Novel Filter of DWT for Image Processing Applications

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Abstract

In this work, wavelets are used in the analysis of medical images, where the efficiency of mathematics in this field has been proven because the basis of the proposed wavelets in this work is newly constructed mathematical equations, and through the MATLAB program, many programs have been designed to be ready for use in the field of image analysis and study. Physical samples were selected that were compressed using the proposed wavelets, and good results were obtained that prove the efficiency of the method used.

Keywords: Discrete Laguerre Wavelet Transform (DLWT); Image Compression; Medical application; De-noise medical image; bit per pixel.

1. Introduction

The compression of the color image, as described in many works, means data compression or bit-rate reduction on cryptographic information using bits lower than the original representation. This is an important technique in the field of image processing and transmission of information where the bit rate reduction rate is based on original image information or encryption information. In order to reduce the storage space, the important benefit of pressure is to minimize the potential loss of data where the identification and elimination of statistical repetition. This technique in information theory is the number of bits used to send a message minus the number of bits of information Effective in the message [1-8].

Where many algorithms are used to explain how to work with this technique to perform data compression without loss and to obtain good results when rebuilding and returning to the original data without loss, the error rate is almost equal to zero through the application mean square error and peak signal-to-noise ratio [9].

The following technique DLWT [10-13], was used to implement the technique mentioned above and apply it to a color image in which the account Bit-per-pixel was reached. In the following sections, the proposed theory was based on a section of a mammalian mammogram that was examined with magnetic resonance imaging.

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2. Wavelets transform

In general, wavelets depend on a basic function that is used as the basis for the wavelets to be created. It is the parent function, which in turn depends on two important factors, namely (a,b) responsible for the contraction and contraction of the wavelets [14-16]

The following family function

$$w_{a,b}(t) = |a|^{-\frac{1}{2}} w\left(\frac{t-b}{a}\right) \qquad a, b \in R \quad a \neq 0 \qquad (1)$$

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

The elements $w_0(t), w_1(t), \dots, w_{M-1}(t)$ are the basis functions, orthogonal on the [0,1].

The proposed method in this work is the developed wavelets that are derived from the polynomials and substituted in the equation (1) by increasing the number of coefficients so that it becomes four parameters that are responsible for expansion and contraction. They are n, m,k, t,
$k = 1,2, \dots,$ $n = 1,2, \dots, 2^{k-1},$ m is ordered for Laguerre polynomials

, and t is normalized time. If we dilation by parameter $a = 2^{-(k+1)}$

and translation by parameter $b = 2^{-(k+1)}\big(2(n-1)\big)$ by transform x and by using (1).

$x = 2^{-(k+1)}(2^k t)$, then we will get equation (2)

$$w_{n,m}(t) = \begin{cases} 2^{k+1/2} w_n(2^k t - 2n + 1) & \frac{n-1}{2^{k-1}} \leq t < \frac{n}{2^{k-1}} \\ 0 & o.w \end{cases} \qquad \textbf{(2)}$$

Depending on the polynomial used by which atoms are obtained at every point, for example

$w_{1,0}(t), w_{1,1}(t) w_{1,2}(t), \dots, w_{1,M-1}(t)$ for n=1

$w_{2,0}(t), w_{2,1}(t) w_{2,2}(t), \dots, w_{2,M-1}(t)$ for n=2

$\vdots$

$w_{2^{k-1},0}(t), w_{2^{k-1},1}(t) w_{2^{k-1},2}(t), \dots, w_{2^{k-1},M-1}(t)$ for n=2^{k-1}

3. Properties wavelets transform.

Waveforms carry the properties that qualify them for image analysis processes. One of these properties is the orthogonality characteristic that helps prove many theories that prove the proximity of functions because the polynomials that are the basis of the wavelets are perpendicular and converging

The family of functions

$$\{C_{n,m}(t)\}_{n,m \in Z} = 2^{-n/2} C(2^{-n} t - m) \forall n, m \in Z, \qquad (3)$$

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it's called wavelet function in n=0 scalar function in equation (4)

$$C(t) = \begin{cases} 1 & if\ 0 \le t \le 1 \\ 0 & otherwise \end{cases} \quad (4)$$

The wavelets system for each $n, m \in Z$, define

$$\{w_{n,m}(t)\}_{n,m\in Z} = 2^{-n/2} w(2^{-n}t - m) \quad (5)$$

from the above equation, The function is called the wavelet system denoted by (W.S.), considering $f(t)$ is defined on $L^2[0,1]$ has an expansion in terms of functions as follows.

