IWNEST PUBLISHER

Journal of Industrial Engineering Research

(ISSN: 2077-4559)

Journal home page: http://www.iwnest.com/AACE/

Lossless Medical Image Compression using Set Partitioning in Hierarchical Trees (SPIHT) Algorithm

Dr. J. Subash Chandra Bose, S.Kavitha, Mr.S.Mohan raj

Master of Engineering Department of Computer Science &Engineering Professional Group of Institutions Palladam, Tirupur, Tamilnadu, India

ARTICLE INFO

Article history:
Received 22 February 2015
Accepted 20 March 2015
Available online 23 April 2015

Keywords:

ABSTRACT

During the Lossless Medical Image Compression using Set Partitioning in Hierarchical Trees (SPIHT) algorithmthe objective is to reduce redundancy of the image data in order to be able to store or transmit data in an efficient form. Image compression can be lossy or lossless. Lossless compression is sometimes preferred for artificial images such as technical drawings, icons or comics.The set partitioning in hierarchical trees (SPIHT) algorithm is enhanced for wavelet-based progressive image-compression with image recognition quality. Complexity of EZW (Embedded Zerotree Wavelet algorithm) increases with progression of efficiency The objective of image compression is to reduce redundancy of the image in order to be able to store or transmit data in an efficient form. The performance measures can be compared using parameters such as MSE (Mean Square Error) and PSNR (Picture Signal to Noise Ratio).The Implementation has been done by using MATLAB 7.0.

To Cite This Article: Dr. J. Subash Chandra Bose, S.Kavitha, Mr.S.Mohan raj., Lossless Medical Image Compression using Set Partitioning in Hierarchical Trees (SPIHT) Algorithm. **J. Ind. Eng. Res.,** *1(4), 58-62, 2015*

INTRODUCTION

To encode the original imagery in a manner that accounts for the ultimate classification task, this motivating consideration of non-MSE distortion measures. Modification of the associated encoders/decoders are necessary. In this project, modifications have been performed in conventional SPIHT algorithm to enhance the quality of image in both low and high bit-rates. An overview of image coding is discussed [2]

The performance measures can be compared using parameters such as MSE (Mean Square Error) and PSNR (Picture Signal to Noise Ratio).

$$\text{Mean Square Error MSE} = 1/N \sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k} - x'_{j,k})^2 \quad (1.1)$$

$$\text{Peak Signal to Noise Ratio PSNR} = 10\log\frac{(2^n-1)^2}{MSE} = 10\log\frac{255^2}{MSE} \quad (1.2)$$

Where *I(x,y)* is the original image, *I'(x,y)* is the reconstructed version and *M,N* are the dimensions of the images.

II. Related Work:

A. Graphics Interchange Format (GIF):

GIF files can be saved with a maximum of 256 colours. This makes it a poor format for photographic images. Because this can sometimes be tight, GIFs have the option to dither, and will mix pixels of two different available colours to create a suggestion of another colour.

B. Portable Network Graphics (PNG):

PNG's main drawback is alpha-channels. Instead of the rudimentary transparency options in other formats (where a pixel is either transparent or opaque), an alpha channel can specify the opacity of any pixel from 0-255, where 0 is fully transparent and 255 is fully opaque.

C. Tagged Image File Format (TIF):

The TIFF format can use one of five data compression schemes: Huffman, Pack Bits, LZW, Fax Group 3, and Fax Group 4. LZW compression is generally used for 24 bits per pixel images. Many applications that support TIFF do not support data compression; therefore it is advisable not to use data compression except for temporary interchange between applications known to support the required type of compression.

D. Embedded and Wavelet:

The Embedded Zero-tree Wavelet (EZW) coding technique was suggested by Shapiro and its modification-set partitioning in hierarchical trees (SPIHT), suggested by Said and Pearlman which was demonstrated the competitive performance of wavelet based compression schemes.

E.SPIHT coding:

The SPIHT process represents a very effective form of coding. A straightforward consequence of the compression simplicity is the greater coding/decoding speed.

III. Proposed Algorithm:

To design and implement an enhanced SPIHT algorithm for compressing low bit –rate images like satellite images and any remote sensing images.Wavelet-based compression provides very good visual quality compare to other compression methods. The proposed algorithm is wavelet based compression algorithm which provides low execution time, low memory and reduce minor peak signal- to noise ratio(PSNR) compare to SPIHT algorithm[3].

