Experimental Study of Fractal Image Compression Algorithm

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ABSTRACT

Image compression applications have been increasing in recent years. Fractal compression is a lossy compression method for digital images, based on fractals. The method is best suited for textures and natural images, relying on the fact that parts of an image often resemble other parts of the same image. In this paper, a study on fractal-based image compression and fixed-size partitioning will be made, analyzed for performance and compared with a standard frequency domain based image compression standard, JPEG. Sample images will be used to perform compression and decompression. Performance metrics such as compression ratio, compression time and decompression time will be measured in JPEG cases. Also the phenomenon of resolution/scale independence will be studied and described with examples.

Fractal algorithms convert these parts into mathematical data called "fractal codes" which are used to recreate the encoded image. Fractal encoding is a mathematical process used to encode bitmaps containing a real-world image as a set of mathematical data that describes the fractal properties of the image. Fractal encoding relies on the fact that all natural, and most artificial, objects contain redundant information in the form of similar, repeating patterns called *fractals*.

Keywords :- Fractal, Compression, Decompression, JPEG

I. INTRODUCTION

Images are stored on computers as collections of bits representing pixels forming the picture elements. Since the human eye can process large amounts of information, many pixels are required to store moderate quality images. Most data contains some amount of redundancy, which can sometimes be removed for storage and replaced for recovery, but this redundancy does not lead to high compression ratios. An image can be changed in many ways that are either not detectable by the human eye or do not contribute to the degradation of the image.

With the advance of the information age the need for mass information storage and fast communication links grows. Storing images in less memory leads to a direct reduction in storage cost and faster data transmissions.

Usually, images are expensive, especially when the quality is greater than needed. Compression is, in almost every case, necessary. Databases holding thousands or millions of images, or network data transfers, can benefit from different compression schemes, in terms of less storage space needed and less data to transfer over the cable, less bandwidth consumption and thus more efficient and faster browsing and less cost and charges by web hosting services. A fractal is a structure that is made up of similar forms and patterns that occur in many different sizes. The term *fractal* was first used by Benoit Mandelbrot to describe repeating patterns that he observed occurring in many different structures. These patterns appeared nearly identical in form at any size and occurred naturally in all things.

Compression:

Once the application initializes its state, it reads the image and starts the compressor. The compressor splits the image into tiles and proceeds to compare each tile with every other part of the image after transforming the image with a set of selected transforms. The blocks that match most, are kept linked along with the transformation that has been applied. The end result is a list of tiles which are linked to a list of transforms, each of whom is linked with a list of points in the original image that, applied to the tile that's linked to them, the result represents that part of the original image.

Decompression:

Decompression works the same way. The application reads a compressed file, as generated by the compression step, and forms back the original image.

II. Fractal Image Compression

Take real word example, imagine a special type of photocopying machine that reduces the image to be copied by half and reproduces it three times on the copy in Fig. - 1. Fig. - 2 show several iterations of this process on several input images. We can observe that all the copies seem to converge to the same final image, the one in Fig. – 2(c). Since the copying machine reduces the input image, any initial image placed on the copying machine will be reduced to a point as we repeatedly run the machine; in fact, it is only the position and the orientation of the copies that determines what the final image looks like.

