Region of Interest based Compression Techniques for Telemedicine Application

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Abstract **-** Recent years there have been great developments in the field of telemedicine and medical imaging. Storage and Compression of medical data remain challenging. Hospital produces a number of images per diagnosis. So, there are a lot of problems to manage the storing facilities and also need of high bandwidth. It is required to reduce the data size to be transmitted. Therefore, there is an enormous need of compression. In medical field only the small portion of the image is more useful. Region Based Coding (RBC) techniques are more considerable in medical field for the sake of efficient compression and transmission. The reason behind for including the regions other than ROI is to make user as more easily to locate the position of critical regions in the original image. So for fulfilling the requirement various image compression techniques are discussed and compared in this paper.

Keywords—*Telemedicine,Compression techniques,Region of interest.*

I. INTRODUCTION

Telemedicine is the use of medical information such as X-ray images, exchanged from one site to another through electronic communications to improve a patient's clinical health status [1].

Telemedicine is not a separate medical specialty. It is the remote delivery of health care services over the telecommunications infrastructure. The main goal behind this concept is to overcome distance barriers and to connect users who are not in the same physical location. Telemedicine use the variety of Information and communication technologies. It supports to improve health outcomes [1], [2]. In telemedicine network growing variety of applications are used to make the communication more effective. Some of those are video conferences, email, smart phones, wireless tools and many other form of telecommunications technology.

In medical imaging, large amount of data is produced such as ultrasound images, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), X-ray which can be stored in hospital information system for future use [2].

Hospital produces a number of images per diagnosis and this can lead to produce the 5 GB to 15% GB data. It increases the difficulties for a hospital storage system to store and manage it. Moreover, for transmission of medical image data, there is a need of high bandwidth which is not possible, especially in rural area [2]. Image compression is useful in reducing the storage and transmission bandwidth requirements. The medical images are bitmap images (too large) so, need of high compression. In case of medical images, quality of the image matters a lot. There are following compression techniques.

II. COMPRESSION TECHNIQUES

Compression is used to reduce the size of data by eliminating redundancy in file. It also helps to reduce the storage space of hard disk by reducing the size of an image [3]. It is useful in reducing the time needed to transmit the data over internet or to reduce the transmission bandwidth. Compression can be lossy or lossless.

A. Lossy compression

In lossy compression and decompression, there is loss of image information. The new constructed image is not similar to the original one [3]. Lossy methods are especially suitable for some application where natural images such as photographs in applications where minor loss of fidelity is acceptable to achieve a substantial reduction in bit rate.

- Transformation coding
- Vector quantization
- Fractal coding
- Block Truncation Coding
- Sub band coding are the main techniques used in lossy compression [4]

B. Lossless compression

In lossless compression techniques, the original image can be exactly recovered from the compressed (encoded) image. There is no loss of quality of image. This method is appropriate for reducing file sizes. Also this can be applied to both image and audio files [3],[4]. However, because no quality is lost, the resulting files are typically much larger than image and audio files compressed with lossy compression.

- Run length encoding
- Huffman encoding
- LZW coding
- Area coding

These are the techniques used in lossless compression [4]. These techniques form the basis of many compression algorithms.

III. REGION OF INTEREST

ROI (Region of Interest) concept is introduced due to the limitation of both lossy and lossless compression. ROI in the image contain the significant information localized over smaller regions, about the 5 to 10% of the total image [1]. These small regions are more important than other regions. In lossless compression techniques the compression ratio is 25%.In case of lossy compression, it is much higher, but there is loss of data[1]. This is the main disadvantage of lossy techniques. Because this loss is unacceptable in the case of medical image. So, there is need of those techniques which are more efficient and will take care of diagnostically important part (ROI) as well as will provide the high compression rate [1],[2].

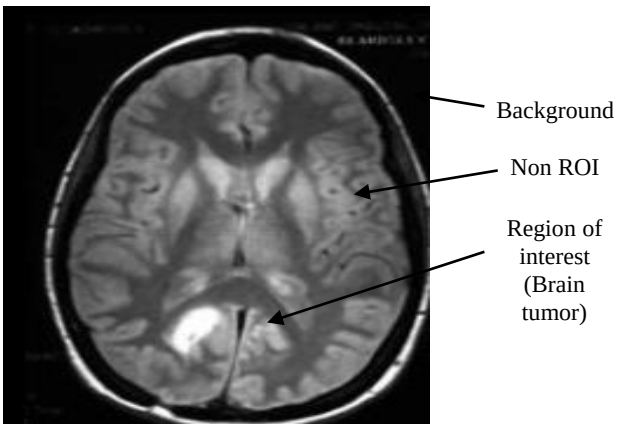

Fig.1: Different parts of an image

A. Image Segmentation

Image Segmentation is the process of subdividing the image into its component regions or objects. It is an important step in image analysis [1].

