International Journal of Computer Science and Software Engineering (IJCSSE), Volume 6, Issue 11, November 2017
ISSN (Online): 2409-4285 www.IJCSSE.org Page: 284-293

Analyze Medical Image and Compress It by Different Algorithms

Haitham AL-TAMEEMI[1] and Thaer Ibrahim[2]

[1, 2] MODES Department, Atilim University, Ankara, Turkey

[1]hai_mah2003@yahoo.com, [2]thair_king@yahoo.com

ABSTRACT

Compression is used just about everywhere. All the images you get on the web are compressed, and the medical image is one of these images. In this paper we analyze the standard medical color image and 3D medical image, after that use different algorithm methods to compress it. The results that obtained it are compared to conclude the paper purpose, and finally we suggest the future works, which related with the compression schemes.

Keywords: *Data Compression, Lossy Compression, Lossless Compression.*

1. INTRODUCTION

Image compression aims to reduce the redundancy of the image data in order to be able to reduce the transmission rate of image, in addition, it useful to save the storage capacity and decrease the storage coast. Image compression may be called lossy if we use a compression scheme method that lead to loss some image data that often not contribute too much to the visual quality of the image. Second method for compression called lossless if we use method to maintain the image data without loss any visual quality of the image by rewrite the image data of the original image in more efficient way without redundancy of the data [1, 2].
Medical imaging is the technique and process of creating visual representation of the interior of a body for clinical analysis and medical intervention. Magnetic resonance imaging (MRI) is one of the medical imaging and part of biological imaging which use the imaging technologies of X-ray radiograph and magnetic resonance. It use to investigate the anatomy and physical of the body in both health and disease [3].
3-D image described and image that provides the perception of depth and it use to create feeling involved with the scene.
In this paper, we survey a lossy and lossless compression scheme for medical image (MRI), in addition to provide a technique by using more than algorithm in order to increase the compression rate.

2. MOTIVATIONS

Through the research papers that have been read and the scientific experiments that have been conducted, we have noticed that the use of deferent types of compassion algorithms can save time. However, the image quality still not satisfactory.
Since we deal with medical images, so the clarity of these images is very important to characterize the type of disease. Therefore, we tried to use an advanced method of image analysis and image compression to obtain higher resolution and this was the catalyst for us to present this paper.

3. LOSSLESS IMAGE COMPRESSION AND PREVIOUS WORK

In this section we present a different compression algorithms in addition present an overview of previous work on compression.

3.1 Image Compression by Using Huffman Algorithm

Huffman coding is the most popular technique for lossless compression data, it founded by Dr. David A. in 1952 [6]. We know all black and white images assumed to be made up of a pixel, this pixel used different numbers to represent the brightness or darkness of the image, and this numbers need 8 bits to encoding by using the binary bit string.
Huffman coding is one of the statistical approach method which used to reduce the amount of bits required to represent a data based on the probabilities of occur this numbers.
The principle of Human algorithm are [7]:

1. After reading the image, we store it in a matrix of numbers (each number represent the color).
2. Calculate the probabilities of occur each color values and arrange them by descending order.

3. Choose minimum two probabilities and assume (0) for minimum one and (1) for other, finally make them as one group by summation them to use this group instead of the two numbers later (with consider this summation is a new probabilities).
4. Rearrange these probabilities and retry step 3 until to obtain one group.
5. The result of step 3 and 4 is to assume a string of code (0 and 1) of each probabilities.
6. Using coding of each probabilities instead of it to represent the color values.

The following figure show the Huffman algorithm.

