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Review on Fractal Based Approach to Colour Video Compression

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Abstract
Fractal Video Compression with affine transform is a recent technique based on the self-symmetry of the image. This process encompasses wide variety of coding schemes. This scheme involves four levels and at each level, there are number of techniques. This survey represents advances on theoretical and practical aspects of fractal coding scheme.

Keywords
Fractal, Partitioning Scheme, Image compression, Transform

I. Introduction

Fractals are generally self-similar and independent of scale [1]. As we know, video is a number of images in sequence; so, the same way we compress images can be applied on the video by compressing each frame of the video separately [23]. Fractal compression technique is based on the individual regions of an image may exhibit similarity to each other at different scales [1]. The fundamental principal was introduced by M. Barnsley in 1988 for fractal image compression is to represent an image with contractive transforms of which the fixed point is close to that image. The contractive transform is based on the collage theorem which provides a bound on the distance between the image to be encoded and the fixed point of a transform. This distance should be sufficiently small and this distance is to be known as college error. The word college means union of mapping from image to itself and the approach derived by Barnsley, was composed of the union of a number of affine mappings on the entire image is known as an iterated function system (IFS) [2-5]. A practical reality was given to fractal compression by Jacquin with partitioned IFS(PIFS) in 1990 [2-3, 6]. By Jacquin, the image is divided into small image blocks i.e. sub-images with non-overlapping is called as Range blocks(R block)and find an image block which is the most similar to current R block is called as Domain block (D block). Generally, the size of the R block is 2x2 and the size of D block is in multiple of 2 or double of R block [7]. The steps [2] for fractal coding scheme are as follows:

- Partition of image to be encoded to form range blocks
- Selection of domain pool
- Form a class of transform applied to the domain block
- Searching most suitable domain block for formation of particular range block

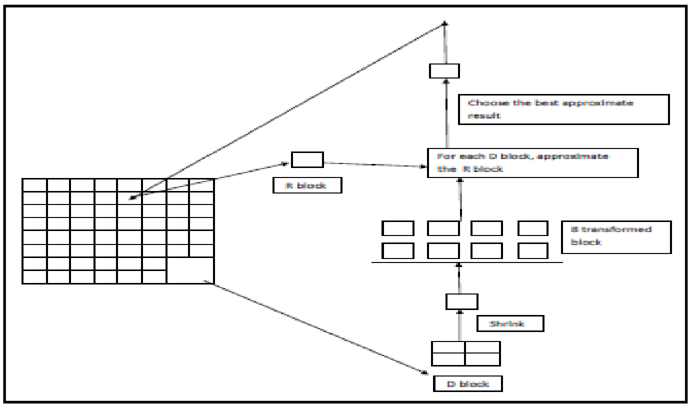

Fig. 1: Fractal Encoding Process

II. Image Partitioning Scheme

In fractal video compression, first case is to form R block and for this, selection of different image partitioning schemes are to be considered.

A. Fixed Block Size Method

This is the simple partitioning scheme and easy to implement. In this method, the image is divided into non-overlapping square range blocks of a fixed size. The merits of this method is that it is the simple partitioning scheme and easy to implement and the demerit of the fixed block size partition is that the image is partitioned without considering the contents of the image. So to consider such regions that would be covered well with smaller and larger R blocks. Due to this it will increase the compression ratio and maintain the clarity [2-3,8].

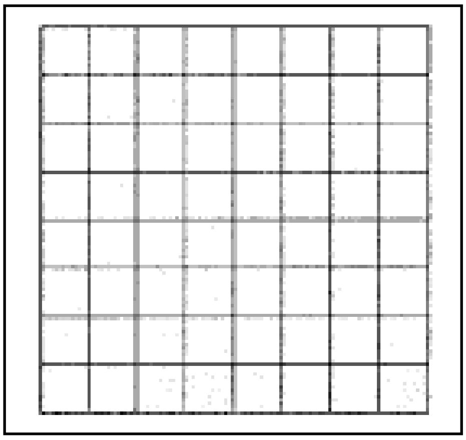

Fig. 2: Fixed Block Size

B. Quad Tree Partitioning

The largest range block are used in a quad-tree partitioning and provides best rate distortion. If the matching criterion is unsatisfied, the size of the range block is halved and the process continues until a minimum block size is reached [2-3,8].

