selected that were compressed. The tables and results demonstrate the efficiency of the proposed theory.

2. Mathematical Method

The Discrete wavelets used in this work is (DHWT) where separate samples are characterized by stretching and contraction, which is one of the most important characteristics that distinguish them from Fourier transforms, which are exploited in common applications such as data compression and noise removal [41-80].

The following family functions

$$w_{s,r}(t) = |s|^{-1/2} w(t - r\,/s)\,, s, r\ \in R, s \neq 0 \tag{1}$$

where: $$w(t) = [w_0(t), w_1(t), \dots, w_{M-1}]^T \tag{2}$$

The elements $w_0(t)$, $w_1(t)$, …, w_{M-1} are the basis functions, orthogonal on the [0,1] Laguerre wavelet $w_{n,m}(t) = w_{t,n,m,k}$ have Four variables, $k = 1, 2, \dots, n = 1, 2, \dots, 2^{k-1}$, m is order for the polynomials.

Expansion and contraction are two variables $s = 2^{-k+1}, r = 2^{-k+1}(2n - 1)$ respectively and use transform x in (1).

$$x = 2^{-k+1}(2^k \times t) \tag{3}$$

Then we will get the following equation

$$w_{n,m}(t) = 2^{k+1/2}\, H_m(2^k t - 2n + 1) \quad , \quad n - 1/\, 2^{k-1} \leq t \leq n/2^{k-1} \tag{4}$$

$$w_{n,m}(t) = 0 \qquad\qquad , \quad \text{Otherwise} \tag{5}$$

A function approximation $f(t) =\in L^2$ [0,1] may be expanded as

$$f(t) = \sum_{n=1}^{\infty} \sum_{m=0}^{\infty} A_{n,m} w_{n,m}(t) \tag{3}$$

where: $$A_{n,m} =< f(t), w_{n,m}(t) \tag{4}$$

In Eq. 4, $<.,.>$ denoted the inner product with weight function $w_n(t)$ on the Hilbert Space [1,0). If the infinite series in above equation is truncated, then Eq. 3 can be written as

$$\text{Let } 2^{k-1} = s\,, f(t) = \sum_{n=1}^{s} \sum_{m=0}^{M-1} A_{n,m} w_{n,m}(t) = A^T w_{n,m}(t) \tag{5}$$

where: A and $w(t)$ are $2^{k-1}\, M \times 1$matrices given by

$$A = [A_{1,0},\quad A_{1,1},\quad \dots,\quad A_{2,0},\quad \dots,\quad A_{2,(M-1)},\quad \dots,\quad A_{2^{k-1},0},\quad \dots,\quad A_{2^{k-1},\ M-1}]^T \tag{6}$$

$$w(t) = [w_{1,0}\,(t),\quad w_{1,1}\,(t),\quad \dots,\quad w_{1,M-1}(t),\quad w_{2,0}(t),\quad \dots,\quad w_{2^{k-1},M-1}(t),\quad \dots,\quad w_{2^{k-1},0}(t),\quad \dots,\quad w_{2^{k-1},M-1}(t)]^T \tag{7}$$

In Eq. 3 when M = 3, the six basis functions are given by the family of DHWT is an orthonormal basis of $L^2(R)$ in the concept of Multi Resolution Analysis (MRA) with finite energy is a sequence $\{V_n\}_{n\in Z}$, Figure 1 shows the steps of the Multi Resolution Analysis (MRA), with the Discrete Hermite Wavelet Transform Filters (DHWTF).

