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# Improvement of Image Quality Based on Fractal Image Compression

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**Abstract:** Fast Fourier Transform and Discrete cosine transform (DCT) are widely used in many practical image/video compression systems because of their compression performance and computational efficiency. The proposed work in Fractal image compression using discrete wavelet transform is followed by Huffman Run length Encoding. The main idea of the proposed procedure for both Encoding process and image compression is performed. To compare the results, the mean square error, signal-to-noise ratio and encoding time criterions and compression ratio (bit per pixel) were used. The simplicity to obtain compressed image and extracted contours with accepted level of the reconstruction is the main advantage of the discrete wavelength transform algorithms.

**Key words:** Image Compression · Fractal Image Compression · Compression ratio (CR) · Peak Signal to Noise Ratio (PSNR) · Encode Time · Decode Time

## INTRODUCTION

Fractal-based image compression (FIC) techniques exploit redundancy due to self-similarity properties in imagesto achieve compression [1]. A fractal may be defined as a geometrical shape that is self-similar i.e. it has parts that is similar to the whole.

Fractal is one effective method to describe natural modality in the process of transformation and iteration. In FIC the image is decomposed two times, into overlapping domain blocks with size d*d to make a domain pool. Multimedia data requires considerable storage capacity and transmission bandwidth. The data are in the form of graphics, audio, video and image. These types of data have to be compressed during the transmission process.

The approaches for lossycompression include lossy predictive coding andtransform coding [2]. Transform coding, whichapplies a Fourier-related transform such as DCT and FFT [3]. Fractal image compression schemes for imagecompression have been developed andimplemented.

**Image Compression:** Image compression means minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level [1]. The reduction in file size allows more images to be stored in a given amount of disk more memory space. It also reduces the time required for image to besent over the internet or downloaded from web pages. The recent growth of data intensive multimedia based web application have not only sustained the need for more efficient ways to encode signals and images but have made compression of such signal central to storage and communication technology [4]. The principle behind image compression is that the neighboring pixels are correlated and therefore contain redundant information. The foremost task then is to find less correlated representation of the image [5].

### Fractal Image Compression

**Definition:** Fractal is one effective method to describe natural modality in the process of transformation and iteration. In 1973, Benoit Mandelbrot firstly brought forward the idea of fractal geometry, Infinity self-similarity is the soul of fractal. It was Michael Barnsley and his research group who first give out the method of fractal-based image compression, via IFS (Iterated Function Systems), according to the local and global self similarprinciple. In 1989, Amaud Jacquin and Michal Barnsley realized a first automatic fractal encoding system [6, 7]. Fractal parameters, including fractal dimension and iterated function systems, have the potential to provide

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efficient methods of describing imagery in a high compact fashion for both communication and storage applications. [8] Fractal image compression is also called as fractal image programming because compressed images are represented by contractive transforms.3.2 Iterated Function Systems

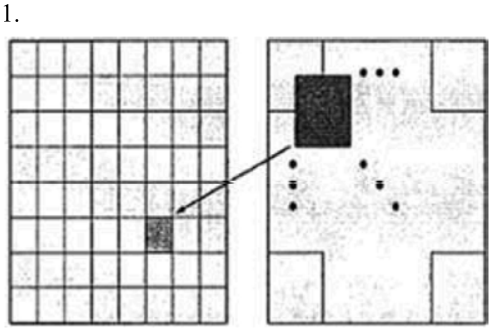
The contractive transforms are composed of group of a number of affine mappings on the whole image, known as Iterated Function System (IFS).Contractive transformation is applied to the IFS'scalled Collage theorem.