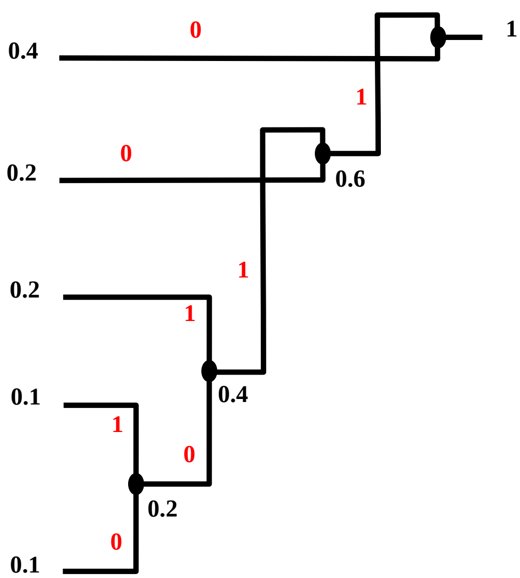


Fig. 1. Huffman algorithm

3.2 Image Compression by RLE

Run-Length Encoding (RLE) is a very simple method to compress the data, it works by found the sequences in which the same data value occurs in many consecutive data elements, and stored as a single data value and count (vector) rather than as the original run (Matrix).
This is most useful on data that contains many such runs. Consider, for example, simple graphic images such as icons, line drawings, and animations. It is not useful with files that do not have many runs as it could greatly increase the file size [1].
In [10], HASHEMI and et al. use three image and compare the performance of the proposed algorithm with Fractal algorithm and concluded the proposed algorithm outperform the Fractal algorithm by using the PSNR value used to measure the difference between a decoded image and its original image.
Another literature was served; it is present by HUSSEEN and his partners [11]. They enhanced image compression by using this algorithm, proposed enhance process compression and performed on sample consists of 10 BMP image. They conclude the RLE algorithm is depend on the number of adjacent pixel value of image. Is an efficient compression method with images have less various between values of adjacent pixels, but fail with images have high difference between adjacent pixels value, and the compression ratio depends on the value of the threshold, which depends on the type of domain that image used it.

4. TRANSFORM & IMAGE COMPRESSION

Transform theory plays a fundamental role in image processing, as working with the transform of an image instead of the image itself may give us more insight into the properties of the image[1][7].
Image compression is a lossy technique by using a transform method, and following we present a different transform for compression image.

4.1 Image Compression by Using DCT

DCT is stands of Discrete Cosine Transform, it founded in 1974 by Ahmed et al [4], it is a widely used in signal processing of image data, especially in coding for compression. DCT is one of Transform method and it similar to the Discrete Fourier Transform. It often used in image compression applications such as it is the heart of the international standard lossy image compression algorithm known as The Joint Photographic Expert Group (JPEG) [5]. It is a mathematical function that transform digital image data from the spatial to the frequency domain for MxN image, the spatial domain represent the color values of each pixel, and the frequency domain consider the image data as a two-dimensional waveform and represents the waveform in term of its frequency components [4].
The principle of DCT is to divide the image into blocks of pixel 4x4 or 8x8 or 16x16 or more. after that from left to right and top to bottom apply DCT for each blocks, the DCT process classify the frequency of each blocks so the high frequency coefficients distributed to the right bottom corner, and the low frequency coefficients in the left top corner. Therefore, the DCT keep only the low frequency coefficients and discarded other one because the others does not use too much in visual quality of the images. The result for this method is lead to reduce the

image size but lower quality of the original image, and it possible to control this method by increasing the compression ratio and decreasing the quality.
The image can reconstructed through decompression method by using the Inverse Discrete Cosine Transform.
In [4] and [5], the authors use DCT to compress the different images.

4.2 Image Compression by Using 3D-DCT

Another DCT transform is used for 3D images called 3D DCT. In [12], ANITHA and her partner takes a full-motion digital video stream and divides it into groups of 8 frames. Each group of 8 frames is considered as a three-dimensional image, which includes 2 spatial components and one temporal component Each frame in the image is divided into 8x8 blocks (like JPEG), forming 8x8x8 cubes. Each 8x8x8 cube is then independently encoded using the 3D-DCT algorithm: 3D-DCT, Quantizer, and Entropy encoder. A 3D DCT is made up of a set of 8 frames at a time. Image compression is one of the processes in image processing which minimizes the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. The reduction in file size allows more images to be stored in a given amount of disk or memory space.

4.3 Image Compression based Wavelet

Wavelets are signals that are local in time and scale and generally have an irregular shape. A wavelet is a waveform of effectively limited duration that has an average value of zero [1].
A wavelet transform can be used to decompose a signal into component wavelets. Once this is done the coefficients of the wavelets can be decimated to remove some of the details. Wavelets have the great advantage of being able to separate the fine details in a signal. Very small wavelets can be used to isolate very fine details in a signal, while very large wavelets can identify coarse details. A wavelet transform can used to enhance image compressing and there are several literature working based on wavelet, such as, in [16], Saffor A. et al. performed a comparative study of image compression, and they compared wavelet with the formal compression standard JPEG by using JPEG wizard. In [17], the authors proposes a new scheme for image compression taking into account psych visual features both in the space and frequency domains.
3D and 4D image now is used to save medical image, then compression these data is very important to transit and save these data with less storage and fast transform through internet networking.

