Implementation of Region Based Medical Image Compression for Telemedicine Application

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Abstract: Many classes of images contain spatial regions which are more important than other regions. Compression methods capable of delivering higher reconstruction quality for important parts are attractive in this situation. For medical images, only a small portion of the image might be diagnostically useful, but the cost of a wrong interpretation is high. Hence, Region Based Coding (RBC) technique is significant for medical image compression and transmission. Lossless compression schemes with secure transmission play a key role in telemedicine applications that help in accurate diagnosis and research. In this project, we propose lossless scalable RBC for Digital Imaging and Communications in Medicine (DICOM) the images based on Integer Wavelet Transform (IWT) and with the distortion limiting compression technique for other regions in image. The main objective of this work is to reject the noisy background and reconstruct the image portions losslessly. The compressed image can be accessed and sent over telemedicine network using personal digital assistance (PDA) like mobile.

1. INTRODUCTION

Large amount of image data is produced in the field of medical imaging in the form of Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Ultrasound Images, which can be stored in picture archiving and communication system (PACS) or hospital information system. A medium scale hospital with above facilities produces on an average 5 GB to 15 GB of data. So, it is really difficult for hospitals to manage the storing facilities for the same. Moreover, such high data demand for high end network especially for transmitting the images over the network such as in telemedicine.

This is significant for telemedicine scenario due to limitations of transmission medium in Information and Communication Technology (ICT) especially for rural area. Image compression is useful in, reducing the storage and transmission bandwidth requirements of medical images.Compression methods are classified into lossless and lossy methods. In the medical imaging scenario, lossy compression schemes are not generally used. This is due to possible loss of useful clinical information which may influence diagnosis. In addition to these reasons, there can be legal issues. Storage of medical images is generally problematic because of the requirement to preserve the best possible image quality which is usually interpreted as a need for lossless compression.3D MRI contains multiple slices representing all information required about a body part.

Some of the most desirable properties of any compression method for 3D medical images include:

(i) High lossless compression ratios
(ii) Resolution scalability, which refers to the ability to decode the compressed image data at various resolutions
(iii) Quality scalability, which refers to the ability to decode the compressed image at various qualities or signal-to-noise ratios (SNR) up to lossless reconstruction.

2. DICOM

The DICOM (Digital Imaging and communications in Medicine) standard is the backbone of modern image display, equivalent only to film in the pre-digital era. Since the inception of this standard some 20 years ago, it has become the driving force behind the entire imaging workflow. DICOM truly controls all parts of digital image acquisition, transfer and interpretation, and many radiologists and other imaging specialists and users may not realize to what extent their work relies on DICOM capabilities. DICOM defines medical device functionality in very precise and device-independent terms. Working with medical devices through their DICOM interfaces becomes a very straightforward process, leaving little room for errors.

To introduce order into the complex medical environment, DICOM uses its own lingo, based on its model of the real world (DICOM information model). Here is that model in a nutshell. All real-world data – patients, studies, medical devices, and so on – are viewed by DICOM as objects with respective properties or attributes. The definitions of these objects and attributes are standardized according to DICOM Information Object Definitions (IODs). Think about IODs as collections of attributes, describing each particular data object. A patient IOD, for example, can be described by name, medical record number (ID), sex, age, weight, smoking status, and so on – as many attributes as needed to capture all clinically relevant patient information.

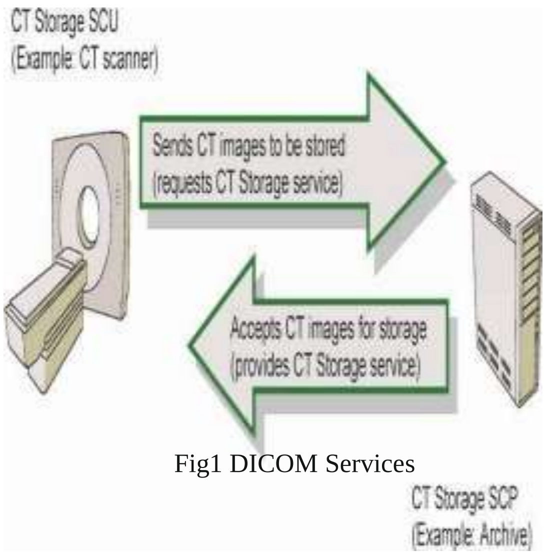

Fig1 DICOM Services

2.1 Image compression: Framework and performance evaluation

Image compression aims at removing or at least reducing the redundancy present in the original image representation. In real world images, there is usually an amount of correlation among nearby pixels which can be taken advantage of to get a more economical representation. The degree of compression is usually measured with the so-called compression ratio(CR), i.e., the ratio of the size of the original image over the size of the compressed one in bytes. For example, if an image with (contrast) resolution of 8bits/pixel (8 bpp) is converted to a 1 bpp representation the compression ratio will be 8:1. The average number of bits per pixel (bpp) is referred to as the bit schemes into two types

2.1.1 Lossless

These methods (also called reversible)reduce the inter-pixel correlation to the degree that the original image can be exactly reconstructed from its compressed version.However, although the attainable compression ratio depends on the modality, lossless techniques cannot give compression ratios larger that 2:1 to 4:1 .