- Formal description for constructing linear fractals
- An IFS consists of a complete metric space(X,d) and a finite set of contraction mappings{ f1,...,fn } with contraction factors s1,...,
- Notation: {X; f1,...,fn }
- Classical IFS are of the form: {R2; f1,….,fn }and {R3;f1,...,fn }

**Attractor of an IFS**

- Frequently the attractor of an IFS is a fractal set.
- An IFS is a short and compact description(encoding) for very complex objects.
- Memory amount for {R2;f1,...,fn} are 6n floating point values. O

In FIC the image is decomposed two times, into overlapping domain blocks with size D*D to make a domain pool [9]. Then we decompose the image again into non-overlapping range blocks with size R*R and usually D=2*R. This type of decomposition is closely related to quad–tree (parent child relationship) where domain block forms parent and small four range block forms children. The whole process of fractal imageencoding is shown in Fig. 1.



Partition Scheme (Range Block) Virtual Codebook (Domain Block)

Fig. 1: Encoding in FIC

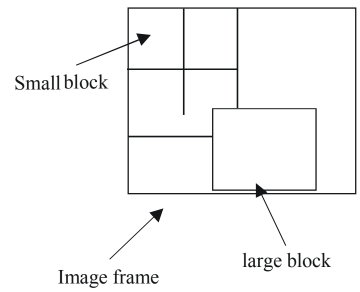



Fig. 2:Image partitioning

The major tool used in describing images with iterated function systems is the affine transformation [10]. This transformation is used to express associations between different parts of an image. The iteration function systemprovides a better quality in the images [11].

**Fractal:** The image compression scheme describe later can be said to be fractal in several senses. The scheme will encode an image as a collection of transforms that are very similar to the copy machine metaphor. Just as the fern has detail at every scale, so does the image reconstructed from the transforms [12, 13]. The decoded image has no natural size, it can be decoded at any size. The extra detail needed for decoding at larger sizes is generated automatically by the encoding transforms.

**Vector Quantization:** Vector quantization is based on the competitive learning paradigm, so it is closely related to the self-organizing map model.

It works by dividing a large set of points (vectors) into groups having approximately the same number of points closest to them [14, 6]. The density matching property of vector quantization is powerful, especially for identifying the density of large and high-dimensioned data.

**Fractal-Based Encoding:** The goal of our fractal-based encoding scheme is to first estimate the conditional probabilities between various sub bands codes and then use these statistical relationships in a predictive coding algorithm.

**Peak Signal-to-Noise Ratio (PSNR):** Peak signal to noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation [15]. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale.

PSNR is most commonly used to measure the quality of reconstruction of lossycompression codes (e.g., for image compression) [16].

$$PSNR = 10\log_{10}\left(\frac{R^2}{MSE}\right)$$

**Mean Square Value (MSE):** MSE is a rick function, corresponding to the expectedvalue of the squared error loss or quadratic loss. MSE measures the average of the squares of the "errors".

MSE has the same units of measurement as the square of the quantity being estimated.

$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M * N}$$

**Compression Ratio (CR):** Data compression ratio is defined as the ratio between the uncompressed size and compressed size.

Cr= Uncompressed image size/Compressed image size

**Encoding Time:** Encoding is the process of putting a sequence of characters into a special format for transmission or storage purposes.

**Implementation**

**Discrete Cosine Transform Process Implementation:** A discrete cosine transform (DCT) expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies.DCTs are important to numerous applications in science and engineering, from lossy compressionof images (e.g. JPEG). The use of cosine rather than sine functions is critical in these applications for compression, it turns out that cosine functions are much more efficient, where as for differential equations the cosines express a particular choice of boundary conditions [8]. General equation for a 1D ($N$ data items) DCT is definedby the following equation:

$$F(u) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} A(i).\cos\left[\frac{\pi.u}{2.N}(2i+1)\right] f(i)$$

Compression is achieved since the lower right values represent higher frequencies and are often small - small enough to be neglected with little visible distortion. The DCT input is an 8 by 8 array of integers [17]. This array contains each pixel's gray scale level.8 bit pixels have levels from 0 to 255.

**Fast Fourier Transform Process Implementation:** We can go between the time domain and the frequency domainby using a tool called Fourier transform

- A Fourier transform converts a signal in the time domain to thefrequency domain(spectrum).
- An inverse Fourier transform converts the frequency domain components back into the original time domain signal.

