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Medical Image Application by Hybrid Transform Coding Scheme

Ali Rostam*, Hawar Hawar, Mhsin Mhamad, Barzan Ahmad and Halo Qad

Department of Computational Mechanics, University of Sulaimany, Iraq

Abstract

Efficient compression of images using hybrid schemes has become the spotlight for developers in recent times. Hybrid compression techniques (DWT and DCT) are the basis of the proposed compression scheme presented in this paper. The aim here is to achieve higher compression threshold while maintaining the quality of the reconstructed image, attempting to achieve this by using different compression levels on wavelet coefficients of the DWT (HH and LL) bands, in the time when (HL and LH) bands are undergoing DCT transform. According to the type of transformation, adaptive quantization of the retained coefficient is performed. Lastly the quantization indices are encoded using entropy coding (variable shift coding). Results of our trails indicate using hybrid DWT-DCT algorithm significantly improves coding performance.

Keywords: Hybrid • Transform • Transformation

Introduction

Embedded coding with progressive transmission, scalability and multi-resolution representation are among the many desirable properties of wavelet transformation [1]. Representation based on multi-resolution that can mimic human visual system can be made using wavelet, where the lower details of an image is presented by large basis function having higher spectral resolution, while the high details of the image are presented by shot basis function having higher spatial resolution [2]. JPEG 2000 image compression method was standardized recently and its transform algorithm uses discrete wavelet transforms [3]. A hybrid technique that uses SPIHT and EBC (embedded block codinig) has been proposed by H Hsin et al. [4]. It uses respective coding for low frequency and high frequency wavelet coefficients separately; the coding operation for the high frequency coefficient is facilitated by the intermediate coding results of low frequency coefficients [4]. Combining Kohonen's Self Organizing Feature Map (SOFM), SET Partitioning Hierarchical Trees (SPIHT) and Vector Quantization (VQ) is another suggested hybrid method, leading to efficient image compression [5]. A strategy to present high decoded image quality after increased compression with little increase in computation burden is discussed [6]. Modified SPIHT and CT methods are combined to encode DCT coefficients [7].

Methodology

This method also improves the quality of image perception by providing low bit rate deblocking function. Loay A George [8] presents an algorithm for entropy coding with a lifting scheme wavelet-based transform, showing how to preserve the quality with increased compression using block sub band coding. Using optimized entropy-based coding, DCT transform and 9/7 tap wavelet filters; a new compression algorithm is suggested and discussed in this paper for medical images. Figure 1 shows the diagram.

The algorithm and its possible implication are discussed in sec 2. The test for evaluation of our method is discussed in sec 3, in sec 4, conclusion is discussed.

Steps of proposed coding algorithm

The details the proposed method for image compression is discussed and is as follows:

A. Color Space Conversion (RGB to YCbCr)

YCbCr does not indicate the color resolution of video signals, of which the digital component is not based on sampling rates. "chroma subsampling" is used to decompress bandwidth, and it refers to Cb and Cr been sampled at a lower rate than Y. this leads to the preservation of brightness (luma) while some image information is preserved.

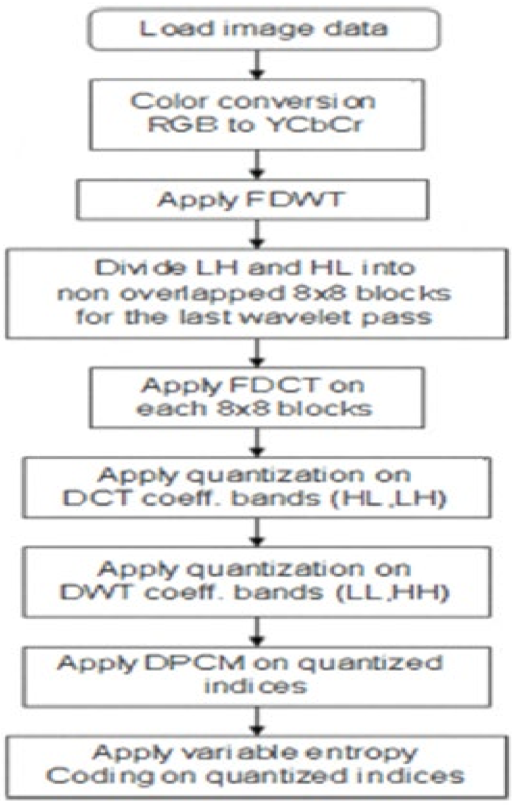

Figure 1. Proposed method diagram.

