International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
www.ijset.com, Volume No.1, Issue No.3, pg:-63-66 01 July 2012

Performance Analysis of Image Compression: A discrete wavelet Transform based Approach

[1]Ms. Yogita Sojitra, [2] Prof.Abhishek Katariya, [3]Ms.A.K. Vibhakar, [4]Ms.Poorvi Patel
Department Of Electronics and Communication Engineering,
[1,2]Shri Balaji College Of Engineering and technology, Jaipur, Rajasthan
[3]Sri Satya Sai Institute Of Science and Technology, Sehore M.P.
[4]Atmiya Engineering college, Gujrat Technical University Rajkot,Gujrat

yvsojitra@aits.edu.in,*bhishek_katariya@rediffmail.com*,akvibhakar@aits.edu.in, phpatel@aits.edu.in

***ABSTRACT*:** *In this Paper we introduce modified EZW algorithm for the purpose of image compression which seems to be an enhanced version compare to the existing algorithm. This algorithm is an extension of EZW algorithm given and analysed by Sharpiro's where we reduce the difficulty of EZW in transmitting the lower bit planes. In this paper, we include digital wavelet transformation and region of interest coding to modified EZW and hence make it more superior to EZW and SPIHT Algorithm and it is proved with the results.*
Keywords—Compression, Wavelet, Embedded zero wavelet, Region of interest, SPIHT

I: INTRODUCTION

Increasingly, medical images are acquired and stored digitally. These images may be very large in size and number and compression offers a means to reduce the cost of storage and increase the speed of transmission. Image compression is minimizing the size in bytes of a graphics file without degrading the quality of the image. The resolution in file size allows more images to be stored in a given amount of disk or memory space. It also reduces the time required for images to be sent over the Internet or download from WebPages. Several compression algorithms were developed. J.M. Shapiro developed the embedded zero tree wavelet algorithm in [7] which yields a fully embedded code and consistent compression. With embedded coding, it is possible to recover the lossy version with distortion corresponding to the rate of the received image at the point of decoding process. EZW is a progressive image compression algorithm. As quoted in [4] EZW is found to have the drawback that the compression decreases during the transmission of least significant bits. This paper proposes an Enhanced modified EZW algorithm that is based on the probability of significant coefficients within each bit plane and it also includes Digital wavelet transform and region of interest coding, ie., ROIDWT(Region Of Interest – Digital Wavelet Transform) [5] and thereby improves the performance.

II: OVERVIEW OF EZW ALGORITHM

One of the most important characteristics of DWT is multiresolution decomposition. An image decomposed by wavelet transform can be reconstructed with desired resolution. When first level 2D DWT is applied to an image, it forms four transform coefficients. The first letter corresponds to applying either low pass or high pass filter to rows and the second letter refers to filter applied to columns. The elimination of high pass components by 2D wavelet transform technique reduces the computation time by reducing the number of arithmetic operations and memory accesses and communication energy by reducing the number of transmitted bits. With the increase in the levels of decomposition, the compression can be made efficient correspondingly, the inverse DWT are performed in the decompressor block[2]. A Quantizer simply reduces the number of bits needed to store the transformed coefficients by reducing the precision of those values. Since this is a many to one mapping, it is a lossy process and is the main source of compression in an encoder. In uniform quantization, quantization is performed on each individual coefficient. Among the various coding algorithms, the embedded zero tree wavelet coding by have Shapiro and its improved version, the SPIHT by Said and Pearlman [6] been very successful. EZW is a progressive image compressionalgorithm ie., at any moment, the quality of the displayed image is the best available for the number of bits received up to that moment. Compared with JPEG – the current standard for still image compression, the EZW and the SPIHT are more efficient and reduce the blocking artefact [1] and [3]. The EZW algorithm forms a hierarchical quad tree data structure for the wavelet-transformed coefficients. The set of root node and corresponding descendents are referred to as a spatial orientation tree (SOT) .The tree is defined in such a way that each node has either no leaves or four offspring, which are from 2 x 2 adjacent pixels. The pixels on the LL sub image of the highest decomposition level are the tree roots and are also grouped in 2 x 2 adjacent pixels. For the convenience of illustrating the real implementation of EZW, the following sets of coordinates are defined

$$S_n(\tau) = \begin{cases} 1, & \max\{|C_{i,j}|\} \geq 2^n, \\ 0, & \text{otherwise} \end{cases}$$

$S_n(\tau)$ indicate the significance of a set of coordinates τ, where T(n) is the preset significant threshold used in thenth stage. A detailed description of the EZW coding algorithm is given in [7].The embedded data are sorted into three main categories and they are listed as:

1.Magnitude Bits (MB): This category contains the magnitude of the coefficients only. It is further sorted to Insignificant Magnitude Bits (IMB) and Significant Magnitude Bits (SMB). Since the coder and the decoder knows which coefficients have been coded as significant prior to this bit plane, it is capable on sorting the coefficients that have not been coded as significant prior to the current pass (IMB) and the bits that are being coded as significant prior to the current pass (SMB).

