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Analysing CT-Scan Images Towards the Early Detection of Lung Cancer Using Medical Images Based Edge Feature Preserving CT-Scan Medical Image Coder (EZWT - EFPIC)

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Abstract

With the current improvements of virtual image processing techniques and scientific technology has received several benefits. Today, all of the scientific diagnostic image processing techniques produce virtual scientific pictures, through which the healthcare specialists analyse and diagnose the abnormality. The frequent view of scientific picture processing might also additionally appear simpler; however, it entails many challenges. As the scientific pics are interconnected with human lives, the laptop aided scientific image processing structures have to be overcautious, if we want to eliminate inaccuracy rates. The utility of medical image processing techniques for the analysis of CT-Scan images similar to lung cancer cells is gaining momentum in current years. This paper discusses the use of a Transform based Edge Feature preserving CT-Scan Medical Image Coder (EZWT - EFPIC) using Computed Tomography (CT) images to help in the early diagnosis of lung cancer. We discuss and explore the design and significance of an EZWT-EFPIC-CT image processed model in cancer diagnosis.

Keywords: CT lung cancer images, Cancer detection, Image Compression, Image processing, Medical-image analysis

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1. Introduction

The Computed Tomography (CT) imaging technique employs x-rays to capture the detailed CT-Scan medical images of the inner human body [1]. The CT-Scanner passes the x-rays through the human body, which is being analysed. The scanner rotates itself, in order to capture the slice of the inner organ. Usually, the CT-Scan is done to analyse the body parts such as chest, stomach, arms, legs, pancreas, liver, bladder, lungs, heart and so on [2]. The sample CT-Scan medical image is presented in fig.1.

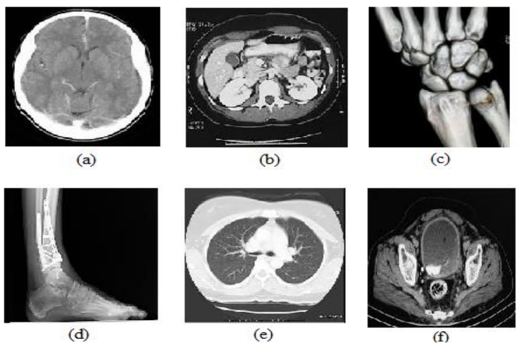


Fig. 1. Sample CT-Scan medical images (a) head (b) abdomen (c) arm (d) leg (e) lungs (f) bladder

The CT-Scan on the chest region can check out for the issues being present in the heart, lungs, esophagus, blood vessels and so on. The cancerous growth in the lung region can also be detected with the help of CT-Scan. The CT-Scan is usually carried out in the abdominal region, in order to detect the presence of cysts, cancerous growth, appendicitis and so on. The CT-Scan may be utilized over kidneys to detect the kidney or bladder stones, urinary track blockage and so on. Besides this CT-Scans are also used in the process of cancer staging.

The major work of this paper has two-fold, viz., edge deduction and preserving edges. Initially, the coder enhances the CT-Scan medical image with the help of the information included in the edge packet at the time carrying out the ZERO TREE wavelet-based transform coding. The edges are efficiently obtained from the CT-Scan medical image during the process of forward transform and reinserted at the decoder at the time of inverse transformation.

Various CT-Scan medical image-processing method development and advancement has enabled analysis of the medical imaging system's output which is advantageous in getting the analyzing patient symptoms easily. Edge detection's role is imperative for various medical imaging applications through the processes of automation and facilitation of anatomical structural delineation [3].

2 Measure of Performance

The Structural Content Performance. The Structural content quantity that is working to attraction an evaluation between two medical CT-Scan medical images Huge value of SC[4]. The formula is

$$SC = \frac{\sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k}^{2}}{\sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k}'^{2}} \quad (2.1)$$

Mean Square Error Performance. MSE is the abbreviated form of 'Mean Square Error'[5]. Generally, it is a criterion that has been widely used and is representative of the classical error estimate as denoted by equation below:

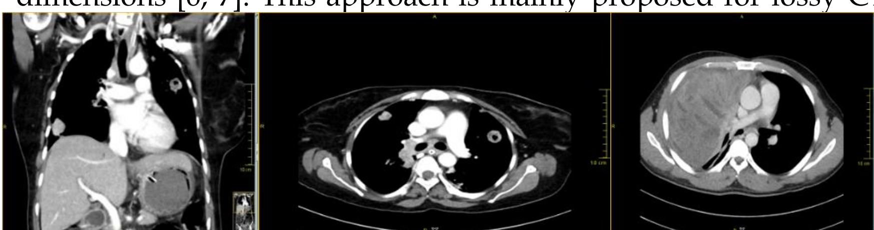
$$MSE = \frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}\left(x_{j,k} - x_{j,k}'\right)^{2} \quad (2.2)$$

where M and N are the CT-Scan medical image dimensions. The **Peak Signal to Noise Ratio performance**. It is given CT-Scan medical image value index, the formula is as follows:

$$\text{value of PSNR} = 10\log\frac{255^{2}}{\text{value of MSE}} \qquad (2.3)$$

3 Proposed Algorithm

In this research work, the EZW encoder is proposed for encoding signals as in CT-Scan medical image and sound, which have varying dimensions [6, 7]. This approach is mainly proposed for lossy CT-



(a) (b) (c)

Fig. 2. (a) Fatty-glandular CT-Scan (mdb218) of miniMIAS database,

(b) Its gray level histogram, and (c) Segmented CT-Scan medical image using FIM

Input: CT scan 8 bit image of size N x N

Output: Edge detected image of size N-2 x N-2

Step 1: If (end of image), go to step 8

Else extract a small image region [I] of size n x n,

Step 2: Compute [β'] = [M]T[I][M], where

$$[\mathbf{M}] = \begin{bmatrix} \mathbf{1} & \mathbf{-1} & \mathbf{1} \\ \mathbf{1} & \mathbf{0} & \mathbf{-2} \\ \mathbf{1} & \mathbf{1} & \mathbf{1} \end{bmatrix}$$

Step 3: Compute the gradient with the help of $G' = (\beta'^2_{01} + \beta''^2_{10})^{\frac{1}{2}}$

Step 4: If the threshold (T < Gradient G'), then go to end.

Step 5: Else the Second Directional Derivative is calculated $I'_{\theta}(x, y) = \frac{\beta'_{20}\beta'^2_{01} + \beta'_{02}\beta'^2_{10} + 2\beta'_{01}\beta'_{10}\beta'_{11}}{\beta'^2_{01} + \beta'^2_{10}}$

Step 6: If (I'_{θ} <0) the edge points are marked at ($i+1$, $j+1$).

Step 7: End

Fig. 3. Proposed algorithm for lung cancer edges

4 Experimental Results and Discussion

The proposed coding scheme has been experimented with more than 852 lung masses of three types from The Cancer Imaging Archive

(TCIA) and Lung CT Screaming Reporting and Data System (RADS)[8, 9]. Sample standard CT-Scan medical image namely CT-Scan Lung Masses without Cancer Cell (CT-LM-WOCC), CT-Scan Lung Masses with Cancer Cell – Predicted (CT-LM-WCC-P) and CT-Scan Lung Masses with Cancer Cell (CT-LM-WCC), which are of size (256 X 256) with pixel values in the range (0-255) are shown in the Figure 3.

Table 1. CT-Scan medical image compression results based on the proposed Algorithms

Lung Masses	CT Scan medical image compression Technique Used	PSNR	MSE	CR	SC
CT-LM-WOCC	DWT	42.4436	9.442	13.5822	4.184
	MEZWTC	37.875	15.524	26.778	2.505
	EZWT-EFPIC	35.564	16.442	35.6648	1.787
CT-LM-WCC-P	DWT	45.434	8.759	22.7598	3.654
	MEZWTC	38.887	12.975	31.632	2.456
	EZWT-EFPIC	37.193	19.486	35.891	1.533
CT-LM-WCC	DWT	47.518	9.832	26.546	2.885
	MEZWTC	40.156	16.563	32.358	1.846
	EZWT-EFPIC	37.163	21.541	35.325	1.265

In our experiment, Discrete wavelet Transform, Modified Embedded Zero-tree Wavelet Transform Coder (MEZWTC) and proposed EZWT-EFPIC is applied to the input CT-Scan medical images are CT-LM-WOCC, CT-LM-WCC-P, CT-LM-WCC has been experimented. MATLAB is the high-level language and interactive environment used by millions of engineers and scientists worldwide.