***Address for Correspondence:** Ali Rostam, Department of Computational Mechanics, University of Sulaimany, Iraq, Tel: +07503599084, E-mail: rostamali904@gmail.com*

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B. Forward Discrete Wavelet Transform (FDWT)

An image can be presented as sum of wavelet functions (wavelets) known as Discrete Wavelet Transform (DWT) that have different scales and locations. Images are decomposed into two waveforms: one that represents the smooth parts or low frequency of the image (scaling function), while the other represents the high frequency part of the image (wavelet function) or the detailed part of the image. This transformation is done by a reversible filter (9/7 tap real to real transform) and lossy coding is imminent in its use. The 2 decomposition levels are shown in Figure 2.

Different levels of bands can be obtained after using FDWT on the image, and according to its nature the coefficients of HH and LH bands are sent to the adaptive quantizer directly. DCT transformation is used on the remaining LH and HL band coefficients.

C. Forward Discrete Consine Transform (FDCT)

Utilizing 2D FDCT the LH and HL bands are converted to frequency domain using below equation, after been divided into 8 × 8 blocks.

D. DCT quantization

By making use of below matrix for luminance quantization, DCT blocks of Y component coefficients are quantized.

The DCT coefficients are divided by their corresponding value in the matrix, then the results is rounded to the closest integer.

The chrominance quantization matrix is used Cb and Cr components quantization:

Through the mentioned process, a great number of higher frequency parts are rounded to zero, while many of the rest become small negative or positive numbers.

E. DWT quantization

Adaptive quantization is not needed for the HH and LL coefficients. Cb and Cr require large step quantization while the luminance component Y suffices with small quantization; this will lead the image HH part to have a large sequence of zeroes.

F. DPCM and mapping to positive

Successive samples of the source signal do not show marked correlation, and this is the basis for DPCM coding. A lower bit rate is implied by using redundancy in sample values for the coding.

The quantized DC coefficients of DCT transform and the quantized (LL band) wavelet coefficients are modified by the forward differential pulse code modulation. The resulting coefficients are transformed into positive values by positive technique mapping. The Figure 3 shows the block diagram.

G. Variable entropy coding

Variable shift coding is the technique of choice in the coding scheme we have proposed, this technique gives many bits to the long code word, while only few bits are given to short code word. Determining the data set's maximum hybrid transform coefficients is the main objective for the shift coding algorithm, at the same time to optimize the coefficients to the least amount of bits possible. The same number of bits is used for the coding of the rest of the coefficients [8].

Decoding Algorithm

The inverse steps are used to reconstruct the image. Figures 4 and 5 shows the processes.

Test Results

An MRI pulmonary image (512 × 512) and a brain image (256 × 256) are the subjects of our test (Figure 6). The different parameters affect the compression ratio differently, and this is displayed by using different scaling factor values (α). Quantization steps (QCr, QCb and QY) are affected by the α, in both DCT and DWT coefficients, as shown in Figure 7. The results of the test for passes 2 and 3 are shown in Tables 1 and 2 respectively. The parameters of quantization are fixed as QCr=40, QCb=40, and QY=35.

Figure 2. Wavelet decomposition (no. of pass=2).

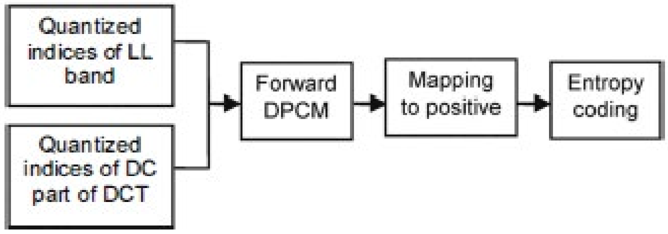

Figure 3. Block diagram of DPCM and mapping.

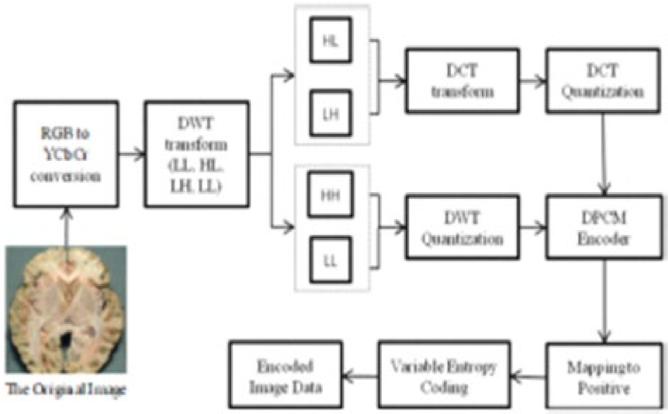

Figure 4. Coding process.

