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Efficient Segmentation using Region Growing and Lossless Compression of Medical Image using MSPIHT method in Telemedicine Application

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Abstract: Healthcare delivery systems and Telemedical applications will undergo a dramatic change due to the developments in technologies, mobile computing, medical sensors and communication techniques. Medical Images taken as X-ray, Positron Emission Tomography (PET), Magnetic Resonance Imaging (MRI), Ultra Sound and Computed Axial Tomography (CAT) will have medical information either in multi resolution or multidimensional form, this creates large amount of data. Due to this storage of data is become more complex. So compression is needed the one in image processing. Anyhow compression of medical data will leads to loss of information. In order to reduce this complexity, as well as preserve the medical data to be lossless for diagnostics purpose, this paper propose techniques called Region growing and Modified Set Partition In Hierarchical Tree (MSPIHT) will enhance the performance of lossless compression and also enhance the Peak Signal to Noise Ratio (PSNR) and Compression Ratio (CR) than the SPIHT coding method In this proposed method PSNR value is about 65 db for lossless compression and compression ratio is about 1%.

Keywords: SPIHT, MSPIHT, CR, PSNR, LZW, JPEG, DCT

I. INTRODUCTION

In recent year, developments in Healthcare practices and distributed collaborative platforms for medical diagnosis results an efficient technique to compress medical data. Due to this compression we get a more detail about image when compared to original image. There are lots of standard which support compression of data and storage data .The standards are PACS, DICOM, and HL7 etc. The entire above standard mainly deal about compression ratio. The importance of compression has become valuable in developing standards for maintaining and protecting medical images and health records for diagnostics purposes. Compression means to reduce the original size of image and to get detailed information about medical image which is also applicable in telemedicine application, so medical images have attained lot of attention towards compression. Image Compression can be lossy, lossless depending on whether all the information is retained or some of it is discarded during the compression process. The recovered data is identical to the original data, in lossless compression, whereas in lossy compression the recovered data is a close replica of the original with minimal loss of data. The lossless compression can be used for text and medical type images. Lossy compression is used for signals like speech, natural images etc. There has been a lot of research going on in lossless data compression. The algorithms which are available for lossless compression is classified as Pixel level coding, Predictive coding. The algorithms available in pixel level coding are Huffman coding or Entropic coding, Pulse Code Modulation, Run length coding, Arithmetic encoding, Bit plan encoding. The algorithms available in Predictive coding are DPCM, Delta Modulation, 1D-DPCM and for lossy compression transform coding used. The algorithm used here DCT, DST, Slant, KL transform etc. The above algorithms will mainly use to compress the image and to obtain compression ratio. Compression ratio is minimization of the number of bits needed to represent the visual information in the images some case its suitable for audio also. Its main aim is to obtain without noticeable loss of information. So above algorithms will ensure that compression ratio plays an important role in medical diagnostics.

II. SYSTEM ARCHITECTURE

The System Architecture of Image Processing has number of stages to process the image and each stage uses different algorithms. Initially we can use the input image as MRI, CAT, Ultra sound etc. Depend upon application it may vary. In this proposed system MRI used as an input image which act as initial stage. The next step is pre-processing; it is used to enhance the given input image it can be done by various algorithms. The algorithm used in proposed system is explained here. After enhancing the image segmentation process will be done. Segmentation is usually done in image processing in order to partition the image to extract the region of interest. Next step to segmentation is classifying the image as Background, ROI and Non-ROI. And then compression, it plays an important role in image processing. Once image is compressed and output is obtained, decompression will be

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done to reconstruct the image. For decompression also lot of algorithms were used. Depend upon application or given image it will vary.