For any integer ≥ 0 .

$$f(t) = \sum_{m=0}^{2^n-1} < f, C_{N,m} > C_{N,m}(t) + \sum_{n=N}^{\infty} \sum_{m=0}^{2^n-1} < f, w_{n,m} > w_{N,m}(t) \quad (6)$$

$$\sum_{m=0}^{2^n-1} a_{n,m}\, C_{N,m}(t) + \sum_{n=N}^{\infty} \sum_{m=0}^{2^n-1} d_{n,m}\, w_{N,m}(t) \quad (7)$$

Which is known as series and $d_{n,m}$ and $a_{n,m}$ wavelet coefficient for wavelet and Scaling coefficients, respectively.

4. Multiresolution Analysis of wavelets (MRA)

Multiresolution analysis of Laguerre wavelets ($MRA_{Lag(wav)}$) is a system for calculation of basis coefficients in $L^2\ (R)$: $f = \sum\sum A_{n,m} w_{n,m}$

$$f \in V_n = \{f(t) | f(t) = \frac{1}{2^{n/2}} h(2^{-n}t),\ \ h(t) \in V0\},$$

Where

$$f(t) = \sum_{n\in z} < f, C(.-m) > C(t-m)$$

Then a multiresolution analysis of wavelets (MRA)) on R is a sequence of subspaces $\{V_n\}$ $n \in Z$ of functions L^2 on R. First and foremost, we should look forward to achieving the following characteristics that allow us to complete our work in the field that

(a) For $\forall\ n, m \in Z, V_n \subseteq V_{n+1}$.

(b) If $f(t)$ is C_c^0 on R, then $f(t) \in span\{V_n\} n \in Z$, with $\epsilon > 0$, there is an $n \in Z$ and a function $C(t) \in V_n$ such that $\|f - g\|_2 < \epsilon$.

(c)$\cap_{n\in Z} V_n = \{0\}$.

(d) A function $f(t) \in V_0$ if and only if $2^{-n/2} f(2^{-n}t) \in V_n$.

(e) There exists a function $C(t), L^2$on R, called the scaling function such that the collection $C(t - n)$ is an orthonormal system of translates and $V_0 = span\{C(t - n)\}$.

4. Application of wavelets in image processing

After designing a suitable program to equip the Matlab program with the newly created wavelets and extracting the appropriate period, the color image is analyzed into the parameters of the ImageImage, which are approaches and details on a number of levels in the first level, the ImageImage is decomposed into four blocks, which are L.L. LH, HL HH.