For this case, 3D discrete wavelet transform using SPIHT algorithm is the modern-day benchmark for three dimensional image compressions, in [18]. Mr. Zala and his partner use it to compress sequence of color images simultaneously, they proposed a compression algorithm 3D SPIHT with PSO based on 3D discrete wavelet transform, and they enhanced than standard SPIHT algorithm in terms of compression ratio (CR), mean-squared error (MSE), and peak signal to noise ratio (PSNR), correlation coefficient and multiscale structural similarity index (MSSIM).

5. IMPLEMENTATION

In this paper we proposed to use different algorithms (loss and lossless) to compress the medical image and compare the results.
After that, we complain several medical image and block it in one data set as a 4 dimension, and apply a 3D compression technique to compress this data set, the results which obtain it well compare it by sing a PSNR.

5.1 2D Image Compression by Different Algorithms

In this paper we proposed to use different algorithms (loss and lossless) to compress the medical image and compare the results in results section.

a) Preprocessing Image

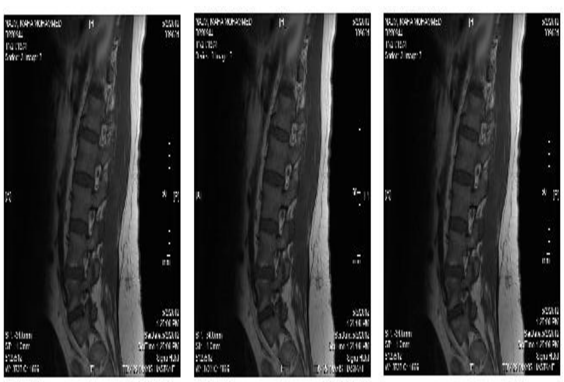
The first purpose for this paper is how to analyze data. The normal image that we use called standard color image, which it stored in 3 layers (for example 512x512x3), figures 2, 3, 4 shows some image.

Fig. 2. 4096x4096x3 unit16

Fig. 3. 399x710x3 unit8

Fig. 4. 512x512x3 unit8

As we show in above figures, each of them is stored in 3 layers, and the first purpose in this paper is to split this images in 3 layers. Figure 5 shows to split images.



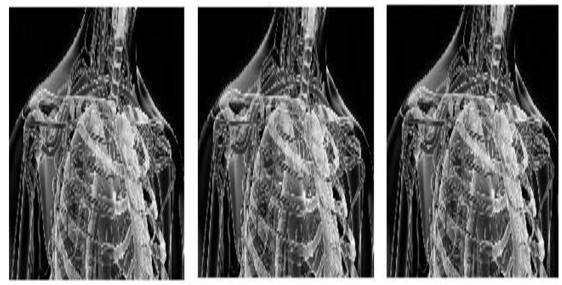


Fig. 5. split image in 3 layers

b) Vectorization

Vectorization is a linear transformation that converts the matrix into a column vector. Use vectorization to convert the matrix of image data set to vector in order to use it in lossless compression data. In general, the 2D matrix data set convert to vector as shown as following.

3x3 matrix

1	2	3
4	5	6
7	8	9

1	2	3	4	5	6	7	8	9

1x9 vector

However, in this paper, we have 3 layers (3D image), for this case we re-split the image in 3 separate layers to find vector for each of them, after that complain this vectors to one vector, as shown as following.

Image Layer 1

1	2	3
4	5	6
7	8	9

1	2	3	4	5	6	7	8	9

Image Layer 2

11	12	13
14	15	16
17	18	19

11	12	13	14	15	16	17	18	19

Image Layer 3

21	22	23
24	25	26
27	28	29

21	22	23	24	25	26	27	28	29

Image Vector

1	2	3	…	11	12	13	…	27	28	29

c) DCT Lossy Compression

In this paper, we apply the DCT for each layer after that combine them. In section (3.a) we explain who to split medical image. In section 2 we explain the DCT for 2D image, and in this procedure we use discard (sets to zero) all but 10 of the 64 DCT coefficients in each block. In this paper, we increase the discarding to get the DCT Proportion as much as possible the same resolution of the original image. Figure 6 shows the different image compression by DCT with different value of discard [8].