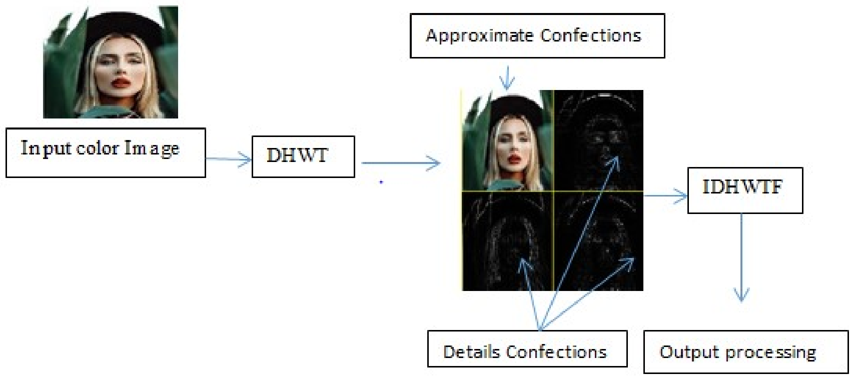

Fig. 1 – The analyses color image with DHWTF.

A novel image processing method for processing color images using wavelets proposed in this work (DHWT) was obtained that the error is close to zero with the help of Matlab software. The image and it's compression to reduce the space occupied by the image data and when taking the inverse of the matrix on the color image to return to the original image without losing the original image information. In a safe way by measuring the image quality standards; Figure 2 illustrates the compression process by level thresholding select thresholding method in scarce high threshold is zero. The result retained energy 100 %, number of zero is 12.17 % in level 1. In Figure 3 thresholding by balance sparsity- Norm and select global threshold 237.5, retained energy 98 %, and number of zero is 75.02 % in level 1.

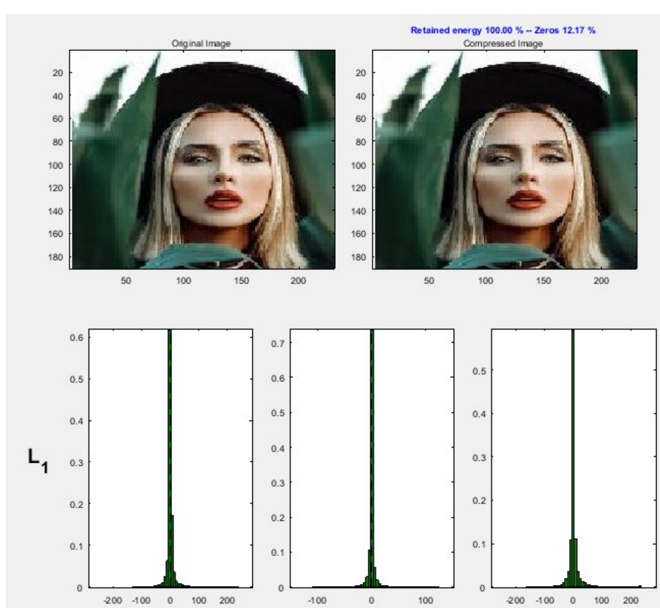

Fig. 2 – compression process by level thresholding select thresholding method in Scarce high threshold is zero and the result retained energy 100% and number of zero is 12.17% in level 1.

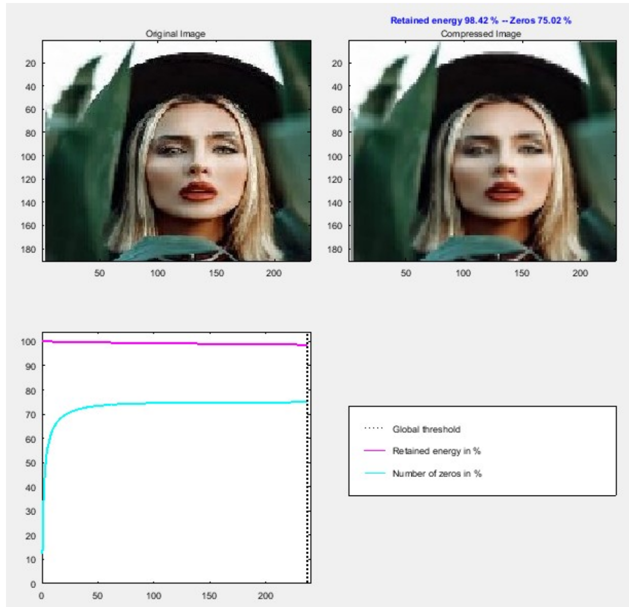

Fig. 3 – Thresholding by Balance Sparsity- Norm and select global threshold 237.5 retained energy 98 % and number of zero is 75.02 % in level 1.