A. Stage One: Pre-Processing

Pre-Processing refers to initial processing of input image to correct the geometric distortion and eliminate the noise. It's called as pre-processing. Because they are used before real analysis and manipulation if image data in order to extract any specific information. In Pre-Processing two steps involved. First indicates conversion of RGB to gray scale image and second resize the image. In proposed system the algorithm used in pre-processing is Contrast Limited Adaptive Histogram Equalization (CLAHE). It differs from ordinary adaptive histogram equalization in its contrast limiting and it can be applied to global histogram equalization, give rise to Contrast Limited Histogram Equalization (CLHE), which is rarely used in practice. It was used to prevent the over amplification of noise. This algorithm explains as it will partition the images into contextual regions and applies the histogram equalization to each region. It will evens out the distribution of used grey values, makes hidden features of the image more visible and it's used to express the image. A variety of adaptive CLAHE are provided. A variation of the contrast limited technique called Adaptive Histogram Clip (AHC) can also be applied. It automatically adjusts clipping level and moderates over enhancement of background regions of portal images. So it seems a good algorithm to obtain a good looking image directly from a raw image, without window and level adjustment. It's one of the possible way automatically display an image without user intervention.

B. Stage Two: Segmentation

Segmentation is a process of extracting required features or Region of Interest from an image for future purpose like compression. The given or input image is sliced into multiple regions based on some properties like pixels intensity, texture, position or some local (or) global statistical parameter. The algorithm used in this proposed system for segmentation is Region growing method and it consists of two methods. The first method is seeded region growing method, it takes a set of seeds as input along with the image and it requires seeds as additional input. The seeds mark each of the objects to be segmented and compare with pixel value. The pixel with the smallest difference measured is allocated to the respective region the difference between a pixel's intensity value and the region's mean, is used as a measures of similarity, this process continues until all pixels are allocated to a region. The second method is Unseeded region growing. Simply it starts off with a single region. It differs from seeded region growing as if the minimum mean pixel value is less than a threshold T then it is added to the respective region If not, then the pixel is considered as it is different from all current regions and a new region is created with this pixel [7].

C. Stage Three: Classification

In image processing, the images like X-ray, MRI, and CAT are classify into three parts: ROI, non-ROI, background. Depend upon the application we can apply the required transforms and compression methods on the above regions. Background region is discarded or make it zero..Initially, this background is made zero

img [i, j] ≤ x then

img [i, j] = 0

Where x is the threshold value of the background of an Image (img) [3]. So background is not important one.

D. Stage Four: Compression

Image compression deals the problem of reducing the amount of data required to represent a digital image. The Reduction process is the removal of redundant data. According to mathematical view, amount of transforming a two-dimensional pixel array into a statistically uncorrelated data set and it is applied prior to storage or transmission of the image. At receiver side, the compressed image is decompressed to reconstruct the original image. The example given below clearly shows the importance of compression. An image, 1024 pixel 1024 pixel 24 bit, If the image is compressed at a 10:1 compression ratio, the storage is reduced to 300 KB and the transmission time will drop to less than 6 seconds. It classify as two types as Lossless compression and lossy compression.

III. FRAMEWORK OF PROPOSED METHOD

In this proposed work given input image is compressed on the basis of lossless and lossy compression. In lossless compression Modified SPIHT (MSPIHT) Algorithm is applied and at lossy compression Discrete Cosine Transform (DCT) is applied.

A. Existing Method

In Existing method, the given input image is compressed based on SPIHT Algorithm. It divides the set of pixels into partitioning subsets and performs the magnitude test. The inherent characteristics of SPIHT algorithm is efficient completely, embedded, precise rate control, idempotent simple and fast self-adaptive. There are three list are available in order to perform sorting it follow as

LIP - List of Insignificant Pixels

LIS -List of Insignificant Sets,

LSP - List of Significant Pixels.