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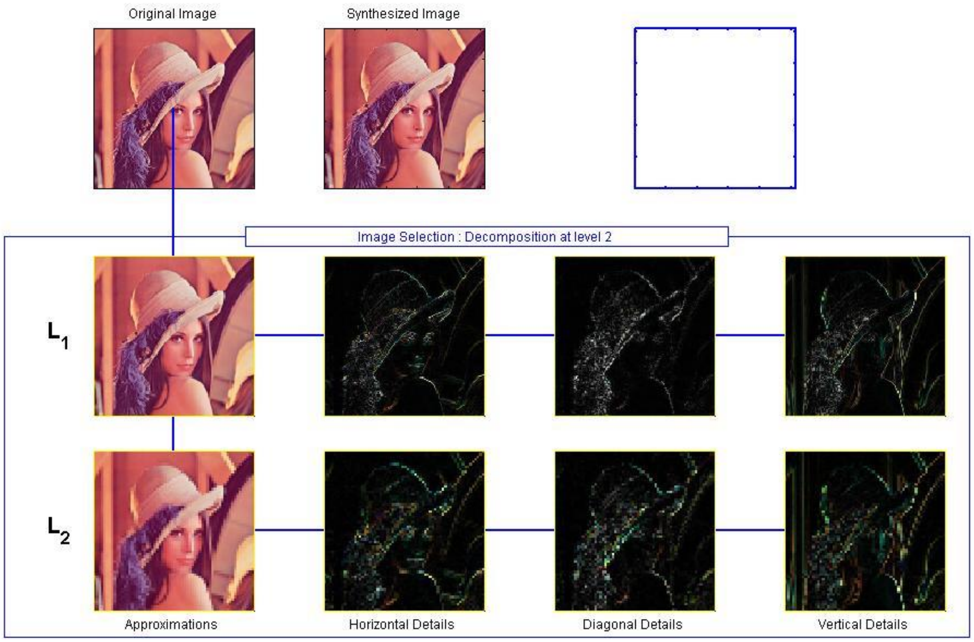

Figure 1: shows the analysis of the color image

The analysis of the color image is taken advantage of in the implementation of many important applications in image processing, which are compression and noise removal. The efficiency of the wavelets is proven when returning to the original ImageImage by passing the inverse of the wave. The ImageImage is reconstructed so that the new ImageImage does not lose its original characteristics. At level 2, the level 1 detail coefficients are preserved, and the level 1 approximation coefficients are decomposed. The following figure shows the analysis of ImageImage by using DLWT levels 1 and 2

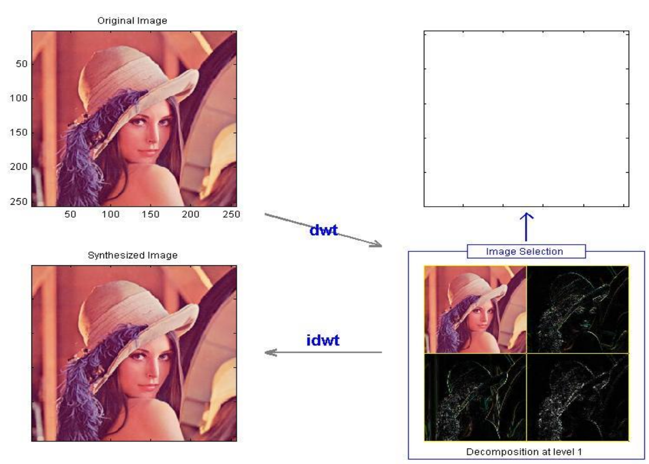

Figure 2: the decomposed ImageImage by using DWT level 1

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5. Discuss the results

the original ImageImage of size (256 × 256) in Fig18 shows the principles of the processing of ImageImage and the analysis it contains statistics, compressed, de-noise and histogram by using DWT with approximate coefficients and details coefficients moreover with the soft and hard threshold. The following figures used the original Image of Lena (256 × 256), a histogram of values (between 1 and 235), and a histogram of wavelet coefficients

The original ImageImage with global threshold 342, retained is 98.84 %, and the number of zero is 93.75%