2. Tree Bits (TB): This category contains the bits responsible for checking the significance of each set. and similar to the MB, it sorts the TB into to Insignificant Tree Bits (ITB) and Significant Tree Bits (SMB).

3. Sign Bits (SB): This category contains the sign of the coefficient. The sign bits are coded once after coding the magnitude bit as a significant bit for the first time. The categorized data are coded in an embedded manner as shown in Fig.1. The whole image is coded bit plane by bit plane and each bit plane is coded slot by slot. The slots are coded in a sequential order of ITB, STB, IMB, SMB then SB. Each slot contains the data and End of Slot Symbol (ESS). The ESS synchronizes the information which indicate the end of coding a particular category within a bit plane[9].

III: PROPOSED SCHEME

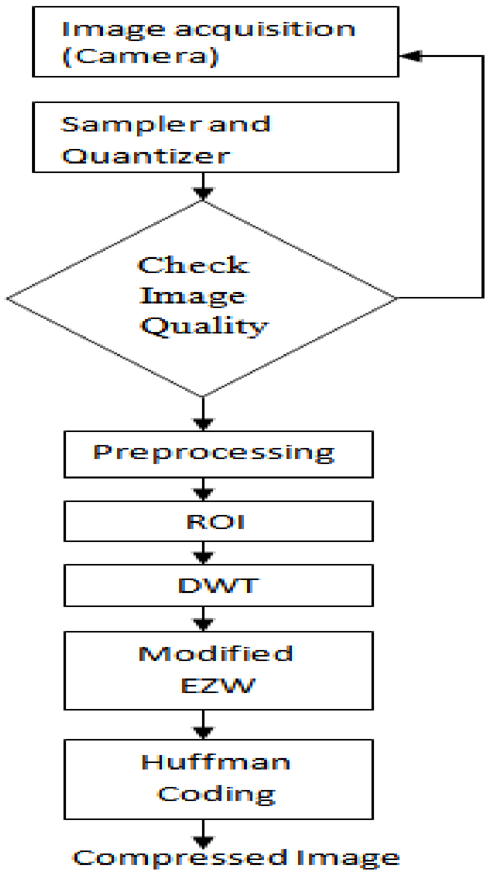

Fig. 2 Modified EZW proposed scheme

Figure shows the overall system flow diagram[13]. It accepts input image and produces segmented image as output. It consists of various modules namely preprocessing, fuzzy segmentation [8]. The proposed system starts with the key frame of the medical image, preprocessing of the image is done for removing the noise for a better segmentation. After preprocessing, segmentation and tracking are performed. A model fitting technique is to be proposed after tracking the borders. The tracked borders are to be decomposed into meaningful regional parameters. The original image can be reconstructed from the compressed image using inverse transforms to the above proposed algorithm model.

IV: EXTRACTION OF ROI

The purpose of feature extraction is to reduce the original data set by measuring certain properties , or features, that distinguish one input pattern from another pattern. The extracted feature should provide the characteristics of the input type to the classifier by considering the description of the relavant properties of the image into a feature space. Two textural features namely contrast, correlation based on the gray level cooccurence matrices (GLCM) have been used in this work.

Spatial gray level co-occurrence estimates image properties relates second order statistics. Haralick [10] suggested the use of gray level co-occurrence matrices (GLCM) which have become one of the well known and widely used texture features. GLCM {P(d,θ)(i,j)} represents the probability of the occurrence of a pair of gray levels(i,j) separated by a distance d at angle θ. The commonly used unit pixel distances and the angles are 0°, 45°, 90° and 135°. A detailed algorithm of calculation of GLCM {P(d, θ)(i,j)} has been given in [11]. Textural characteristics like Contrast and Correlation can be captured from images using second order distribution gray levels using the following formulas.

