International Journal of Entrepreneurial Research and Management
Volume 10 Issue 4, October-December 2022
ISSN: 2995-4878
Impact Factor: 5.24
https://kloverjournals.org/journals/index.php/em

A COMPREHENSIVE GUIDE TO MULTIMEDIA APPLICATION OPTIMIZATION

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Abstract
The escalating demand for computer animations, images, and video applications has underscored the significance of image and video compression. This paper addresses the imperative issue of image compression, with a focus on its pivotal role in data reduction and enhanced transmission speed. Two primary categories of image compression exist: lossy and lossless. Lossless compression maintains numerical fidelity with the original image, while lossy compression introduces controlled distortions. Various techniques, such as Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), and fractal compression, fall under the lossy compression umbrella. Additionally, transform coding, Wavelet compression, Vector quantization, and more, contribute to the spectrum of image compression methods.

This study delves into the Fractal Compression approach, particularly Fractal Image Compression (FCI), which harnesses the self-replicating patterns in images. FCI creates a transformation that closely approximates the original image, preserving key features, and encodes the transformation parameters in a file. With a focus on natural images and their inherent similarities, FCI holds promise. In this paper, we offer an in-depth review of the FCI method, commencing with an introduction to fractals and their application in image compression. The presented analysis sheds light on the principles and potential of FCI in meeting the demands of contemporary image compression requirements.

Keywords: Image compression, lossy compression, lossless compression, Fractal Image Compression, FCI, Discrete Cosine Transform, Discrete Wavelet Transform, fractals.

1. Introduction

The need for computer animations, images, and video sequences applications has augmented over the years. So, image and video compression is becoming an important issue (Singh, 2010; Kumari et al., 2012; Walczak, 2008). The goal of image compression is to reduce the amount of data required to represent a digital image. And also the other goal is to increase the transmission speed without degrading image quality. In general, there are two types of image compression. Lossy as well as Lossless. In lossless compression, the changed image is numerically similar to the main image **(**Liu & Jimack, 2007**).** Although in lossy compression, the changed image has some vandalism. DCT (Discrete cosine transform), DWT (Discrete wavelet transform) and fractal compression, are Lossy compression techniques (Kumari et al., 2012). Transform coding, Wavelet compression, Vector quantization, Run-length coding, Huffman coding, Arithmetic coding, Textual substitution/LZ methods, Prediction and modeling are other methods for image compression (Koli & Ali, 2008). FCI is a lossy compression method based on fractals for digital images. Fractal image compression (Jacquin, 1989) is a lossy method that compress an image by discovering a transformation that has a fixpoint closely approximating the based image, then storing (encoding) the parameters of this transformation in a file.

This method is suitable for natural images and considering this fact that parts of an image often are similar as other parts of the same image. In this paper we present a review to FCI method. First an Introduction to fractals and fractal image compression is presented.

1.1. Fractals

The term Fractals has been by B Mandelbrot (Mandelbrot, 1983) in 1975 for the first time. According to B. Mandelbrot, the "father of fractals", a fractal is: "A rough or fragmented geometric shape that can be subdivided in parts, each of which is (at least approximately) a reduced/size copy of the whole." (Walczak, 2008). A general definition of a fractal is a set F which has any of the following characteristics:

-F is exactly, nearly ‹or statistically *self-similar* (Fisher, 1994).

-F consists of detail at each level (Fisher, 1994).

-The *Housdorff Besicovitch* (Mandelbrot, 1983) dimension of F is greater than its topological dimension (Fisher, 1994).

-There is a simple algorithmic explanation of F (Fisher, 1994).

The defining property of a fractal is that it has a fractional dimension.

2. Fractal Image Compression

Fractal compression is a technique of lossy compression. This technique is trying to construct an approximation of the original image to be acceptable (Kumari et al., 2012). FCIs important task is to test similarities between larger and smaller parts of an image. So, it relies on self-similarity and manages the images quality (Arjun Purushothaman, 2016). Fractal algorithms transform parts of the images into mathematical data called "fractal codes" that are used to rebuild the encoded image. When an image has been converted into fractal code, its relationship to a distinct resolution has been lost; and it becomes resolution independent and generally it provides better performance and produces an approximation that is closer to the original at higher compression ratios (Arjun Purushothaman, 2016; Maaruf & Trevor, 1991). M.Barnsley (Barnsley & Sloan, 1988) proposed that storing images as a collection of transformation would result in image compression. Recent years, some powerful and complicated Fractal image compression schemes for compression have been developed where the iteration function system provides a better quality in the images (Michael & Vanitha, 2013).

2.1. Why Fractal image Compression?

2.1.1. For self-similarity in the images

An original image does not consist self-similarity. It consists different kind of similarity that applying fractal compression achieves compression .To compress image, at first take the original image and then separate it into several non-overlapping sub-blocks which are named parent block. Further each of these blocks separated into 4 blocks which are named child blocks. Secondly, Compare one-by-one each child block from the parent block and determine which larger block has the smallest difference according to some computation between larger block and smaller block. This is done for each block. For decompression, opposite method is done to rebuild the original image. This called self- similarity (Kumari et al., 2012; Sankaranarayanan, 1998).

