www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 03 Issue 07 July, 2014 Page No. 7054-7057

A New Color Image Compression Based on Fractal and Discrete Cosine Transform

K. Sharmila, K. Kuppusamy,
Research Scholar[1]

[1]Department of Computer Science and Engineering, Alagappa University, Karaikudi, India
Sharmilavarun79@gmail.com
Professor[2]
[2]Department of Computer Science and Engineering, Alagappa University, Karaikudi, India
kkdiksamy@yahoo.com

Abstract: ***Fractal Image Compression is a compression method in which self similar nature of an image is used. It is a way to encode images that require less storage space. In this paper, an implementation based on fractal with quadtree and Discrete Cosine Transform is proposed to compress the color image. Initially the image is segmented and DCT is applied to each block of the image. Then the block values are scanned in zigzag manner to prevent zero coefficients. The resultant image is partitioned as fractals by quadtree technique. Finally the image is compressed using Run Length encoding Technique. Experimental results show that the proposed technique compresses the image effectively with high PSNR value and SSIM index.***

Keywords: Image compression, fractal, quadtree, run length encoding, zigzag scanning, DCT

1. Introduction

Image Compression has become an important aspect in the storing and transferring of digital image in information society [1]. The idea of the fractal image compression (FIC) is based on the assumption that the image redundancies can be efficiently exploited by means of block self-affine transformations [2][3]. In 1988, Barnsley [4] proposed the idea of fractal image compression for the first time. The first practical fractal image compression scheme was introduced in 1992 by Jacquin [5] [6]. The fractal compression technique relies on the fact that in certain images, parts of the image resemble other parts of the same image. Fractal algorithms convert these parts, or more precisely, geometric shapes into mathematical data called fractal codes which are used to recreate the encoded image. Once an image has been converted into fractal code its relationship to a specific resolution has been lost; it becomes resolution independent. The image can be recreated to fill any screen size without the introduction of image artifacts or loss of sharpness that occurs in pixel-based compression schemes [7].

In Fractal image compression, compressed images are represented by contractive transforms. These transforms are composed of group of a number of affine mappings on the whole image, known as Iterated Function System (IFS).Contractive transformation is applied to the IFS called Collage theorem. This theorem is the technique core of the fractal coding [8]. Fractal image compression is a modern image compression technique based on self similarity. In FIC the image is decomposed two times, into overlapping domain blocks to make a domain pool. Then the image is decomposed again into non-overlapping range blocks. After decomposition, for each range block best matched domain block in the domain pool with a contractive affine transformation is searched. Finally the best matched domain block can be found for each range block in the original image [9]. In order to improve the efficiency of FIC, quadtree technique can be used.

The rest of the paper is organized as follows: Section 2 describes some of the recent related works. The proposed methodology is described in section 3. Experimental results of the proposed methodology are explained and discussed in section 4. Finally, conclusion is provided in section 5.

2. Related Works

Numerous researches have been proposed for the color image compression process by researchers. In this section, a brief review of some important works from the existing literature is presented

Sofia Douda, Abdallah Bagri, Amer Abdelhakim El Imrani [10] proposed a new method based on the DCT coefficients. In this method, the domain blocks with a low activity are discarded from the domain pool. The activity of blocks is based on the lowest horizontal and vertical DCT coefficients. Ruhiat Sultana, Nisar Ahmed and Shaik Mahaboob Basha [11] proposed an advanced fractal image compression algorithm based on quadtree that construct search attractor directly from the big domain block. And if domain block cannot search the similar range block, the most similar range block is searched and calculates the correctional value to construct the fictitious

range block. Gohar Vahdati *et al* [12] proposed a fractal image compression method based on spatial correlation and hybrid particle swarm optimization with genetic algorithm. There are two stages for the algorithm. The first stage exploits local optima by making use of the spatial correlation between neighboring blocks. If the local optima are not satisfied, the second stage of the algorithm is carried out in order to explore further similarities from the whole image.

Kharate and Patil [13] proposed that the compression ratio as well as the quality had been considerably improved by appropriate selection of the mother based on the nature of images. The technique they have proposed had been based on Threshold Entropy with enhanced run-length encoding based wavelet packet best tree. As complete tree had not been decomposed, their method had minimized the time complexity of wavelet packets decomposition. Sub bands that include significant information based on threshold entropy had been chosen by their algorithm. D. Venkatasekhar and P. Aruna [14] proposed that Genetic algorithm is used to find the best block of replacement, so fractal image is done easily. Here Genetic algorithm with Huffman coding is used for fractal image compression. Khalil [15] implemented a Run Length coder that had been made simple and more effective. Their proposed algorithm had worked on quantized coefficients of the DCT where several concurrent tokens existed.

