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Region Based Lossless Compression for Digital Images in Telemedicine Application

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ABSTRACT:

Region Based Coding Technique is significant for medical image compression and transmission. In medical images, only a small portion of the image might be diagnostically useful. In these regions, lossless compression can helps to achieve high efficiency performance in telemedicine applications. This paper proposes a very efficient and low complexity compression method for Digital Imaging and Communications in Medicine (DICOM) images. Main advantages of Region based coding technique is exploited in this paper. Segmentation of these regions leads to optimal performance. Here the ROI part of the image is identified by manually and combined with effect of Integer Wavelet Transform (IWT). IWT compression technique is useful to reconstruct the original image, reversibly with desired quality. The overall compression process helps to reach a satisfactory level for image transmission in limited bandwidth over a telemedicine application.

Keywords: Compression, Discrete Cosine Transform (DCT), Integer Wavelet, Region of Interest (ROI).

I INTRODUCTION

The objective of image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form Image compression may be lossy or lossless. Lossless compression is preferred for archival purposes and often for medical imaging, technical drawings, clip art, or comics. Lossy compression methods, especially when used at low bit rates, introduce compression artifacts. Lossy methods are especially suitable for natural images such as photographs in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. The lossy compression that produces imperceptible differences may be called visually lossless.

Methods for lossless image compression are:

- Run-length encoding – used as default method in PCX and as one of possible in BMP, TGA, TIFF
- DPCM and Predictive Coding

- Entropy encoding
- Adaptive dictionary algorithms such as LZW – used in GIF and TIFF
- Deflation – used in PNG, MNG, and TIFF
- Chain codes

Methods for lossy compression:

- Reducing the color space to the most common colors in the image. The selected colors are specified in the color palette in the header of the compressed image. Each pixel just references the index of a color in the color palette, this method can be combined with dithering to avoid posterization.

- Chroma subsampling. This takes advantage of the fact that the human eye perceives spatial changes of brightness more sharply than those of color, by averaging or dropping some of the chrominance information in the image.

- Transform coding. This is the most commonly used method. In particular, a Fourier-related transform such as the Discrete Cosine Transform (DCT) is widely used: N. Ahmed, T. Natarajan and K.R.Rao, "Discrete Cosine Transform," IEEE Trans. Computers, 90-93, Jan. 1974. The DCT is sometimes referred to as "DCT-II" in the context of a family of discrete cosine transforms; e.g., seediscrete cosine transform. The more recently developed wavelet transform is also used extensively, followed by quantization andentropy coding.

- Fractal compression

The best image quality at a given bit-rate (or compression rate) is the main goal of image compression, however, there are other important properties of image compression schemes: Scalability generally refers to a quality reduction achieved by manipulation of the bitstream or file (without decompression and re-compression). Other names for scalability are progressive coding or embedded bitstreams. Despite its contrary nature, scalability also may be found in lossless codecs, usually in form of coarse-to-fine pixel scans. Scalability is especially useful for previewing images while downloading them (e.g., in a web browser) or for providing variable quality access to e.g., databases. There are several types of scalability:

- Quality progressive or layer progressive: The bitstream successively refines the reconstructed image.
- Resolution progressive: First encode a lower image resolution; then encode the difference to higher resolutions.
- Component progressive: First encode grey; then color.

Region of interest coding. Certain parts of the image are encoded with higher quality than others. This may be combined with scalability (encode these parts first, others later). Meta information. Compressed data may contain information about the image which may be used to categorize, search, or browse images. Such information may include color and texture statistics, small preview images, and author or copyright information. Processing power. Compression algorithms require different amounts of processing power to

encode and decode. Some high compression algorithms require high processing power.

The quality of a compression method often is measured by the Peak signal-to-noise ratio. It measures the amount of noise introduced through a lossy compression of the image, however, the subjective judgment of the viewer also is regarded as an important measure, perhaps, being the most important measure.

II. LITERATURE SURVEY

A. An Interactive tool for ROI Extraction and Compression on Whole Side Images: This paper was published in IEEE/2016 by Yuhang Dong, Hongda Shen and W. David Pan. In this paper, we presented an integrated graphical user interface (GUI) tool, which supports interactive regions of interest (ROIs) extraction from whole slide imagery and provides lossless compression of the ROIs extracted, leading to over 40 times compression on the original images.

B. A Joint 3D DWT and SPIRT based algorithm for 3D MRI image Compression: This paper is published in IEEE/2015 by Safa Vakili, Mehdi Khalili they use the 3D magnetic resonance imaging; symmetric wavelet transform; decoupled wavelet transform; SPIHT. In this paper, an effective algorithm is proposed to compress the magnetic resonance imaging (MRI) image. In the proposed scheme, 3D discrete wavelet transform (DWT) and set partitioning in hierarchical tree (SPIHT) coding are jointed to achieve more desired quality image. The proposed scheme not only achieves the satisfactory MRI image quality reconstruction, but also improves the results.