To encode the original imagery in a manner that accounts for the ultimate classification task, this motivating consideration of non-MSE distortion measures. Modification of the associated encoders/decoders are necessary. In this project, modifications have been performed in conventional SPIHT algorithm to enhance the quality of image in both low and high bit-rates. An overview of image coding is discussed.

In Enhanced SPIHT coding, preprocessing steps like segmentation, weight estimation and scaling process are performed to enhance the quality of output. The scaling of coefficients is a well-known technique for adjusting their relative importance prior to encoding.

The performance measures can be compared using parameters such as MSE (Mean Square Error) and PSNR (Picture Signal to Noise Ratio).

$$\text{Mean Square Error MSE} = 1/N \sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k} - x'_{j,k})^2 \quad \ldots\ldots\ldots\ldots\ldots(1.1)$$

$$\text{Peak Signal to Noise Ratio PSNR} = 10\log\frac{(2^n-1)^2}{MSE} = 10\log\frac{255^2}{MSE} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1.2)$$

Where $I(x,y)$ is the original image, $I'(x,y)$ is the reconstructed version and M,N are the dimensions of the images.

A.Data structure used in SPIHT algorithm

Step 1: Initialization

Set LSP as the empty list

Step 2: Sorting Pass

During the sorting pass the significance of LIP and LIS are tested, followed by removal (as appropriate) to LSP and set splitting operations to maintain the insignificance property of the lists.

Step 3: Refinement Pass

In the refinement pass, the th most significant bits in the LSP, which contains the coordinates of the significant pixels, are scanned and output.

Step 4: Quantization-step update

In SPIHT algorithm, the wavelet coefficients are divided into trees originating from the lowest resolution band. The coefficients are grouped into 2- by-2 arrays that, except for the coefficients in band 1, are offspring of a coefficient of a lower resolution band. The coefficients in the lowest resolution band are also divided into 2-

by-2 arrays. The coefficient in the top-left corner of the array does not have any offspring and is known as the root node.

B. The trees are further partitioned into four types of sets, which are sets of coordinates of the coefficients:

Step 0: (i, j) – Set of coordinates of the off springs of the wavelet coefficient at location (i, j). As each node can have either four off springs or none, the size of O (i, j) is either zero or four. For example, in Fig 10 the set O (0, 1) consists of the coordinates of the coefficients b1, b2, b3 and b4.

Step 1: D (i, j)– Set of all descendants of the coefficient at location (i, j). Descendants include the offspring, the offspring of the offspring, and so on.

Step 2: L (i, j) – Set of coordinates of all descendants of the coefficient at location (i, j) except for the immediate offspring of the coefficient at location (i, j). In other words,

L (i, j) = D (i, j) – O (i, j)

C. Implementation Using MATLAB 7.0:

The new image compression algorithm has been simulated using MATLAB 7.0.The image compression using SPIHT Algorithm.

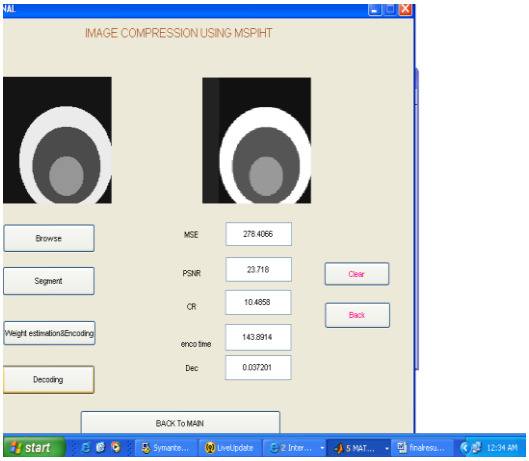

Fig. 1: Image Compression using SPIHT

The Enhanced SPIHT compression and displays related MSE and PSNR values compared with original image.