Lists tested in order of LIP, LIS, and LSP for efficient embedded coding. The initial procedure will start as LIP: Co-ordinates of all tree roots. LIS: Co-ordinates of all tree roots with non-empty descendant roots. LSP: Empty. The memory usages of SPIHT algorithm is Size of transform block (full image for wavelet) < 1/4 block size for LIS and LIP rate-dependent < block size for LSP rate-dependent. The properties of SPIHT is Idempotency - lossless re-compression at same bit rate, re-compression builds same ordered lists and transmits same bits Multiresolution Scalability SPIHT is a simple and efficient algorithm with many unique and desirable properties The main drawback of this method is No floating point multiplications, no estimation, no rate allocation, search only for largest MSB in transform quick first pass, second pass does coding Addressing - increment, decrement, bit shifts and most computation for transform.

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$\text{Max}_{(i,j)\,\varepsilon\,T}\{|C_{i,j}|\} \geq 2^n$

B. Proposed Method

In this proposed method the given image is compressed based on lossless compression by MSPIHT Algorithm and follow by Integer Wavelet Transform (IWT).And then in lossy compression Discrete Cosine Transform (DCT) is applied.. The block diagram of proposed method is shown in fig 2 and fig 1 shows an different parts of input image (MRI).

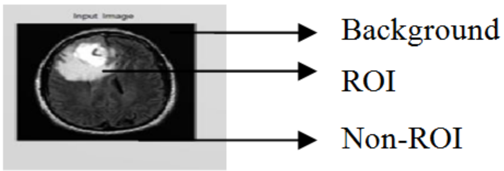

Fig 1 Different parts of Input Image (MRI)

As discuss in stage four compressions, the background is not important one. So it is discarded or make it zero. In this proposed method Region of Interest is extracted from input image by using Binary and Expectation Maximization algorithm. For non-ROI depends upon application DCT, DST etc can be used.

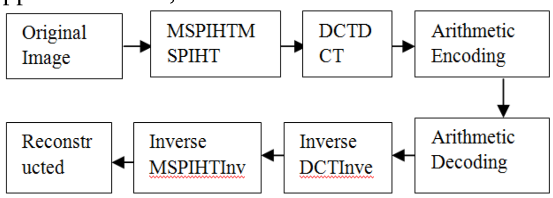

Fig 2 Block Diagram of Proposed Method

1) Lossless Compression

Lossless compression defines as reconstruct the image without any loss of data. So lossless compression is essential one. The algorithm used in lossless compression is MSPIHT. At first the SPIHT coder is a powerful image compression algorithm that produces an embedded bit stream from which the best reconstructed images in the mean square error sense can be extracted at various bit rates. The Modified SPIHT (MSPIHT) coding uses a Quantization Matrix which compresses the encoding redundant bits in the SPIHT encoded bit streams. The perceptual image quality, however, is not guaranteed to be optimum since the coder is not designed to explicitly consider the Human Visual system (HVS) characteristics; there are three perceptually significant activity regions in an image: edge, smooth and textured or detailed regions. By combining the differing sensitivity of HVS to these regions by image compression schemes such as SPIHT, the quality of the images can be improved at lower bit rates. Hence MSPIHT can improve the above image qualities effectively. The algorithm is given as [8].

2) Algorithm

1. Output n = [log (max $_{i,j}\{|C_{i,j}|\}$)] to the decoder
2. Output μ_n, followed by the pixel coordinates $\eta(k)$ and Sign of each of μ_n coefficients such that $2^n \leq |C_{i,j}| < 2^{n+1}$(sorting pass)
3. Output the nth most significant bit of all the coefficients With $|C_{i,j}| \geq 2^{n+1}$(i.e., those that had their coordinates transmitted in previous sorting passes), in the same order used to send the coordinates (refinement pass);
4. Decrement n by one, and go to Step 2.