Image Fourier transforms is the classical algorithm which can convert image from spatial domain to frequency domain [18].

Because of its good concentrative property with transform energy, Fourier transform has been widely applied in image coding, image segmentation, image reconstruction.

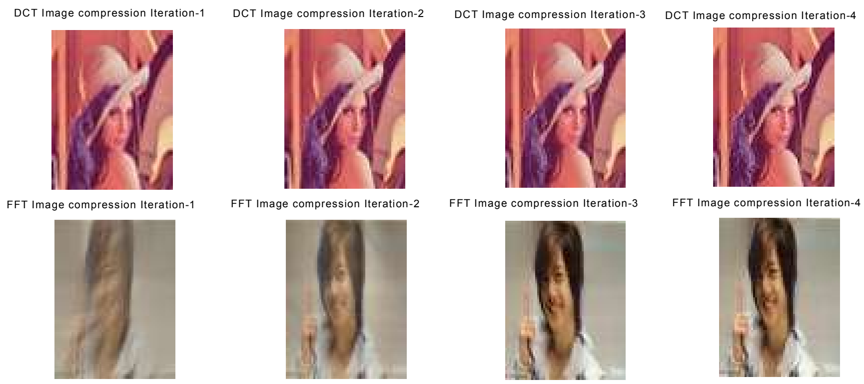
- Remote sensing via satellites and other space craft's.
- Image transmission and storage for business application.
- Medical processing.

**Experimental Results:** In this paper two different images are selected Lena.jpg (8497 bytes) and kim.jpg (132505 bytes) to simulate and evaluate result offractal image compression [19]. The simulation resulthas shown in Table 1, Table 2. Table 1, Table 2 show compressed size, Compression Ratio, Peak Signal to Noise Ratio, Mean Square Error (MSE) for image at different search block size.. It can be seen from that quality of reconstructed image is much closer to the quality of the original image [20]. It has been analyzed that result obtained from the Fractal image compression provide good visual qualityandPSNR value and compression ratio [13].

**Result on Images:**

Original image

Original image




**Experimental Results:**

Table 1: Performance Evaluation of Fractal Image Compression Using Discrete Cosine Transform Algorithm

| Increases of value of search block | Iteration 1 | Iteration 2 | Iteration 3 | Iteration 4 |
|---|---|---|---|---|
| Compressed size | 2938 | 3217 | 3326 | 3346 |
| MSE | 62.1188 | 63.3734 | 63.5449 | 62.6361 |
| PSNR | 30.2326 | 30.1966 | 30.1457 | 30.1340 |
| Compression Ratio | 10.2110 | 9.3255 | 9.0198 | 8.9659 |
| Encoding time (sec) | 0.2340 | 0.0312 | 0.0156 | 0..0196 |

Image Size: Lena.jpg(8497)bytes

Table 2: Performance Evaluation of Fractal Image Compression Using Fast Fourier Transform Algorithm

| Increases of value of search block | Iteration 1 | Iteration 2 | Iteration 3 | Iteration 4 |
|---|---|---|---|---|
| Compressed size | 1887 | 2256 | 2486 | 2655 |
| MSE | 63.1700 | 63.7432 | 64.6016 | 64.3334 |
| PSNR | 30.0804 | 30.0624 | 30.1205 | 30.9732 |
| Compression Ratio | 11.2994 | 12.0870 | 13.2979 | 15.8983 |
| Encoding time (sec) | 0.0426 | 0.0332 | 0.0253 | 0.0213 |

Image Size: Kim.jpg (132505) byte

## CONCLUSION

In this paper, the results of lena.jpg and kim.jpg images are compared which are obtaining from fractal image compression using Discrete Cosine Transform and Fast Fourier Transform algorithm.[8] This compression algorithm provides a better performance on picture quality at higher compression ratio and the effects of image contents and compression ratios are examined. From this, it is observed that fractal image compression using Fast Fourier Transform algorithm provides better result because the compression ratio is high.

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