Vijaya-Prakash and Gurumurthy [16] proposed a technique to enhance the data compression technique. In their work a new DCT and Quantization architecture had been designed for performing image compression. Compression of image data could be achieved by employing the DCT. Later, compression has been achieved by performing quantization of the DCT data coefficients. Yih-Lon Lin and Wen-Lin Chen [17] proposed the method in which particle swarm optimization method is adopted with classification and Dihedral transformation in order to speed up the fractal image encoder. The PSO algorithm is used to search the best match solution in the search space. In the search mechanism, similarity measures are performed only when both the domain and range blocks are of the same type.

From the literature survey, it is clear that in fractal image compression, the encoding time and complexity is very high. To overcome these issues, an efficient hybrid scheme based on DCT and fractal with quadtree technique and run length encoding is proposed.

3. Proposed Method

Compressing the image effectively using Discrete Cosine Transform and fractal based quadtree technique is the main goal of proposed work. Initially the color image will be partitioned into non-overlapping blocks. DCT will be employed to every block of the image. Next the DCT coefficients of each block will be quantized. The zero coefficients will be eliminated by scanning the block values in a zigzag manner. The resultant image is segmented by quadtree technique as fractals. Then the image will be compressed using Run Length encoding. The complete process of proposed method is described in the following.

3.1 Image Compression using DCT

The DCT is used to compress the image in proposed method. DCT is employed to each non overlapping block of the image. It is described in the following equation.

$$D(i,j)=\frac{1}{\sqrt{2N}}C(i)C(j)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1}I(x,y)\cos\left[\frac{2(x+1)i\pi}{2N}\right]\cos\left[\frac{(2y+1)i\pi}{2N}\right]$$

$$C(u)=\begin{cases}\frac{1}{\sqrt{2}} & if\ u=0\\ 1 & if\ u>0\end{cases}$$

Here I(x, y) represents the (x, y)th element of the image represented by I. N is the size of the block that the DCT is done on. The equation calculates one entry (i, j)th of the transformed image from the pixel values of the original image matrix. Then the DCT coefficients are quantized.

3.2 Zigzag Scanning

The entire quantized coefficients are rearranged in a zigzag manner. After quantization, most of the high frequency coefficients become zeros. A zigzag scan of the matrix which yields long strings of zeros is used to eliminate the number of zeros. At the end of this process, A list of non-zero tokens for each block proceeded by their count will be obtained [18]. Following Figure illustrates this process.

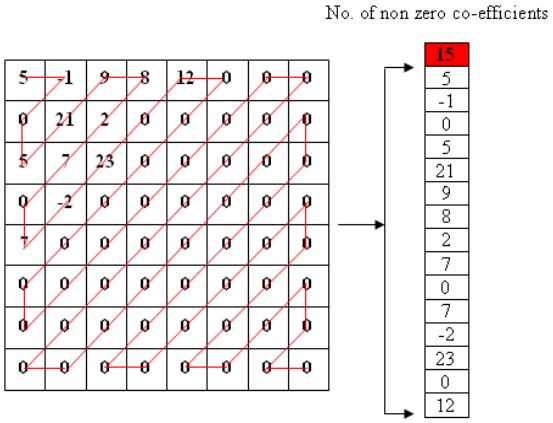

Figure 1: Zigzag Scanning

3.3 Fractal with Quadtree Technique

Fractal Image Compression uses the property of self-similarity of fractal objects. It is used to avoid performing repetitive compression on the similar block. It must be used before encoding the quantized image. The quadtree technique is used to partition the resultant image into four equal blocks, and then each block is tested to verify some condition of homogeneity. If a block meets the condition, it is not partitioned further. Else, it is partitioned again into four equal blocks, and the test condition is applied to those blocks. This process is repeated iteratively until each block meets the condition of homogeneity.

3.4 Run Length Encoding

Run Length Encoding is a very simple lossless compression technique in which runs (sequence) of data are stored as a single data value and count. Run length encoding (RLE) achieves best results with images containing large areas of contiguous color, and especially monochrome images. Run length encoding represents a string by replacing each subsequence of consecutive identical characters with (char; length). The string 1111112222233331111 would have representation (1; 6) (2; 5) (3; 4) (1; 4). Then compress each (char; length) as a unit. This method works well when the characters repeat often [19] [20]. In the proposed method, RLE is used to compress the image effectively. Figure 2 illustrates the compression process.

