ijecs open access www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 3 March 2015, Page No. 10984-10987

Various Techniques of Fractal Image Compression - A Review

Veena K K[1] , Bhuvaneswari P [2]

[1]PG Student, Department of Electronics and Communication,
RajaRajeswari Collage of Engineering, Bangalore, India,,
email: veena.sampan@gmail.com

[2] Associate Professor, Department of Electronics and Communication,
RajaRajeswari Collage of Engineering, Bangalore, India
email: bhuvanasamuel@gmail.com

Abstract*: Image compression is a method in which we can condense the space for storing images, video which will be helpful in transmission performance. There are many application which requires image compression such as multimedia, internet, remote sensing etc. This paper presents analysis of fractal image compression (FIC), fractal compression is a lossy compression methods for digital images, based on fractal. The method is appropriate for natural images and textures. FIC is an image coding technology based on the self-similarity of image structure and broadly used in image authentication, image denoising, image encryption etc. In this context, the review summaries the major FIC method spanning across different FIC technique.*

Keywords*:* Fractals, Iterated Function System (IFS), Image Coding, PSNR

1. Introduction

Image compression deals with minimizing number of bits used to represent a digital image without destroying the quality of image. Data compression has become a vital concern for information transmission and storage [3]-[5]. Large amount of data cannot be stored if there is a low storage capacity, hence compression plays a very vital role in transmission and storage. Basically there are two types of compression methods [6]

1. Lossless compression method
2. Lossy compression method

In lossless compression methods the reconstructed image after the compression method is applied, is identical to that of the original image i.e. there is no loss of information in the image. It is broadly used in the field of medical image processing, where each minute information details is very important. In lossy compression method, the reconstructed image after applying compression methods contains quality degradation relative to the original image, but to an acceptable level. In general lossy compression method is

widely used because higher compression ratio can be achieved compared to lossless compression method [3].

The rest of this paper is organized as follows. The concept of fractal image compression is briefly summarized in section 2. The property called iterated function system is explained in section 3. In section 4 we focus on the property of self-similarity. In section 5 various Fractal compression techniques are discussed. Finally the conclusion of various methods is drawn in section 6.

2. Fractal image compression

Fractal Image Compression (FIC) was first proposed by Michael Barnsley in 1987 [1], who introduced basic principle of FIC. FIC is a technique which is used to encode the image in such a way that it reduces the storage space by using self-similar portion of the same image. FIC is a lossy compression technique for digital image, based on fractals. In certain images, some parts of the image resemble the other parts of same image, these self similar parts are called fractals and these fractals are used in order to compress image. Fractal algorithms convert these parts (referred as fractals) or geometric shapes into mathematical information which is also called as 'fractal codes' which are later used to reconstruct an image. One of the images is converted into fractal code it become resolution independent. In the below figure1 we can observe that whole image is repeated pattern of the part of the same image.

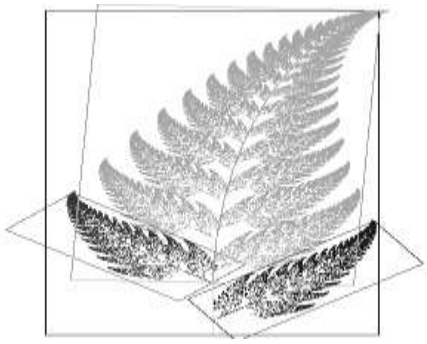

Figure 1 Example of fractal fern

Merits and Demerits of FIC

When compared to other compression method which is used for compressing different kind of images, FIC has some main advantages and drawbacks.

Merits

- Mathematical encoding frame is good
- Resolution independent
- Achieves high compression ratio
- Fast decoding

Demerits

- Encoding speed is slow

3. Iterated function system (IFS)

According to Michael Barnsley, an image can be represented as a set of mathematical equations and this idea of taking an image and express it as an IFS code forms the basis of FIC, but this found impractical because of its complexity, an improvement is made to it by Arnaud Jacquin [2], by using partitioned iterated function system(PIFS). PIFS consists of metric space X, a group of sub domain Di, I=1…..n and a group of contractive mappings Wi: Di→ X, I=1…..n. The images with the IFS are called affine transformations. Affine transformations can be combination of translation, rotation and scaling. Let Wi be the affine transformation on I→ I^2 that

$$w1(X) = w1\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} e \\ f \end{pmatrix}$$

Where a, b, c, d, e, f are co-efficient which are used to rotate, shrink, and translate the image