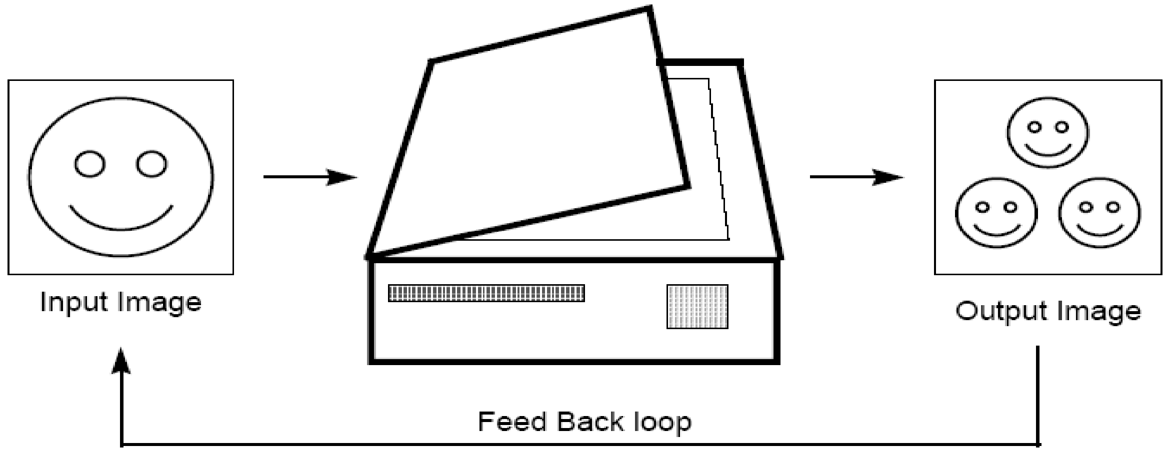

Fig. – 1 : A copy machine that makes three reduced copies of the input image

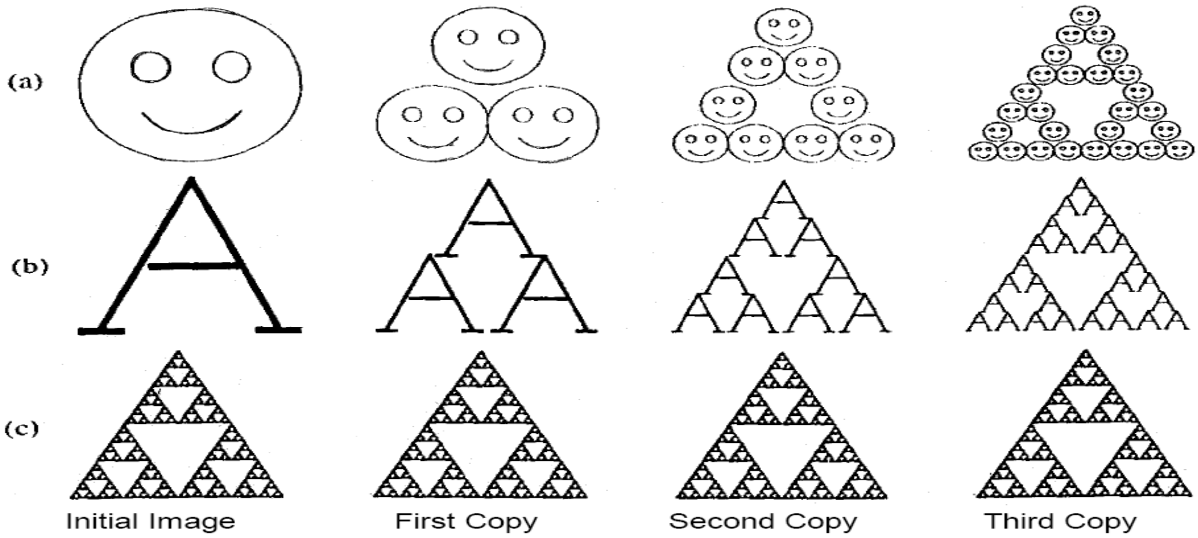

Fig. – 2 : The first three copies generated on the copying machine Fig. – 1.

The way the input image is transformed determines the final result when running the copy machine in a feedback loop. However we must constrain these transformations, with the limitation that the transformations must be contractive, that is, a given transformation applied to any two points in the input image must bring them closer in the copy. This technical condition is quite logical, since if points in the copy were spread out the final image would have to be of infinite size. Except for this condition the transformation can have any form.