Several different statistical parameters like Mean Square Error or MSE, Rate Distortion or RD, Structural Content or SC, Normalized Cross-Correlation, Maximum Difference and Normalized Absolute Error are inherent for all three CT-Scan medical images respectively with respect to decomposition level 5. Here 8bit medical has been selected for stimulating decomposition as well as reconstruction so that a comparison might be drawn with respect to Discrete wavelet

Transform, Modified Embedded Zero-tree Wavelet Transform Coder (MEZWTC) and proposed EZWT-EFPIC.

4.1 Peak Signal to Noise Ratio (PSNR in dB)

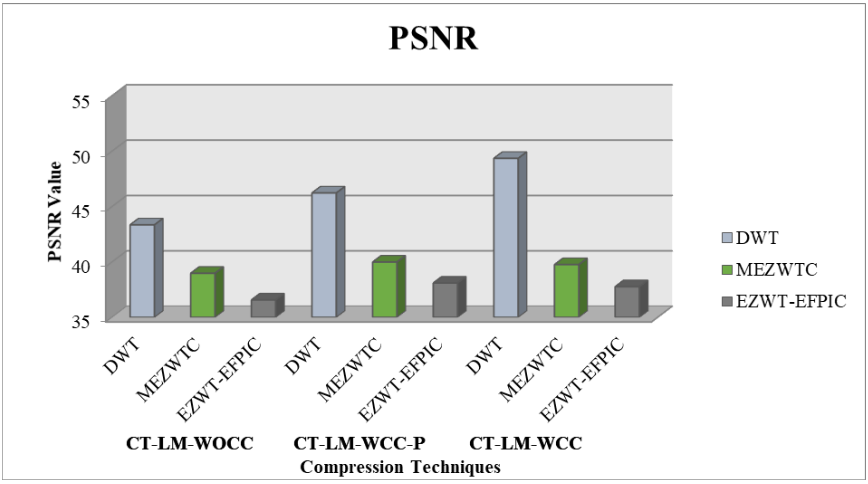


Fig. 4. Comparison of PSNR for variable Bit Rate (bpp) for lung cancer edges

Fig. 4 clearly depicts results while comparing PSNR for variable Bit Rate (bpp). Proposed algorithm's PSNR value is lower here in comparison with existing algorithm like DWT and MEZWTC. With respect to approaches that have been considered here PSNR value linearly decreases. As the proposed EZW is straightforward and computationally uncomplicated also on the basis of the embedded block coding with coefficient truncation, CT-Scan medical image quality here is enhanced further leading to a higher PSNR rate.

Table 1 shows PSNR Results where its value is comparatively higher than DWT, MEZWTC and Proposed EZWT-EFPIC. Hence proposed MEZWTC approach PSNR rate is higher generating a higher CT-Scan medical image. In first CT-LM-WOCC Lung Masse gave good result in EZWT-EFPIC for Peak Signal to Noise Ratio (PSNR in dB) value is 35.564 less than DWT and MEZWTC value is 42.4436 and 37.875 respectively. In Second CT-LM-WCC-P sample Lung Masse gave good result in EZWT-EFPIC for Peak Signal to Noise Ratio (PSNR in dB) value is 37.193 less than DWT and EZWT-EFPIC value is 45.434 and 38.887respectively. In Third CT-LM-WCC sample Lung

Masse gave good result in EZWT-EFPIC for Peak Signal to Noise Ratio (PSNR in dB) value is 37.163 less than DWT and MEZWTC value is 47.518 and 40.156 respectively.

4.2 Mean Square Error (MSE)

Figure 5 shows the results while drawing a comparison between MSE for variable Bit Rate (bpp). Proposed algorithm's MSE value is seen to be much less in comparison with existing algorithms like DWT and MEZWTC. For the given approaches MSE value is seen to linearly increase. As proposed EZW does not necessitate any training, CT-Scan medical image quality is enhanced leading to a lower MSE rate.

