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STEGANOGRAPHY OF FINGERPRINT IMAGES BY USING DISCRETE WAVELET TRANSFORM

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ABSTRACT
In this paper, image compression was performed by using Violet technique. Therefore, wavelet transform is applied to the image in 3 steps. At first, the image is divided into 16 blocks and one-dimensional discrete wavelet transform is done in rows, resulting in a rectangular matrix. In column one-dimensional discrete wavelet transform is done and this work will continue to analyze the image to the third phase of wavelet transform. Then, by applying Kuantazysyun practice and apply the modified zero-tree algorithm will continue to compress. By using this algorithm, the Violet coefficients are coded with a larger scope. If the domain of a coefficient is equal or greater than the specified threshold, coefficient is considered as a significant coefficient. Otherwise it is meaningless. Finally, in order to further compression of the coefficients of the modified zero tree will be used of discrete cosine transform.

KEYWORDS: Discrete Violet transform, Kuantazysyun, medical images, image compression

INTRODUCTION
Compression of images is the use of data compression on digital images, in other words, the aim of this work is to reduce redundancy photo contents to save or transfer data to enable optimal form (Fatahi,2012). For storage should be reduced size of Information as much as possible. The basis of all compression methods is excluding some information and data. Coefficient or compression ratio make specified the amount and percentage of abandonment Information that the storage of data transfer become easier and reduce bandwidth and frequency requirements(Bukhari, 2002). Nowadays, increased recording and transmission of medical images in digital form for use in telemedicine systems, hospitals and medical centers have been faced with a huge amount of information. Due to the high volume of medical images and the necessity of filing and transmission is necessary compression of images. One of the methods used in this context is wavelet transform (Loganathan, Kumaraswamy,2011). Wavelet transform is an efficient tool for image processing and signal. In recent years, the use of wavelet transforms in image compression without losses and casualties in many of the new standards, such as JPEG2000 compression standard has been successful. Until recently was used Fourier transform to analyze and reconstruct the original signal, but Fourier transform is included no local data of main signal. Then short-time Fourier transform was presented that time-frequency disc was sampling Smoothly. Finally, by providing wavelet transform, good temporal resolution and poor frequency resolution at high frequencies and frequency resolution at low frequencies were good and poor temporal resolution.

In this paper, Wavelet image compression methods have been studied, and a good way to have a good quality image compression, based on medical images is implemented. For this reason, the wavelet transform is used that is necessary in medical images to be retained desired information, and compression does not eliminate the diagnostic information and maintain image quality. In fact, Wavelet transform divides the image into details that can be maintained the details of the picture by working on them.

Compression by using discrete wavelet transform
In this section, wavelet transform to the image is applied to three steps. Then, by applying of Kvantazysyvn operation and modified zero tree algorithm, is continued to compression, finally, by applying the discrete cosine transform of compression operation will be terminated.

Apply of discrete wavelet transform
Each function that is integrable square with discrete wavelet transform. View a function as the sum of a family of basic functions with wavelet functions' name, is called discrete wavelet transform. One-dimensional discrete wavelet coefficients, by performing inner multiplication between the input signal and wavelet functions are obtained. Two-

dimensional discrete wavelet transform is performed by using removable method. At first, the image is divided into 16 blocks. Then the one-dimensional discrete wavelet transform is done in rows, and then the result is a rectangular matrix (Due to the reduction in the sampling line is rectangular), this time is performed in column of one-dimensional discrete wavelet transform. Figure 1 shows the analysis of wavelet to the third level. The first level of analysis is a low-pass sub-image LL2, and three top-pass sub-images (LH2, HL2,HH2). This process is repeated again on the LL2 and is output (LH2, HL2, HH2). The processing of the low-pass image similarly continues to break down to higher levels. In fact, the two-dimensional discrete wavelet is analyzed to the image to the sub- images by the pyramid structure that at every high level, the power of resolution is reduced in domain of scale (frequency, however, the power of resolution is increased in domain of location. To retrieve the image after compression is used of inverse discrete wavelet transform. Thus, by combining the filter, we use high-pass sampling.