4. Self- similarity property

Self- similarity is one of the base properties of fractal image. An object is said to be self similar if it looks "roughly" the same on any scale. Figure2 shows an example of fractal. But all image doesn't contain this type of self similarity found in fractals, rather it contains different sort of similar portions [8], [9]. Self similar portion in the Lena image it shown in the below Figure3. A part of her shoulder overlaps smaller regions which is almost similar, and piece of the reflection of the hat in the mirror similar to the smaller part of the Hat [7]. In this kind of image only a part of image is self similar where as figure1 and figure2 entire image is self similar

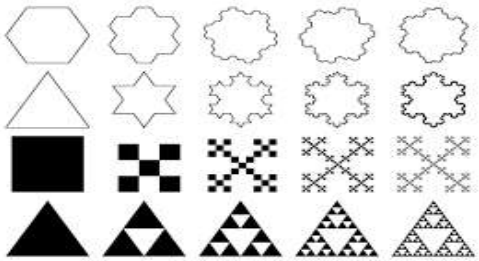

Figure 2 Fractal repeated at different location

Figure 3 Displaying self-similarity different locations

General Fractal Encoding Procedure

Step 1: Read the binary image
Step 2: Convert it into gray level image
Step 3: Divide the image into small square blocks Without overlapping called as range blocks.
Step 4: Introduce large square blocks, with overlapping called as domain blocks. The **size** of domain block is double the size of range block
Step 5: For each range block find the matching domain block which closely resembles range block with respect to some metric and accordingly parameters are computed.
Step 6: Write out compressed data in the form of local IFS code
Step 7: Apply data compression algorithm to obtain a Compressed IFS code.

5. Fractal Image Compression Techniques

There are many techniques proposed to improve the efficiency of FIC. As discussed in the earlier sections FIC is a

lossy compression technique and few major methods are reviewed in this section.

1. Particle Swarm Optimization (PSO). PSO is a technique used for computation developed by Eberhart and Kennedy [10]. PSO is a general purpose optimization algorithm which is also used for the concept of fitness. PSO based on the analogy of the group of birds. It gives mechanism that individuals in the group communicate and exchange information, which is similar to insect and human being behavior. It is a method which is proposed to reduce the encoding time. PSO is inexpensive algorithm and can be implemented in the few lines of code since it required only primitive mathematical operation where as full search FIC can exactly find the best domain block for each corresponding range block but it is very time consuming.

2. Genetic Algorithm (GA): GA is a Algorithm simulating process of natural evaluation, which is applied for constraint functions and controlled parameters for optimization. GA is very effective in solving non-linear and multiple extreme problems. GA was proposed to get the matching domain block for each range block in FIC, which uses the PIFS [12]. GA attempts to find the close optimal solutions without going through an exhaustive search mechanism. Thus GA as merit of huge reduction in searching space and time also achieves high PSNR

3. Embedded Zero tree Wavelet (EZW) coding: EZW was introduced by Shapiro. It is a wavelet based technique used for compression [13], [15]. EZW mainly operates on 2-D images. It provides high compression ratio and better quality of a reconstructed image but yields in lower PSNR. Here all the co-efficient corresponding to the same spatial location is organized in tree structure. These trees have parent- child relationships among the co-efficient of sub-bands having spatial orientation. Hence for better visual quality we choose EZW algorithm.

4. Huffman coding: This method was introduced by D.A.Huffman. This is used to remove the redundancy in the image [11], [14]. In this algorithm the probability of all alphabet symbols are arranged in decreasing order. Then it constructs from the bottom up, a binary tree with a symbol at every leaf node. This is done in steps, where in each step two symbols with the smallest probability are chosen and added, placed in the top of the tree and then deleted from the list, and replaced with another symbol representing the two original symbols. This is repeated until only two symbols is retained at the end of the tree. Finally to determine the codeword's of the symbols the tree is traversed from leaf node to root node. It is a variable length coding. According to this algorithm, the symbols with small frequency will have long code words and vice- versa.

5. Quadtree decomposition: It is one of the partition based methods. It divides an image into variable size range block. In this type of partition, a square image is splited into square blocks of equal sizes, and then tests each block to check whether each block meets some criteria of homogeneity. If a block meets the criteria it is not divided any further, if the block does not meet the criteria, then the block is splited into further four blocks and again test is applied to those blocks[11], [14]. This process is repeated iteratively until each and every block meets the criteria resulting in many different sizes of blocks. It is represented in a tree like structure, where each node will have four sub nodes. Adjustments of Quadtree size is done by using two parameters, minimum level and maximum level. By this method we can increase the compression ratio and reduce the bits used to represent an image i.e bits per pixel (bpp).

