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RESEARCH ARTICLE

Fractal Image Compression - A Review.

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Abstract

Fractal image compression is a very appropriate technique based on the representation of an image by a transformations. Fractal compression is a lossy compression method for digital images. The method is best for textures and natural images, which is based on the fact that parts of an image frequently similar with other parts of the same image. In this paper review of different fractal image compression with other techniques have been discussed from which researches can get an concept for efficient techniques which they can be use for their work. This analysis of various techniques gives knowledge to distinguish the beneficial points and help to choose appropriate method for compression. This paper will be very helpful for beginners in fractal image compression.

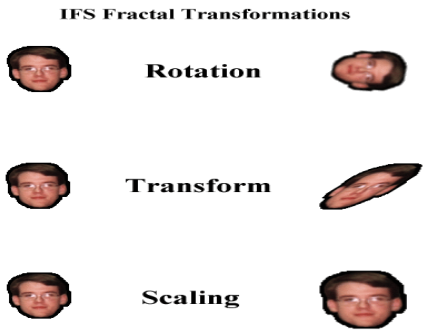
Introduction:-

An image consist of large amount of data and needs large amount of storage space in memory. If there is more number of data present in image for transmission then it takes much time to deliver at receiver side.

By using image compression techniques time used for transmission can be reduced at some point. Compressed image require less storage space in memory and it also takes less time for transmission. The main purpose of image compression is to restrict the quantity of data which is necessary for representing the digital images and reduce the cost of storage space and transmission.[2] At present Fractal image compression has become most excellent technology in image compression for its high compression ratio and resolution independence.[11] The basic idea of Fractal image compression was introduced by Barnsley in 1988.[22] A fractal is rough or fragmented geometric shape that can be split into parts, each part is reduced sized copy of whole, a property is called self-similarity. [16]
Fractal Image Compression (FIC) technique exploits similarities between distinctive parts of the image. It divides the image into sub-blocks. The self-similarities included in the images are represented by Iterated Function System (IFS). For each image it has finite set of contraction mapping that has fixed-point similar to itself. Appling that transforms repeatedly on an arbitrary starting image, the result comes to original image. Image is encoded by transformations on a complete metric space.[12] Jacquin proposed partitioning of image into square blocks that are called range blocks. After that it search for region or block which are self similar according to certain criterion and if match is found then transformations are performed. A special type of IFS i.e. Partitioned Iterated Function System (PIFS) is used to represent image blocks that can achieve high compression ratio and good quality of decompressed image by utilizing the different portions of image. [1]

Fractal image compression:-

The fundamental idea behind fractal image compression is delineate as self-vector quantization. In this blocks are encoded by using simple transformations. Transformations used in this are scaling, rotations and reflections.



In this approach, region or portion of image is searched in rest of the whole image, to discover a suitable portion which is similar in a statistical manner. [19] This technique is a search process which consist of three steps: partitioning the image into blocks, search the blocks which are similar with each other and, if match is discovered then transformations are carried out.

Self-similarity is basic property of fractals. Self-similarity shows that small parts of the image appear like large parts of same image. The search for this similarity forms the principal of fractal compression scheme. To find self-similarity in other parts of image, it is divided into blocks. This is major part of fractal encoding techniques.[11] Figure 1 shows some of the self–similar portions in Lena image, there is a reflection of the hat in the mirror. The reflected portion can be acquire using an transformations of a small portion of her hat. Parts of her shoulder are almost alike and a portion of the reflection of the hat in the mirror is similar to a smaller part of her hat.[21]

Fig 1:- Self-similarity in Lena image

The difference in fig is that the whole image is not self-similar, but portions of the image are self- similar with absolute transformed parts of itself.

An IFS consists of a set of affine transformations. An input image can essentially be represented by a series of IFS codes. In this way, a compression ratio 10000:1 can be achieved .[22] For fractal image compression an image is defined by fractals rather than pixels. Each fractal is represented by unique IFS that consist of a group of affine transformations.[13]

The structure of Partitioned Iterated Function System **(**PIFS) codes is nearly same as IFS codes but the only difference is that PIFS code is acquired and applied to particular part of an image instead of whole image.