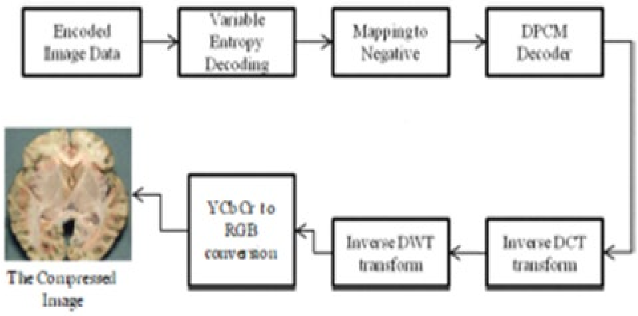

Figure 5. Decoding process.

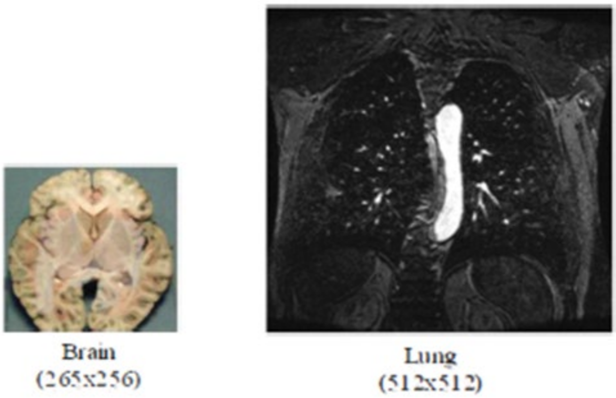

Figure 6. Images used in tests.

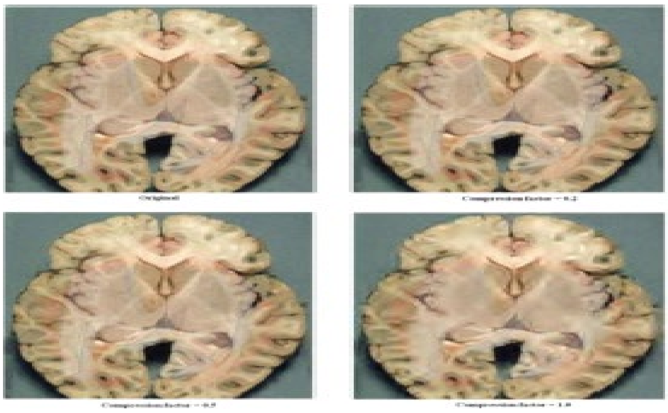

Figure 7. Compressed images with different compression factors and number of DWT passes=2.

Table 1. Resulting parameters where no. of pass=2.

Image	DWT Quantization factor	DCT Quantization factor	Compression ratio	PSNR
Brain	0.2	0.2	28.88	35.96
	0.5	0.5	42.78	34.24
	1.0	1.0	58.15	32.41
Lung	0.2	0.2	28.10	35.79
	0.5	0.5	42.59	33.73
	1.0	1.0	59.66	31.25

Table 2. Resulting parameters where no. of pass=3.

Image	DWT Quantization factor	DCT Quantization factor	Compression ratio	PSNR
Brain	0.2	0.2	17.7	35.8
	0.5	0.5	32.9	33.2
	1.0	1.0	51.9	29.2
Lung	0.2	0.2	21.89	35.77
	0.5	0.5	34.89	33.17
	1.0	1.0	54.50	28.89

Conclusion and Future Works

A new hybrid scheme that is based on DCT and DWT compression techniques is discussed in this paper, designed specifically for medical images. The same medical images are used as test subjects for the compression technique using the same compression factor values (the quantization factor for DCT and DWT). The higher compression ratio we obtain, the lower the quantization factors will be, but the quality measurement (PSNR) will increase. The results show that if the quantization factor is more than 0.5, the quality image will be preserved, however it will slowly lose its quality the more the quantization factor goes above 0.9.

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