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Comparison of two Compression Algorithms for Medical Images (Fast Fourier Transform (FFT) and Discrete Wavelet Transform (DWT))

Idepefo, O. Felix[1], Longe, O.B[2] & Okunade, T.A[3]
[1,2]Department of Computer Science
Caleb Business School, Caleb University, Magodo, Lagos, Nigeria
[3]Department of Computer Science,
Lagos State Polytechnic, Ikorodu, Lagos, Nigeria
E-mail: [1]felixidepefo@gmail.com, [2]longeolumide@gmail.com, [3]taokunade@yahoo.com

ABSTRACT

The effect of digitalization, rapid expansion of computer technologies and the birth of electronic medical recording such as *X-rays*, *MRI's* (Magnetic Resonance Imaging), *CT's* (Computer tomography) and *US's* (Ultrasound) has placed greater demand on efficient data storage and medical image content. The only solution to this dilemma is Data Compression. The paper implement two (2) image compression algorithms based Fast Fourier Transform and Discrete Wavelet using Biothogonal Wavelet. The two algorithms were implemented using Microsoft Visual C++. Performance Quality Metrics were used to compare the performance of the two algorithms and the Discrete Wavelet Transform using Biothogonal Wavelet outperformed the Fast Fourier Transform.

Keywords: Cox Regression, Tuberculosis, Diabetes Mellitus, Survival function, Hazard function

1. BACKGROUND TO THE STUDY

Medical imaging is a subdomain of Imaging that is used to generate images of the human body (or parts of human body) for medical or clinical purposes. Medical imaging is used for generate images of internal body part of human body. Medical image is an essential part of modern health care and it provides a large set of data that is used in research and treatment of diseases. It also provides a wealth of information that is increasingly relied upon in the clinical management of patients and conduct planning ((Pathak and Sarvaiya, 2017)).
The effect of digitalization, rapid expansion of computer technologies and the birth of electronic medical

recording such as *X-rays*, *MRI's* (Magnetic Resonance Imaging), *CT's* (Computer tomography) and *US's* (Ultrasound) has placed greater demand on efficient data storage and medical image content(Al-Khafaji, and Ghanim, 2017). Medical imaging data collected from community and human resource with respect to time are not removed lightly because it is needed for future research and for repetition of test. Advances in technology have created the opportunity for radiology systems to use complex data that consume huge data storage and pose great problem during transmission and retrieval. The only solution to this dilemma is Data Compression. Data compression is the technique used to reduce the redundancies in data representation in order to decrease data storage requirements and hence communication costs. There are two types of compression, lossy and lossless. Lossless techniques are applied when data are critical and loss of information is not acceptable. On the other hand, Lossy compression techniques are more efficient in terms of storage and transmission needs but reduced file size by eliminating some unneeded data that would not be recognize by human after decoding an is often used by video and audio compression (Mofreh *et al.*, 2016).

2. STATEMENT OF PROBLEM

Uncompressed Medical images require considerable storage capacity and transmission bandwidth. Efficient image compression solutions are becoming more critical with the recent growth of data intensive, multimedia-based web applications. Because Medical images require large amounts of data, storing and transmitting this data places a significant load on the computer systems and data transmission facilities used. Compression of data reduces the cost of medical image storage by increasing the effectiveness of storage resources and increases the effective speed of transmission. So, it is apparent and necessary to find and develop efficient compression algorithms and then putting them into practical use on medical imagery and therefore, are the main task of this research work.

3. OBJECTIVES OF RESEARCH

The specific objectives of the research are:

(i) To compare two medical image-compression techniques using some image quality performance metrics
(ii) To develop a robust image compression for compressing medical imagery.
(iii) To implement new image-compression techniques.

4. REVIEW OF RELATED LITERATURE

Himani and Pawan (2018) proposed a compression method for medical imaging based on Discrete Cosine Transform (DCT) with block processing. To stimulate image transformation, discrete cosine transformation is used first. The Discrete Cosine Transformation transform image into several parts by keeping image visual quality. After successful transformation using DCT method, block processing is applied on transformed image. In block processing, operations are performed on blocks of image instead processing whole image. In the proposed model, block processing on image is done with 8X8 block. Experimental results shows that block processing with DCT compress images faster compared with conventional DCT and older variant of other variant of DCT but the blocking artifact that degraded the image quality as is peculiar to DCT was not removed.