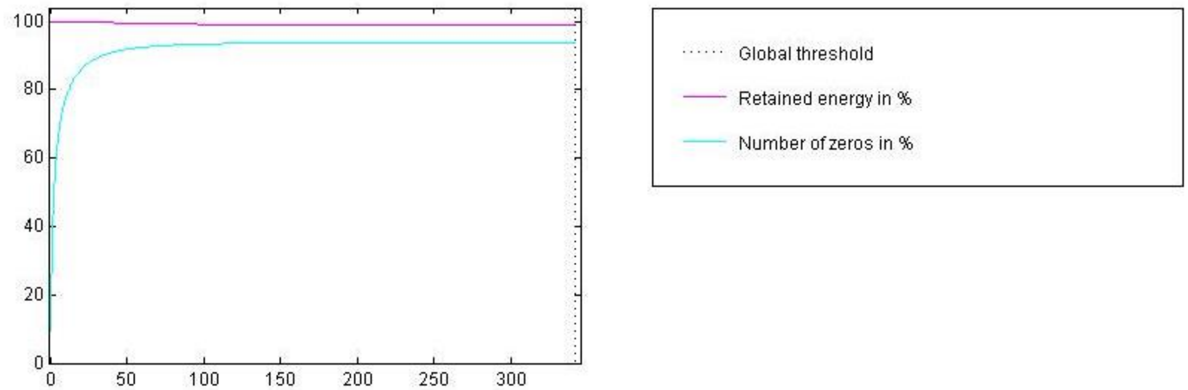

Figure 3: the original Image with a global threshold

The statistics of the ImageImage by using DWT level 2. The following figure shows the original statistics and their properties

Compressed ImageImage by with DWT level1 Global threshold return energy 98.84% and zeroes 93.75%

Compressed image by DWT level2 by level threshold return energy 100% and zeros 16.08%

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In the above figure, the right ImageImage is compressed with a selected threshold of 1.5, and the retained energy of 100% with the number of zero is 16.08%

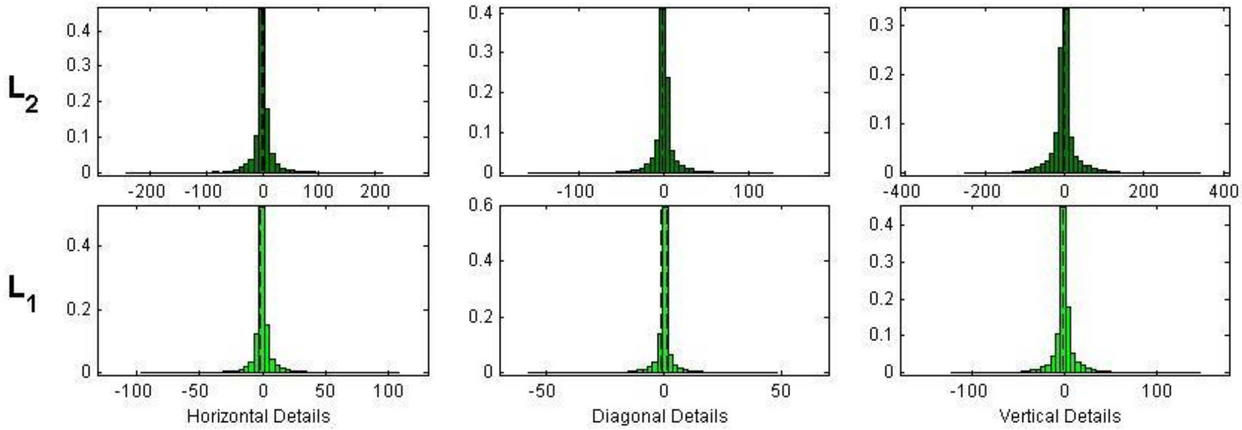

Figure 4: horizontal diagonal and vertical details with DWT level 2

The problem of de-noising of signal 1D was identified. In this section, the problem of de-noising of ImageImage will be identified.