C. Irreversible wavelet compression of radiological image based on visual threshold: The paper was published in 2015 IEEE by scholar Chandrika B.K. , Aparna P. and Sumam David S, the method used in their paper is Discrete wavelet transform. This paper proposes a novel coding scheme in which wavelet based visual model is embedded into lossless compression algorithm to compress the volumetric medical image data gray scale radiologic images. A wavelet based visually lossless approach is proposed to have both better image quality and compression ratio.

D. An efficient block based lossless compression of medical images: Published by Dr. Venugopal ,S. Mohan , Sivanantha Raja in Elsevier/2015, the method involved is LHT and Huffman coding technique. In the proposed algorithm, lossless compression of medical images is done using LHT and Huffman coding .Here simple validation of NBT , proper truncation and fairer evaluation of DC are used .The proposes algorithm that is best suited for medical image and satisfy the requirement of band effective storage and useful for telemedicine applications. The main drawback is that it is not for color medical image compression.

III PROPOSED SYSTEM

For adaptive thresholding algorithm input is grayscale or color image. After the implementation of algorithm binary image is output of adaptive thresholding. In the given image threshold value for each image

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calculated. If the pixel value is below the threshold it is set to the background value, otherwise it assumes the foreground value. In Adaptive thresholding, there are two main approaches to finding the threshold such as,

- the Chow and Kaneko approach
- local thresholding.

The assumption behind both methods is that smaller regions in an image are more likely to have approximately uniform illumination.

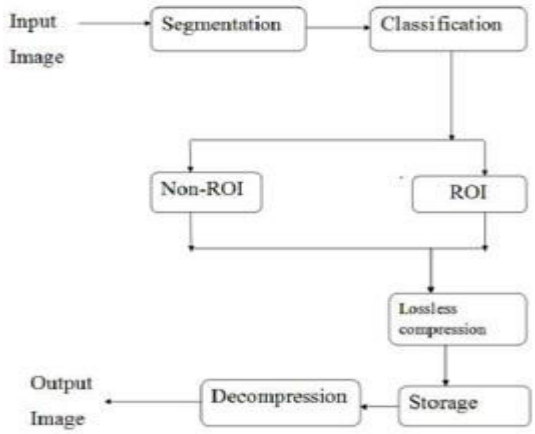

Fig 1: Block diagram of Proposed system

Chow and Kaneko divide an image into an array of overlapping sub-images and then find the optimum threshold for each sub-image. The threshold for each single pixel is found by interpolating the results of the sub-image. The main drawback is that it is computational expensive and not appropriate for real time applications. Local thresholding method used to calculate the intensity values of the local neighborhood of each pixel. The statistic which is most appropriate depends largely on the input image. The mean of the local intensity distribution is

T=mean the median value,

T=median

or the mean of the minimum and maximum values,

T = (max + min) / 2

IV. METHODOLOGY

ROI concept is introduced owing to limitations of lossless and lossy compression techniques. Most of the lossless compression techniques, the compression ratio are near to 80% of original size, whereas for lossy encoders the compression ratio is much higher (up to 5-30 %) [1][3] but there may be significant loss in data. This loss may hamper effective treatment, losing diagnostically important parts of the medical image. Hence, there is a need for lossless compression technique which will preserve diagnostically important part (ROI) as well as provide high compression ratio [1][6]. The functionality of ROI is important in medical applications where certain parts of the image are of higher diagnostic importance than others. For most medical images, the diagnostically significant information is located over relatively small regions, near about 5-10 % of the total area of the image. In such cases, these regions need to be encoded at a higher quality than the background, lesser important regions. During image transmission for telemedicine purposes, these regions are required to be transmitted first or at a higher priority. The comparison of different ROI-based coding techniques is summarized [7]. The JPEG 2000 imaging standard has been tested in previously published works on medical images. A major drawback is that it does not support lossy to lossless ROI compression. An overview of ROI coding scalable techniques applied on medical images is summarized in [6][7], which

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further proposes an ROI-based coding technique based on Discrete Wavelet Transform (DWT). The observed drawback of this method is that every time, in each sub-band the information about the ROI shape has to be maintained. This may increase computational complexity. Here in this proposed work, an attempt has been made to reduce this complexity.

V. RESULTS

This section will present the simulation results and performance analysis of our proposed scheme. The presentation focuses on the recovery performance of our scheme in various situation.

