ROI and NROI based Medical Image Compression using MSPIHT and Hybrid DWT with DCT

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Abstract— This paper is intended to provide such medical image compression method which provides good peak signal to noise ratio (PSNR) for diagnosis important area also known as clinically region of interest (ROI) and a good compression ratio (CR) for non-region of interest (NROI) that is background of the medical image. The proposed method is used taking into account the salience of medical images. With the improvement of digital imaging the space required by the images gradually increases. The medical images occupy large space in storage device. High transmission time and high resolution proves the need for images compression. The main task in medical imaging is coding and transmission of medical images by preserving the clinically important information with reduction in storage space with the help of compression. Nowadays medical image compression is an important area of research which aims at producing algorithms that reduce file size and at the same time maintain relevant diagnostic information. This paper concentrates on using such methods which preserves the CROI with loss less method and other then that region like edges and background known as NROI with lossy method. In this paper the lossless modified set partitioning in hierarchical trees (MSPIHT) algorithm in ROI part, which is gives more appropriate and robust image transmission, and the hybrid of lossy methods DCT with DWT is used in NROI part of image.

Key words: Modified Set Partitioning in Hierarchical Trees (MSPIHT), Transform Coding, Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), ROI, NROI, PSNR, CR. Structure Similarity Index (SSIM)

I. INTRODUCTION

Images are virtually everywhere, our brain has the ability to recognize, people and objects within a seconds. Digital images are made up of pixels where each pixel represents the 2-D as f(x, y) which is amplitude or the intensity of pixels at the (x, y) location. The f(x, y) is the product of illumination and the reflectance.

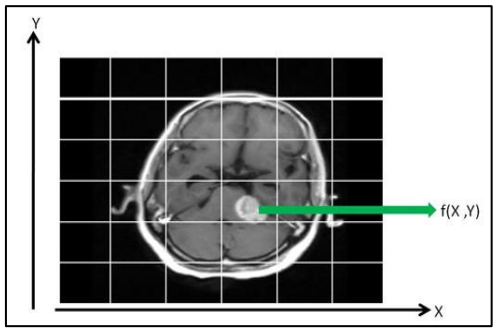

Fig. 1: Image Formation

f(x, y) = illumination* reflectance.

This is the basic principle behind of imaging. The same principle is also used for making of medical images but the size of medical images is much larger than non-medical images.

With the improvement of imaging system the storage space required by the images increases gradually. The medical images produces the digital form of human body picture, hence we can understand the importance of medical image in our daily life.

Numbers of patients come for diagnosis in even small hospital and it is become mandatory to preserve the patient's health record for long duration for monitoring. This records either in form of hard or soft copy of in the DICOM images format which are occupy more space in the storing device. The problem faced by radiology department is to store the images and to process them because such large image are difficult to store for long time and also increase the complexity while processing and transmitting them.

The medical images occupy large space in storage device, high transmission time and high resolution proves the need for images compression.

The medical image compression is an important area of research which aims at producing algorithms that reduce file size and at the same time maintain relevant diagnostic information.

There are two ways to segment the region of interest (ROI) one this automatic segmentation and another is manually selection of region of interest. In order to provide the transmission speed of image data in real time, a transmission and coding algorithm for ROI automatic detected target image is studied as the same time as it is realized in the framework of modified SPIHT Algorithm [3]. The review on the various method has been already done and found that the automatic segmentation and proposed algorithm will give good result for region based image compression based image. In the region based medical image compression the data that are not important known as NROI part of the image.

Since in medical imaging NROI part of the image which is background or the edges of the image are not important in respective of diagnosis area hence must be compressed with lossy compression method.

Currently, in many application want representation of images with minimal storage of data. The size of image can be reduced by the truncation of redundant data in the image. The redundancy of the image be in the pixels by their intensities and second is that the image contain same kind repeat section (same region). These identical sections do not need to be encoded many times to avoid redundancies and, therefore, we need an image compression to minimize the memory requirement in representing a digital image. Then general principle used in the process of image compression is to reduce duplication of data within the image so that the memory needed to represent the image is smaller than the original image.