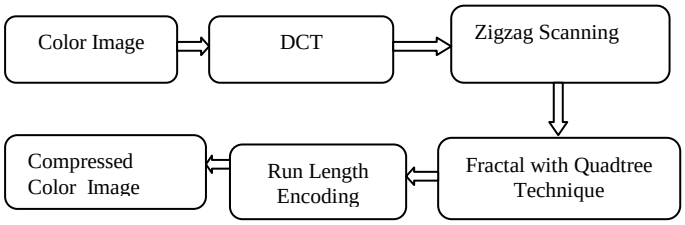

Figure 2: Flow Diagram of Compression Process

3.5 Decompression Process

The decompression process is simple. The compressed image is decompressed by reversing the entire process. Run length decoding and Fractal decoding is applied to the compressed image. Then inverse zigzag is applied. Finally inverse DCT is employed, the compressed color image get decompressed. Figure 3 illustrates the decompression process.

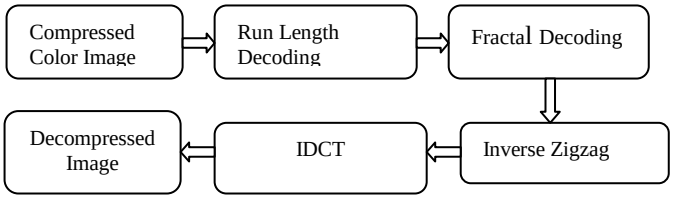

Figure 3: Flow Diagram of Decompression Process

4. Results and Discussions

In this section, the effectiveness of the proposed method is illustrated by means of the experimental results, proposed method was implemented in Matlab 7.9 and the proposed method was evaluated using color images. The test images used in the experiments include: Bird, Roses, Baby and Boat. Quality of the reconstructed images was determined by measuring the Peak Signal to Noise Ratio (PSNR) value and Structural Similarity (SSIM) index and the compression efficiency of the proposed method was determined in terms of the compression ratio.

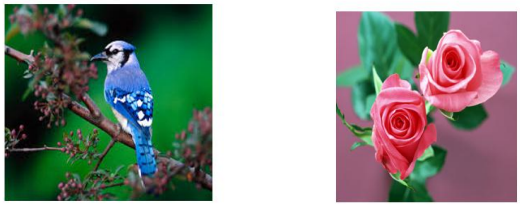

Figure 4: Original Images: i) Bird, ii) Roses

The Test images are compressed and decompressed using the proposed method and following output is obtained.

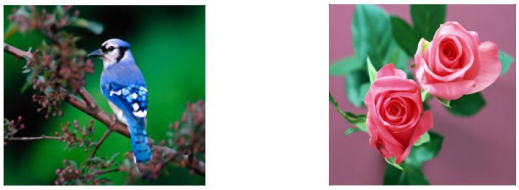

Figure 5: Decompressed Images using Proposed Method

Table 1 illustrates the performance of proposed method using the test images.

Test Images	*Original Size (KB)*	*Compressed Size (KB)*	*Compression Ratio*	*PSNR*	*SSIM*
Bird	896	63	14.20	29.45	0.8879
Roses	1078	82	13.14	32.57	0.8562
Baby	1256	106	11.84	31.36	0.8496
Boat	1344	111	12.10	30.89	0.8714

Table 1: Overall Performance of Proposed Method

The proposed method is compared with standard algorithm of quadtree technique and the results are shown in Table 2 and Table 3.

Table 2: Comparison of Std. Algorithm of Quadtree Technique with Proposed Method

Test Images	*Compression Ratio*		*PSNR*	
	Std .Alg of Quadtree Technique	*Proposed Method*	*Std. Alg of Quadtree Technique*	*Proposed Method*
Bird	10.23	14.20	24.66	29.45
Roses	9.89	13.14	26.08	32.57
Baby	8.76	11.84	25.45	31.36
Boat	10.47	12.10	24.96	30.89

Table 3: Comparison of Std. Algorithm of Quadtree Technique with Proposed Method for SSIM Index

Test Images	*SSIM*	
	Std. Alg of Quadtree Technique	*Proposed Method*
Bird	0.7659	0.8879
Roses	0.7494	0.8562
Baby	0.7351	0.8496
Boat	0.7627	0.8714

Experimental results and comparative analysis show that the proposed method compresses the image effectively with high PSNR value and SSIM index

5. Conclusions

A New Color Image Compression based on Fractal and DCT is proposed in this paper. The proposed algorithm compressed the input color image by employing DCT to the image and DCT coefficient was scanned in zigzag manner, Fractal with Quadtree technique and Run Length encoding technique was applied. The compressed color image is decompressed by

reversing the compression algorithm. The compression ratio calculated describes that the proposed scheme compresses the color image in a better way. Table 1, Table 2 and Table 3 shows that the proposed technique compressed the image effectively with high PSNR value and SSIM index.