2.1.2 Lossy

The compression achieved via lossless schemes is often inadequate to cope with the volume of image data involved. Thus, lossy schemes (also called irreversible)have to be employed, which aim at obtaining a more compact representation of the image at the cost of some data loss, which however might not correspond to an equal amount of information loss. Compression ratios achieved through lossy compression range from 4:1 to 100:1 or even higher.

2.1.3 Wavelet Transform

The term wavelet refers to an oscillatory vanishing wave with time-limited extend, which has the ability to describe the time-frequency plane, with atoms of different time supports Generally, wavelets are purposefully crafted to have specific properties that make them useful for signal processing. They represent a suitable tool for the analysis of non-stationary or transient phenomena.

Wavelets are a mathematical tool, that can be used to extract information from many kinds of data, including audio signals and images. Mathematically, the wavelet, is a function of zero average, having the energy concentrated in time:

$$\int_{-\infty}^{\infty} \varphi(t)dt = 0 \qquad (2.16)$$

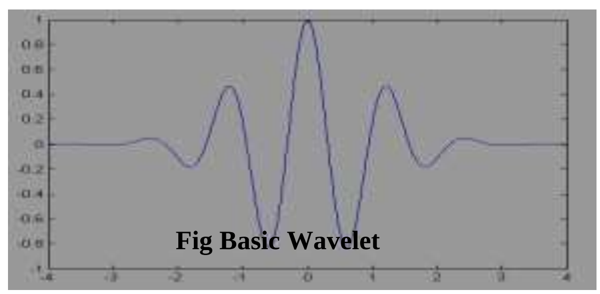

Fig Basic Wavelet

The wavelet analysis is performed by projecting the signal to be analyzed on the wavelet function. It implies a multiplication and integration.

Depending on the signal characteristics that we want to analyze, we can use different scale and translation of the mother wavelet. The particularity of the wavelet analysis is that it allows us to change freely the size of the analysis function (window), to make it suitable for the needed resolution, in time or frequency domain. For high resolution in time-domain analysis we want to capture all the sudden changes that appear in the signal, and we do that by using a contracted version of the mother wavelet. Conversely, for high-resolution in the frequency-domain we will be using a dilated version of the same function.

we can conclude that the Wavelet Transform can be seen as a convolution between the signal to be analyzed and the reverse function derived from the Mother Wavelet.

3 PROPOSED METHOD

If we consider any medical image it requires large amount of data for storage and requires large transmission bandwidth, so we have to compress medical image.

A medical image for Compression can be a single image or sequence of images. The diagnostic data produced by hospitals has geometrically increased. Some of medical images which indicate that a compression technique is needed that results with greater data reductions and hence transmission speed. In medical cases, a lossy compression method that preserves the diagnostic information is necessary. Recently ROI based coding has also been proved as a good approach for medical image compression especially in telemedicine applications. Region of interests (ROI) are those regions which can be given more importance in any given image.

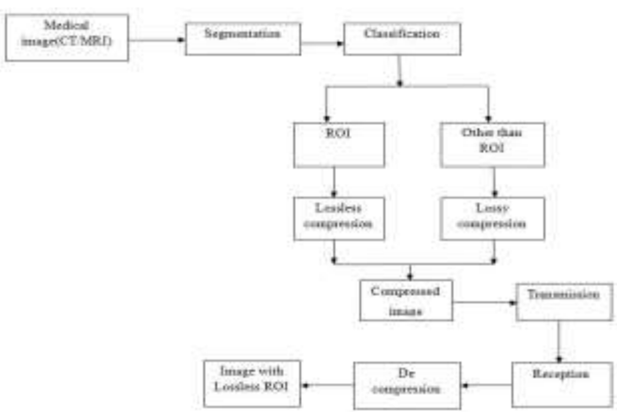

Fig 3.1 ROI based DICOM image compression

If loss of quality is affordable, then many compression schemes produce high compression rates for general images.