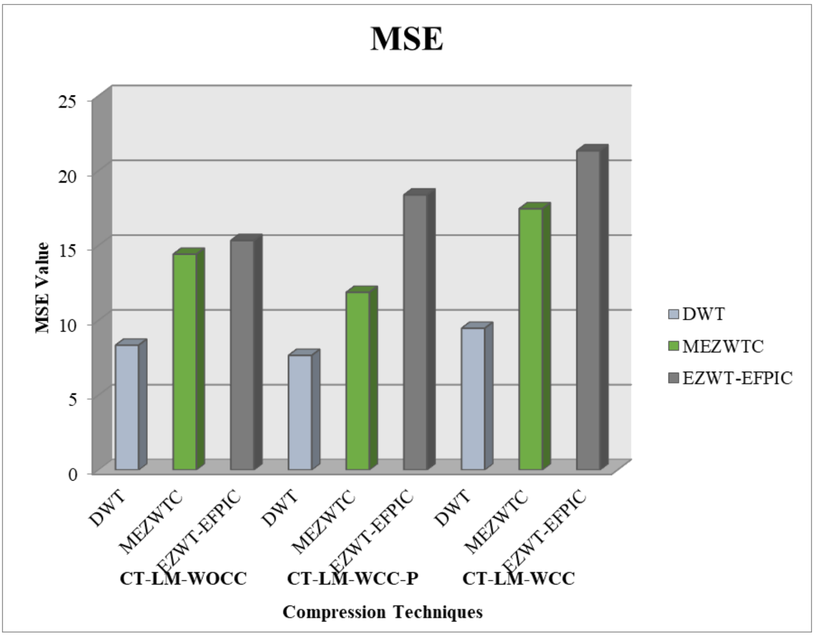


Fig. 5. Comparison of MSE value for lung cancer edges

In first CT-LM-WOCC Lung Masse gave good result in the EZWT-EFPIC produce best result for Mean Square Error (MSE) value is 16.442 higher than DWT and MEZWTC value is 9.442 and 15.524 respectively. In Second CT-LM-WCC-P sample Lung Masse gave good result in the EZWT-EFPIC produce best result for Mean Square Error (MSE) value is 19.486 higher than DWT and MEZWTC value is 8.759 and 12.975respectively. In Third CT-LM-WCC sample Lung

Masse gave good result in the EZWT-EFPIC produce best result for Mean Square Error (MSE) value is 21.541 higher than DWT and MEZWTC value is 9.832 and 16.563 respectively.

4.3 Compression Ratio (CR)

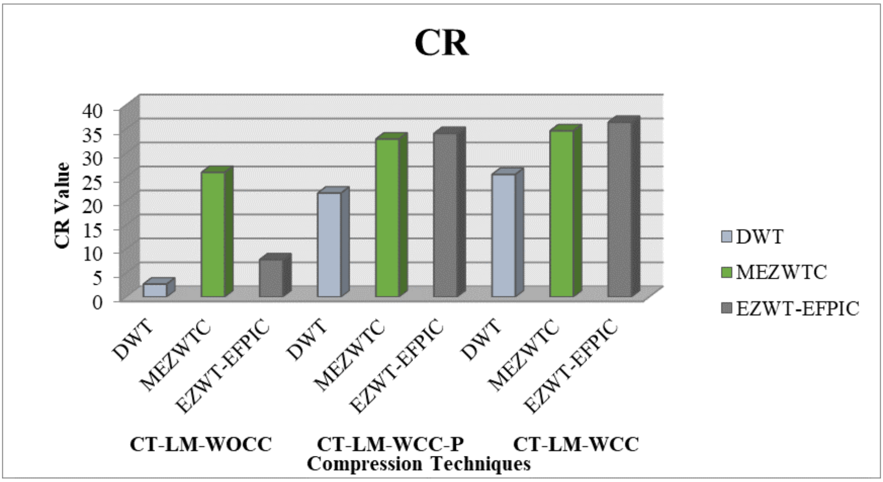


Fig. 6. Comparison of CR for lung cancer edges

Figure 6 illustrated the CR result while comparing CR on variable bit rate. Proposed algorithm's CR value is seen to be much less in comparison with existing algorithms like KLT and WHT. Also, with respect to approaches that have been considered here CR value linearly decreases. As proposed EZWT-EFPIC reduces number of bits necessary while representing CT-Scan medical image, it enables in reducing storage space as well as cost of transmission, augments CT-Scan medical image quality and further reduces computational time thus resulting in higher CR rate.

