Medical Image Analysis and Achieving Compression using Hybrid Lossless and Lossy Compression Technique

Jay Kumar Soni
M.E. Scholar
Department of Electronics & Telecommunication Engineering
Shri Shankaracharya Technical Campus (SSTC), SSGI (FET), Junwani Bhilai C.G

Mr. Chandrashekhar Kamargaonkar
Associate Professor
Department of Electronics & Telecommunication Engineering
Shri Shankaracharya Technical Campus (SSTC), SSGI (FET), Junwani Bhilai C.G

Dr. Monisha Sharma
Professor
Department of Electronics & Telecommunication Engineering
Shri Shankaracharya Technical Campus (SSTC), SSGI (FET), Junwani Bhilai C.G

Abstract

Medical images like X-ray, CT or MRI produces visual representation of inner body structure. To recognize and name the exact character of a disease or a problem of human health condition, medical imaging is best method for them. For storage & transmission purpose there exist a need for compression of these images. Current compression schemes provide a very high compression rate with a considerable loss of quality. In medical imaging, it is a prime requirement to maintain high image quality in region of interest i.e diagnostically important regions. This work analyses a hybrid model of lossless compression in region of interest with high compression rate and lossy compression in other region. In this paper medical image is separated into two region, one is called NROI and other is called ROI. Region of interest part is compressed with ASPIHT algorithm and NROI part is compressed with the help of Block Truncation Coding algorithm. Our algorithm provide better PSNR and CR for medical images.

Keywords- Image compression, WT (wavelet transform), db (Daubechies wavelet), BTC(Block Truncation Coding) SPIHT(Set Partitioning In Hierarchical Tree), ASPIHT(SPIHT using adaptive coding order), PSNR (Peak signal to noise ratio), Compression Ratio(CR), MSE(mean square error), region of interest(ROI)

I. INTRODUCTION

Today the Medical imaging has had an excellent impact on the identification of diseases and surgical planning. However, imaging devices still generate a lot of information per patient, usually one thousand images or sizes larger in MBs. This information requires large storage and economical transmission. Regardless of greater improvement in transmission storage space and communication technologies, demand of medical image compression rises consistently. In the field of digital image processing, there are mainly two Type of compression, one is lossy compression and other is lossless compression.

A. Lossy and Lossless Compression

In lossless compression, the reconstructed image after compression is numerically same as the original image on a pixel by-pixel basis. Lossy compression on the other hand, the reconstructed image contains information loss relative to the original, because redundant information is discarded during compression. Region of interest based Image compression has been most dominating issues in the field of image compression and coding. Non region of interest part is of lesser importance because it is the background part which is not much useful in diagnosis of the disease. Hence, using the lossy method of compression for compressing the background portion will make the compression easier and will also not affect the issue of diagnosing the disease.

II. METHODOLOGY

The block diagram of the proposed methodology is shown below in figure 4. The methodology consists of following parts

1) Filtration
2) Segmentation of ROI and NROI
3) ROI compressed with the help of advanced SPIHT algorithm.
4) NROI compressed with the help of Block Truncation coding algorithm.

A. Filtration

Filtering is process to suppress high frequency or low frequency. In image processing, it is often desirable to be able to perform some kind of noise reduction on an image so that image could be clearly visible. In our proposed methodology median filter is used. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a kind of pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing, because under certain conditions, it conserve edges meanwhile removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring or adjacent entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 2D (or higher-dimensional) signals such as images, more complex window patterns are possible. In this methodology a brain tumor image is considered as shown in Fig 5(a). Noise in the form of salt & pepper noise is added. After filtration it get removed.

B. Segmentation of ROI and NROI

Dividing an image into several parts is called segmentation and it is typically used to identify object and other relevance information. In the proposed methodology free hand cropping and image thresholding method is used for segmentation of the image into ROI and NROI part. Image thresholding is a simple, yet effective, way of partitioning an image into a foreground and background. This image analysis technique is a type of image segmentation that parted the objects by converting grayscale images into binary images. Image thresholding [6] is most effective in images with high levels of contrast. The easiest thresholding methods replace each pixel of an image with a black pixel if the image intensity is less than some fixed constant T, or a white pixel if the image intensity is more than that constant. In our method the ROI part is the tumor part of the brain having the intensity greater than the background part so tumor part or diseased part is separated from the original brain image and further compressed for transmission. The segmentation of NROI and ROI part is shown in Fig 5(b) and 5(c) respectively.