In practice, choosing transformations of the form

$$w_i \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} a_i & b_i \\ c_i & d_i \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} e_i \\ f_i \end{bmatrix}$$

is sufficient to generate interesting transformations called affine transformations of the plane. Each can skew, stretch, rotate, scale and translate an input image.

A common feature of these transformations that run in a loop back mode is that for a given initial image each image is formed from a transformed and reduced copies of itself, and hence it must have detail at every scale. That is, the images are fractals.

Each transformation *wi* is defined by 6 numbers, *ai*, *bi*, *ci*, *di*, *ei*, and *fi* , see equation, which do not require much memory to store on a computer (4 transformations x 6 numbers / transformations x 32 bits /number = 768 bits). Storing the image as a collection of pixels however required much more memory.

III. EXPERIMENTAL RESULTS

In this paper to evaluate Fractal Image Compression, we use Lena.jpg. It perform various panel size to identifies compressed file size, compression ratio, compression time etc. Fig. – 3 represent the application screen layout of fractal image compression algorithm. Table – 1 represent the experimental result of the image lena.

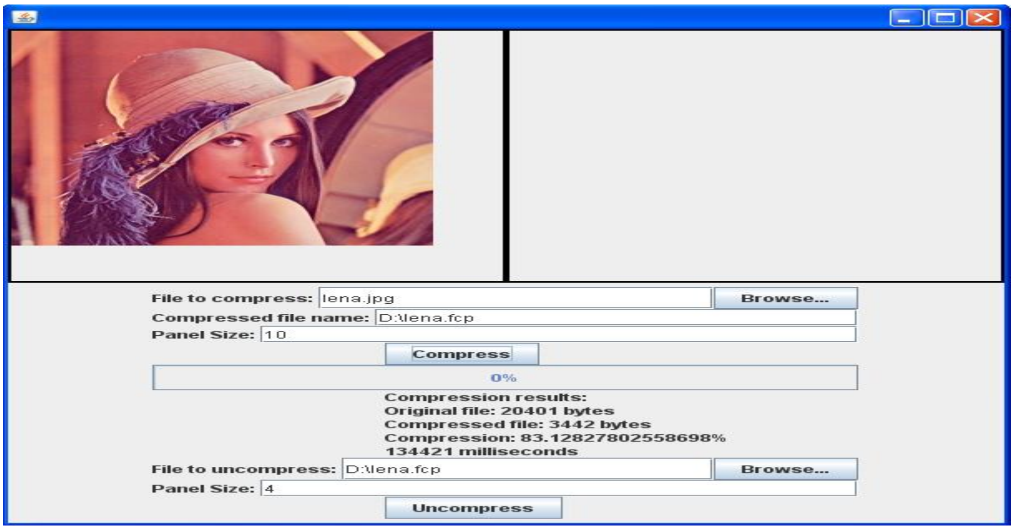

Fig. – 3 Screen Layout

Panel Size	Original File (in bytes)	Compressed File (in bytes)	Compression Ratio	Processing Time (in milliseconds)
5	20401	13112	35.73	164891
6	20401	9365	54.10	161188
7	20401	6930	66.03	153922
8	20401	5512	72.98	163360
9	20401	42890	78.97	146734
10	20401	3442	83.13	134221
11	20401	2684	86.84	116609
12	20401	2511	87.69	133672
13	20401	1853	90.92	93797
14	20401	1887	90.75	128875
15	20401	1523	92.53	100313