II. APPLIED METHODOLOGY

The methodology consist the following parts:

A. Image Acquisition

The selection of images which are processble under the region based image compression is done in this section. This section become important because it should be known by the physician that which image falls under this categories. Once the image is selected then the images are send for the further process

B. Pre-Processing

The pre-processing of the image is a step in image processing here we do many process like resize, filtering to make images more processble.

The applied methodology [26] is depicted in the figure no.1 below.

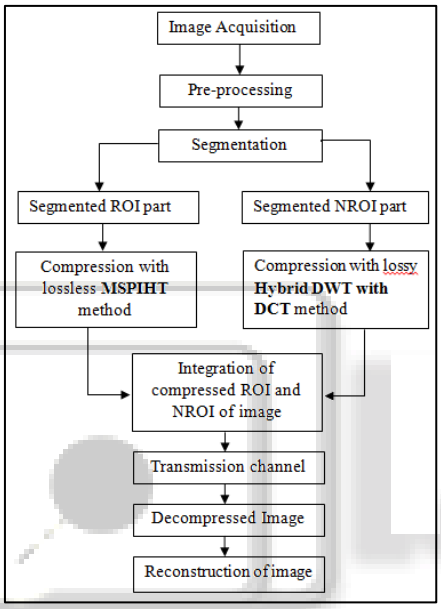

Fig. 2: Methodology flow chart Diagram

The basic idea behind the working principle of median filter is the filters runs through entry by entry throughout entire signal called "window. The window may be 2D (or high pattern is possible) or more complex pattern can be used for image filtering. In this methodology a brain tumor image is considered as shown in Fig 3. Noise in the form of salt & pepper noise is added. It is filtered with the help of median filter and the output is shown in Fig 4.

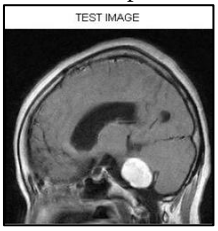

Fig. 3: Test Input image

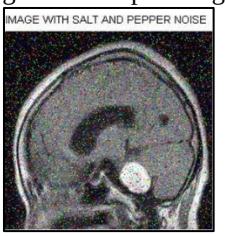

Fig. 4: Test Image with salt and pepper noise

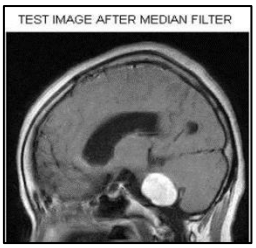

Fig. 5: Test Image after Median Filter Applied

C. Segmentation

The segmentation is more often a critical step in region base image compression technique. Here the image is segmented into clinically important area and un-important area, i.e. the process for partitioning of an image into foreground and background is done in segmentation. The segmented parts are named on the basis of the important area they preserve, the diagnosis area which is more important respective of compression and should be compressed with lossless method while sending to another end is known as "region of interest (ROI)" and in images which are not important in respective of diagnosis like background and edges is known as "non-region of interest (NROI)". In the proposed methodology the binary segmentation is used. The thresholding value is greater than 200. Which mean that the pixels having values greater than 200 is replaced by higher intensity value which is 255 and white pixel.

The segmented ROI and NROI part of the image is shown below.

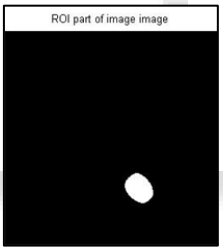

Fig. 6: Segmented ROI part of image

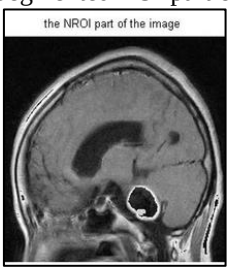

Fig. 7: Segmented NROI part of image

D. Compression with lossless method (MSPIHT)

The proposed methodology is improved method of as "Set partitioning in hierarchical tree (SPIHT) "[3] by Amir said and William A. Pearlman in 1996, which was earlier implemented by Jerome .M. Shaprio in 1993 the method named as is "Embedded Zero tree wavelet (EZW) "[28], Traditional SPIHT has the advantages over the embedded code-stream is structure, high compression rate, low complexity [26].However the SPIHT also having flaw [27] are the following .