C. SPIHT Algorithm

The powerful wavelet based image compression method SPIHT algorithm was introduced by said and Pearlman. It is an image compression algorithm that exploits the inherent similarities across the sub bands in wavelet decomposition of an image. It is a controlling, well organized and yet computationally easy image compression algorithm. The flow chart of conventional SPIHT is shown in fig.1

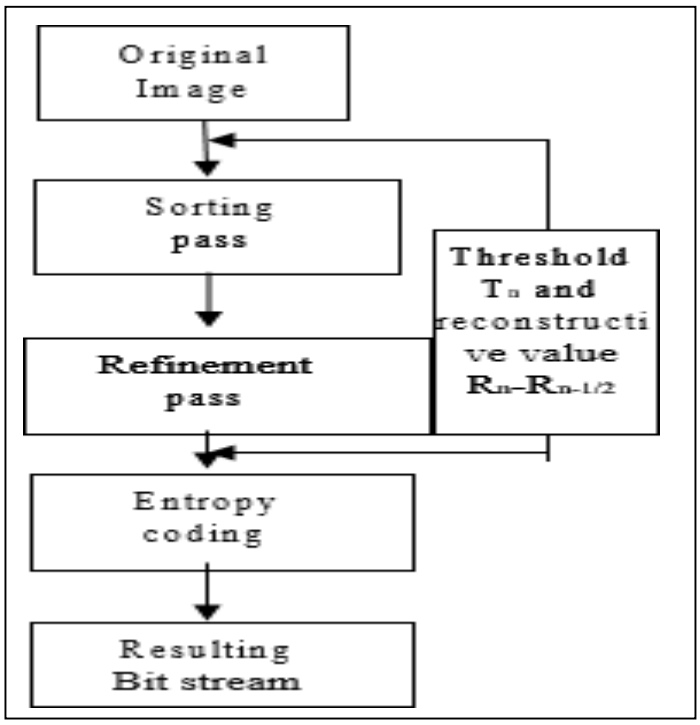

Fig. 1: Flow chart of SPIHT

In order to obtain better compression on image edge, an improved Set partitioning Hierarchical trees (ASPIHT) algorithms based on prior scanning the coefficients around which there were more significant coefficient was proposed. The coefficient or sets were sorted according to the number of surrounding significant coefficients before being code and the previous significant coefficient were refined as soon as sets around which there existed any significant coefficient had been scanned. The scanning order was confirmed adaptively and did not need any extra storage. It can code more significant coefficients at a specified compression ratio.

Adaptive coding refers to variants of entropy encoding methods of lossless data compression. They are particularly matched to streaming data, as they adapt to localized alteration in the characteristics of the data, and don't require a first pass over the data to calculate a probability model. The cost paid for these advantages is that the encoder and decoder is somehow complex to keep their states synchronized, and more computational power is needed to keep adapting the
Encoder/decoder state.

D. Block Truncation Coding

The Block Truncation Coding (BTC) is a type of the lossy Image compression algorithm in which first and second order Moments are preserved in each image block. Block truncation coding (BTC) is a simple lossy image compression technique to compress monochrome image data, first proposed by e.j and O.R Mitchell at Purdue University. . It divides the original images into blocks and then uses a quantiser to reduce the number of grey levels in each block whilst maintaining the same mean and standard deviation. The present work investigates image compression based on Block Truncation Coding. Here we develop a technique to express our coding algorithm, a pixel image is divided into blocks of typically 4x4 pixels. Nonparametric quantizer is used. For each block the Mean and Standard Deviation of the pixel values are calculated; these statistics generally change from block by block. The pixel values choosen for each reconstructed, or new, block are chosen so that each block of the BTC compressed image will have (approximately) the same mean and standard deviation as the corresponding block of the original image. The proposed method gives better performance in terms of PSNR values when compared to the previous lossy method of Daubechies wavelet transform method. To determine image quality some parametric measures bring into service such as: Peak Signal to Noise Ratio (PSNR), Structural Similarity Index (SSIM), and mean square error, bit per pixel. BTC has also been adapted to video compression. The basic block diagram of BTC for image compression and decompression is shown below in fig. 2 and fig. 3 respectively.

E. BTC Algorithm

A pixel of image is arranged into blocks of typically 4x4 pixels. For each and every block the Mean and Standard Deviation of the pixel values are computed; these statistics generally change from block to block. The pixel values selected for each reconstructed block or new block are chosen so that each block of the BTC algo. Compressed image will have (approximately) the same mean and standard deviation as the corresponding block of the original image.

Step1. Input images divide into several non-overlapping block of size n x n. For example 4 x 4 or 8x8 and so on. Non parametric quantizer is used.

Step 2. Compute the two statistical values (mean) and σ (standard deviation). Both values are calculated for each block of Image by using following equations.

A) □ = 1/□$\sum^{n}_{i=1}$ xi

B) σ =√ 1/□ = $\sum^{n}_{i-1}$ (xi=□' i)

Here xi represent the ith pixel value of the image block and
n is represents total number of pixel in particular block

Step3. The and σ are termed as a quantizers of this technique. The is the threshold value of presenting bit plan and obtained by comparing each pixel value of image with defined threshold value

Step 4. In decoding phase encoded block are reconstruct by replacing 1 as H (high intensity) and 0 as an L (low intensity) which is given by as follow.

$$H= x'+ \sigma\sqrt{(p/q)}/$$
$$L= x+ \sigma\sqrt{(q/p)}$$

Where p and q are the number of 0"s and 1"s in the compressed bit plane respectively.

