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**Research Article**

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# Plane fitting approach to edge extraction for efficient compression

**K. Vidhya*, B. Sathyasri and S. Mekala**

*Department of Electronics and Communication Engineering, Vel Tech, Avadi, Chennai, Tamilnadu, India*

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## ABSTRACT

*An effective algorithm to compress and to reconstruct medical images without any loss of diagnostic data is proposed. The proposed algorithm extracts edge information of medical images by using plane fitting method. This paper discusses a coding algorithm to maximize compression ratio without sacrificing diagnostic information. The effectiveness of the proposed method is evaluated by applying it to CT and MRI images and in terms of objective quality measures by comparing with existing image compression methods.*

**Key words:** Discrete Wavelet Transforms; Image compression; Entropy coding; Digital imaging.

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## INTRODUCTION

Image compression addresses the problem by reducing the amount of data required to represent a digital image. The compression of medical images has a great demand due to the use of different imaging modalities. Any compression algorithm will try to find and reduce the most redundant and repetitive information. The diagnostic data produced by hospitals has geometrically increased and a compression technique is needed that results with greater data reductions. In these cases, a lossy compression method that preserves the diagnostic information is needed.

Discrete Cosine Transform (DCT) [1] and Discrete Wavelet Transform (DWT) [2] methods are most popular methods preferred by the medical community. Joint Photographic Experts Group (JPEG) is DCT based compression standard [3]. The DWT [4] has gained wide popularity due to its excellent decorrelation property. The wavelet transform is suitable for analysis of images because it provides a good representation of the image data in terms of both spatial and frequency localization. For image coding the wavelet transform is used to decompose the image into different frequency subbands. Separating the smooth variations and details of the image can be done by decomposition. The lack of blocking effect is the major advantage of wavelets over DCT. So algorithms based on wavelets have been shown to work well in image compression. It is widely recognized that 9/7 biorthogonal wavelet filters [5] are among the best filters for DWT-based image compression [6].

After DWT was introduced, several compression algorithms were proposed to compress the transform coefficients as much as possible. Among them, Embedded Zero tree Wavelet (EZW) [7], Set Partitioning In Hierarchical Trees (SPIHT) [8] and Embedded Block Coding with Optimized Truncation (EBCOT) [9] are the most popular methods. Medical image compression technique combines integer wavelet transform with EBCOT in [10]. Wavelet based medical image compression with prediction is proposed in [11,12].

A fast hybrid coder [13] is introduced that combines the speed of the wavelet transform to the image quality of the fractal compression, but with considerable loss of quality.

Edge preservation is an important step while processing medical images as edges indicate the boundary of region of diagnosis. The proposed compression algorithm utilizes plane fitting parameters [14] to preserve the edges of the image.

The proposed compression algorithm is transform based method utilizing Huffman coding. Huffman coding is a variable length coding technique [15].

## EXPERIMENTAL SECTION

The medical images are decomposed using Haar wavelet filter into low frequency components and high frequency components. The compression algorithm uses low frequency components only. The low frequency components are Huffman coded.

As errors are commonly found at edges than inside uniform regions, the edges of the original image are preserved using plane fitting scheme [14] to achieve a decompressed image with a higher content of visual information. The simplest surface is the plane i.e. f(x, y) or z=ax+by+c, where the parameter c is the mean parameter which has maximum information and the parameters a and b form the plane gradient. Mathematically a simplified derivation for first order polynomial fitting is given in the Equation 1

$$\underset{a,b,c}{Minimize} \sum_{x=1}^{N} \sum_{y=1}^{N} \{af(x) + bf(y) + c - g(x,y)\}^2 \quad (1)$$

where g(x, y) is the original intensity and a, b and c are called the plane parameters, N represents the block size and f(t) = 2t-N-1. The parameters a and b indicates the presence of horizontal and vertical edges. The intensity is almost constant unless there is an edge [16]. To preserve the edge information the parameters a and b are utilized and Huffman coded. The encoded bitstream includes coded wavelet coefficient bitstream and edge information. The receiver decodes the compressed bit stream and reverses coding to reconstruct spatial pixel values. The edges of the decompressed image are replaced with the decoded edge information.

## RESULTS AND DISCUSSION

Various modalities of gray images with size of 512 x 512 pixels and 8 bpp are selected for experiments. The proposed method has been discussed for MRI and CT images. The results are shown in tabular form which compares the results of compression methods in terms of quantitative measures: compression ratio and PSNR.