Fractal image coding is based on partitioning of the original image into non-overlapping regions/portions called range blocks and overlapping regions/portions called domains blocks. For each range block, the best matching domain block can discovered by transformations Wi is of the form as follows in equation(1)

$$Wi\begin{bmatrix}x\\y\\z\end{bmatrix}=\begin{bmatrix}ai & bi & 0\\ci & di & 0\\0 & 0 & si\end{bmatrix}\begin{bmatrix}x\\y\\z\end{bmatrix}+\begin{bmatrix}ei\\fi\\oi\end{bmatrix} \quad (1)$$

Where si regulate the contrast and oi regulate the brightness and ai, bi, ci, di, ei, fi denote the eight symmetries such as identity, rotation around +90º, rotation around +180º, rotation around -90º, reflection almost mid-vertical axis, reflection almost mid-horizontal axis, reflection almost first diagonal and reflection almost second diagonal. [8] Transformations such as scaling, translation, rotating, sharing, scaling etc and adjustment of brightness/contrast are used on the domain block to get the best match.

Fig 2:- The transform between domain block (*Di*) and range block (*Rj*) when *Wi* applied to the *Di* should get something that is very close to *Rj*.

The most significant of the encoding image is to discover contractive maps *Wi* that minimize the distances between R*i* and corresponding *Di* see Figure 2 [11]

Literature review:-

Rasha Adel Ibrahim et al.[2015] has proposed " An Enhanced Fractal Image Compression Integrating Quantized Quadtrees and Entropy Coding". They introduces an improved model integrating quantized quad trees and entropy coding used for fractal image compression. Quantized quad tree method divides the quantized original gray level image into various blocks depending on a threshold value. Entropy coding is used to enhance the compression quality. They compared their proposed algorithm with previous algorithms which show that the proposed compression approach can reduce the encoding time. There is also a very small increase in retrieve image's quality and compression ratio.

Umesh B. Kodgule and B A. Sonkamble [2015] has proposed " Discrete Wavelet Transform based Fractal Image Compression using Parallel Approach". In this paper parallel algorithm for fractal image compression using NVIDIA's GPGPU is proposed. Novel discrete wavelet transform based feature detection is used to reduce the number of block comparisons. DWT and Parallel block classification and comparison method is prepared into the fractal image compression to speed up the encoder. Experimental results show that the visual effect is better and the average speed up ratio of proposed method over full search method is good as compare to other.

Ming-Sheng Wu [2014] has proposed " Genetic algorithm based on discrete wavelet transformation for fractal image compression". A genetic algorithm (GA) based on discrete wavelet transformation (DWT) is proposed to overcome the liability of the time-consuming for the fractal encoder. Experiments show that, using the same number of MSE computations, the PSNR of the proposed GA method is reduced 0.29 to 0.47 dB in comparison with the SGA method. Furthermore, at the encoding time, the proposed GA method is 100 times faster than the full search method, while the penalty of recover image quality is somewhat acceptable.

Shweta Pandey and Megha Seth [2014] has proposed " Hybrid Fractal Image Compression Using Quadtree Decomposition with Huffman Coding ". Quadtree is used to make various blocks of the image. Huffman coding is used to compress the image. Comparative analysis process evaluates the performance of each dimension and acquires which format of image provides the highest performance in fractal image compression. They analyzed and that the png and jpeg image work well with this proposed method but this method is not suitable for bitmap image format. So, this method is done for color images that take more encoding time but achieve high compression ratio and better PSNR value.

Chandan Singh Rawat and Sukadev Meher [2013] has proposed " A Hybrid Image Compression Scheme using DCT and Fractal Image Compression". DCT is used to compress the image and fractal image compression is used to reduce the repetitive compressions of analogous blocks. Given image is encoded and decoded by Huffman coding. Implementation results shows the efficiency of proposed algorithm in compressing the color images. They have also done comparative analysis of their algorithm with known image compression standard JPEG with particular image qualities. They have concluded that proposed technique has successfully compressed the images with high PSNR value, SSIM index and the UIQI value.

Comparison Table of previous research work

S.No.	Name of Author	Technique Used	Result
1.	Rasha Adel Ibrahim et.al. [2015]	Quadtree and entropy coding	Proposed algorithm decreases encoding time
2.	Umesh B. Kodgule and B A Sonkamble [2015]	Discrete Wavelet Transformation using parallel approach	They recovered that visual effect and average speed up ratio is good as compare to other methods.
3.	Ming-Sheng Wu [2014]	Genetic algorithm using Discrete Wavelet Transform	The proposed GA method is 100 times faster than the full search method. PSNR value is reduced in comparison with SGA method
4.	Chandan Singh Rawat and Sukadev Meher [2013]	Discrete Cosine Transformation	Proposed method has high PSNR, SSIM, UIQI value of compressed images

Conclusion:-

This paper represents the concept of Fractal image compression and various technologies used with Fractal image compression used by various author . All the compression techniques are useful in their related areas and every day new compression technique is developing which gives better compression ratio. This review paper gives clear idea about basic compression techniques.

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