De-noise with DWT level 2 soft threshold

De-noise with DWT level 2 hard threshold

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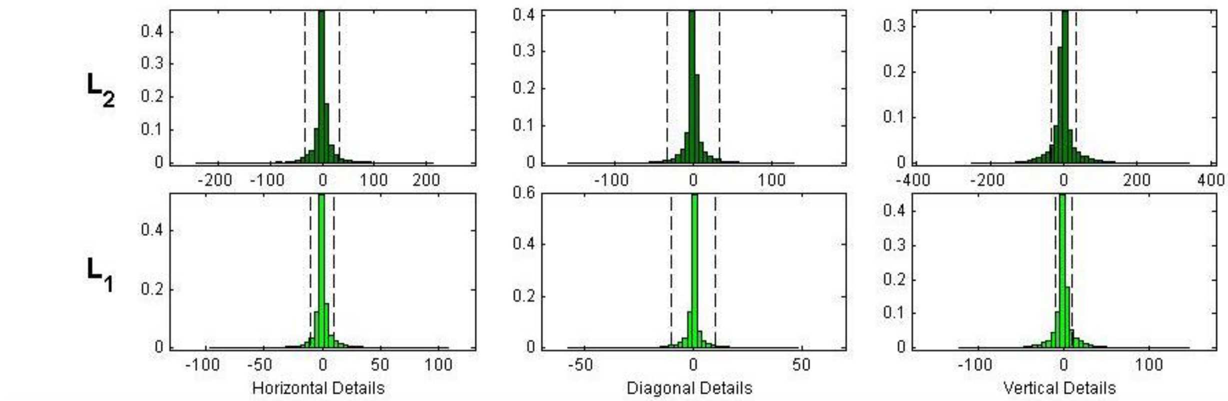