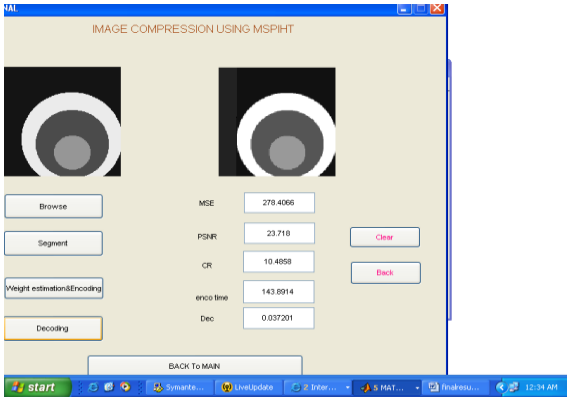

Fig. 2: Enhanced SPIHT

IV. Comparison Metrics:

The following are the list of metrics used to analyze the performance of the new image compression algorithm in comparison with the existing Enhanced SPIHT Algorithm Shown in the table.

Table 1: Test images using SPIHT and Enhanced SPIHT.

Test Image	SPIHT		ENHANCED SPIHT	
	MSE	PSNR	MSE	PSNR
Bird.gif	11465	16.6	451	30.7
Bridge.gif	10148	17.1	505	30.2
Camera.gif	11555	16.5	384	31.4
Circles.gif	10539	17.0	278	32.8
Goldhill.gif	9645	17.3	503	30.2
Horiz.gif	760	28.4	261	33.0
Lena.gif	8021	18.1	426	30.9

Conclusion:

The modification of popular SPIHT scheme, called Enhanced SPIHT. The compression performance of Enhanced -SPIHT has been compared to SPIHT both visually and in terms of PSNR. Simulation results, conducted at different bit-rates, have demonstrated that Enhanced –SPIHT significantly outperforms SPIHT . The future work can be Enhanced SPIHT algorithm has Good image quality with a high PSNR in both low and high amplitude.Enahnced SPIHT has fast coding and decoding, fully progressive bit –stream property. It has ability to code the image for exact bit rate or PSNR and requires no training data[3].

Table 2: Test images using Enhanced SPIHT

TEST IMAGE	SPIHT		ENHANCED SPIHT	
	MSE	PSNR	MSE	PSNR
Canvas.gif	13685.0	15.8	2486.7	23.2
DaveBright.gif	5980.7	19.4	614.4	29.3
Face.gif	5662.0	19.7	326.3	32.0
Fprit1.gif	12556.2	16.2	2315.6	23.5
Grass1.gif	13623.6	15.9	2511.8	23.2
Man.gif	3342.5	22.0	298.2	32.4
Nsin.gif	13122.3	16.0	2196.2	23.8
Wheel.gif	1871.4	24.5	83.1	38.0
Xrea.gif	5990.8	19.4	273.0	32.8

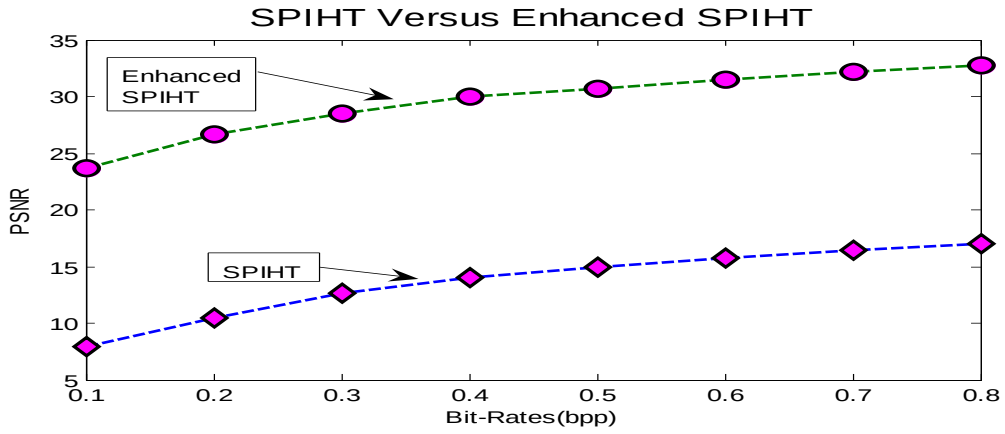

Fig. 3: Comparative plot between SPIHT and Enhanced SPIHT

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