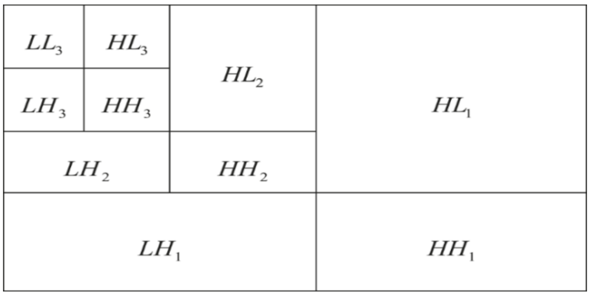

Figure 1: 3-level wavelet transform

Quantization

There are several ways to quantization. Due to the nature of quantization operation, complete reconstruction and without an error signal is impossible, and must accept the quantization error. Quantization operation is done three surface and to form an iterative algorithm. At each stage of quantization, a threshold value is determined which is calculated by the following equation:

1) $$\Theta_i = \begin{cases} \frac{1}{2}.\max_k(|c[k]|) & , \quad i=1 \\ \frac{1}{2}.\Theta_{i-1} & , \quad i>1 \end{cases}$$

In which Θi is the threshold value in the -i-th algorithm iteration, with a threshold value every step of the algorithm iteration, quantized coefficients obtained at each stage so that $d\Theta i\,[k]$, –k th is quantized coefficients in -i-th iteration of the algorithm.

$$d_{\Theta_i}[k] = \begin{cases} 1 & if\left(c[k]-\sum_{n=1}^{i-1} d_{\Theta_n}[k]\Theta_n\right) > \Theta_i \\ -1 & if\left(c[k]-\sum_{n=1}^{i-1} d_{\Theta_n}[k]\Theta_n\right) < -\Theta_i \\ 0 & else \end{cases}$$

2)

That $d\Theta i\,[k]$ =1 represents important coefficients than the threshold level at each stage of the algorithm iteration, and $d\Theta i\,[k]$ =0 is indicative of insignificant coefficients of each stage. In the decoding, reconstruction of the wavelet coefficients of the quantized coefficients and having the initial threshold are done according to the following equation.

3) $$\hat{c}[k] = \Theta_i \sum_{n=1}^{i} d_{\Theta_i}[k].2^{1-n}$$

In this article, quantization is performed so that each layer (R. G. B.) values of a step in the range [0.01 to 0.5] is done. In step staircase to the first layer of always values between [0.01 to 0.05] and for the second and third layers amounts of

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more than 0.05 can be used. This factor can be used to reduce the maximum amount in each layer. If the step increases, will increase the vulnerability of image that's why we always choose small quantities to achieve good image quality and better compression.

Embedded zero tree wavelet algorithm (EZW) and how its performance

EZW algorithm was developed in 1993 by Hapiro, the full name of this word means the gradual coding by using embedded zero tree wavelet. This algorithm wavelet coefficients as a set of trees is considered for spatial orientation. Each tree contains coefficients of all sub-bands of the frequency and location that are specific to a particular area of the image. At first, the algorithm is coded wavelet coefficients with a larger range, if the domain of coefficient is equal or greater than the specified threshold, the coefficient is considered as a significant coefficient and otherwise is nonsense. If a tree is significant, the biggest coefficient is greater than or equal to the threshold in the view of domain and otherwise it is meaningless tree.

The amount of threshold is halved every step of the algorithm, thus larger coefficients are sent as soon as possible. At each stage, first, the significance of these coefficients is evaluated related to the lower frequency sub -band. If a collection is meaningless, a zero tree symbols used to show that all coefficients are zero otherwise set is broken into four subsets for further evaluation, and after all coefficients and collections have been evaluated, this phase is completed. EZW coding is based on the assumption that power spectral density decreases quickly in most natural images, this means if a coefficient is small in the lower frequency sub-bands, most likely coefficients are small children in these higher sub-bands. In other words, if a parent coefficient is meaningless to children, it is probably meaningless. If thresholds are powers of two, EZW coding can be regarded as a bit-plane coding. In this way, at the same time, a series of bits from the MSB is started and coded, with the gradual coding sequence of bits and evaluate the trees of lower frequency sub-bands to more frequency sub-bands in each bit string can be achieved to embedded coding.