6. *Artificial Bee Colony optimization (ABC):* ABC is one of the most widely defined algorithms by Dervis Karaboga in 2005 inspired by the behavior of honey bees [16]. It is also an iterated based technique. It is an optimization tool which provides a population based search procedure where each individual called food positions are altered by artificial bees with time aiming to find out the food source with large nectar amount. ABC consists of 3 types of bees (a) employed bee, (b) onlooker bee and (c) scout bee. Employed bees are responsible for giving the information for the onlooker bees waiting in the hive about the nectar sources which has been explored before, onlooker bees decide a food source to exploit depending on the information given by the employed bees and scout bees search the food source randomly in the environment in order to find food [17]. ABC algorithm can appreciate the fractal image coding in reduced time.

6. Conclusion

The field of fractal compression is comparatively new, as it is the study of fractals. It is one of the techniques used for image compression due to considerable merits of resolution independence and rapid decoding. The main concept used in this compression scheme is to use IFS to reproduce image. In this paper many FIC techniques is reviewed and based on the experimental outcomes given by respective authors we conclude that (1) In PSO algorithm, encoding time is less than any other conventional methods. (2) GA will increase the rate of convergence for reaching best block and also increase the speed of compression and produce high PSNR.(3) EZW coding provide better visual quality and hence the good PSNR (4) and (5) Huffman and Quadtree decomposition can be applied for achieving high compression ratio and better PSNR values for satellite imaginaries . (6) ABC algorithm yield in less amount of time in image coding as well as with good PSNR.

References

[1] M. F. Barnsley and A. E. Jacquin, "Application of recurrent iterated function systems to images," Proc. SPIE, vol. 1001, pp. 122–131, Nov. 1988.

[2] A. E. Jacquin, "Image coding based on a fractal theory of iterated contractive image transformations," IEEE Trans. Image Process., vol 1, no.1, Jan 1992

[3] Kaouri, A. H. ." Fractal coding of still images" Queen's university of Belfast,UK, 2002

[4] Hu, L., Chen, Q. and qing, Z." An image compression method based on fractal theory". The 8th international conference on computersupported cooperative work in design proceedings, 546 – 550. 2003.

[5] Clarke r. J., "Digital compression of still images and video", London, academic press, 2nd printing, 1996.

[6] Gonzalez, R. and Eugene, R. Digital image processing, 466, . 2008

[7] Yancong, Y. and Ruidong, P. “Fast Fractal Coding Based on Dividing of Image”, 2010.
[8] R. Distasi, m. Nappi, and d. Riccio, “R range/domain approximationerror-based approach for fractal image compression,”IEEE trans. Image process., vol. 15, no. 1, pp. 89–97, jan. 2006.
[9] T. K. Truong, j. H. Jeng, i. S. Reed, p. C. Lee, and a. Q. Li, “A Fast encoding algorithm for fractal image compression using the dct inner product,” IEEE trans. Image process., vol. 9, no. 4, pp. 529–535, apr. 2000
[10] Y. Chakrapani and K. Soundararajan “Implementation of fractal Image compression employing particle swarm optimization” World journal of modeling simulation, vol.6, 2010, no.1.pp 40-46
[11] Yung- Ching Chang, Bin-Kai Shyu,Jia- Shung Wang “ Region Based fractal compression for still image”, 2010
[12] Suman K. Mitra, C. A. Murthy, and Malay K. Kundu “ Technique for Fractal Image Compression Using Genetic Agorithm” IEEE Transactions On Image Processing, VOL. 7, NO. 4, APRIL 1998
[13] Hitashi Gaganpreet Kaur Sugandha Sharma “ Fractal imagecompression- a review” International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 2, February 2012
[14] Veenadevi .S. V and A.G. Ananth “Fractal image compression using Quadtree decomposition and Huffman coding” , signal and image Processing: an international journal(SIPIJ) vol.3, no. 2, April 2012
[15] R. Sudhakar, M.R. “Image compression using coding of wavelet Coefficients- a survey”, ICGST_GCCIP Journal, vol.5, no.6 pp 25- 38, June 2005
[16] D. Karaboga, An idea based on honey bee swarm for numerical optimization, Tech. Report TR06, Erciyes University, Engineering , Faculty, Computer Engineering Department, 2005.
[17] D. Karaboga, B. Basturk: A powerful and efficient algorithm for numerical function optimization: artificial bee colony (ABC) algorithm, Journal of Global Optimization, Vol. 39, 2007, pp. 459- 471