International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-3, June 2015
ISSN: 2395-3470
www.ijseas.com

MEDICAL IMAGES COMPRESSION USING HYBRID TECHNIQUE

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Abstract- In recent times, developing hybrid schemes for effective image compression has gain enormous popularity among researchers. This paper presents a proposed scheme for medical image compression based on hybrid compression technique (DWT and DCT). In Medical fields, compression is necessary for big data storage and data transfer for diagnosis. Many compression techniques where used in medical advancement. The goal is to achieve higher compression rate by applying different compression thresholds for the wavelet coefficients of each DWT band(LL and HH) while DCT transform is applied on(HL and LH) bands with preserving the quality of reconstructed medical image. The retained coefficients are quantized by using adaptive quantization according to the type of transformation. Experimental results show that the coding performance can be significantly improved by the hybrid algorithm.

Keywords- Image Compression, Hybrid scheme DWT, DCT, Huffman encoding , DPCM.

I. INTRODUCTION

Compression refers to reducing the quantity of data used to represent a file, image or video content without excessively reducing the quality of the original data [1].Image compression is the application of data compression on digital images. The main purpose of image compression is to reduce the redundancy and irrelevancy present in the image , so that it can be stored and transferred efficiently[2]. The compressed image is represented by less number of bits compared to original. Hence, the required storage size will be reduced, consequently maximum images can be stored and it can transferred in faster way to save the time , transmission bandwidth.[3]

Compression of image plays an important role in medical field for efficient storage and transmission. There are many types of medical image compression techniques are available. Different techniques uses in different image like X-ray angiograms(XA), magnetic resonance image (MRI), etc[4].

Compression is achieved by the removal of one or more of three basic redundancies: (1) Coding redundancy, which is present when less than optimal(i.e. the smallest length) code words are used. (2) Interpixel redundancy, which results from correlations between the pixels of an image. (3) psycho visual redundancy which is due to data that is ignored by the human visual system(i.e. visually noessential information)[5]. Most of existing image coding algorithm is based on the correlation between adjacent pixels and therefore the compression ratio is not high. Image compression may be lossy or lossless. Lossless compression is preffered for archival purposes and often for medical imaging, technical drawings, clip art. This is because lossy compression methods,especially when used at low bit rates, introduce compression artifacts[6]. Lossy methods are especially suitable for natural imagessuch as photographs in applications where minor loss of fidelity is acceptable to achieve a substantial reduction in bit rate. It is possible to compress many types of digital data in a way that reduces the size of computer file needed to store it,with no loss of the full information contained in the original file.[7]

II. TYPES OF COMPRESSION

Two ways of classifying compression techniques are mentioned here:

A. **Lossless Vs. Lossy compression:** In lossless compression schemes the reconstructed images, after compression is numerically identical to the original image. However, lossless compression can only a achieve a modest amount of compression. An image reconstructed following lossy compression contains degradation relative to the original. Often this is because the compression scheme completely discards redundant information. However, lossy schemes are capable of achieving much higher compression.[8]

B. **Predictive Vs. Transform Coding:** In predictive coding, information already sent or available is used to predict future values and the difference is coded. Since, this is done in the image or spatial domain, it is relatively simple to implement and is readily adapted to local image characteristics. Differential Pulse Code Modulation is one of the example of predictive coding. Transform coding on the other hand, first transform the image from its spatial domain representation to a different type of representation using some well-known transform values (coefficients). This method provide greater data compression compared to predictive method, although at the expense of greater computation.[9]

Discrete Cosine Transform

The discrete cosine transform(DCT) represents an image as a sum of sinusoids of varying magnitudes and frequencies. The DCT has the property that, for a typical image, most of the visually significant information about the image is concentrated in just a few coefficients of the DCT.The DCT works by separating images into the parts of different frequencies. During a step called Quantization, where parts of compression actually occur, the less important frequencies are discarded, hence the use of the lossy. Then the most impotant frequencies that remain are used retrieve the image in decomposition process. As a result , reconstructed image is distorted.[10]