Thus, this algorithm works that the bit stream of wavelet transform processing, according to the importance of embedded zero tree wavelet algorithm EZW is arranged. The order of scan in the sub-bands is done from the lowest to the highest frequency band. On this basis, and according to the principle that decoder without knowing of location coefficients will not be able to reconstruct the image, is used of the default methods that the most famous of them can be seen the following.

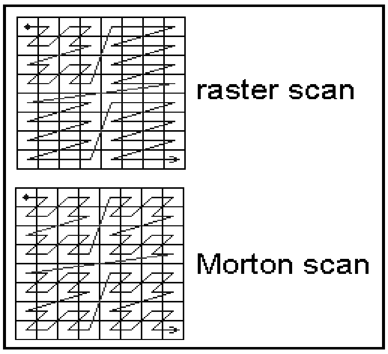

Figure 2: Types of survey of wavelet coefficients

Discrete cosine transform

Cosine transform is one of the transforms that has many applications in digital Signal Processing and Image Processing. Two-dimensional DCT is a standard technique for compressing and encoding of images that is used of this transform in standards such as JPEG, MPEG 1, MPEG 2. Recently, DCT is as one of the most important means of compression coding HDTV image.

Generally, to calculate DCT is used of two direct and indirect methods. The indirect method is used algorithms such as FFT and FHT, and by these algorithms is performed transform calculation. Due to hardware problems, such as complex structure with non local communications of indirect method is usually implemented in software. In contrast, the direct method can be used for hardware implementation. Hardware implementation of second method because of ordered structure of the matrix that has shown in the relationship, will be easier. One-dimensional discrete cosine transform will be calculated according to the following formula.

$$X_c[k] = \sum_{n=0}^{N-1} 2x[n]\cos\left(\frac{\pi(2n+1)k}{2N}\right)$$

4)

And in the case of two-dimensional, in the event of conversion to image,the image is divided into blocks of arbitrary size and discrete cosine transform is applied.

5)

$$X_c[k_1,k_2] = \sum_{n_1=0}^{N_1-1}\sum_{n_2=0}^{N_2-1} 4x[n_1,n_2]\cos\left(\frac{\pi(2n_1+1)k_1}{2N_1}\right)\cos\left(\frac{\pi(2n_2+1)k_2}{2N_2}\right)$$

$$x[n_1,n_2] = \frac{1}{N_1N_2}\sum_{k_1=0}^{N_1-1}\sum_{k_2=0}^{N_2-1} C[k_1]C[k_2]X_c[k_1,k_2]\cos\left(\frac{\pi(2n_1+1)k_1}{2N_1}\right)\cos\left(\frac{\pi(2n_2+1)k_2}{2N_2}\right)$$

$$C[k] = \begin{cases} 1/2, & k=0 \\ 1, & k \neq 0 \end{cases}$$

Simulation

In this paper, on simulation in JPEG format and combine DWT, DCT activity is done. JPEG format is used by the advantage of greater sensitivity of the human eye to changes in brightness than to changes in color. And also the brightness in the image advocates more examples of chrome and color information. Thus, color information is reduced to half. By reducing of encryption, lighting redundant information in the image, and general information is also declined. Other values and all remaining information that are sustainable, and are encoded like the method of compression without loss. Work algorithm is shown in Fig.