Fig. 6. DCT with 10 discard for image

Fig. 7. DCT with 36 discard for image

To calculate the noise for each results, we used the PSNR (Peak signal to noise ratio) to choose the higher quality of image [9], the result of PSNR are shown as following:

Figure 6	70.74
Figure 7	78.80

The idea to choosing the higher PSNR is determined the medical image, because in medical image and especially MRI image contributes to a medical diagnosis and the better quality of MRI helps to diagnose diseases better, for this reason we use Figure 7 as a result for DCT lossy compression.

d) Lossless Compression Algorithm

Another algorithm that used in this paper is lossless algorithm. We use RLE algorithm and Huffman algorithm and get the results for each of them.
For lossless algorithm approach, we split medical image in layers, after that make vectorization the image, and finally apply the algorithm that used.
Figure 8 show the lossless algorithm scheme.

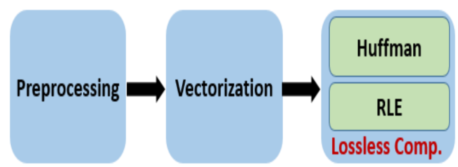


Fig. 8. Lossless Algorithm

e) Loss and Lossless Compression

The second purpose for this paper is to use loss and lossless compression algorithm in the same time. The main idea for this approach is to reduce the redundancy of image data by different algorithm to try get better compression ratio.
In this paper, we use Huffman algorithm after that use RLE algorithm to try reducing the redundancy of binary string, this idea lead to increase the compression ratio. Second trying is used DCT after that RLE to get better PSNR for image. This idea is helpful to get good results as shown as in results section.
Figure 8 which followed showed the multi compression method scheme which used.

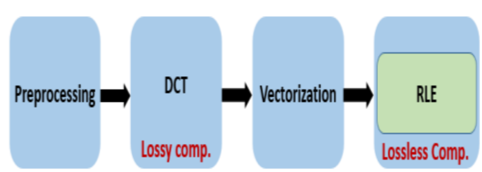


Fig. 9. DCT and RLE Compression

Figures 10, 11, 12, 13, 14, 15, 16 shows the implementation GUI which used.

In order section 3.3, and in addition the above algorithm, we use the wavelet transform to compress the 2D true image, and the result well be show in result section. In addition, we use a discrete wavelet transform (DWT) and modern approach called SPIHT was used in this paper and finally all results was show in result section.