Discrete Wavelet Transform

All mainstream encoders use the Discrete Cosine Transform (DCT) to perform transform coding. The DCT maps a time domain signals to a frequency domain representation. We can compress the frequency domain spectrum by truncating low intensity regions. However, the DCT has several drawbacks. Computation of the DCT takes an extremely long time and grows exponentially with signal size. To calculate the DCT of an entire video frame takes an unacceptable amount of time. The only solution is to partition the frame into small blocks and then apply the DCT to each block. However, this leads to degradation in picture quality. The Discrete Wavelet

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ISSN: 2395-3470
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Transform (DWT), offers a better solution.[11]

The DWT is another transform that maps time domain signals to frequency domain representations. But the DWT has a distinct advantage, in essence, can be computed by performing a set of digital filters which can be done quickly. This allows us to apply the DWT on entire signals without taking a significant performance hit. By analyzing the entire signal the DWT captures more information than the DCT and can produce better results. The DWT separates the images high frequency components from the rest of the image , resizes the remaining parts and rearranges them to form a new transformed image. [12]

The major steps in the proposed method are:

1. First step is to load the image.
2. Resize Image properly.
3. Convert the RGB image into YCbCr image
4. After conversion apply Forward discrete wavelet transform on the image using multiresolution technique.
5. Divide LH and HL into non overlapped 8x8blocks for the last wavelet pass.
6. Apply DCT transform on LH and HL bands each of 8x8 blocks.
7. Adaptive quantization technique is applied on DCT coefficient bands (LH &HL).
8. And then apply quantization on DWT coefficients bands (LL & HH).
9. Apply differential pulse code modulation technique on quantized indices.
10. Apply Adaptive Huffman coding algorithm indices.
11.

III. Proposed Method

In this section all the steps which are required for the medical image compression are proposed.

1.Image loading & Resizing of image:

In order to compress the image,the foremost step is to load the image and then the loaded sized into 256x256 format so to reduce the compression time.

2.Color Space Conversion (RGB to YCbCr))

YCbCr refers to the color resolution of digital component video signals, which is based on sampling rates. In order to compress bandwidth, Cb and Cr are sampled at a lower rate than Y, which is technically known as "chroma subsampling." This means that some color information in the image is being discarded, but not brightness (Juma) information.

$$Y = 0.2989 * R + 0.5866 * G + 0.1145 * B$$

$$Cb = -0.1687 * R - 0.3312 * G + 0.5 * B$$

$$Cr = 0.5 * R - 0.4183 * G - 0.0816 * B$$

3.Forward DWT

A two dimensional discrete wavelet transform for a two dimensional signal (image) can be implemented by applying one-dimensional transform twice; one row wise and other column wise. The 1st level DWT is represented in fig 1. LL is the approximation image of the input image as we get that image by passing the input image through low pass filters row wise and column wise.

Therefore only low frequency details will be present in that image both row wise and column wise. LH is the vertical detail image as it contains vertical details of input image. HL subimage carries the horizontal details of the input image and HH carries the diagonal details.

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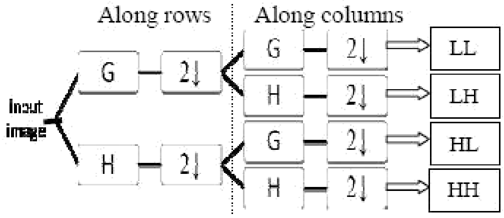

Fig1. Block Diagram for Forward 1st level DWT Reverse DWT

The reverse process of the DWT is shown in figure 2. Here along with the synthesis filters, upsamplers are used. The four sub images bring back to a reconstructed image which is used in the decoding side. i.e. at the receiver side.

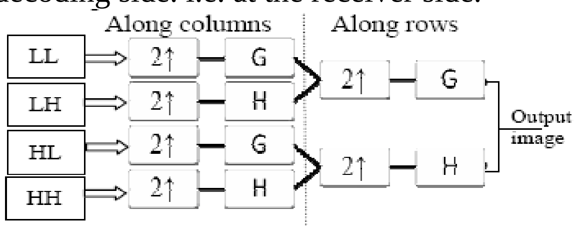

Fig2. Block Diagram for Reverse 1st level DWT

4.Forward DCT

The discrete cosine transform (DCT) is a technique for converting a signal into elementary frequency components. One of the advantages of DCT is the fact that it is a real transform, whereas DFT is complex.