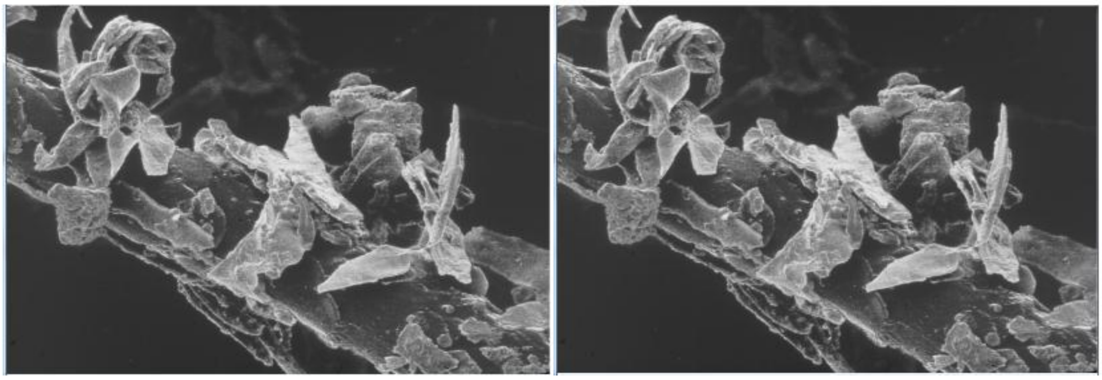

Figure 3: Microscopic image compression by JPEG algorithm applied by author. Upper image is the main image, and the bottom image is compressed.

The above figure represents a microscopic image with BMP format and the size is 5.98MB. By applying Jpeg algorithm has decreased the amount to the 333k.Time of program execution is 46.85274 seconds in MATLAB.

Table 1: The results of the microscopic image compression by JPEG algorithm apply

SIZE pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
2063*3038	119.738	27.3485	0.9960	0.0436	**0.9961**

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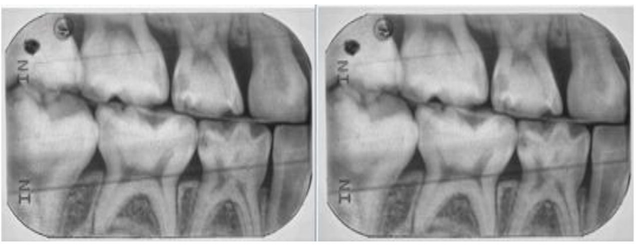


Figure 4: image compression dental 1 by JPEG algorithm applied by author. Upper image is the main image, and the bottom image is compressed.

Elementary image Size is 670 k, and an image dental is a BMP format, and the volume of compressed image is by jpeg algorithm 20k that compress the amount is desirable compression. But we are faced with some contrast of images. Time of program execution is 8.206284 seconds in MATLAB.

Table 2: The results of the microscopic image compression by JPEG applied algorithm

SIZE pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
367*567	183.6619	25.4906	0.9906	0.0954	**1.0004**

Figure 5: image compression dental 2 by JPEG algorithm applied by author. Left side image is the main image, and the right side image is compressed.

Elementary image Size is 2.95MB and BMP format is a dental image, and the image is compressed by the algorithm .74k Time of program execution is 6.332599 seconds in MATLAB.

Table 3: The results of the dental 2 image compression JPEG algorithm acts

SIZE pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
861*1201	59.1686	30.4099	0.9950	0.0378	**1.0067**

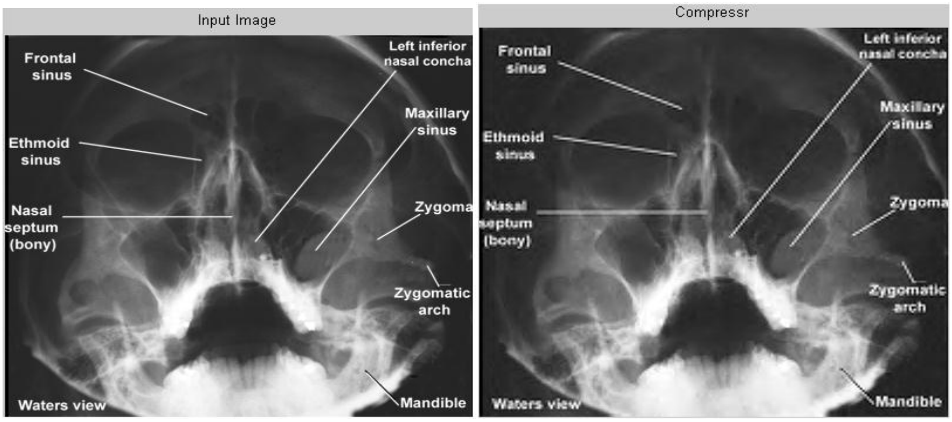


Figure 6: Pictures of the brain and JPEG acts

Elementary image Size is 425KB and BMP format is a dental image, and the image is compressed by the algorithm 17KB. Time of program execution is 6.822551 seconds in MATLAB.