3. Results and Discussion

In this section, mathematical equations are used in the previous section and programmed in the MATLAB program in which the role of MATLAB is seen and its close relationship with mathematical relations is seen. Programs were created and filters were used that were extracted from the mathematical equations. Table 1 illustrated the parameters of the resulting image quality, Man Square Error (MSE), Max Error (ME), L2Norm Ratio, Peak Signal to Noise Ratio (PSNR), Bet Per Pixel (BPP) and Compression Ratio (CR) and compared with standard wavelets such that bior, db and smy wavelets in MATLAB program.

Table 1 - The compare proposed method with other methods.

Wavelet	M.S.C.	Max Error	L2-Norm Ratio (%)	P.S.N.R	B.P.P	Comp Ratio (%)
DLWT	3.706	36	99.94	42.44	5.2839	22.02
bior	4.0672	33	96.80	40.85	4.1107	20.23
db	4.3032	35	94.88	40.31	4.3939	20.42
sym	5.3725	34	98.99	40.42	4.7382	21.23

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Physical Application [81-94]

A physical three samples in Figure 4 was taken where the threshold value was taken far from zero, and a satisfactory result was obtained, with used Balance Sparsity - Norm Method (BSNM) and Remove near Zero for Compressed Image (RNZC) Figure 5 shows the results of these methods. Mean Square Error (MSE) and Peak signal-to-noise ratio (PSNR) in Table 2.

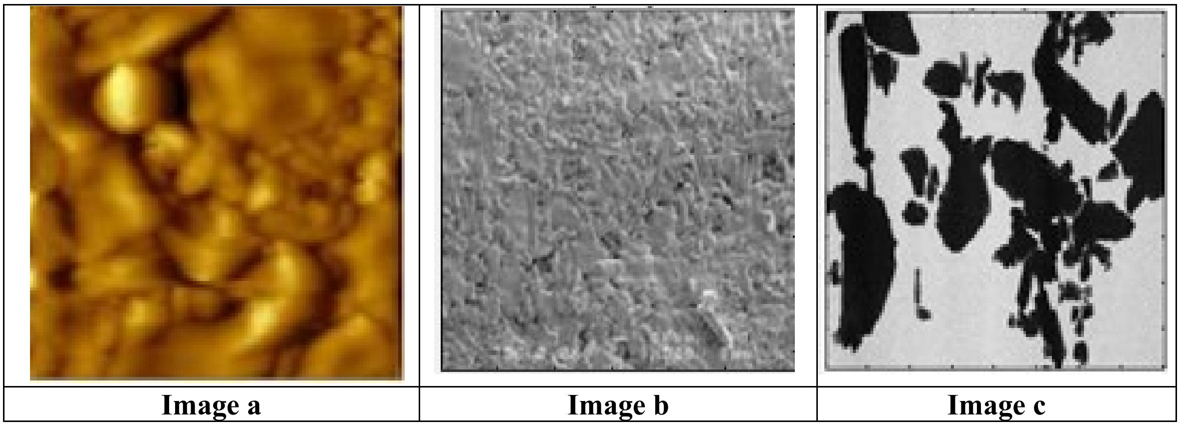

Fig. 4 – Three physical samples.