Table 1 shows CR Results where CR value of CR is seen to be comparatively higher considering DWT and MEZWTC as well as the Proposed EZWT-EFPIC. Hence the suggested MEZWTC approach CR rate is higher further resulting in a higher CT-Scan medical image quality as well as decreased complexity. In first CT-LM-WOCC Lung Masse gave good result in the EZWT-EFPIC produce best result for Compression ratio (CR) value is 35.6648 less than DWT and MEZWTC value is 13.5822 and 26.778 respectively. In Second CT-

LM-WCC-P sample Lung Masse gave good result in the EZWT-EFPIC produce best result for Compression ratio (CR) value is 35.891 less than DWT and MEZWTC value is 22.7598 and 31.632respectively. In Third CT-LM-WCC sample Lung Masse gave good result in the EZWT-EFPIC produce best result for Compression ratio (CR) value is 35.325 less than DWT and MEZWTC value is 26.546 and 32.358 respectively.

4.4 Structural Content (SC)

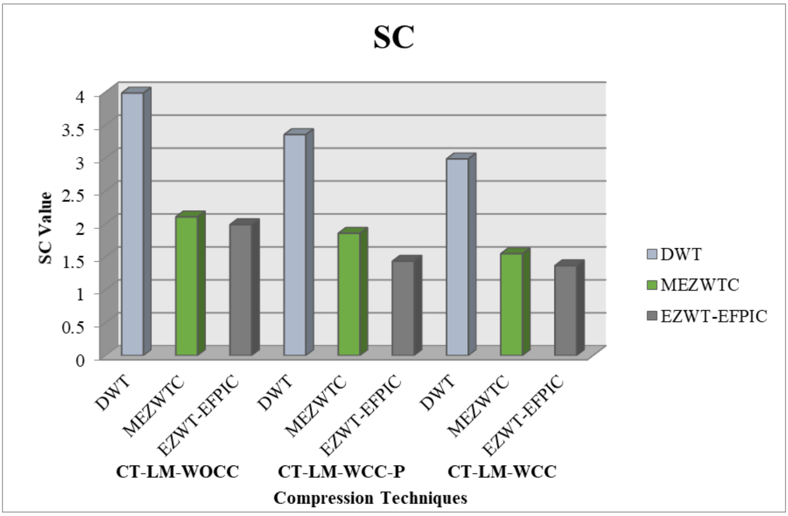


Fig. 7. Comparison of SC for lung cancer edges

The results while drawing a comparison between PC for various input CT-Scan medical images has been shown in Fig.7. Proposed algorithm SC value is seen to be less in comparison with existing algorithm like DWT and MEZWTC. Given the approached that have been considered here SC value linearly increases. As for the proposed EZWT-EFPIC, Lower-rate codes have been embedded right at the bitstream's start, in order to procure the best CT-Scan medical image quality for a specific given bitrate resulting in a lower SC rate [10, 11].

Table 1 shows SC Results wherein value of SC is seen in comparison with DWT and MEZWTC and Proposed EZWT-EFPIC as lesser. Hence the proposed EZWT-EFPIC approach SC rate is lesser resulting in generating a higher CT-Scan medical image quality. In first CT-LM-WOCC Lung Masse gave good result in the EZWT-EFPIC produce best result for SC value is 1.787 less than DWT and MEZWTC value is 4.184 and 2.505 respectively. In Second CT-LM-WCC-P sample Lung Masse gave good result in the EZWT-EFPIC produce best result for SC value is 1.533 less than DWT and MEZWTC value is 3.654 and 2.456 respectively. In Third CT-LM-WCC sample Lung Masse gave good result in The Proposed EZWT-EFPIC produce best result for SC value is 1.265 less than DWT and MEZWTC value is 2.885 and 1.846 respectively.

5 Conclusion

This proposed work is focused on the comparison among three important DWT and MEZWTC and Proposed EZWT-EFPIC methods of CT-Scan medical image compression. Here new CT-Scan medical image compression architecture using the EZWT-EFPIC has been proposed in lieu of the research and study work. Structural efficiency has been bettered specifically in design through the deployment of Proposed EZWT-EFPIC coder architecture. Threshold’s calculation structure’s condensed hardware convolution has been included and implemented. With respect to DWT coefficient calculation, the scheme that has been deployed here is the lifting-based scheme. Structure that has been suggested here is apparently scalable even in the case of higher number of levels. Single RAM has been used here to store DWT coefficients which enable significant reduction of hardware elements through the process of deploying the very same memory while calculating throughout. As the architecture as well as the suggested EZWT-EFPIC coder resultantly increase compression ratio, with no considerable increase in memory bandwidth, this is well suited for implementing high speed CT-Scan medical image processing. Architecture also can be enhanced further in lieu of processing CT-Scan medical images of large size and also for processing video signals.

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