Image segmentation should stop when regions of interest have been isolated. The simplest segmentation method is called the threading method. It is based on threshold values .It turns the gray scale images into binary images [1].

- The image background is detected with the help of threshold values [2].
- The image background value is less than the threshold values [2].
- ROI-mask is generated so that the foreground is totally included and background pixel values made zero [2].

B. Classification

In digital image processing all digital images contains the following three parts:

- ROI(the diagnostically important part)
- Non-ROI part
- Background part of the image

1) ROI detection:

Initially, the background is made zero using image segmentation.

$$Img\ [i, j] \leq x\_th, \text{ then } img[i, j] = 0. \quad (1)$$

In this equation *x_th* is the threshold value of an image (img) background. Then the ROI part is classified from image.ROI is detected by an automated process. ROI-mask is generated in which foreground part of the image totally included in that mask[2]. Morphological operations are used, which contain the values. The image foreground value is '1'and background is '0'.Then the following and operation is applied to separate-out ROI and Non-ROI in equation 2.

$$ROI\ \_mask \&\& img = I\ MG\_ROI. \quad (2)$$

C. ROI and non-ROI processing

In this, both ROI and non-ROI are processed separately as per the user requirements.ROI with any lossless and Non-ROI will be compressed with any accepted lossy technique. This is shown in figure 3.

- ROI is the main part of the image, so it is required to compress that portion very carefully and without any loss. Any loss is unacceptable in this case because it is diagnostically important part. So, ROI part will be processed by Lossless compression such as Huffman, Arithmetic, RLE, LZW, ZIP, JPEG2000etc. These methods preserve the diagnostically important part (ROI).
- The main reason for preserving the non-ROI is make user as more easily to locate the position of important regions in the original image .The non-ROI is compressed by SPIHT, lossy version of JPEG ,Fractal compression etc.

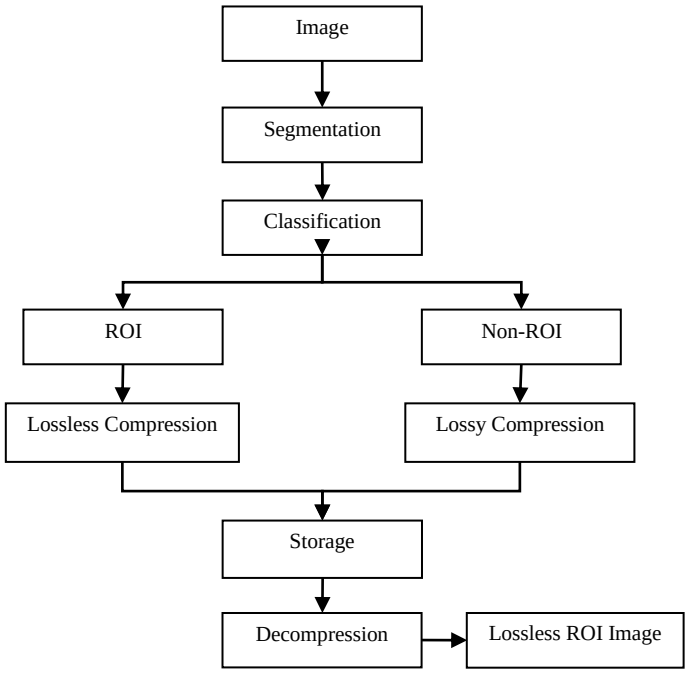

Fig.2: Methodology for ROI Compression

D. Related work

For any type of compression method the most required properties for medical images include the following factors:

- High lossless compression ratios for images
- Resolution scalability: It is the ability to decode the compressed image at a variety of resolutions levels
- Quality scalability: It is the ability to decode the compressed image at various qualities such as signal-to-noise ratios (SNR) up to lossless reconstruction of image.