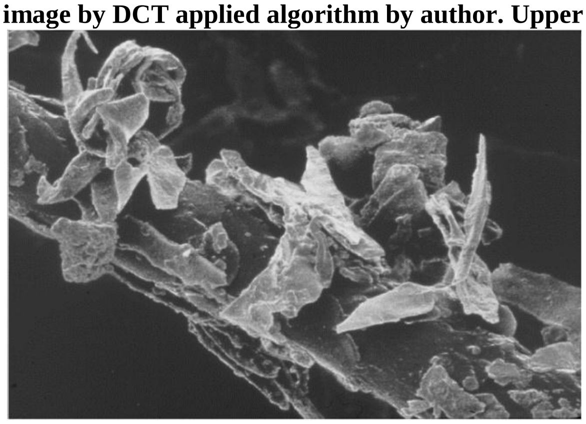
Table 4: The results of the brain image and JPEG algorithm acts

SIZE pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
400*363	820.7562	18.9887	0.9479	0.1287	**1.0364**

Simulations by using DCT compression

As mentioned, cosine transform is one of transforms that in the digital signal processing and image processing has many applications. Figure 4 has been shown to compare the results of compression by using the DCT. The following simulation results are presented for each photo by completed DCT algorithm. The first image is related to the microscopic image.

Figure 7: Microscopic compressed image by DCT applied algorithm by author. Upper image is the main image



When Simulation is running, it is faced with a lack of memory error that was created in the FFT catching of the picture. The next image is a dental image.

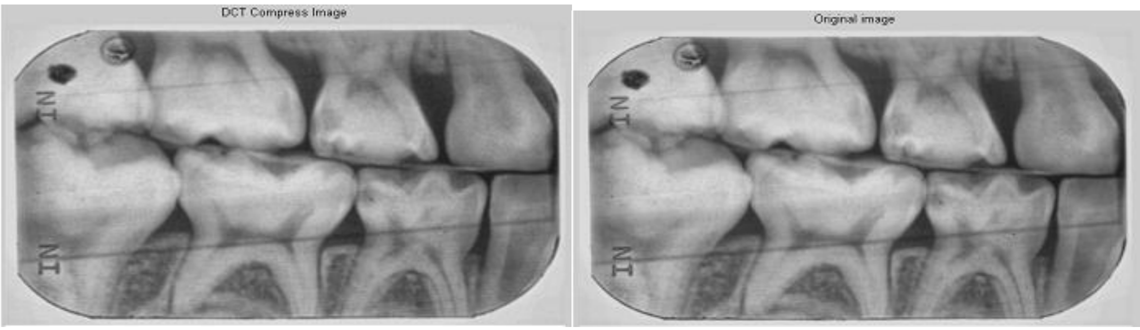


Figure 8: base Pictures and acts of DCT

Primary image volume is 610 K and BMP format is a dental image, and the image is compressed by the algorithm 206k. Time of program execution is 0.745612 seconds in MATLAB.

Table 5: The results of the brain image and JPEG algorithm acts

SIZE pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
367*367	50.4965	30.4566	0.9996	0.0149	1.0005

Figure 9: base Pictures and apply DCT

Primary image volume is 2.95 MB and BMP format is a dental image, and the image is compressed by the algorithm 1.014 MB. Time of program execution is 1.287537 seconds in MATLAB.