Figure 5: the de-noise Image by DWT hard threshold

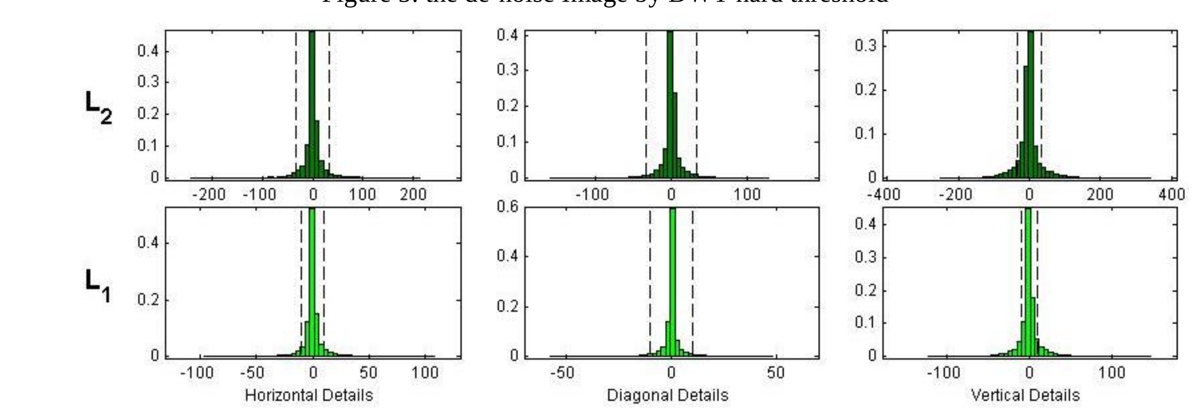

Figure 6: de-noise image by DWT soft threshold

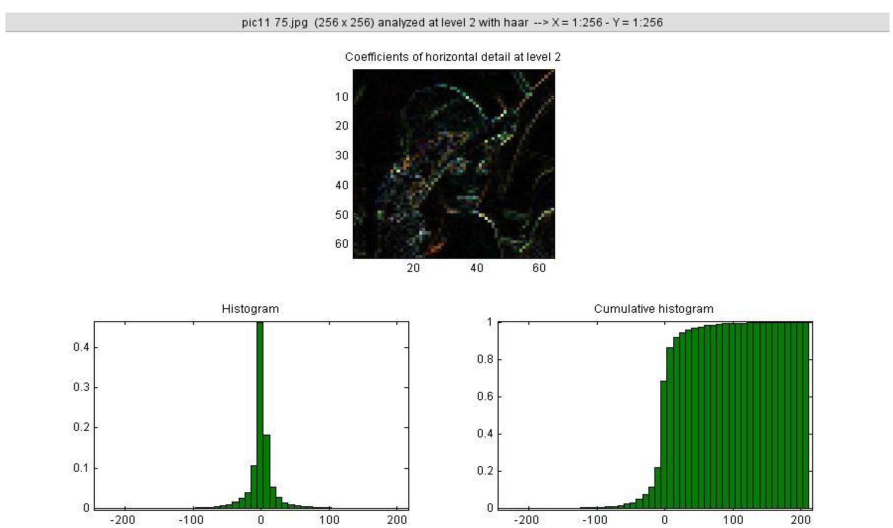

Figure 7: the statistic of details coefficients horizontal with DLWT level 2

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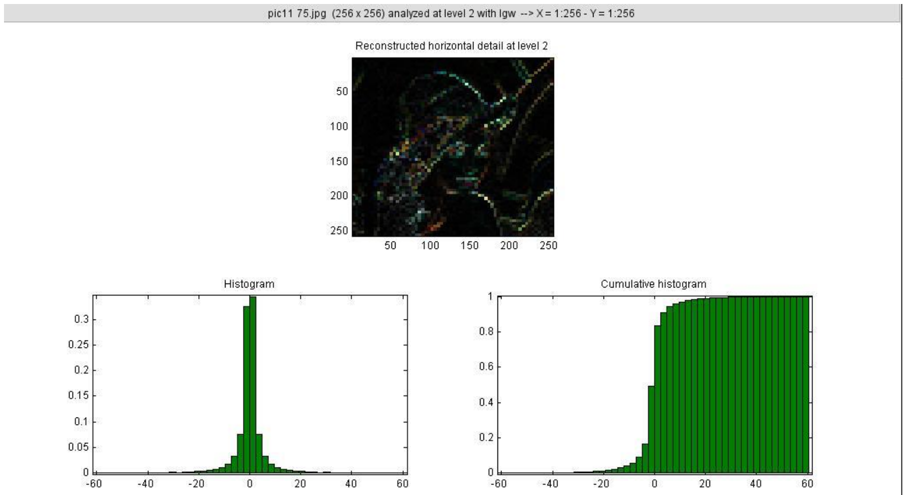

