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Region based Coding of 3D Magnetic Resonance Images for Telemedicine Applications

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ABSTRACT
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 paper we propose a lossless compression approach based on 3D integer wavelet transform, 3D SPIHT algorithm of MR images. The use of lifting scheme allows to generate truly lossless integer to integer wavelet transforms. The main objective of this work is rejects the noisy background and reconstructs the image portion losslessly. In this work different integer wavelet transforms will be used to compress the 3D MR images. The performance of the system has been evaluated based on bits-per-pixel and peak signal-to-noise ratio.

Keywords
3D SPIHT algorithm, Integer Wavelet Transform, Lossless compression, Medical Image Compression, Region Based Coding.

1. INTRODUCTION
Image compression is useful reducing the storage and transmission bandwidth requirements of medical imges.Compression methods are classified into lossless and lossy methods. In the medical image 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 magnetic resonance image (MRI) data, which contains multiple slices representing a part of a body, requires compression for efficient storage and transmission. Compression of medical data is also required in telemedicine applications where image data needs to be transmitted over the network. Lossless compression, Progressive transmission and region of interest (ROI) are important functionalities for a compression scheme. Wavelet-based techniques are the latest development in the field of image compression. It offers multiresolution capability that is not available in any of the other methods. The wavelet transform analyzes a signal in time and scale. The low frequency components in the signal that are spread out in time, as well as the high frequency components that are localized in time are captured by a variable-length window [3]. The window is shifted by different units of time in a discrete manner, thus covering the entire signal. Lifting is a technique used in constructing second generation wavelets, entirely in the spatial domain [6]. The first generation wavelets are translates and dilates of a single mother wavelet, and Fourier techniques are essential in their construction. The lifting scheme does not use the Fourier technique [5]. It is a very fast method compared to the first generation wavelets. Moreover, the inverse transform is obtained by replacing addition with subtraction and reversing the operations in the forward transform. The goal of quantization is to encode the data from a source, with some loss, so that the best reproduction is obtained. Set partitioning hierarchical trees (SPIHT) achieves more compression than EZW [4].A typical MR image foreground contains clinical information which needs to be compressed without any loss. On the other hand the background does not contain any clinical information. It is only noise and consumes unnecessary bit budget and impairs the performance of a compression scheme. In this work we ignore the background part. We generate image masks in such a way that the foreground part is totally included and the pixel values in the foreground part are made zero. Morphological operations can be effectively used to generate image masks, which contain a value of '1' in the foreground and a value of '0' in the background. The original image is then multiplied with these masks to obtain "background noise free" images while keeping the information in the foreground part. In this paper we compare proposed work using different integer wavelets with the original scheme using 3DSPIHT algorithm.

2. PROPOSED WORK
The proposed work can be obtained by integer wavelet transform followed by SPIHT algorithm.Fig.1. Shows the general architecture of the proposed system. The proposed image compression and reconstruction architecture addressed in this paper involves the following steps.

Step 1: Select ROI in 3D MRI images and decomposed using 3D integer wavelet transform. Integer wavelet transform can be developed using lifting scheme.

Step 2: 3D SPIHT coding technique is applied to the data obtained in the previous step, to encode a decomposed coefficients of four symbols are used

1) set LSP as empty list,

2) Sorting pass,

3) Refinement pass,

4) Quantization step update.

Step 3: In decoding operation, the inverse 3D SPIHT method is applied to step 2.

Step 4:3D Inverse Integer wavelet transform is applied to the decompressed data obtained in the previous step to reconstruct the original image.

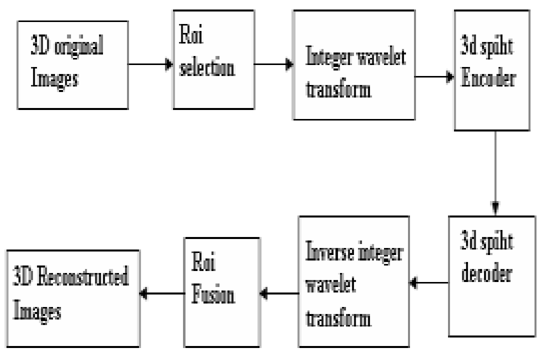

Fig.1 Block Diagram of Proposed Compression Techniques

2.1 Region of Interest

ROI coding is one of the most important features provided by JPEG-2000. It allows, imposing heterogeneous fidelity constraints to different regions of the image rather than encoding the entire image as a single entity. This property is especially useful for image coding applications, where the image consists of regions that can be encoded at different bit rates, such as compression of medical images [1]. For most medical images, the diagnostically significant information is localized over relatively small regions of interest. In this case, region-based coding for better utilization of the available bit rate since the high quality should be maintained only for the aforementioned diagnostically significant regions and the rest of the image can be encoded at a lower bit rate. Once the region of interest is selected efficiently, the significant region is transformed using lossless integer wavelet transform filter. Then the transformed images are encoded using SPIHT algorithm. Fig.2 (a), (b), (c) shows an original MR image, its mask and background suppressed image.