Table 5: The results of the base pictures and DCT algorithm acts

SIZE Pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
1201*861	22-2074	34-6658	0-9986	0-029	**1-0014**

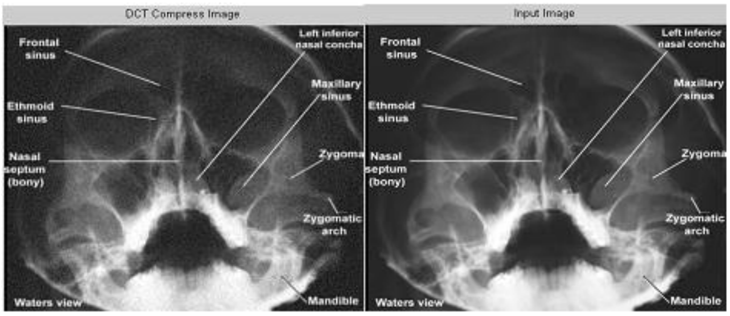


Figure 9: images of the brain and acts of DCT

Primary image volume is 425KB and BMP format is a dental image, and the image is compressed by the algorithm 145KB. Time of program execution is 0.77860 seconds in MATLAB.

Table 6: Results of the brain images and apply of DCT algorithm

SIZE pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
400*363	93-4218	28-4263	0-9917	0-0729	**1-0088**

Applying of Violet transform

3 steps of convert of image can be applied by using the Harma Violet transform, then we show simple compression without discrete cosine transform and deletion zero tree. In the following, is mentioned the results of applying this algorithm to compression step for db Violet.

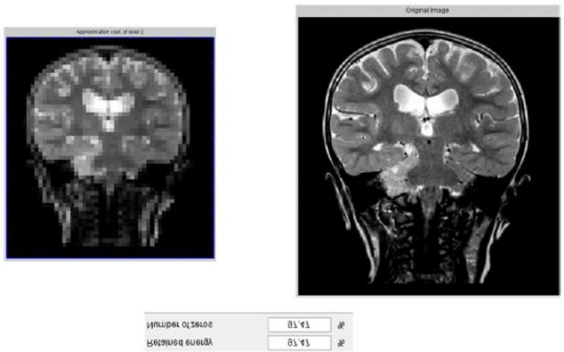


Figure 10: image of compressed neck only by using of applying 3 Step of DB Violet

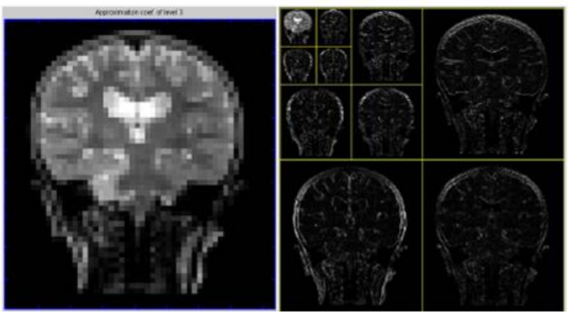


Figure 11: The head image: A) Original image b) Acts 3 steps of db Violet c) LL3 image

Deployment of zero transition of coefficients tree and apply of discrete cosine transform

One of the useful aspects Wavelet transform in the field of compression is that usually the input energy is concentrated in the relatively small number of wavelet coefficients. Whereas, only by encoding a relatively small number of coefficients with high energy can be achieved to the bit rate and relatively low mean squared error (MSE). The only problem with this theory is that because only a selected number of coefficients can be coded, coding should be also send spatial data of coefficients to reconstruct the data correctly in decoder. Depending on the used method, the number of bits required for encoding spatial information, can be a significant part of the total, so that further compression utility makes neutral energy. After applying zero transition of coefficients tree, we are performed image compression by applying discrete cosine transform of LL3matrix array.The resulting images of our applying algorithm through the combination of hybrid Violet and discrete cosine transform: The first image is a microscopic image.