Dr.S.Shenbaga Devi K.Vidhya in 2009 have described a wavelet-based compression with SPIHT (set partitioning in hierarchical trees), it gives extremely good results in the medical image compression for telemedicine applications. The SPIHT algorithm performs better than the standard JPEG compression in both manners objective and subjective. In subjective manner, the visual inspection of the compressed images and the experiments are carried out among different images at a range of bit rates (bpp) and decomposition levels. In order to reduce the storage cost, diagnostic analysis cost and transmission time without significant reduction of the image quality, M. Firoozbakht in 2010 has implemented a context-based and regions of interest (ROI) based approach .This is especially to compress vascular type medical images where ,there is requirement of high resolution and contrast.IWT is recommended in (Vinayak K and Ashok M Sapkal 2014), for critical medical application because of its perfect reconstruction property. The floating point representation of the DWT gives small error in the system. ROI-based compression is providing better results as compared with lossless methods, along with preservation of diagnostically important information.In 2009 Puja Bharti, Dr. Savita Gupta and Ms. Rajkumari Bhatia proposed a compression technique for telemedicine applicatons in which the both images i.e the Decompressed and original image are more likely when the SPIHT/SPIHT ROI hybrid methods are used. Results show the higher values of Correlation and PSNR. Further, it is concluded that it is always good to take two regions i.e. ROI and background and then apply compression on image rather than taking image as one region.

Various region based techniques are detailed and compared in (Doukas & Maglogiannis 2007), the general scaling, the MAXSHIFT, the EZW-based, and the ROI-VQ methods have one thing same i.e the requirement of additional coefficients to decode the object. But the rest of the detailed techniques require the same number of coefficients as the entire image for both the background and the ROI.

In (Dhaarani,Venugopal and Raja 2014)combination with ripplet transform the Huffman algorithm is used as compression method of gray scale medical images. It works well for the images of different sizes and also gives better PSNR, low MSE compared to various previous compression schemes.

Transmission over internet goes more complicated with Resolution Factor and number of images (Adina Arthur and V.Saravanan 2012) in this paper author firstly studied compression techniques and compared Algorithm LZW, JPEG, MPEG, with lossy compression methods and also uses Huffman coding. A new method is then achieved by improving the prediction model which is used in JPEG i.e improved DPCM.It shows the better results for telemedicine applications.

Radon transformation (Sujitha Juliet and Ezra 2014**)**is also used for medical image compression. Its basic functions are effective and it computes projections of the images. The periodic re-ordering of the elements of radon projections needs minimal interpolation and preserves all of the original image pixel intensities. Then, resultant Randon coefficients are encoded with SPIHT.It performed well in all the ways and gives results with high compression ratio, PSNR and computational time. PSNR value can be improved using system error compensation method (Tanasak Phanprasit 2013).This method is based upon quantization curvelet transformation decomposes the errors into six scale. Only one and six scale number is used in encoding. Both bit rate and PSNR can improve by 40.48%, 9.69% when compared to the existing methods. High Efficiency Video Coding provides an improvement to medical image compression in communication and picture archiving system.

E. Comparison table of various techniques

Reference	ROI Coding Method	Medical Image category	Additional Coefficients to Decode the Object	Exact decoding of object	Results (PSNR in dB) (bits per pixel)
[1][2]	IWT	2-D still images	Required	Not Possible	35 (0.8 bpp)
[5]	ROI-VQ	2-D still images	Required	Possible	31.58 (0.03 bpp)

[13]	Lossy-to-lossless ROI coding	2-D still images	Not Required	Not Possible	44.4 (0.08 bpp)
[15]	General ROI-based Scaling method.	2-D still images	Required	Not Possible	44.91(0.08 bpp)
[18]	DWT	Volumetric images	Not Required	Possible	52.5 (0.50 bpp)
[19]	MAXSHIFT	2-D still images	Required	Not Possible	44.90 (0.08 bpp)
[20]	Extended 3D-SPIHT	Volumetric images	Not Required	Not Possible	38.78 (0.52 bpp)
[21]	Hybrid coder	Volumetric images	Not Required	Possible	32.0 (0.52 bpp)

IV. CONCLUSION

Medical images contain redundancy. We can identify that redundancy and compress images so that the size of image gets reduced. This paper discussed a ROI based medical image compression techniques both lossy and lossless such as DWT, EZW, VQ, SPIHT, IWT, MAXSHIFT, JPEG2000, etc. For ROI part of an image a lossless compression is used and non ROI is compressed with lossy technique. These techniques have different characteristic to compress the image .But these techniques have some drawbacks .The research is going on to overcome these shortcomings and also to enhance quality of the reconstructed image with high compression rate, PSNR for medical image.

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