The following sets of coordinates are used to present the coding method:

O (i, j): set of coordinates of all offspring of node (i, j)
D (i, j): set of coordinates of all descendants of the node
H: set of coordinates of all spatial orientation tree roots (nodes in the highest pyramid level);

L(i, j) = D(i, j) - O(i, j)

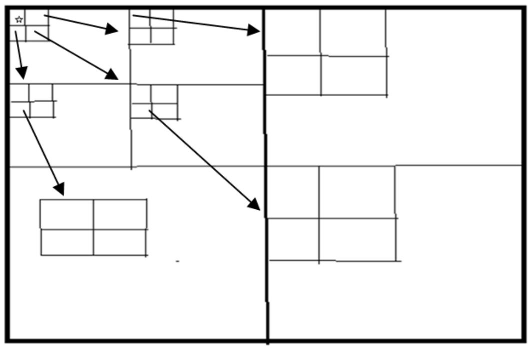

Fig 3 Structure of Modified SPIHT

3) Lossy Compression

Lossy compression is acceptable in many imaging applications. In video transmission, a slight loss in the transmitted video is not noticed by the human eye. Lossy compressors generally obtain much higher compression ratios than do lossless compressors. In order to achieve higher rates of compression, we give up complete reconstruction and consider lossy compression techniques there are two basic lossy compression schemes: One is Transform: In transform coding , samples of picture or sound are taken, divided into small segments, transformed into a samples and these sampled values will be quantized. After process of quantization, coding process i.e. compression will done. The another process is Predictive: In predictive coding, previous or present data used to determine the current sound sample or image. The difference between the predicted data and real data, together will used to extract extra information needed to produce the prediction error, then quantized and coded.In some systems transform and predictive techniques are combined, with transform coding being used to compress the error signals generated by the predictive stage. In proposed work the scheme used for lossy compression is transform coding. Generally different algorithm and techniques are used. The technique used here is Discrete Cosine Transform (DCT).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 .If DCT is said to be linear then it is given as

$T(\alpha p+\beta q) = \alpha T(p) + \beta T(q)$

Where α and β are constants and p and q are any functions, variables or constants.

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IV. QUALITY MEASURES

The Quality of the reconstructed image is measured in terms of Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Compression Ratio (CR).

A. Mean Square Error

The MSE is also called as reconstruction error variance or distortion and it is defined as difference between the original image and the reconstructed image as given as

$$\text{MSE (db)} = 10\log10\ [1/N*N\textstyle\sum_{i=0}^{N*N}(X_i - Y_i)^2]$$

B. Peak Signal to Noise Ratio

The PSNR is defined as the ratio between signal variance and reconstruction error variance. The PSNR between two images in terms of decibels (dBs) is given by

$$\text{PSNR} = 10\log10\ (255^2/\text{MSE})\ \text{db}$$

C. Compression Ratio

The term CR is defined as the ratio of the number of bits required to represent the image before compression to the number of bits required to represent the image after compression and it is given as

CR=Original Image/Reconstructed Image

V. CONCLUSION

This paper discussed about the efficient image segmentation and image compression using Modified SPIHT algorithm. It gives high Compression Ratio (CR) and Peak Signal to Noise Ratio (PSNR) when compared to SPIHT algorithm and thus expected values are achieved.

OUTPUT

The output of this proposed method is shown in fig 5 as difference between the input image and compressed image. The compressed image has given more detail then the input image. Table 1 show an output of proposed method which gives expected values for PSNR and CR using MSPIHT and DCT and overall compression ratio is 0.3665

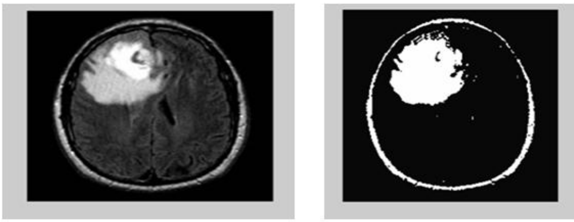

Fig 4 Difference between the input image and Compressed Image

TABLE 1
OUTPUT VALUES USING PROPOSED METHOD

Compression	PSNR (dB)	Compression Ratio (CR)
Lossless compression (ROI)	69.50 db	0.5540
Lossy compression (non-ROI)	13.20 db	1.0834
Compression of full image using DCT	35.30 db	0.2770

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