Fig. 10. Huffman Compression

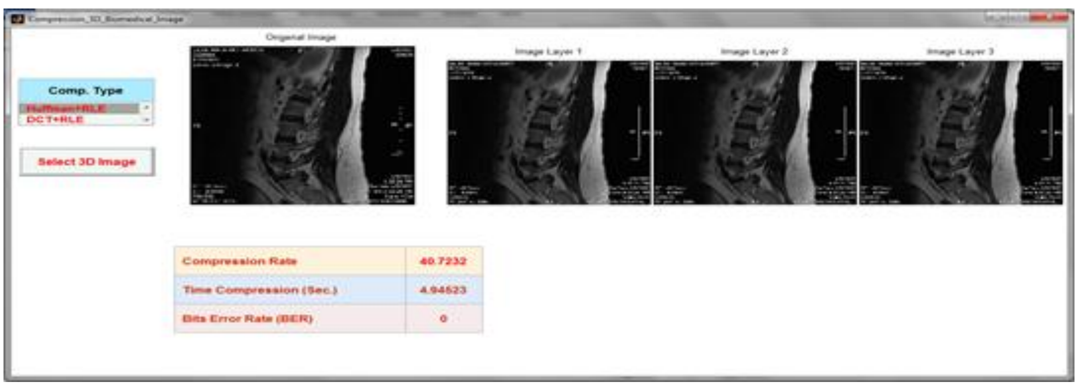


Fig. 11. Huffman and RLE Compression

Fig. 12. DCT Blocking Process

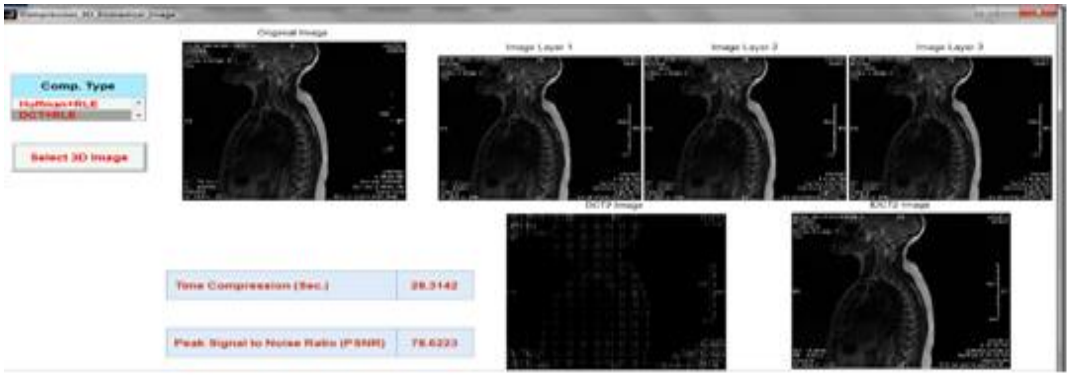


Fig. 13. DCT and RLE Compression

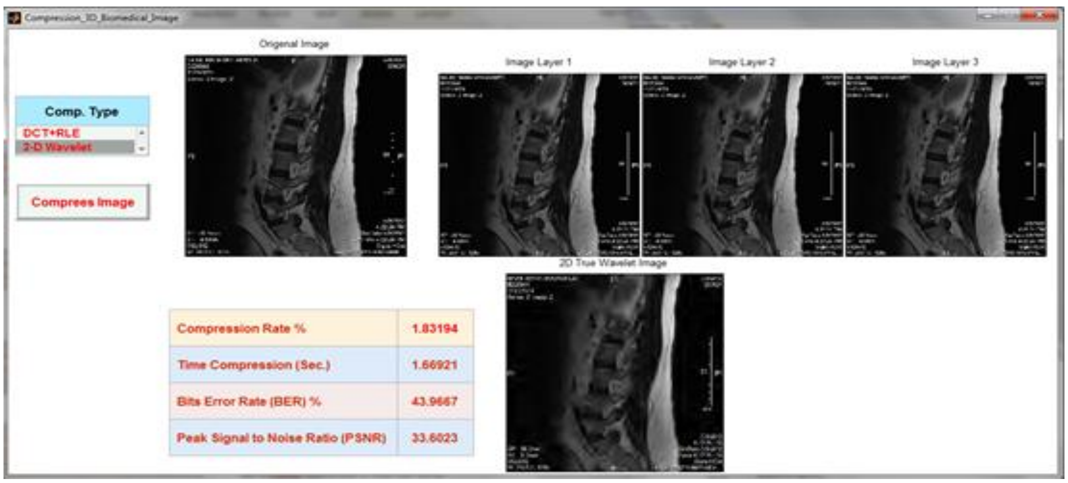


Fig. 14. 2D True Image Wavelet Toolbox software

Fig. 15. Discrete Wavelet Transform Compression

Fig. 16. Image Compression based SPIHT Algorithm

f) Results

In this section, we listed the results for compress an example image during the algorithm type.

Huffman algorithm

Compression Ratio %	21.2
Time Compression Sec.	4.3
EBR %	0

RLE Algorithm

Compression Ratio %	7.7
Time Compression Sec.	0.07
EBR %	0

Huffman and RLE algorithms

Compression Ratio %	40.7
Time Compression Sec.	4.9
EBR %	0

DCT and RLE algorithms

Compression Ratio %	23.4
Time Compression Sec.	27.3
EBR %	43.75
PSNR %	78.7

2D Wavelet Toolbox software in Matlab

Compression Ratio %	1.8
Time Compression Sec.	2.1
EBR %	43.96
PSNR %	33.6

2D DWT

Time Compression Sec.	0.09
PSNR %	27.2

SPIHT algorithm

DWT Time Sec.	0.02
PSNR Time	14
PSNR %	44.07
Compression Ratio	2.07

g) Conclusion

From this paper and implementation, we conclude this step:

1. Use lossless algorithms can save some time however, the compression ratio is lower, for example we approximately get (22%) for Huffman and (10%) for RLE with little time.
2. Use two lossless algorithms can save the time of compression, but the compression ratio was increased instead of use one of them, for example we get (41.5%) compression ratio within few seconds, this mean we success to increase the

compression ratio by using two lossless compression method

3. Use loss and lossless compression method can help to increase the compression ratio but we loss the visual quality of image. In this paper we loss about 45% of image because we use 36 blocks with DCT, as we mentioned above, we use this number of blocks because we compress the medical image, and we can reduce this percentage by decrease the number of blocks when we compress other image.