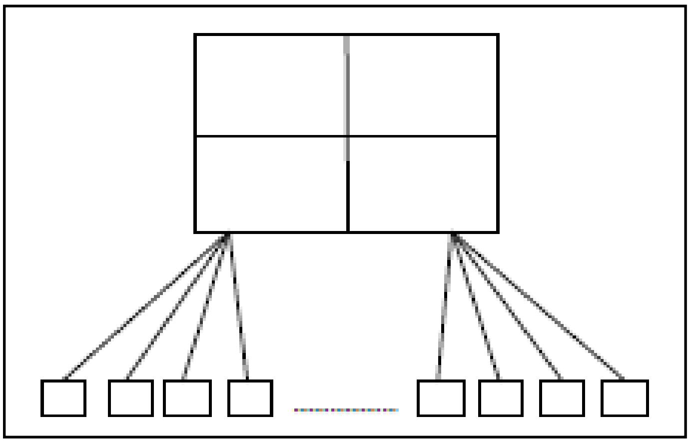

Fig. 3: Quadtree

Horizontal-Vertical Partitioning

It is similar to the quad-tree and produces tree-structure partition of the image. In this, each image block is divide into horizontal or vertical line. The horizontal or vertical splitting positions are based on the accuracy of approximation by constant pixel values in each of the new blocks created by a particular split [3,9-10].

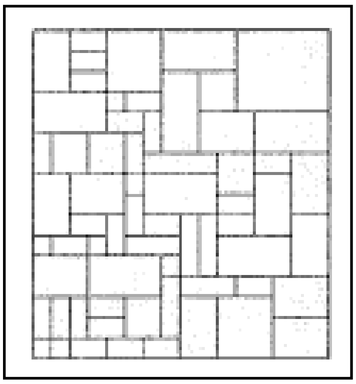

Fig. 4: Horizontal-Vertical

D. Irregular Partitioning

Different merging strategies on fixed square block may construct an area of plain tiling by right-angled irregular-shaped ranges [3,11].

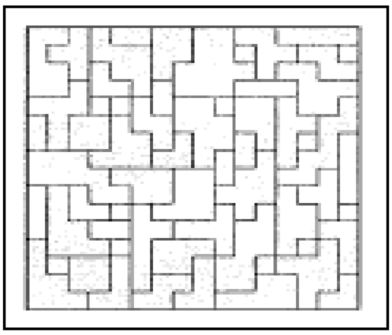

Fig. 5: Irregular Partition

E. Polygonal Blocks

In this partitioning, to find out several different shapes of triangular partitions and to start with splitting the image into two main triangles, either by three-side split in which a new vertex is created on each of the sides of an existing triangle, or by one-side split in which an existing triangle is split into two by inserting a line from a vertex of the triangle to a point on the opposite side [3].

III. Selection of Domain Block

Selection of domain block is depend on the type of partitioning scheme. Two types of domain block is used. First, Global domain block is the simplest domain block and provides a fixed domain block for all range blocks of image [2,4]. The experimental results are provided by global domain block is much better when the spatial distance between the range block and domain block is less [2,12] and second, local domain block or masking of range block. In this, the mask is centred at range block [2-3,13].

IV. Selection of Suitable Transforms

After selection of domain block, transforms are applied to form range blocks [2]. The selection of transform is depend on which type of domain block and partition scheme used and each of transform can skew, stretch, rotate, scale and translate any domain image[6,14]. The transformation suggested by Jacquin having only eight transformations for the domain blocks:

1. Rotation by 0.
2. Rotation by 90.
3. Rotation by 180.
4. Rotation by 270.
5. Flip about horizontal median.
6. Flip about vertical median.
7. Flip about forward diagonal.
8. Flip about reverse diagonal.

Transformation used in fractal encoding is of three types. Firstly, affine transformation in which the domain block is transformed into eight small blocks as per the size of the range block and then match with the vertices of the range block. Secondly, Wavelet-Based-Fractal-Transform is based on the theory of multi-resolution analysis as well as iterated-function-system and its ability to construct the same image iteratively as well as provide local time frequency analysis on the image [2-5]. At last, Discrete-Cosine-Transform form an efficient basis for image blocks due to existence of mutual orthogonally [2,15].

