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Scintigraphic Image Coding of Region of Interest Based On SPIHT Algorithm Using Global Thresholding and Huffman Coding

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***Abstract*—**Medical imaging produces human body pictures in digital form. Since these imaging techniques produce prohibitive amounts of data, compression is necessary for storage and communication purposes. Many current compression schemes provide a very high compression rate but with considerable loss of quality. On the other hand, in some areas in medicine, it may be sufficient to maintain high image quality only in region of interest (ROI). This paper discusses a contribution to the lossless compression in the region of interest of Scintigraphic images based on SPIHT algorithm and global transform thresholding using Huffman coding.

***Keywords*—**Global Thresholding Transform, Huffman Coding, Region of Interest, SPIHT Coding, Scintigraphic images.

I. Introduction

THE massive use of the digital terms in medical imaging produces volumes of data more increasingly important. Compression of digital images becomes a necessity to ensure their archiving on the one hand and facilitate their transmission on the other. For a good number of medical images, clinical information is concentrated in one or more regions of the image. An approach that brings a high compression rate with good quality in the ROI is thus necessary.

The general idea is to preserve quality in diagnostically critical regions, while allowing lossily encoding the other regions. It is in this framework that is this present work. Afterthe evolution of digital imaging techniques, many researchers have attempted to apply compression methods to medical data. The lossless compression studies have all resulted in low compression rate. Transform coding schemes such as DCT transform and wavelet transform (DWT) were applied [1]-[3] to get better rates. In order to achieve higher compression rates without detracting from quality, region of interest based methods were investigated [4], [5].

In this paper, we propose a compression algorithm by region of interest of the scintigraphic image based on SPIHT algorithm and global transform thresholding using Huffman coding.

The paper is organized as follows. Section II describes the proposed process of compression. Section III explains experimental results and discussion. Finally, a conclusion is given in Section IV.

II. The Process of Compression

The block diagram in Fig. 1 describes the process of our coding scheme. To find a good compromise between compression ratio and the clinical information of the medical image, we thought of implementing an algorithm by areas of interest (regions of interest: ROI).

Indeed, the ROI will be coded without loss with SPIHT algorithm [6]-[8] using the classic SPIHT algorithm adapted to the lossless compression while the difference image will be encoded with losses representation using global thresholding and Huffman coding.

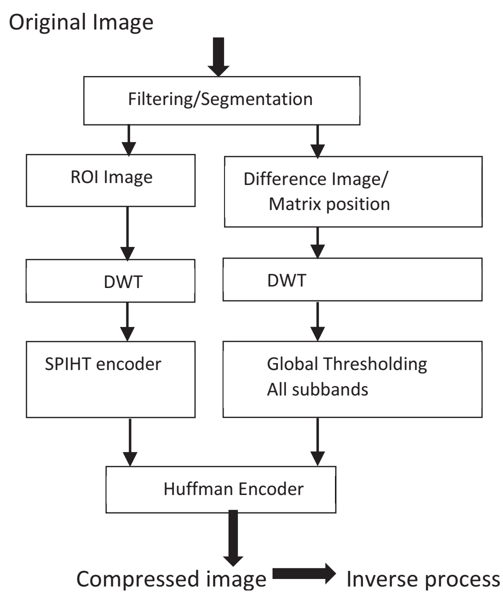

Fig. 1 Description of the Proposed Coding scheme

A. Selection of the Regions of Interest ROI

The principle of scintigraphy is to get the image of a body after injection of a weakly radioactive solution in a body and save the emitted radiation over time. The quantity of

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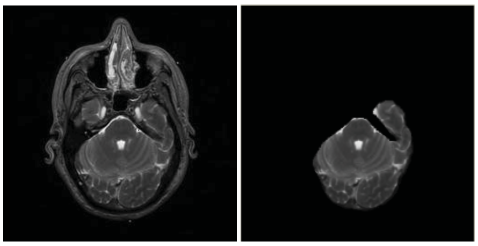
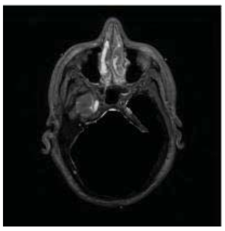
registered radiation to learn more about the activity of the body explored.