Peak Signal to Noise Ratio (PSNR) is commonly used quantitative measure for image quality evaluation. PSNR is based on Mean Square Error (MSE). MSE is the distortion measure between the original image x(i,j) of size M pixels by N pixels and reconstructed image $x_R(i,j)$.

The formula for MSE is given by

$$MSE = 1/(M * N) \sum_{i} \sum_{j} (x(i,j) - x_R(i,j))^2 \quad (2)$$

The formula for PSNR is given by

$$PSNR = 10 \log_{10} [255 * 255 / MSE] \text{ dB} \quad (3)$$

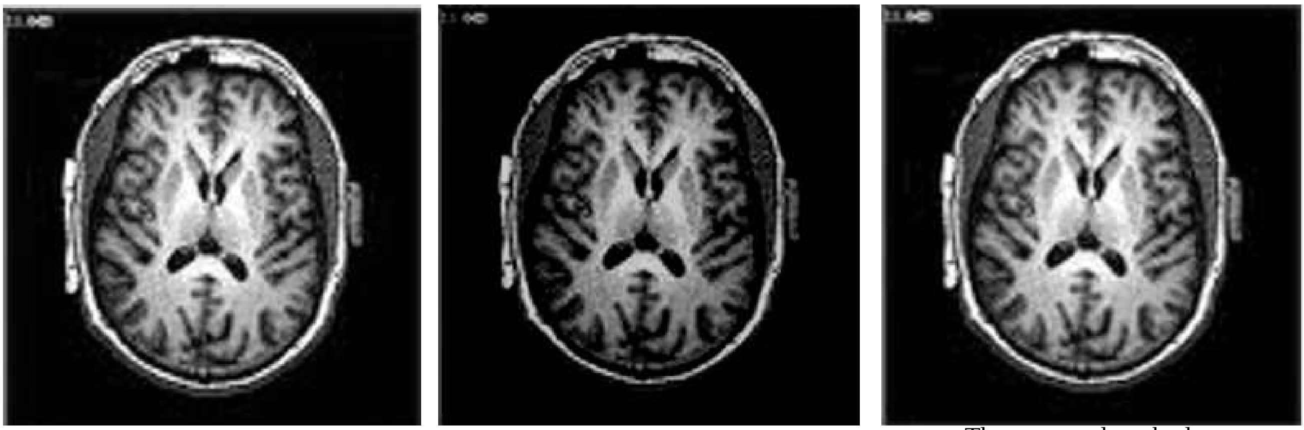
Compression Ratio is defined as

CR = Original file size / Compressed file size (4)

Fig. 1 presents CT image compressed with proposed method and DCT. The original MRI image and reconstructed images processed by proposed method and also for comparison purpose the same image processed using DCT is shown in Fig. 2. To show the performance of the proposed method in comparison to other compression methods, the image fidelity of the decompressed images is measured with MSE and PSNR. The proposed method was tested on CT and MRI images. The comparison table of the proposed method with DCT can be seen in Table 1.

Original image DCT The proposed method

**Figure 1 Visual quality of CT image using different compression algorithms for compression ratios of 4:1**



Original image DCT The proposed method

**Figure 2 Visual quality of MRI image using different compression algorithms for compression ratios of 4:1**

The proposed method is superior to DCT in terms of PSNR measure. For CT images average PSNR obtained with the proposed method is equal to 45.5109 dB for compression ratio of 4:1 and approximately 40.8659 dB for compression ratio of 8:1. For MRI images average PSNR obtained with the proposed method are 45.8776 dB for compression ratio of 4:1 and 41.7165 dB for 8:1.

**Table 1 Numerical results of CT and MRI images**

| Compression ratio | Technique | PSNR(dB) CT | PSNR(dB) MRI |
|---|---|---|---|
| 4 | DCT | 41.9315 | 43.9183 |
| | Proposed | 45.5109 | 45.8776 |
| 8 | DCT | 37.8265 | 38.7758 |
| | Proposed | 40.8659 | 41.7165 |

## CONCLUSION

The proposed method discusses a method to preserve diagnostic information in medical images. The efficiency of this technique has been shown on CT and MRI images. Comparative analysis is done in terms of two parameters: compression ratio and PSNR. The experimental comparison shows that the proposed method has higher compression performance.

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