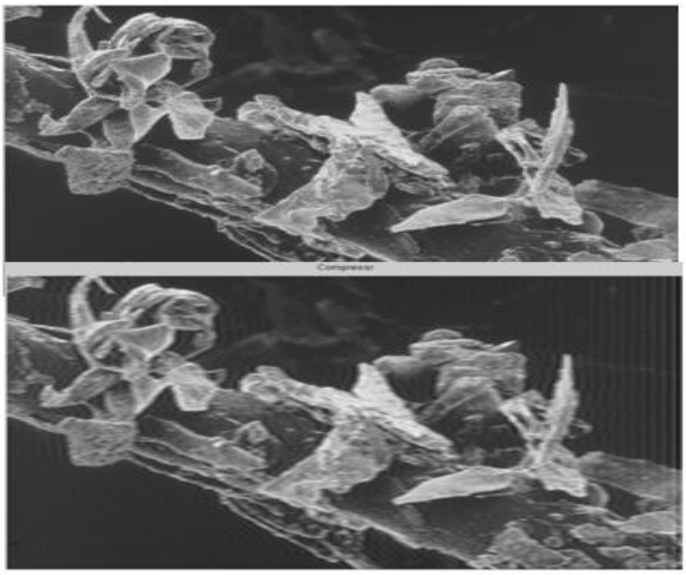


Figure 12: Microscopic image compression by DCT & DWT algorithm applied by author. Upper image is the main image, and the bottom image is compressed.

The above figure represents a microscopic image with BMP format and with the size of 5.98MB,and the volume of compressed image is by 2.1 MB algorithm. Time of program execution is 55.941045 seconds in MATLAB.

Table 7: The results of the microscopic compressed image by the applied DCT & DWT algorithm

SIZE pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
3038*2063	185.1376	25.4559	0.9906	0.0954	**0.0004**

The next picture is related to dental image.

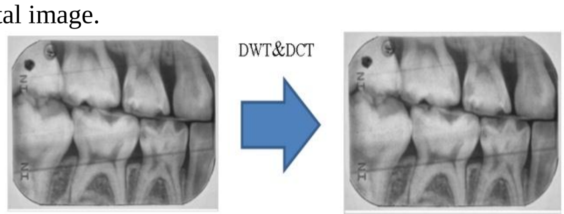


Figure 13: base pictures and apply DCT & DWT

Primary image volume is 610k and BMP format is a dental image, and the image is compressed by the algorithm 205k. Time of program execution is 4.479600 seconds in MATLAB.

Table 8: The results of base pictures and apply the DCT & DWT algorithm

SIZE Pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
367*367	46-4965	31-4566	1-0019	0-0260	**0-9943**

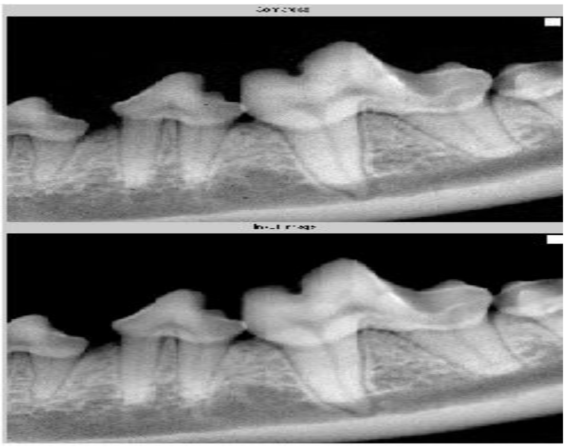


Figure 14: base pictures and apply DCT & DWT

Primary image volume is 2.95MB and BMP format is a dental image, and the image is compressed by the algorithm0.99 MB. Time of program execution is 12.112958 seconds in MATLAB.

Table 9: The results of base pictures and apply the DCT & DWT algorithm

SIZE pixel	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
861*1201	71.5770	29-5831	0-9971	0-0490	**0-0016**