Clinical information locates so in fixation of the radiopharmaceutical product areas, which thus define the areas of interest.

The selection of the ROI is by application of 3 stages: filtering, enhancement and segmentation [9]. The image is thus partitioned into two parts, as shown in Fig. 2.



(a) Original Image (b) Region of Interest ROI



(c) Difference Image (remaining area)

Fig. 2 Scintigraphic image Partition

B. Encoding of DWT Coefficients

The SPIHT algorithm operates on a wavelet transformed image with equal length and width of an integer power of 2 [10]. It encodes the wavelet coefficients in a way that uses a hierarchical organization of the coefficients. This algorithm, which is based essentially on differencing between significant and insignificants pixels, allows sending high order bits of coefficients before low order bits.

In our proposed method, the coefficients in all sub-bands of the ROI image (selected part of the original image) are encoded directly by SPIHT encoder followed by Huffman coder without thresholding (high frequencies coefficients in sub-bands are considered important for ROI). We also need to encode in a lossless manner and transmit a position matrix in order to delimit border and position of the ROI image. This issue guarantees to us to reduce the effect of border in the reconstructed image between ROI image and remaining image. After introducing many zeros in all sub-bands of the remaining area due to the global thresholding, we encode the coefficients by Huffman coder to convert redundant data into bit stream. The use of Huffman encoder makes compressed data ready for transmission.

III. Simulation Results

For measuring the originality of the compressed image, Peak Signal to Noise Ratio (PSNR) is used,

$$\text{PSNR (dB)} = 10 \log_{10} (255)^2 / \text{MSE} \qquad (1)$$

where MSE is the mean squared error between the original image I_{ij} and the reconstructed compressed image I'_{ij} of the size MN, which is calculated by,

$$\text{MSE} = \frac{1}{MN} \sum_{j=1}^{M} \sum_{i=1}^{N} \left(I'_{ij} - I_{ij} \right)^2 \qquad (2)$$

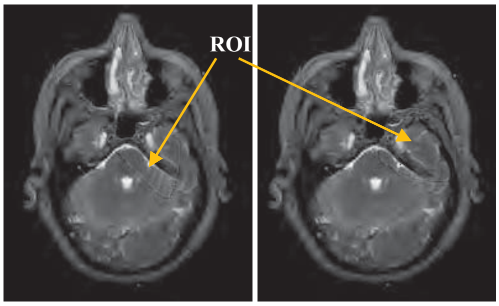
We conducted several simulations on a group of medical images in order to test the effect of the proposed coding method.

The measurements were performed for different level of decomposition using bior4.4 wavelet for DWT with 13/19 tap filter in first stage and 14/14 tap filter beyond level one. For different size medical images, and different form of region of interest, we applied the following steps,

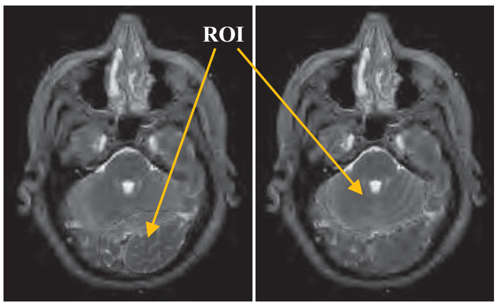
1. Selection of region of interest,
2. Compress the image of the remaining (Fig. 2 (c)) with global thresholding and Huffman coding,
3. Compress the position matrix of ROI and the ROI image (Fig. 2 (b)) with SPIHT coder and Huffman coding.