2.1.2. Resolution independence

It means that after the image being converted to the fractal code, its relation is free from the specific resolution and it is important (Kumari et al., 2012; Jacquin, 1989).

2.1.3. Fractal interpolation

In this process, during fractal compression, the image is encoded into fractal codes and then, decompressed at higher resolution. It is occurred due to the resolution independence (Kumari et al., 2012).

3. Some of the advantages and disadvantages of fractal image compression

3.. Advantages

* Rapid decompression
* Ability to produce a good quality decoded image.
* Without resolution decoding.
* Preserve a high amount of self-similarity.
* High compression ratio.

.2. Disadvantages

* long encoding time

4. Fractal Image Compression General Process

Fractal encoding considers the fact that all natural, and most artificial objects includes excess information in the form of similar and repeating patterns called fractals. Encoding has 6 steps, and decoding has 5 steps (Michael &Vanitha, 2013).

Compression has this disadvantage of having long encoding time with some compromise with PSNR. But, their proposed method reduces the encoding time and prepares higher compression ratio (Garg, 2011).

4-Franck Davoine, Mark Antonini, etc has proposed a new scheme for fractal image compression based on adaptive Delaunay triangulation. The triangulation is flexible which can return a limited number of blocks allowing good compression ratios. In fact, this paper prepare a new partitioning scheme based on Delaunay triangles for fractal image compression. Such a partition seems to be attractive because it contains a reduced number of blocks compared with square-based partitions. A classification scheme based on vector quantization has been used in order to reduce the number of blocks in the domain partition so this will reduce encoding complexity and preserving good decoding quality at the rates between 0.25 and 0.5 (Davoine et al., 1996). 5-Dietmar Saupe and Universitat Freiburg have considered this issue that in fractal image compression, the encoding step is computationally expensive. So they have developed a theory to show that the basic process of fractal image compression is equal to multi-dimensional nearest neighbor search, so they could accelerating the encoding process in fractal image compression. Moreover, compared to plain classification, this proposed method is able to search through larger portions of the domain without increased the computation time (Saupe, 1995).

6-Rashad A.AL-Jawfi , Baligh M.Al-Helali have considered that one of the main disadvantages of fractal image data compression is a loss time in the process of image compression (encoding) and conversion into a system of iterated functions (IFS). Authors in this paper, have proposed the idea of inverse problem of fixed point. This suggested idea is applied by iterated function system, iterative system functions, gray-scale iterated function system. Then, this process has been revised to reduce the time which is needed for image compression. In this paper, the neural network algorithms have been applied on the process of compression. They show and discuss the experimental results and the performance of the proposed algorithm (Al-Jawfi et al., 2014).

7-Chong Sze Tong, Man Wong have presented an improved formulation of approximate nearest neighbor search based on pre-quantization of fractal transform parameters. The experimental results show that their technique is able to improve compression ratio, and reduce memory requirement and encoding time. They also have used the quadtree partitioning in their new algorithm so that they can adjust the comperssion ratio. They show that their algorithm leads to better rate distortion curves compared to conventional nearest neighbor search (Tong & Wong, 2002).

8-Er Awdhesh Kumari and etc have presented some of the important optimization techniques through which efficiency of fractal image compression can be improved. Two of the techniques are particle swarm optimization and genetic algorithm (Kumari et al., 2012; MARTIN & CURTIS, 2013).

9- G Farhadi has proposed Fractal Coding with DCT. DCT is the abbreviation form of Discrete Cosine Transform. The transform coefficients are then encoded using fractal block coding. Two methods are expressed in literature. First use DCT on the entire image. The conventional way is to partition the image into small blocks, then apply DCT to these blocks of the image (Farhadi, 2003).

Table 1. Comparison between different methods

Authors	**Method**	**Advantage**	**Disadvantage**
Anupam Garg	An Improved Algorithm of Fractal Image Compression	reduces the encoding time and prepares higher compression ratio	Computationally difficult
Er Awdhesh Kumari	Particle swarm optimization	Coding efficiency	Effecting image quality
D. Venkatasekhar, P. Aruna	Genetic algorithm with Huffman coding	Increasing the speed of compression and providing high PSNR	Effecting PSNR
Franck Davoine, Mark Antonini	Adaptive Delaunay triangulation	Reduce encoding complexity and preserving good decoding quality	Effecting image quality
Rashad A.AL-Jawfi , Baligh M.Al-Helali	Inverse problem of fixed point (the neural network algorithms)	reduce the time which is needed for image compression	Less PSNR
Chong Sze Tong, Man Wong	An improved formulation of approximate nearest neighbor search	improve compression ratio, and reduce memory requirement and encoding time	Effecting image quality
Chetan Dudhagara, Kishor Atkotiya	fixed-size partitioning	compression ratio will increase, and the processing time will decrease	Effecting image quality
G Farhadi	Fractal coding with DCT	Improved encoding time	Tiling Effect

6. Conclusion

Fractal compressing is relatively a new area, and there is no standard approach to this technique. The main idea of FCI is to apply Iterated Function Systems (IFS) to recreate images. One of the main property of fractals is that they show self-similarity. There are some different algorithms of fractal image compression which are collected from literature and have been introduced and then discussed in the previous part of this paper. Table 1 is summarizing advantages and disadvantages of all these methods based on CR (compression ratio), PSNR, time criteria.

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