Table – 1 Experimental result of Lena

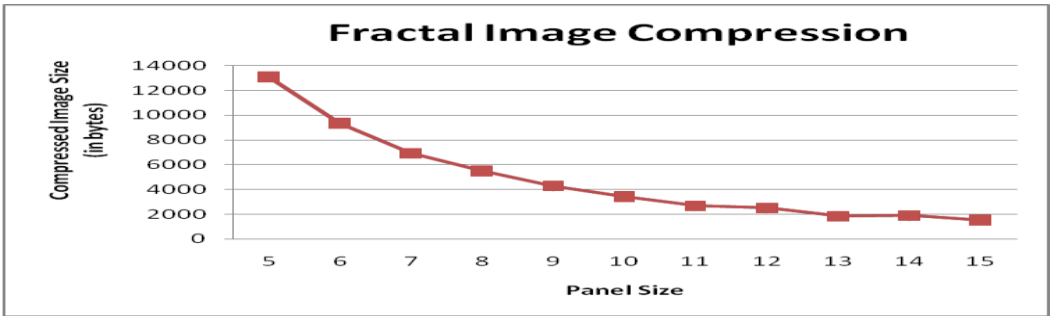

Fig. – 4(a) Panel Size v/s Compressed Imag Size

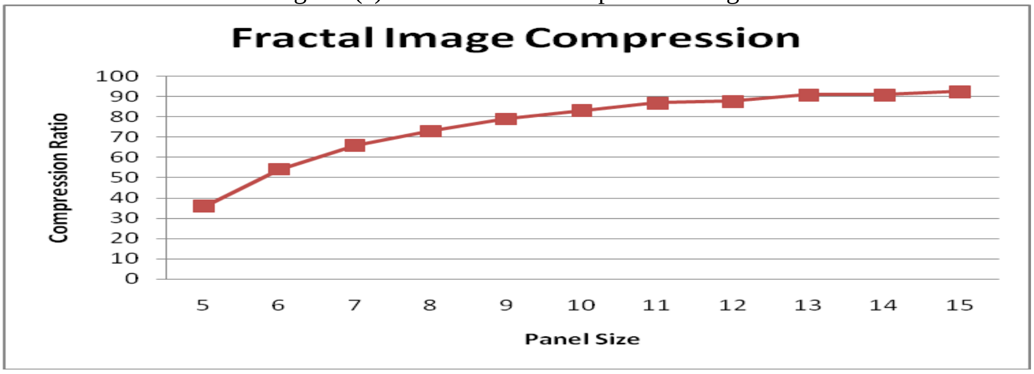

Fig. – 4(b) Panel Size v/s Compression Ratio

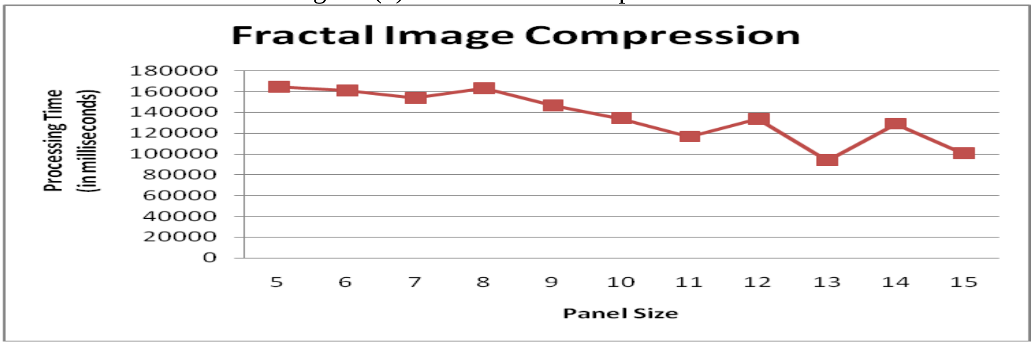

Fig. – 4(c) Panel Size v/s Processing Time

IV. CONCLUSION

Fractal compression is lossy. The process of matching fractals does not involve looking for exact matches, but instead looking for "best fit" matches based on the compression parameters (encoding time, image quality, and size of output). But the encoding process can be controlled to the point where the image is "visually lossless." That is, you shouldn't be able to notice where the data was lost.

In Fractal Image Compression, when we increase the panel size, it will decrease the original file size and increases the image compression ratio. It will also decrease the processing time.

V. REFERECES

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