TABLE I
Performance Coding for Image 'MRI.BMP'

Level-1 decomposition		Level-2 decomposition		Level-4 decomposition	
bpp	**PSNR(dB)**	**bpp**	**PSNR(dB)**	**bpp**	**PSNR(dB)**
2	35,41	1.5	32,12	0.6	29,012
3.4	36,432	1.76	34,031	0.7	29,87
4.2	36,61	1.9	34,87	0.8	31,32



(a) bpp =1,2 (b) bpp =1,5



(c) bpp =1,9 (d) bpp =0,8

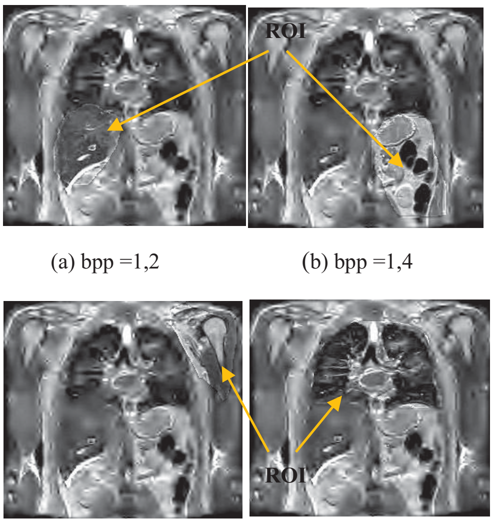
Fig. 3 Reconstructed image for different ROI position at various 'bpp' (Table III)

The results are presented in Tables I and II. Figs. 3 and 4 show the reconstructed images at various bit rates and at different positions of ROI. In Figs. 3 and 4, we can see that regions of interest present good image quality at low bpp (PSNR = 31,3 dB) and the other part of the original image is compressed with loss manner procedure.

Observing results, we conclude that PSNR is inversely proportional to compression ratio (CR). At first level of decomposition ‘bpp’ is more than higher levels due that low sub-bands requires more numbers of bits. The total number of bit required to compress the scintigraphic image decreases as we set up the level of decomposition. Slight reduction in image quality is observed.

TABLE II
PERFORMANCE CODING FOR IMAGE ‘THORAX.BMP’

Level-1 decomposition		Level-2decomposition		Level-4 decomposition	
bpp	PSNR(dB)	bpp	PSNR(dB)	bpp	PSNR(dB)
2	32,97	1.2	31,5	0.55	29,8
2.9	33,012	1.4	31,7	0.7	30,865
4.1	34,32	1.8	32,14	0.8	31,45



(a) bpp =1,2 (b) bpp =1,4

(c) bpp =1,8 (d) bpp =0,8

Fig. 4 Reconstructed image for different ROI position at various ‘bpp’ (Table II)

We achieve good CR at level 4 of wavelet decomposition. Highest CR achieved with proposed method is 42% for image ‘thorax.bmp’ (PSNR= 29,8dB, bpp=0.55). Table III reveals that the proposed method is competitive with existing methods.

TABLE III
COMPARISON WITH EXISTING METHOD (CBTC-PF [11])

Proposed method MRI image			CBTC-PT		
bpp	PSNR(dB)	CR	bpp	PSNR(dB)	CR
0,8	31,3	29,6	1.17	31,93	20,51
1,5	32,12	15,4	1.50	30,15	16
1,2	32,02	23,2	1.20	31,79	20
1,9	34,87	14,7	1,12	31,31	21,42

IV. CONCLUSION

In this work, we propose a method for compression based on region of interest of medical images using two algorithms based on SPIHT and Huffman coders. The original image is first divided into two images: one containing the regions of interest and another containing the rest, the first is coded without loss using SPIHT coding and the second is encoded with loss using global thresholding and Huffman coding.

A matrix of position of the ROI is also coded with loss and transmitted to the decoder to reduce border effect. Our proposed method has comparable results with low complexity. This issue of coding medical images is very interesting and allows us to compress only the important area in image (ROI) by lossless compression. The use of SPIHT coder for lossless compression shows interesting results and we have achieved good CR with proposed method (42%). The rest of the image has been coded by global threshold algorithm and Huffman coding which makes compression data ready for transmission.

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