This demonstrates that the algorithm is asymmetric in that the encoder has much more work to do than the decoder. This is because the decoder is merely replacing 1's and 0's with the approximated value whereas the encoder is also required to calculate the mean, standard deviation and the two values.

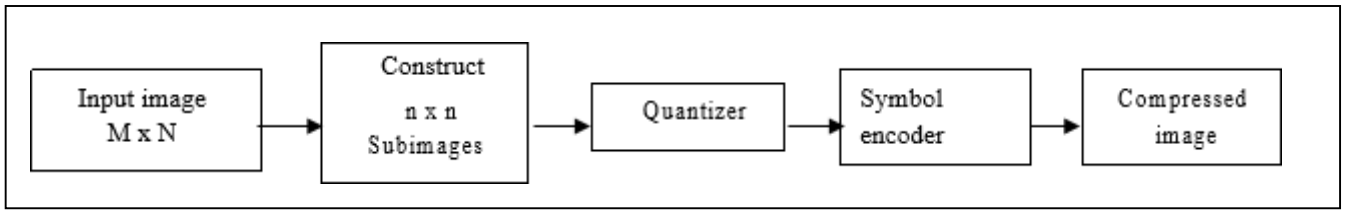

Fig. 2: The Basic block diagram of BTC for image compression

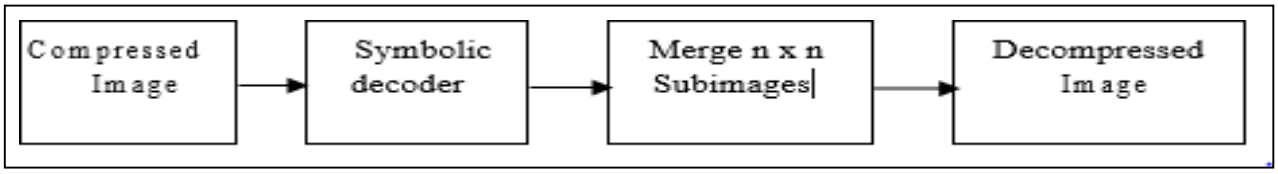

Fig. 3: The Basic block diagram of BTC for image decompression

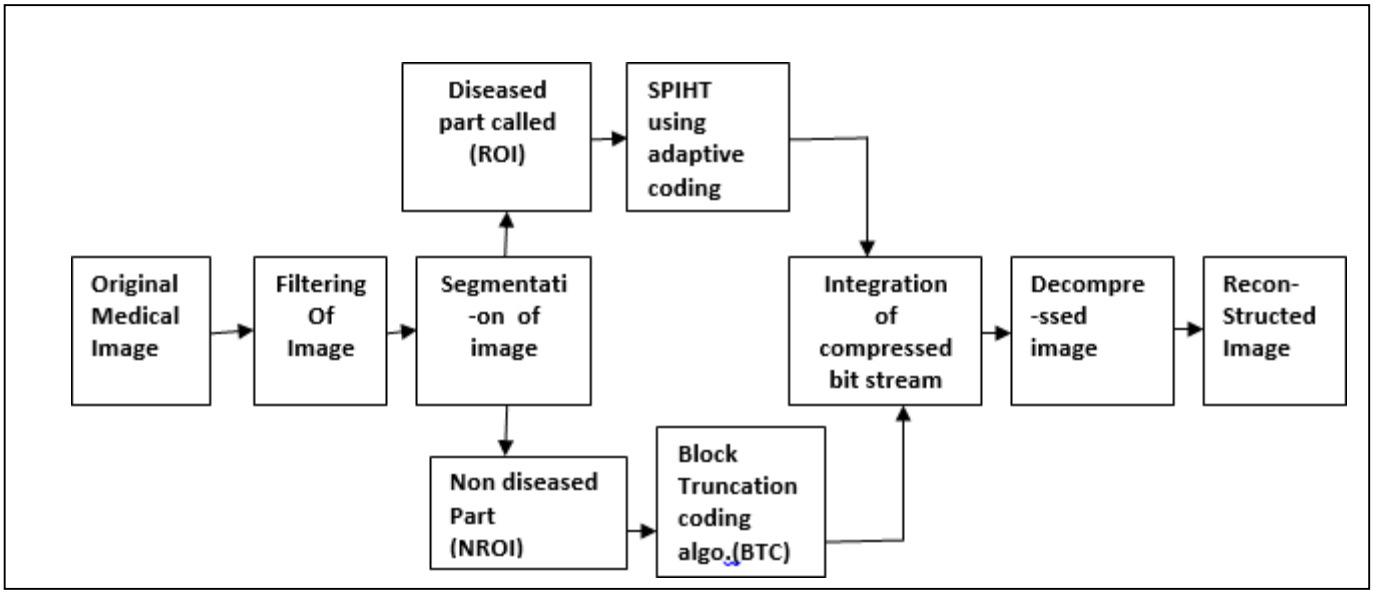

Fig. 4: Block diagram of proposed methodology

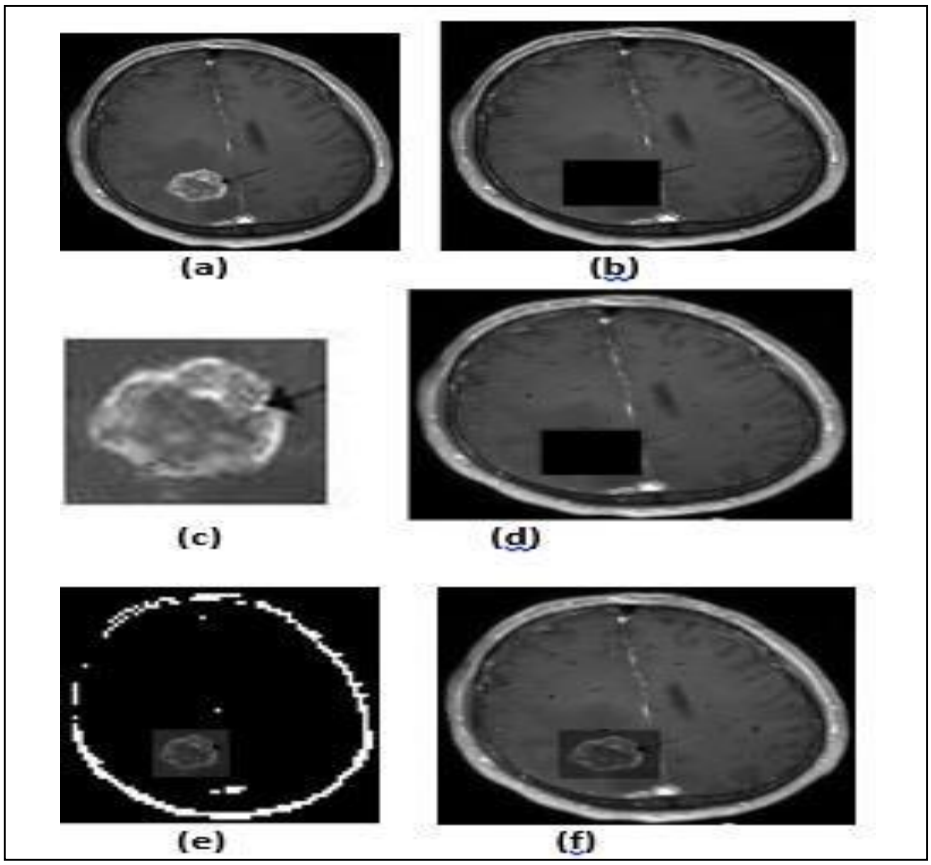

Fig. 5: (a) Brain image with tumor (b)NROI uncompressed portion before applying BTC algorithm (c)ROI uncompressed part before applying ASPIHT (d) Reconstructed NROI region after compressed with BTC. (e)Integrated image with ROI(SPIHT) and NROI(db6). (f)Integrated image with ROI(ASPIHT) and NROI(BTC).

III. RESULT AND CONCLUSION

Compression of image is much important phenomenon in digital image processing. It may be either lossless or lossy depend on energy retention. If energy retained is 100%, the compression will be lossless and if any values are altered means loss of energy then it will be lossy compression. In these paper comparisons of various method of image compression is illustrate. At the final stage of algorithm we have combine NROI and ROI part and calculate quality measure parameter PSNR values MSE value. Here

the table 1 shows the comparisons of PSNR (in db) and MSE of current method with proposed method in accordance with different bit per pixel of images. We conclude that our proposed method (NROI with BTC algorithm and ROI with ASPIHT) shows better output then previous method (NROI with db6 and ROI with SPIHT). So we obtained a satisfactory result and in future we would try to compress colored image.

Table 1: PSNR and MSE comparisons

S.no	SPIHT(ROI) and db6(NROI)		ASPIHT(ROI) and BTC(NROI)	
	PSNR	MSE	PSNR	MSE
1.	53.32	0.30	60.72	0.05
2.	53.41	0.29	60.43	0.05
3.	53.76	0.27	59.87	0.06
4.	53.85	0.26	59.76	0.06
5.	55.06	0.20	62.86	0.03
6.	56.28	0.15	64.11	0.02

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