Contrast

$$s_c = \sum_i \sum_j (i-j)^2 P(i,j)$$

Correlation

$$S_o = \frac{\sum_i \sum_j (ij)p(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y}$$

V: ROI BASED MODIFIED EZW

In Shapiro's EZW algorithm [12], a "zerotree" consist of a parent and its offsprings are insignificant, then the ancestor is coded as zerotree. If the value of the coefficient is lower than the threshold and has one or more significant descendants with respect to 'j'th level, then they are coded as "isolated zero". The insignificant coefficients of the last sub-bands, which do not accept descendants and are not themselves descendants of a zerotree are also considered to be zerotree. The significance symbols of the image coefficients are then placed in the dominant list. The amplitudes of the significant coefficients are placed in the subordinate list. Their values in the transformed image are set to zero in order not to undergo the next step. Finally to the above coefficients, Huffman coding is applied.

Quantization and Refinement

A bit corresponding to *2j-1* is emitted for all the significant values in the refinement list S in order to increase the precision of those values transmitted. The coefficients are then converted into binary by the coding technique. This process is repeated by dividing the threshold by *2*. The process is reiterated until the desired quality of the reconstructed image is reached or until the number of transferable bit required is exceeded.

The modified algorithm works in the following way:

1. Symbols were added to the significance test stage to allow a better redistribution of the entropy.
2. The coding of the dominant elements and the subordinate list quantization bits was optimized.

VI: HUFFMAN ENCODING

Huffman coding assigns less codes for coefficients whose probabilities of occurrence is high and vice versa for coefficients whose probabilities of occurrence is low. The significant size is obtained by binary regrouping of several symbols. Further all the possibilities regarding the coefficient are to be worked with and have to perform for the different iteration levels. Further the proposed method proves to yield better result with limited computational complexity. Arithmetic coding is a coding scheme that utilizes the probabilities of the individual pixel values in a given image. These probabilities enable the algorithm to translate a bit stream into real numbers of determined precision. As more symbols are added to the encoding stream, the precision and the number of bits required to represent the real number increases. Since each symbol represents a unique interval less than one, adding a symbol to stream decreases the code word range in a unique way. This allows for unambiguous decoding which results in a lossless coding scheme. The one problem that arises in machine computation is data precision. Larger number of distinct pixel values in a given image loses the probabilities for individual pixels, thus decreasing the subinterval for each pixel. This causes smaller real numbers (between 0 & 1) which are difficult to represent and can encounter round off error. The problem of precision was remedied, however by scaling the probabilities into integer representation. Varying number of pixels, determined by the number of bits allowed for representation, are coded into individual code words to ensure that no information is lost. This error can be overcome by Huffman coding in the proposed coding which yields better result with computationally efficient technique.

VII: Results and Discussion

The method of separate transforms to the two regions proves better results compared to the ordinary way of applying only single transforms to the whole image. The proposed technique of modified EZW for a 8-bit 256 x 256 images were tested. In the proposed method of compression, to take the whole value as array of bytes, the medical image values having attributes are coded and taken as a sequence of bits. The Region of Interest region is coded using the contourlet transform and the remaining portions are coded using Haar Wavelet filter. Fig (3) and Fig (4) shows the input and reconstructed Images.

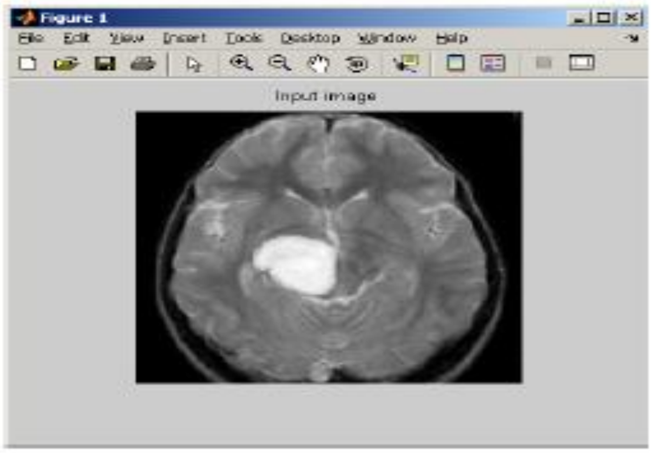

Fig. 3. Input Image

Fig. 4. Reconstructed Image through modified EZW

The compression ratio for contourlet based modified EZW increases than the normal EZW algorithm. The PSNR and CR for the proposed algorithm is shown in Table.1

Table 1: PSNR and CR for EZW, SPIHT and Proposed algorithm.