V. Image Compression Techniques

Image compression techniques are of two types: lossless and lossy depending on whether they are reversible or irreversible. Some popular compression techniques are as follows.

A. Differential Pulse Code Modulation(DPCM)

DPCM has the lowest complexity as compared with other encoding techniques and can provide compression ratios of about 2: 1 to 3: 1 with minor distortion. In this technique. a prediction of a current pixel is formed from neighbouring encoded pixel elements. DPCM is mostly used in telecornmunications for speech coding, and in visual communications for image coding, such as in digital cameras [16].

B. Transform Coding

Image transforms perform linear operations, which convert image data into a set of transform coefficients. After applying the corresponding inverse transform, the transform coefficients can be converted back to the original image. Transform coding is applied over fixed blocks, typically of size 8 x 8 or 16 x 16. Orthonormal transformations, such as the Karhunen-Loeve transform, the Discrete Cosine Transform (DCT), the Walsh-Hadamard transform, and the discrete Fourier transform, etc., have been found useful for image coding [17].

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C. Vector Quantization

Shannon originates the basic idea of Vector Quantization (VQ) that can be achieved by quantizing the output of a source as vectors. In this technique, the image is first partitioned into small a block that is 4 x 4, then each block is compared with a set of representative vectors. The representative vector is called a code word and the set is called a codebook. The performance of VQ depends on the codebook and compression is achieved when the number of codebook entries is less than the total number of possible input vectors. As compared to transform coding, VQ gives a better performance, at bit rates of about 0.25 bpp and lower [18].

D. Wavelet Coding

Wavelets mean a set of orthonormal basis functions. The basic idea of the discrete wavelet transform (DWT) is to decompose the input signal into one low pass approximation and a set of Band pass frequency channels and compression is achieved by keeping only the most relevant coefficients within each channel. DWT has both local spatial and frequency domain properties due to the compact support of its base function when compared with DCT. By performance, wavelet coding is better than transform coding at low bit rates of about 0.25 bpp [19-20].

E. Entropy Coding

Encoders often generate a set of code parameters which have non-uniform probability distributions and by taking advantage of the non-uniform distribution of the underlying data, entropy coding such as Huffman coding, run-length coding and arithmetic coding can achieve data compression. Entropy coding is lossless coding, i.e., the original data can be exactly recovered from the compressed data [22].

F. Model Based Coding

In model based coding, the 2-D perspective projection of a 3-D scene is expressed by a semantic model, such as, a wire frame model with texture mapping is used to render the shape of the subject and a fractal model can be used to render the outdoor natural scenes, such as mountains and landscapes [21].

VI. Existing Approach

Previously, some authors used fractal coding for video compression. Hurd and Gustavus[24] extended the Jaquin's method for video compression and also used motion compensation for coding some range blocks by reporting compression ratios from 21:1 at an average PSNR of 39.2 dB to 79:1 at an average PSNR of 30.8 dB for a 160 x 120, 8-bit grayscale video sequence. Lazar and Bruton [25] extended Jacquin's work by using 3-D blocks and reported an average compression ratio of 74.39 at an average PSNR of 32-33 dB , for the 360 x 280, 8 bit/pixel 30 Hz 'Miss America' video sequence. Mohammad Gharavi-Alkhansari and Thomas S. Huang [26] used matching pursuit algorithm and coded at 80 Kbits/sec with an average PSNR of 36-37 dB, 12.5 Hz 'Miss America' Video sequence. Yarish Bnjmohan and Stanley H. Mneney used wavelet for video compression by comparing the video compression standard H.263+ on the "Akiyo" sequence and obtained average bit-rates of 0.078bpp and 0.085bpp with the average PSNR as 32.05dB and 30.82dB.

VII. Conclusion

This survey paper has to take general view of most significant advances in different steps on fractal video compression. At every steps of process lots of partition schemes as well as transforms are available. In this paper, we have also appraised compression techniques for fractal coding. Vector quantization and wavelet coding give better performance as compared to transform coding. By taking review on existing approach and conclude that the fractal technique is best for video compression due to high compression ratios, fast decompression times and insensitivity to errors.

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