5.2 3D & 4D Image Compression by Different Algorithms

In this section, we present algorithms to compress 3D image.

a) Preprocess image

In the first time we use a sample DICOM data that we obtain it from Math lab website [13], it contains a set of MRI image, which describe a slides of human brain. The value of this image is 512x512 separately, and we use Math lab instructions to read this set of image. The idea is to compare this image to create a 4D data set to these images and save it, the size of this data set is about 4 MB.

b) 3D DCT3

As we mentioned in section 3.2 we can use the 3D DCT transform as a first step to 3D image compression, in our implementation we transform these data set to compress it. A lot of previous work use 3D DCT to compress image, one of these work was present it by Xiuqi and her partner [14] which use DCT to compress 3D image, The basic idea of them is to de-correlate similar pixel blocks through 3D DCT transformation. A number of adjacent pixel blocks are grouped together to form a three-dimensional data cube. Each data cube is 3D DCT transformed, quantized, and Huffman encoded. In concluded the PSNR of reconstructed which obtain it is about 41.76, and the PSNR of reconstructed is about 41.58.
In this paper, we can use the same idea to transform the data set, and in the future work we can complete the compress this data set.

6. FUTURE STUDY

In order, this paper and implementation we conclude:

1. We compress image by using different methods, in order to mix more than two compression methods to try obtaining better compression ratio.
2. We use standard color medical image in this paper, and in the future we want to use a 3D medical image and 4D medical image to compress it by modern compression methods.

There are many modern algorithms, such as DCT3 and SPHIT etc. in this paper; we try to choose these algorithms to enhance the compression ratio.

REFERENCES

[1] D. Salomon, "Data compression: the complete reference", Springer Science & Business Media, Fourth Edition, 2007.
[2] Blelloch, Guy E. "Introduction to data compression", Computer Science Department, Carnegie Mellon University (2013).
[3] S. Angenent, E. Pichon, and A. Tannenbaum. "Mathematical methods in medical image processing", Bulletin of the American Mathematical Society 43.3 (2006): 365-396.
[4] N. R. Thota and S. K. Devireddy, “Image Compression Using Discrete Cosine Transform”, Georgian Electronic Scientific Journal: Computer Science and Telecommunications, India, 2008, No.3 (17).
[5] K. Cabeen and G. Gent, "Image Compression and the Discrete Cosine Transform", College of the Redwoods, 1998.
[6] Mridul K. M., Seema L., Dr. Dheeraj S., "Lossless Huffman Coding Technique For Image Compression Abd Reconstruction Using Binary Trees", Mridul Kumar Mathur et al,Int.J.Comp.Tech.Appl,Vol 3 (1), 76-79.
[7]
[8] Salomon D.,"A concise introduction to data compression", Springer Science & Business Media, 2007, ch.2, pp. 61-91.
[9] http://www.mathworks.com/help/images/discrete-cosine-transform.html, "Discrete Cosine Transform",
[10] http://www.mathworks.com/help/vision/ref/psnr.html, Compute peak signal-to-noise ratio (PSNR).
[11] AL-HASHEMI R., AL-DMOUR A., FRAIJ F., MUSA A., "A Grayscale Semi-Lossless Image Compression Technique Using RLE", Journal of Applied Computer Science & Mathematics, no. 10 (5), 2011, Suceava.
[12] HUSSEEN H., MAHMUD S., MOHAMMED R., "Image Compression Using Proposed Enhanced Run Length Encoding Algorithm", Ibn Al-Haitham J. For Pure & Appl. Sci. Vol. 24 (1), 2011.
[13] ANITHA S., NAGABHUSHANA B., "3D-Discrete Cosine Transform Foe Image Compression", Journal of Information Engineering and Applications, Vol 1, No. 3, 2011.
[14] http://www.mathworks.com/matlabcentral/fileexchange/2762-dicom-example-files

[15] Xiuqi L., Borko F., "An approach to image compression using three-dimensional DCT" Image 1.2 (2003): 3-4.
[16] Antonini M. et al. "Image coding using wavelet transform" Image Processing, IEEE Transactions on 1.2 (1992): 205-220.
[17] Saffor A., Abdul Rahman R., Kwan-Hoong Ng., "A Comparative study of image compression between JPEG and wavelet", Malaysian Journal of computer science 14.1 (2001): 39-45.
[18] Antonini M., et al. "Image coding using wavelet transform", Image Processing, IEEE Transactions on 1.2 (1992): 205-220.