Type	EZW		SPIHT		MODIFIED EZW	
	PSNR	CR	PSNR	CR	PSNR	CR
image-1	34.16	8:1	36.28	16:1	32.08	17:1
image-2	32.04	20:1	33.16	30:1	31.84	31:1

VIII: CONCLUSION AND FUTURE CONSIDERATIONS

In this paper, we proposed a new image transform called MEZW to compress medical image based on the combination of the wavelet transform and the nonsampled directional filter banks. The proposed algorithm is simple and computationally less complex which is based on embedded block coding with coefficient truncation. Further addition of two new symbols results in efficient compression with reduced computational time. The compression of the proposed algorithm is superior to EZW, SPIHT etc., Our new method of compression algorithm can be used to improve the performance of Compression Ratio (CR) and Peak Signal to Noise Ratio (PSNR). In future this work can be extended to real time applications for video compression in medical images. The results shown above reveal the superior performance of contourlet against wavelet transform at higher compression ratios. However at lower compression ratios wavelet transform proves a suitable approach.

Formulas

The bit per pixel (bpp) and PSNR for the arbitrary shaped region is evaluated by the following. The
PSNR is the measure of quality of reconstruction of lossy compression codecs.

$$PSNR = 10log \frac{MAX^2}{\frac{1}{w*h}\sum_{i=1}^{w}\sum_{j=1}^{h}(o(i,j)-c(i,j))^2}$$

Where O_{ij} is the original image, C_{ij} is the reconstructed image, w is the total number of row elements and h is the total number of column elements, *MAX* is 255.

$$CR(bpp) = \frac{number\ of\ coded\ bits}{n*m}$$

Where n, m is the image size.

REFRENCES

[1] Peng Jiang, Qingbo Huang, Yaguang Kang and Li Chai, "Research on Compression Method based on IWT and SPIHT for Historical Data in Process Industry", Computer and Computational Sciences 2006, Proceedings (IMSCCS '06).

[2] Ahmed Abu-Hajar and Ravi Shankar, "Region of Interest Coding using Partial-SPIHT", IEEE 2004.

[3] A. Abu-Hajar and R. Shankar, "Enhanced Partial-EZW for Lossless Image Compression" Acoustics, Speech and Signal processing 2003, Proceedings (ICASSP '03).

[4] Abu-Hajar A and Shankar R, "Wavelet based lossless Image compression using partial SPIHT and bit plane based arithmetic coder", ICASSP 2002; 4:3497-3500.

[5] J. Reichel, G. Menegaz, M. J. Nadenau, and M. Kunt, "Digital Wavelet Transform for Embedded Lossy to Lossless Image Compression". IEEE Trans. Image Proc., 10930:383-392, March 2001.

[6] A. said and W.A. Pearlman, "A New, Fast and Efficient Image Codec Based on Set Partitioning in Hierarchical Trees", IEEE Trans. On Circuit and Systems for Video Technology, 1996.

[7] J.M. Shapiro, "Embedded image coding using the zero trees of wavelet coefficients", IEEE Transactions on Image Processing, Vol. 41, No. 12, pp. 3445-3462, December 1993.

[8] Troung T. Nguyen and Soontorn Oraintara, 2004. "Textural Classification Using Non-Uniform Directional Filter Bank", IEEE eleventh Digital Signal Processing workshop and *IEEE Signal Processing Education Workshop*.

[9] Haralick, R.M., 1979 "Statistical and structural approaches to texture", Proceedings of the IEEE,vol. 67, pp. 786-804.

[10] Dzung Pham and Jerry Prince, 1999. "An adaptive fuzzy C-means algorithm for image segmentation in the presence of intensity inhomogeneties" pattern Recognition Letters, vol.20, no.1, pp. 57-68.

[11] Chen, C.H., L.F., Pau, P.S.P., Wang, 1998. "The handbook of Pattern recognition and computer vision", II edition, World Scientific Publishing Company.

[12] Shapiro. J.M., 1993. "Embedded image coding using zerotrees of wavelet coefficients, *IEEE Trans Signal Process*. 41, 3445-3462.

[13] Senjaliya Radhika, Prof.A.C.Suthar, Vithlani Avani A, Devangkumar U.Shah" Wavelet based medical image compression using ROI EZW and SPIHT coding.