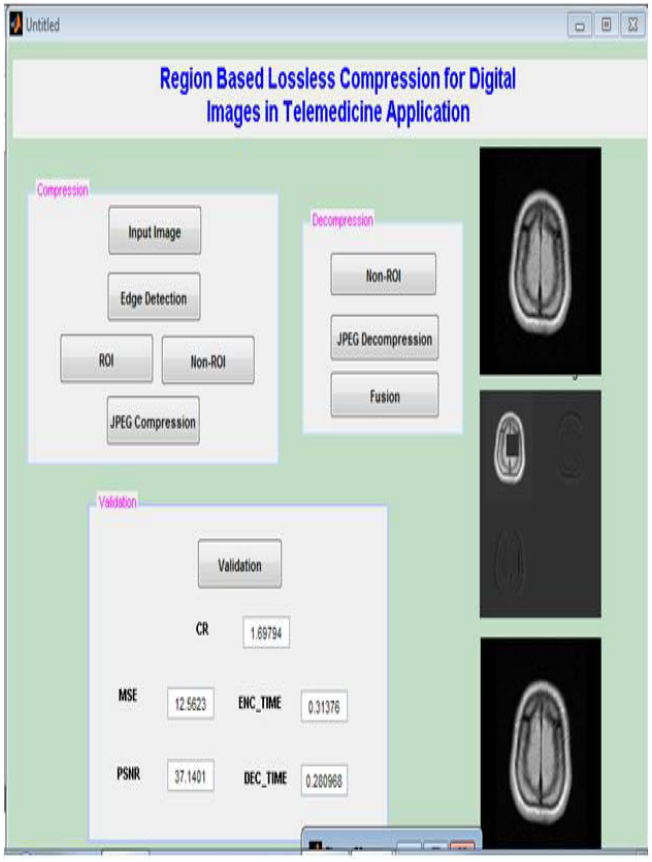

Fig 2: Simulation Output

Fig 3. Original Image

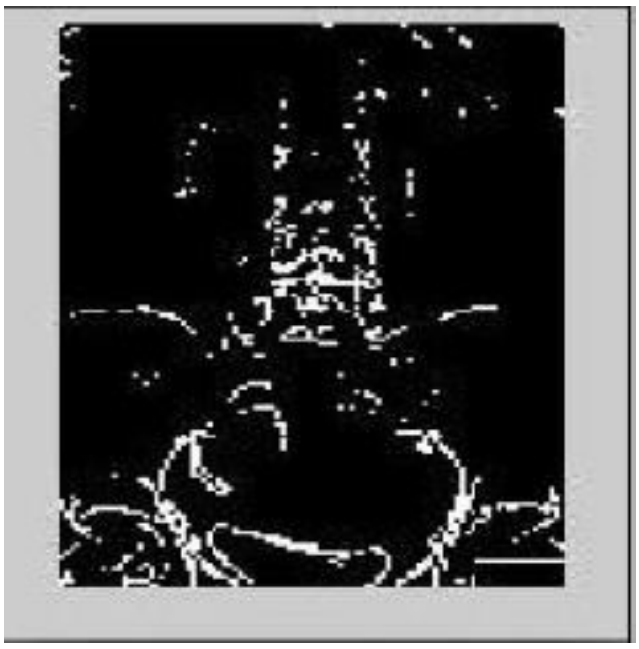

Fig. 4. Region Growing

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Fig. 5. ROI Detection

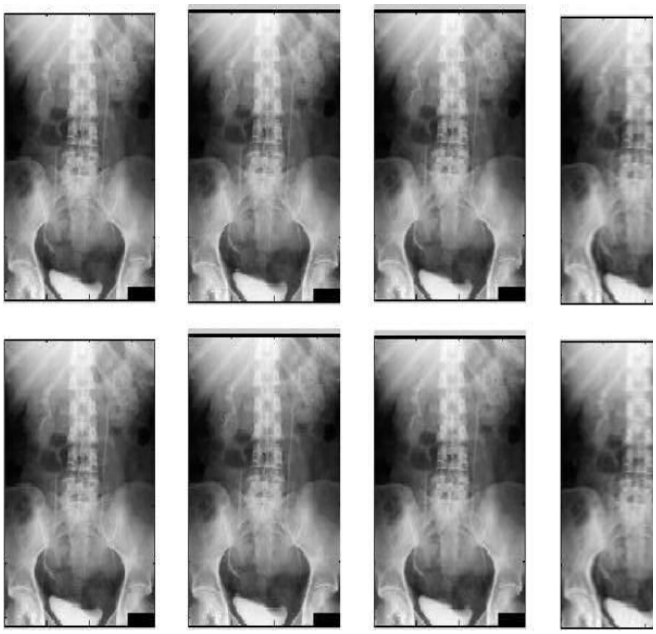

Fig 6: Results of compression algorithm (from left to right) original image, compression factor 2, compression factor 4, compression factor 8.

VI. CONCLUSION

This paper discusses ROI-based medical image compression. IWT is recommended for medical image applications because of the perfect reconstruction with low computation complexity. Different techniques can be used for non-ROI compression of medical images. Non-ROI part must be encoded, because it gives the accurate position of ROI. ROI based coding is used along with compression for non- ROI reflects an accurate measure of performance. ROI based compression provides better performance compared with other methods. The proposed technique is less complexity and allows progressive transmission in telemedicine applications.

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