Fig.2 (a) Original MR image (b) Mask (c) Background suppressed image

2.2 Integer Wavelet Transform

The wavelet transform (WT), in general, produces floating point coefficients. Although these coefficients can be used to reconstruct an original image perfectly in theory, the use of finite precision arithmetic and quantization results in a lossy scheme. Recently, reversible integer WT's have been introduced [2]. The use of the lifting scheme allows generating work, the following integer wavelet transforms based on lifting scheme have been used with notation (N,M) where N and M represent the number of vanishing moments of analysis and synthesis high pass filters respectively.

a. spilne (2,2) transform b. spline (4,4) transform

c. spline (4, 6) transform d. spline (5,3) transform

Lifting allows simple inverse transform of the same complexity as the forward one- Reversible integer wavelet transform being composed of the elementary operations of the forward one, taken in reverse order. The image is compressed using 3DSPIHT algorithm.

2.3 SPIHT Coding Algorithm

The set partition in hierarchical trees (SPIHT) coding algorithm was proposed by Said and Pearlman [7]. This algorithm has been successfully applied to several forms of data such as images [7] and electrocardiograms. The experimental results show that the 3D SPIHT algorithm is among the best in terms of compression performance. Previously, the SPIHT was designed for lossy data compression. By combining the integer-to-integer WT with the 3D SPIHT, both the lossy and lossless compression modes are now supported.

3. EXPERIMENTAL RESULTS

We implement 3D algorithm on group of 8 MR images. The size of images is 128 X 128 X 8. Fig.3 shows a group of 8 MR images. Table I shows the comparison on Peak Signal to Noise Ratio (PSNR) of different integer wavelet transform of the proposed algorithm with the original scheme at different bit rates. Fig.4 shows PSNR vs. Bit rate performance curves of 3D MR schemes

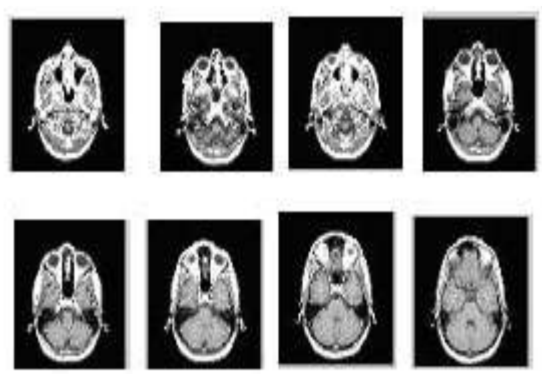

Fig.3 Group of 8 MR images

Table 1.Compaision on PSNR of different integer wavelet transform of the proposed approach with original scheme

Bit rate	Original Scheme	Proposed Approach			
		(4,4)	(4,6)	(5,3)	(2,2)
0.2	8.53	9.07	8.83	11.53	17.22
0.4	15.95	17.34	16.66	17.12	22.75
0.6	20.03	21.35	20.30	22.57	28.70
0.8	24.81	26.30	25.50	26.03	28.96
1.0	25.72	27.10	26.68	28.46	34.79

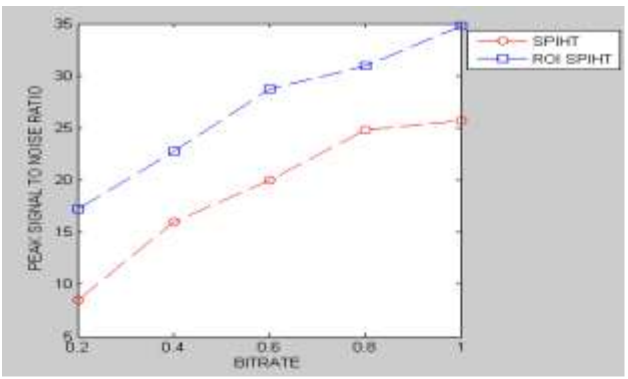

Fig.4 PSNR vs. Bit rate performance curves of 3D MR schemes using (2, 2) transform

4. CONCLUSIONS

The performance of integer wavelets in general depends on Image characteristics. The experimental results show that the proposed scheme is better than the original scheme and PSNR of the ROI using (2, 2) is better than that of the other integer wavelet transform for different bit rates at level3 for 3D MRI images. In addition, Image types other than MRI may also be suitable with the proposed approach, but this requires further study. We have implemented the algorithm for 3D images and we propose to extend this approach to color 4D images.

5. REFERENCES

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