Figure 8: the statistic of details reconstruct horizontal with DLWT level 2

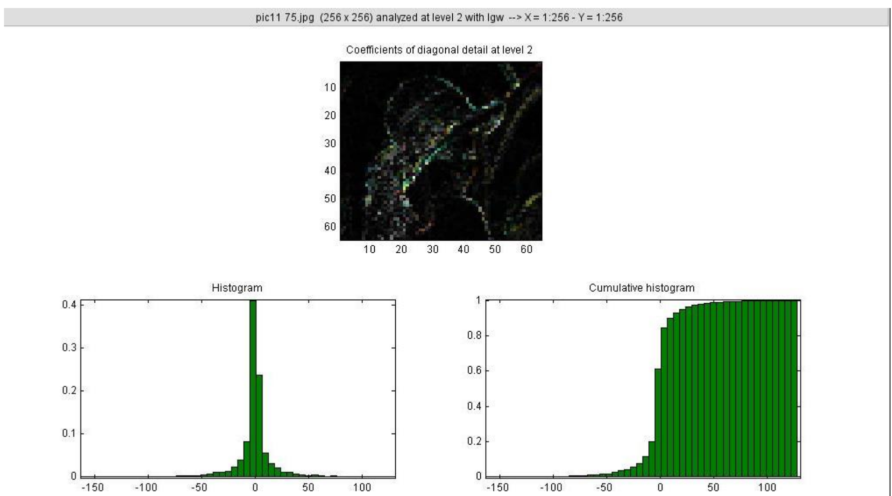

Figure 9: the statistic of details coefficients diagonal with DLWT level 2

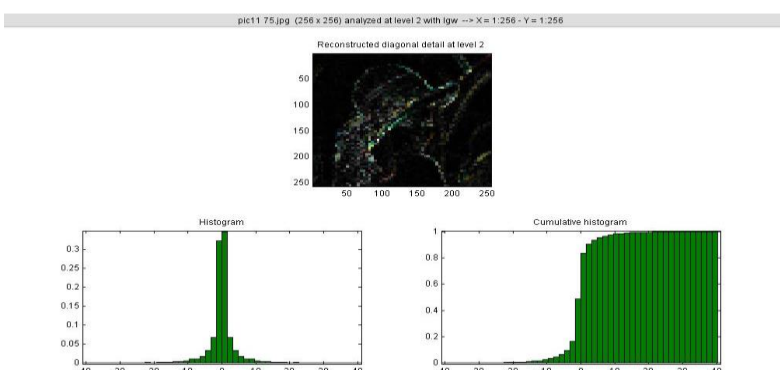

Figure 10: the statistic of details reconstruct diagonal with DLWT level 2

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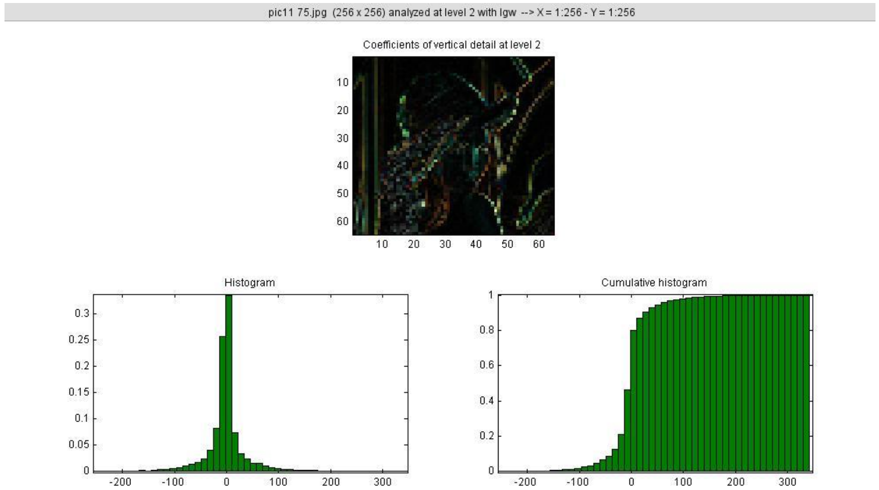

Figure 11: statistic of details coefficients vertical with DLWT level 2

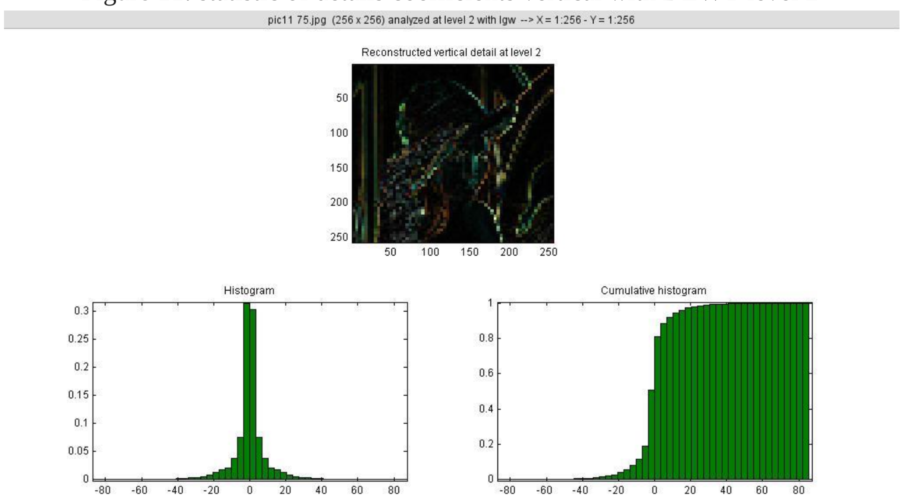

Figure 12: the statistic of details reconstruct horizontal with DLWT level 2

6. Conclusion

This work aims to analyze different color images by analyzing the color image. Based on the analysis of different image compression techniques, this paper provides a presentation on the analysis of discontinuous waves of images, where approximate factors and details are exposed, and its role in image analysis using waves with basic theories, which illustrates the smooth and effective theory proposed in terms of accuracy in our site results. Some medical applications have used a separate wave transformation (DWT) where satisfactory results have been obtained, our proposed theory has proven its effectiveness, and the example applied has demonstrated the strength and the role of wavelets in image processing.

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