References

[1] Y.Chakrapani, and K.Soundera Rajan, "Hybrid Genetic-Simulated Annealing Approach for Fractal Image Compression", International Journal of Information and Mathematical Sciences, Vol.4, No.4, pp. 308-313, 2008.

[2] J. Crilly, R.A. Earnshaw, H. Jones, Fractals and Chaos, Springer-Verlag, New York, 1991.

[3] H.O. Peitgen, J.M. Henriques, L.F. Penedo, Fractals in the Fundamental and Applied Sciences, Elsevier Science Publishing Company Inc., New York, 1991.

[4] M.F. Barnsley, Fractal Everywhere, Academic, New York, 1988.

[5] A.E. Jacquin, "Image coding based on a fractal theory of iterated contractive image transformations," IEEE Transactions on Signal Processing, vol. 1, pp. 18-30, 1992.

[6] W. Xing-Yuan, and et al, "Fractal image compression based on spatial correlation and hybrid genetic algorithm," Journal of Visual Communication and Image Representation, Vol.20, No.8, pp. 505-510, 2009.

[7] Sindhu M, Rajkamal R, "Images and Its Compression Techniques –A Review," International Journal of Recent Trends in Engineering, Vol 2, No. 4, November 2009.

[8] Selim, A., Hadhoud, M. and Salem, M.O.," A Comparison Study between Spiral and Traditional Fractal Image Compression," International Conference on Computer Engineering & Systems, pp.39 – 44, 2002.

[9] Gaganpreet Kaur, Hitashi, Gurudev Singh," Performance Evaluation of Image Quality Based on Fractal Image Compression," International Journal of Computers & Technology, Volume 2 No.1, February 2012.

[10] Sofia Douda, Abdallah Bagri, Amer Abdelhakim El Imrani, "A reduced domain pool based on DCT for a fast fractal image encoding", Electronic Letters on Computer Vision and Image Analysis, 10(1):11-23, 2011

[11] Ruhiat Sultana, Nisar Ahmed and Shaik Mahaboob Basha, "Advanced Fractal Image Coding Based on the Quadtree," Computer Engineering and Intelligent Systems, Vol 2, No.3, ISSN 2222-1719 (Paper) ISSN 2222-2863 (Online).

[12] Gohar Vahdati, Habib Khodadadi, Mahdi Yaghoobi and Mohammad-R. Akbarzadeh-T, "Fractal Image Compression Based on Spatial Correlation and Hybrid Particle Swarm Optimization with Genetic Algorithm," 22nd International Conference on Software Technology and Engineering (ICSTE), 2010.

[13] Kharate G. and Patil V., "Color Image Compression Based on Wavelet Packet Best Tree," International Journal of Computer Science Issues, vol. 7, no. 2, pp. 31-35, 2010.

[14] D. Venkatasekhar and P. Aruna, "A Fast Fractal Image Compression Using Huffman Coding," Asian Journal of Computer Science and Information Technology, vol. 2, no. 9 pp. 272- 275, 2012.

[15] Khalil M., "Image Compression using New Entropy Coder," International Journal of Computer Theory and Engineering, vol. 2, no. 1, pp. 39-42, 2010.

[16] Vijaya-Prakash A. and Gurumurthy K., "A Novel VLSI Architecture for Digital Image Compression using Discrete Cosine Transform and Quantization," International Journal of Computer Science and Network Security, vol. 10, no. 9, pp. 175-182, 2010.

[17] Yih-Lon Lin and Wen-Lin Chen, "Fast Search Strategies for Fractal Image Compression," Journal of Information Science and Engineering, 28, 17-30, 2012.

[18] Chandan Singh Rawat and Sukadev Meher, "A Hybrid Image Compression Scheme using DCT and Fractal Image Compression," The International Arab Journal of Information Technology, Vol. 10, No. 6, November 2013.

[19] Jessica.F. (2002),"Algorithms for Massive Data Sets Context-based Compression," CS 493,1:1-3,www.docstoc.com/docs/54164044/Run-length-encoding.

[20] A. H. Husseen, S. Sh. Mahmud, R. J. Mohammed, "Image Compression Using Proposed Enhanced Run Length Encoding Algorithm," IBN AL- Haitham J. for Pure & Appl. Sci. Vol.24 (1), 2011.