1) When scanning the list of insignificant pixels (LIP), list of insignificant sets (LIS), or list of significant pixels (LSP), the repeated coefficient comparison can increase complexity of the algorithm.

2) The coefficients put into LIP at last scanning procedure which are smaller than the current threshold will result in redundancy.
3) Early coding for non-important coefficients in SPIHT will affect the performance of channel coding, especially for Unequal Error Protection (UEP).

Therefore, the modified SPIHT algorithm [25] mainly makes the following changes.

– SPIHT codes four coefficients and then shifts to the next four ones. Therefore, views the four coefficients as a block. The maximum of them regarded as the compared threshold will decrease number of comparison, which is related with the distribution of coefficient matrix. Even more, when the maximum in the block is smaller than the current threshold or equal to it, the block will be coded with only one bit instead of four zeros. Therefore, this proposed method can reduce redundancy to a certain extend.
– When computing the maximum threshold, the modified algorithm can initialize the maximum of every block. So, it can obviously reduce number of comparison when scanning and coding zero trees.

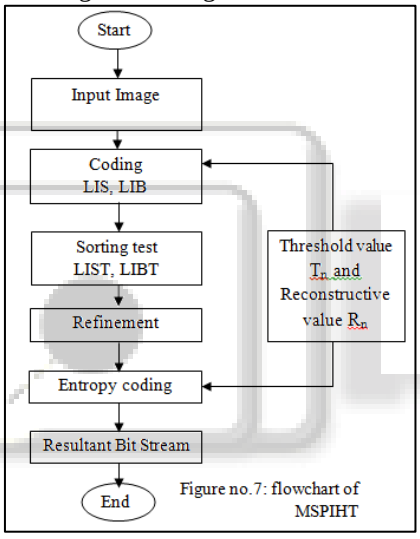

Fig. 7: flowchart of MSPIHT

Fig. 8: ROI Compressed with MSPIHT
PSNR= 41.3905 and CR= 35.905 at BPP=1

E. Compression with lossy method (Hybrid DCT with DWT)

1) DCT (Discrete Wavelet Transform)

Discrete Cosine Transform (DCT) [7], The DCT decomposes the original signal into AC and DC components. Using the techniques of fourier analysis, any signal can be denoted as a sum of multiple signals that are sine or cosine waveforms at various amplitudes and frequencies. The inverse DCT (IDCT) is used to reconstructs the original signal. So now we can summarize the DCT in following point DCT is real part of Fourier transform.

– Having high energy compaction compare to FT.
– The image is concentrated in only in few coefficient.

2) DWT (Discrete Wavelet Transform)

DWT exploits both the spatial and frequency correlation of data by dilations or contractions and translations of mother wavelet on the input data. It divides the information of an image into approximation and detail sub-signals. The details show changes in the image [10], [11]. These details, always, are very small. Most of the work that have been adopted to reduce redundancy and hence increase CR is based upon using threshold algorithms [2], [7]. So now we can summarize the DWT in following point.

– Wavelet (title waves) are function that are concentrated in time as well as frequency around the certain point.
– DWT overcome the drawback of Fourier transform.
– This transform is appropriate for non-stationary signals.

Wavelet divides the information of an image into details and sub-signals.