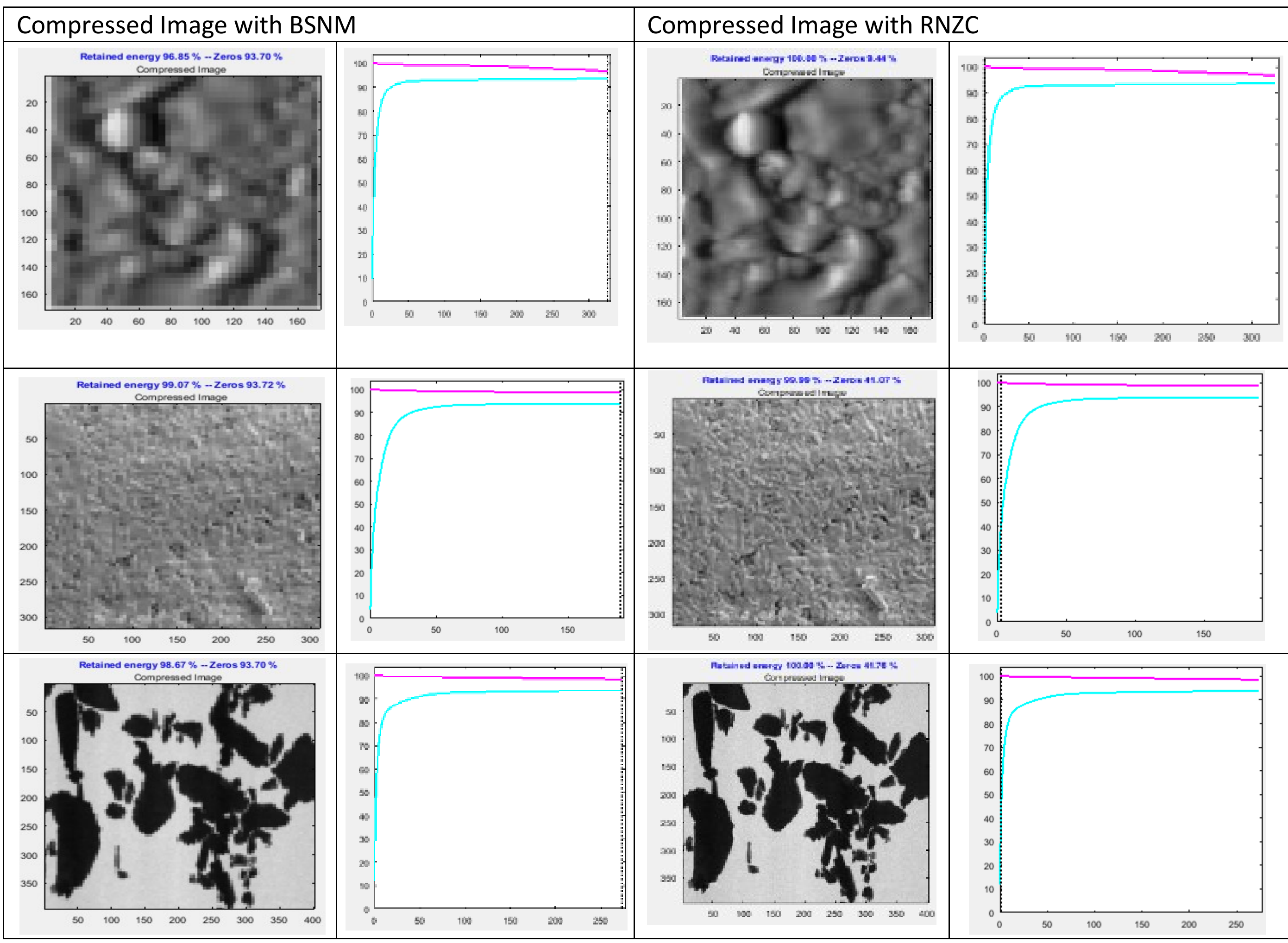

Fig. 5 – Compressed three physical samples.

Table 2 - The results with SPIHT.

Image	M.S.C.	P.S.N.R	B.P.P	Comp Ratio (%)
a	0.04209	61.89	8.1659	102.07
b	0.06728	59.85	7.1107	88.88
c	0.3032	53.31	7.3939	92.42

4. Conclusion

The separate wavelets proposed in this work in image processing the wavelets were tested on the color image. The image was analyzed and compressed, and the efficiency of the new technique was evident through the results obtained in this work. Through the analysis of the image and signal using the proposed theory and access to satisfactory results by comparing them with other types of theories, which makes us strongly emphasize the efficiency of the proposed theory, which makes it possible to use in many areas for example in medical image processing, In addition, three physical samples were selected that were compressed using the proposed wavelets, and good results were obtained that prove the efficiency of the method used.

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