3.1 SPIHT Algorithm

In a wavelet-based still image coding algorithm known as set partitioning in hierarchical trees (SPIHT) is developed that generates a continuously scalable bit stream. This means that a single encoded bit stream can be used to produce images at various bit-rates and quality, without any drop in compression. The decoder simply stops decoding when a target rate or reconstruction quality has been reached. In the SPIHT algorithm, the image is first decomposed into a number of sub bands using hierarchical wavelet decomposition. The sub bands obtained for two-level decomposition are shown in Fig 3.2.1 The sub band coefficients are then grouped into sets known as spatial-orientation trees, which efficiently exploit the correlation between the frequency bands. The coefficients in each spatial orientation tree are then progressively coded bit-plane by biplane, starting with the coefficients with highest magnitude and at the lowest pyramid levels. Arithmetic coding can also be used to give further compression.

In general, increasing the number of levels gives better compression although the improvement becomes negligible beyond 5 levels. In practice the number of possible levels can be limited by the image dimensions since the wavelet decomposition can only be applied to images with even dimensions. The use of arithmetic coding only results in a slight improvement for a 5 level decomposition.

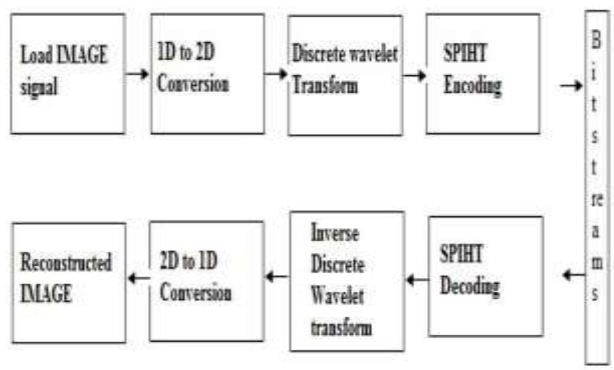

Fig 3.2 proposed block diagram for DWT-SPIHT encoding and decoding

The method provides the following which requires special attention.

1. Good image quality and high PSNR especially for the color images
2. It is optimized for progressive image transmission
3. Produces a fully embedded coded file
4. Simple quantization algorithm
5. Can be used for lossless compression
6. Can code to exact bit rate or distortion
7. Fast coding/decoding (nearly symmetric)
8. Has wide applications, completely adaptive

4. RESULTS

In this paper we have taken different medical images and compress those images by using Integer wavelet transform and SPIHT algorithms. Below figures represent the results of our project.

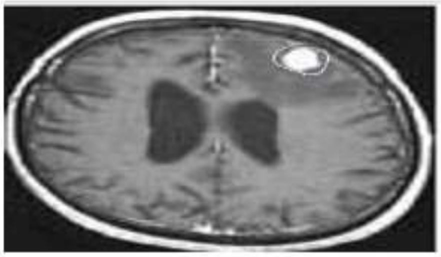

Fig 4.1 original image

From Fig 4.1 we can observe that the medical image contains tumor part which is diagnostically more important than other so it is consider as ROI part. Remaining part to be consider as a NON- ROI part. Region based coding is significant for medical image compression and transmission. Lossless compression schemes with secure transmission play a key role in Telemedicine applications that helps in accurate diagnosis and research. .

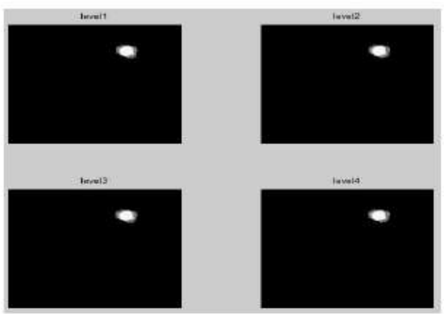

Fig 4.2 compressed ROI part

In this project, we propose lossless scalable RBC for Digital Imaging and Communications in Medicine (DICOM) the images based on Integer Wavelet Transform (IWT) and with the distortion limiting compression technique forother regions in image.

The Fig 4.2 represents the selection of ROI part by using in freehand method. A freehand region of interest can be dragged interactively using the mouse.

Fig 4.3 Compressed image

After separation of both ROI part and NON-ROI part we have to apply Integer wavelet transform to ROI part and SPIHT to NON-ROI part. We use wcompress method for compression of NON-ROI part. wcompress True compression of images using wavelets. ROI part will be compressed losslessly by using lifting wavelet transform.

5. CONCLUSION

Every image contains some redundant information, which needs to be identified by the user to obtain compression. The floating point representation of the DWT gives small error in the system. The IWT is recommended for critical medical application because of its perfect reconstruction property. ROI-based compression is providing better results as compared with lossless methods, along with preservation of diagnostically important information. we have concluded that ROI based image compression is the best one. Bythis analysis we make sure that the compressed image will be helpful in telemedicine. After this compression we can send the medical image through mobile.

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