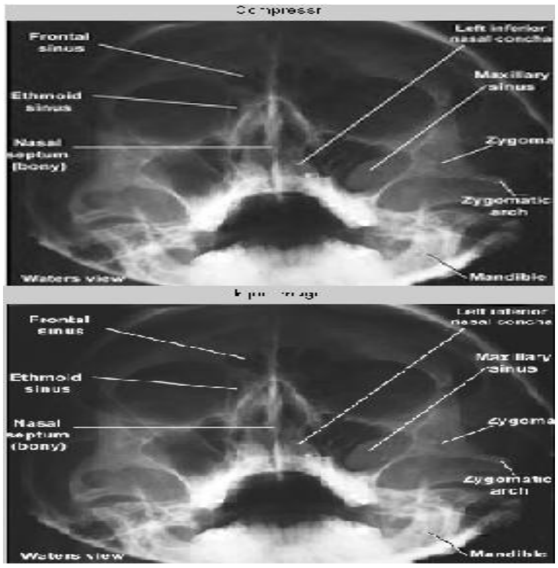


Figure 15: Pictures of the brain and acts of DCT & DWT

Primary image volume is 425kB and BMP format is a dental image, and the image is compressed by the algorithm 143kB. Time of program execution is 2.811310 seconds in MATLAB.

Table 9: The results of the brain and acts of DCT & DWT algorithm

SIZE pixel	MSE	PSNR d**B**	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
400*363	244.59750	24.2463	0.9828	0.0689	0.0140

3.4. The DCT_DWT proposed method

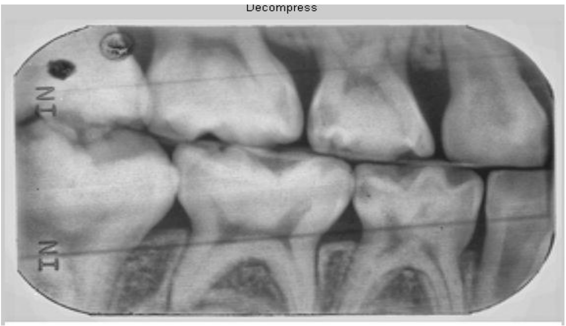


Figure 6: compressed picture of 1 dental by applying the DCT_DWT algorithm

Figure 7: compressed picture of 2 dental by applying the DCT_DWT algorithm

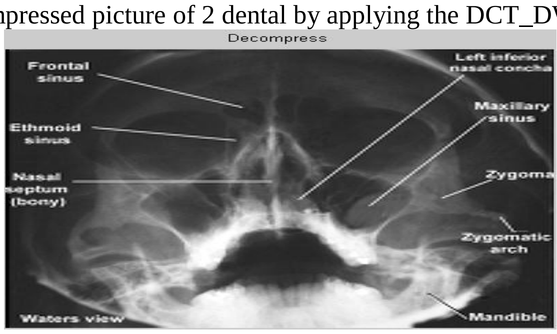


Figure 8: compressed picture of brain by applying the DCT_DWT algorithm

CONCLUSIONS

In this paper, a method is proposed based on DWT-DCT which is provided an image compression method by wavelet while maintaining of image quality. Assess of its performance shows that Wavelet transform method is more efficient than other methods in terms of compression with losses. In terms of compression, JPEG algorithm has its highest

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compression rate. DCT transform has the most favorable for time calculation in terms of time due to the low volume calculations. The lowest average of the MSE is allocated to DCT-DWT method. Similarly, the lowest value of the maximum signal to noise ratio PSNR is also owned by DCT-DWT.

Table 10: Compare of DCT_DWT and DCT and JPEG and conclusion

	FINAL SIZE kb	FIRST SIZE	TIME	MSE	PSNR dB	Normalized Cross-Correlation	Normalized Absolute Error	Structural Content
DCT	455	840	0.9372	120.88	28.42	0.9966	0.0260	**0.9943**
DCT_DWT	446	840	6.4679	41.47	33.93	0.9933	0.0149	**0.0005**
JPEG	37	840	4.385	354.22	24.95	0.9778	0.0954	**0.0004**

The results are shown in Table 10, it expressed that the proposed algorithm has a higher quality of image reconstruction after compression than other methods. A notable case is that rate of high compressed algorithm is JPEG which is suitable for compression in environments such as the Internet, however does not have image quality. According to the presentations for future work, we try to combine this algorithm with other transformation, so we can achieve to better compressed rate and better PSNR. If the provided DCT-DWT algorithm can be removed more unnecessary details that are not visible to the eye, we are able to achieve higher compressed rates with PSNR.

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