Al-Khafaji, and Ghanim (2017) proposed a Medical Image Compression Algorithm using Hybrid Technique of Wavelet Transformation and Seed Selective Predictive Method. In this paper, a hybrid coding system of lossless and lossy base is introduced for compressing medical images where the selected seed predictive coding of approximation subband, and the detail subbands of hierarchal scheme of wavelet transform exploited respectively. The test results indicate that the suggested method can lead to promising performance using various thresholding values and extended scheme. The preserved coefficients of the detail subbands increase the quality and improve with less compression ratio (i.e., small threshold leads to more significant coefficients of nonzero value). A Further Increase in the threshold results in better compression ratio with less quality.

Reddy, Venkatraman, and Suganya (2018) proposed an algorithm based on Principal Component Analysis (PCA) with Set Partitioning in Hierarchical Trees (SPIHT) to accomplish an image compression. A lossy technique is introduced through the PCA which is followed by SPIHT to enhance the compression performance. The Peak Signal to Noise Ratio (PSNR) value of the reconstructed image acquired from the PCA methods is not found to be sufficient which can be further improved by another method called SPIHT. Finally, it is concluded that the proposed PCA-SPIHT performs better than other recent state-of-the-art techniques with loss of image quality and also introduced unnecessary blocking artifacts.

5. METHODOLOGY

Two image compression algorithms are used which are the Fast Fourier Transform and Discrete Wavelet Transform using Biothogonal Wavelet. Discrete Wavelet Transform (DWT). Discrete Wavelet Transform (DWT) is any wavelet transform for which the wavelets are discretely sampled. Wavelet based coding provides substantial improvement in picture quality at high compression ratios mainly due to better energy compaction property of wavelet transforms. The Fast Fourier Transform (DFT) converts a finite list of equally spaced samples of a function into the list of coefficients of a finite combination of complex sinusoids, ordered by their frequencies, that has those same sample values. It can be said to convert the sampled function from its original domain (often time or position along a line) to the frequency domain. Five Performance metrics which are Compression ratio, Compression time, Mean Square Error (MSE), Peak Signal to Noise ratio (PSNR) and Retained Signal Energy are used to compare the performance of the two Algorithms using Five (5) selected Medical Images. The block diagram of proposed system is shown Fig 1 below using an Activity flow diagram.

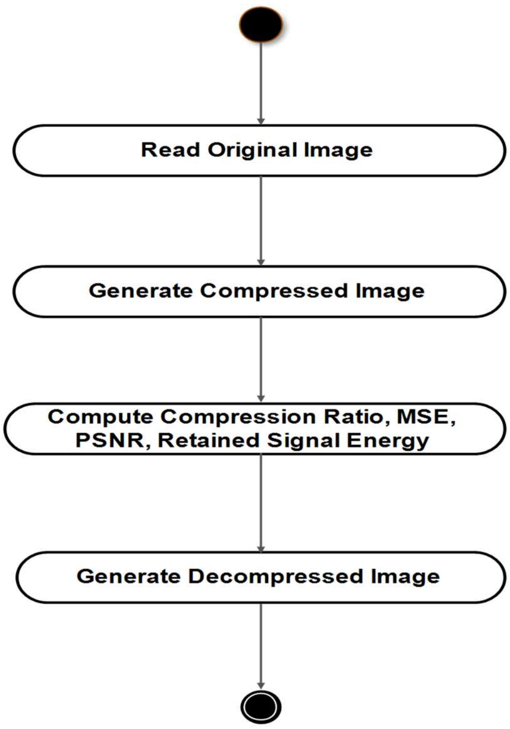

Fig 1: Activity Diagram of Proposed Algorithm

6. EXPERIMENTAL RESULTS (COMPRESSION AND DECOMPRESSION

Four (4) Medical Images were used for the Compression and Decompression and the results obtained are as follows:

Fig 2: Sagittal thoracic and sternum coronal Compressed by FFT

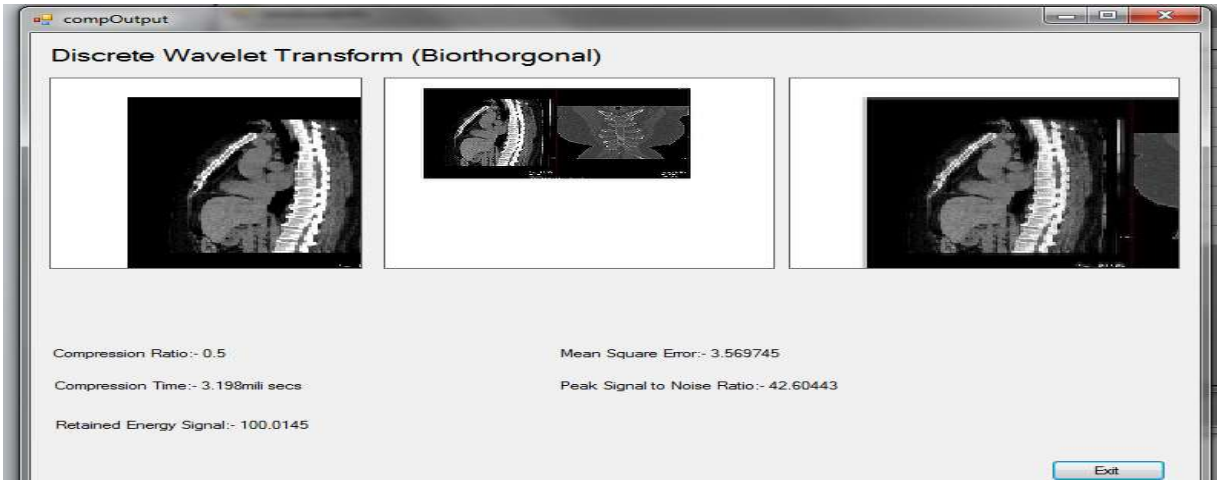

Fig 3: Sagittal thoracic and sternum coronal Compressed by DWT

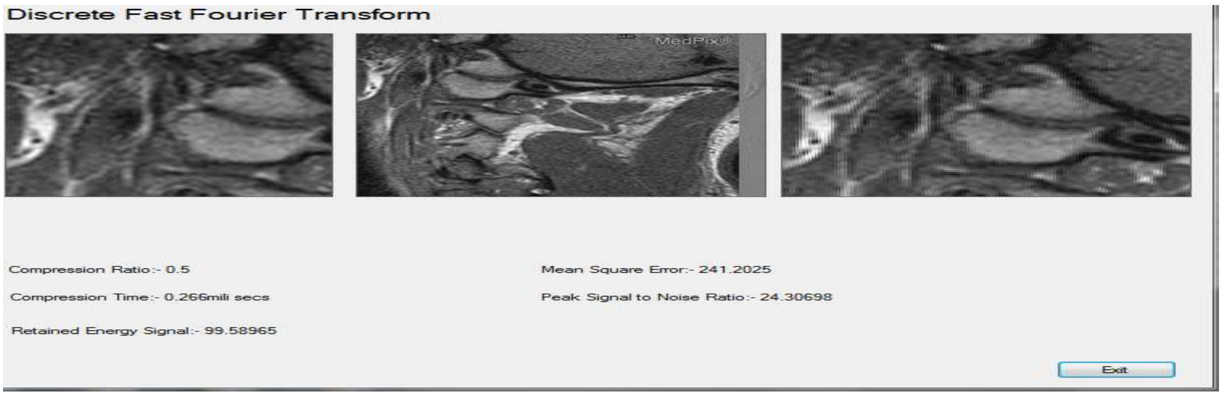

Fig 4: Cervical Pedicle Compressed by DFT

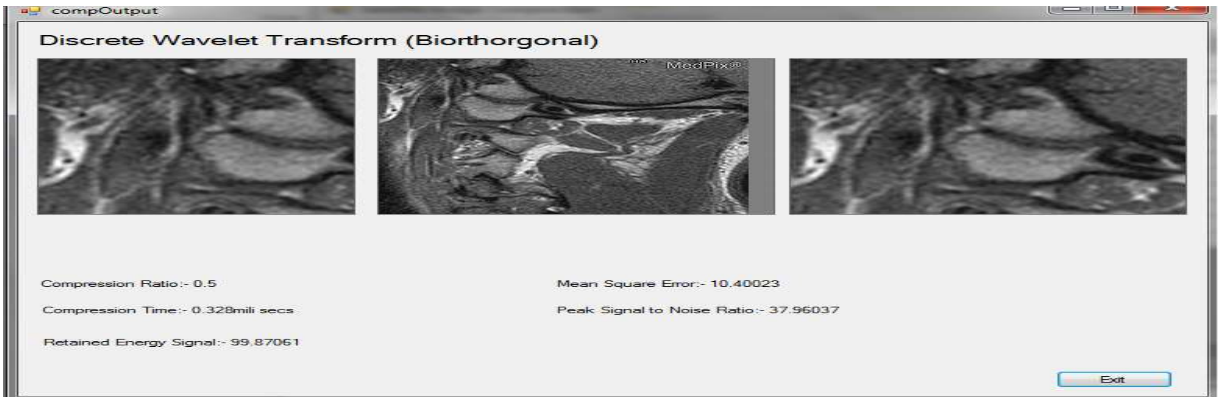

Fig 5: Cervical Pedicle Compressed by DWT

Fig 6: PA CXR Compressed by FFT

Fig 7: PA CXR Compressed by DWT

Fig 8: Abdominal Aortic Compressed by FFT

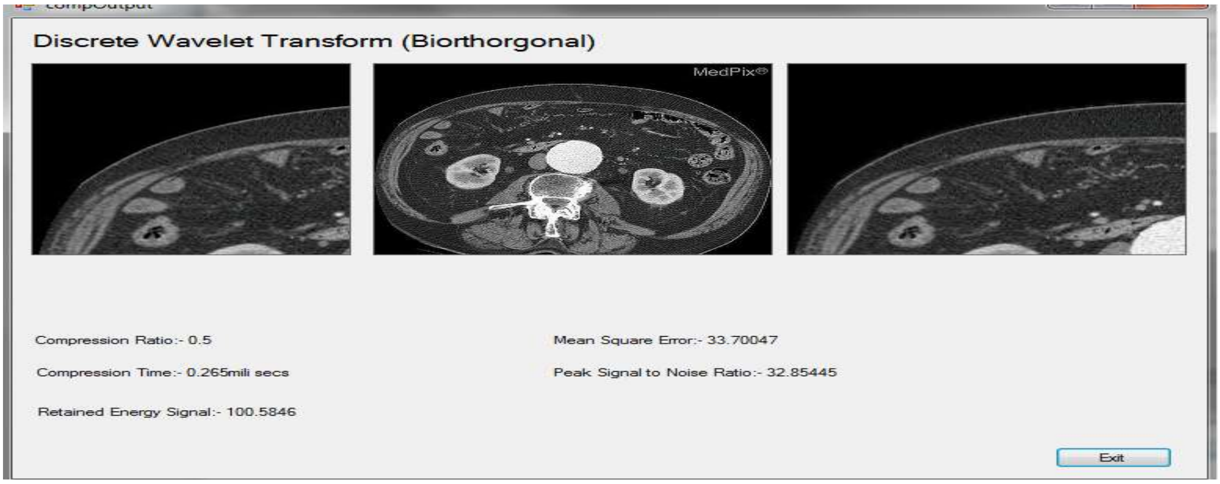

Fig 9: Abdominal Aortic Compressed by DWT

7. RESULTS AND DISCUSSION OF FINDINGS

7.1 Results

The Performance Quality Metrics used are tabulated below:

Table 1: Performance Quality Metrics

Image	Algorithm	CR	CT	RES	MSE	PSNR
Sagittal thoracic and sternum coronal	FFT	0.5	2.46	100.0	41.78	31.92
	DWT	0.5	3.19	100.01	3.57	42.60
Cervical Pedicle	FFT	0.5	0.26	99.59	241.20	24.30
	DWT	0.5	0.33	99.87	10.40	37.96
PA CXR	FFT	0.5	1.26	99.95	146.08	26.48
	DWT	0.5	1.56	100.04	12.73	37.08
Abdominal Aortic	FFT	0.5	0.22	99.29	745.25	19.41
	DWT	0.5	0.26	100.59	33.70	32.85

7.2 Discussion of Findings

The above results show that at 50% Compression ratio, the Fast Fourier Transform (FFT) performed better than the Discrete Wavelet Transform (DWT) in Compression Time while the Discrete Wavelet Transform (DWT) outperformed the Fast Fourier Transform (FFT) in other Performance Metrics (Retained Energy Signal, Mean Square Errors (MSE), and Peak Signal to Noise Ratio (PSNR)) and hence, the Discrete Wavelet Transform (DWT) is a better Algorithm for Compressing Medical Images.

8. CONCLUDING REMARKS

The researchers have been able to implement two algorithms for Medical Image Compression. The Algorithms performed very well with the Fast Fourier Transform (FFT) performing better in Compression time but with low image quality. The Discrete Wavelet Transform (DWT) performs very well in all the Performance Metrics with good Image quality. In Future, the two algorithms may be combined to benefit from good compression time of Fast Fourier Transform (FFT).

9. CONTRIBUTION TO KNOWLEDGE

The research work has developed robust Image compression algorithms for Medical Images and the algorithm has also been implemented to demonstrate the viability of the proposed algorithms. The algorithms performed creditably well for Medical Images.

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