$$D(u,v) = \frac{1}{\sqrt{2N}} C(u)C(v) \sum_{x=0}^{N-1}\sum_{y=0}^{N-1} P(x,y) \cos\frac{(2x+1)u\pi}{2N} \cos\frac{(2y+1)v\pi}{2N} \quad \ldots\ldots\ldots \quad (1)$$

where C (i) = $1/\sqrt{2}$ if i=0
1 if i>0

5.DCT Quantization

The DCT transformed coefficients are then quantized with the help of quantization tables separately for Y, Cb and Cr components. Each value of transformed coefficients are divided by the corresponding elements in the Q table and they are rounded off to the nearest integer as shown below.

S'(u, v) = round(S (u, v)/Q (u, v)) ..(2)

where S (u, v) = DCT coefficient matrix

Q (u, v) = Quantization matrix

Remaining all values is approximated to zeros so that redundant information can be avoided.

6.DCT Quantization

OCT block's coefficients of Y component must be quantized using the following luminance quantization matrix:

1 6	1 1	0	16	24	40	5 1	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	60	59
14	1 7	22	29	51	87	80	62
18	22	37	56	68	109	03	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

The quantization is done by simply dividing each OCT's coefficient by its corresponding value In the quantization matrix and then rounding to the nearest integer.

The Cb and Cr components are quantized using chrominance quantization matrix:

17	18	24	47	99	99	99	99
18	21	26	66	99	99	99	99
24	26	55	99	99	99	99	99
47	66	99	99	99	99	99	99

99	99	99	99	99	99	99	99
99	99	99	99	99	99	99	99
99	99	99	99	99	99	99	99
99	99	99	99	99	99	99	99

In the resulting matrix many of the higher frequency components are rounded to zero, and many of the rest become small positive or negative numbers.

7.DWT Quantization

The LL, HH coefficients must be quantized using adaptive quantization. The luminance component Y requires the small step of quantization while Cb and Cr need a large step. After this step, a large sequence of zeros is obtained especially in HH part of the image.

8.DPCM and Mapping to Positive

Basic concept of OPCM - coding a difference, is based on the fact that most source signals show significant correlation between successive samples so encoding uses redundancy in sample values which implies lower bit rate.

The forward differential pulse code modulation is applied on the quantized (LL band) wavelet coefficents and quantized DC coefficients of OCT transform. And then all the coefficients must be converted into positive values by mapping to positive technique.

9. Adaptive Huffman Coding

The Huffman method assumes that the frequencies of occurrence of all the symbols of the alphabet are known to the compressor. One approach to this problem is for the compressor to read the original data twice. The first time, it only counts the frequencies; the second time, it compresses the data. Between the two passes, the compressor constructs the Huffman tree.

The main idea is for the compressor and the decompressor to start with an empty Huffman tree and to modify it as symbols are being read and processed (in the case of the compressor, the word "processed" means compressed; in the case of the decompressor, it means decompressed). The compressor and decompressor should modify the tree in the same way, so at any point in the process they should use the same codes, although those codes may change from step to step.

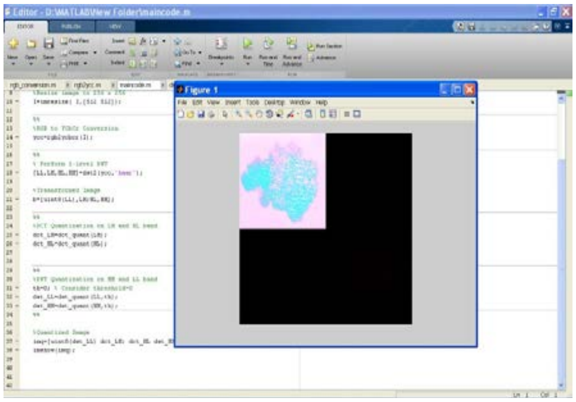

Fig3. Adaptive Quantization

IV. CONCLUSION

In this, the proposed scheme presents for medical image compression based on hybrid compression technique . Here, observes quantization on different bands and the retained coefficients are quantized by using adaptive quantization according to the type of transformation. Further improvement can be achieved by encoding the difference image using an appropriate method.

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