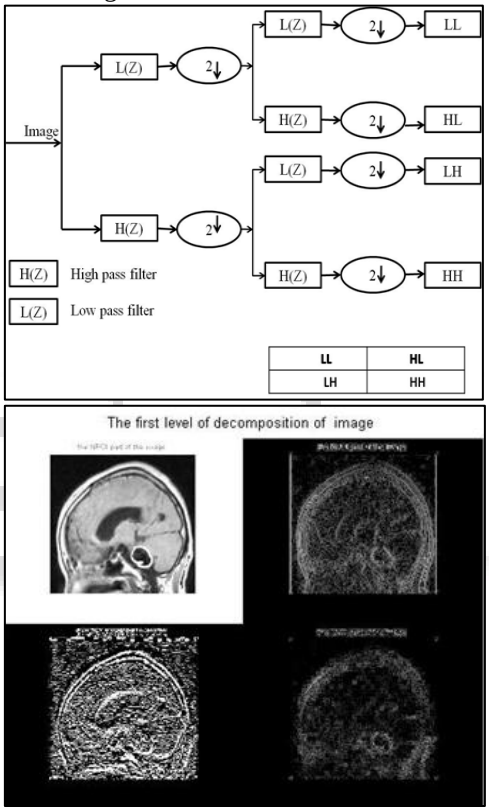

Fig. 9: Wavelet details and sub-signals

III. RESULT AND DISCUSSION

At the final stage the both foreground and background are combined and the PSNR for the method MSPIHT (ROI) and reconstructed image is shown in below table. The bit per pixel (BPP) is varied from 0.25-2 and the table tries to show the difference in PSNR values when the MSPIHT used alone and with a lossy method.

The table below shows the PSNR and Compression ratio for lossless (MSPIHT) alone and final. The plot above is plotted between the PSNR and bit per pixels (BPP). Another plot is plotted between the compression ratio and BPP. MSPIHT method of compression and we have found that our algorithm is better. From Table-1 it is evident that for higher bit rate higher PSNR is obtained and our algorithm shows better PSNR and CR output than MSPIHT. Hence we have obtained a satisfactory result and in future we would try to compress coloured image.

S. No.	BPP	MSPIHT		MSPIHT (ROI) +(DWT+DCT) (NROI)	
		PSNR dB	CR	PSNR	CR
1	0.25	24.86	29.620	41.3402	35.7808
2	0.50	28.3833	30.8659	42.5902	36.2808
3	0.75	31.6458	33.5776	43.8402	36.4802
4	1.0	41.3905	35.905	45.0902	37.6408
5	1.25	41.3905	35.7682	47.5902	38.288
6	1.50	41.3905	35.7682	47.5950	38.2566
7	1.75	44.9369	36.5182	48.8402	38.7802
8	2.0	48.4921	37.2686	50.0902	39.2808

Table 1: PSNR and Compression ratio for lossless (MSPIHT)

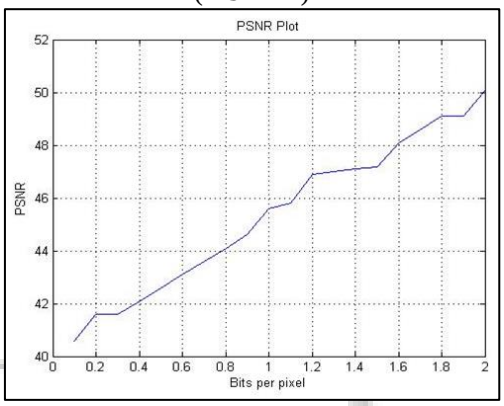

Fig. 10: Plot [1] - PSNR VS BPP

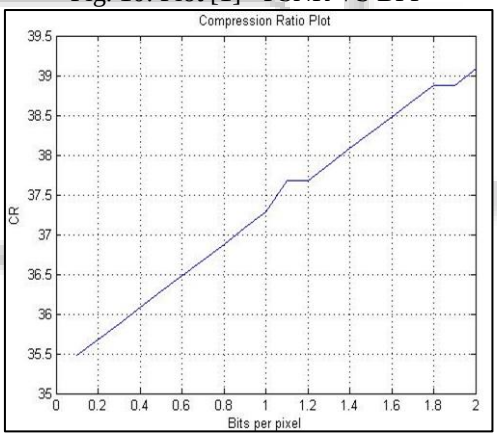

Fig. 11: Plot [2] - CR VS BPP

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