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A Hybrid Method on Fractal Image Compression Using Quadtree Decomposition and Run length Encoding

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Abstract— ***Fractal image compression is a relatively recent image compression method which exploits similarities in different parts of the image. Fractal Image compression (FIC) is one among the compression techniques in the spatial domain which exploits similarities in different parts of the image. One can see the self similar regions in the image above. In this paper we discuss about the two methods combined and form a one method. By using threshold value of 0.2 and Runlength Encoding for encoding and decoding of the image these techniques have been applied for the compression of satellite imageries. The compression ratio (CR) and Peak Signal to Noise Ratio (PSNR) values are determined. The Matlab simulation results show that for the Quad tree decomposition approach shows very significant improvement in the compression ratios and PSNR values derived from the fractal compression with range block and iterations technique.***

KeyWords-Runlength encoding,CR,PSNR,

I. INTRODUCTION

Fractal image compression is a relatively recent image compression method which exploits similarities in different parts of the image. Fractal Image compression (FIC) is one among the compression techniques in the spatial domain which exploits similarities in different parts of the image. One can see the self similar regions in the image above. Fractal compression stores this type of information to achieve compression. To do Fractal compression, the image is divided into sub blocks. Then for each block, the most similar block if found in a half size version of image and stored. Then during decompression, the opposite is done iteratively to recover the original image. It is a block based image compression, detecting and coding the existing similarities between different regions in the image. Time consuming is one the main drawback of Fractal image compression. In Fractal image compression encoding is take long time compared to decoding. Decoding is fast than encoding. In encoding the process is searching the appropriate domain for each range. In nowadays, Fractal image compression is very attractive. Fractal image compression is developed by Hutchison and Barnsly.It is based on theory of IFS (Iterated

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Function System).In Image compression Jacquin and barnsly can first use of IFS.In ifs coding scheme the image will be partitioned into non overlapped range blocks. For each block,a similar domain block is found using IFS mapping. In IFS mapping coefficient will represent a data of block of the compressed image. Decoding proceed as follows. For reducing an encoding time, recently we have some improvements and modification have been studied.

Contractive Transformations

Since the way the input image is transformed determines the final result of running the copy machine in a feedback loop, the transformation will be described. Different transformations will lead to different attractors (final images), provided that the transformations must be *contractive*, that is, given a transformation *W*, any two points *P1*, *P2*, in the input image must be closer in the copy. In other words, the distance between the two points:

$$d(W(P1), W(P2)) < sd$$

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for s < 1. In the case of a plane, if the points have coordinates *P1* = (*x1*, *y1*) and *P2* = (*x2*, *y2*), then

$$d(P1, P2) = \sqrt{(x2 - x1)2 + (y2 -}$$

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This condition is natural and obvious, because if the transformation is not contractive, points in the copy will be spread out. It follows that the final image will be of infinite size. Except for this condition, the transformations can have any form. In practice, the transformation can be *affine*, which will be sufficient to yield an interesting set of attractors:

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

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II. PROCEDURE OF FRACTAL IMAGE COMPRESSION

After a series of *T* transformations, the initial image will converge to the original one. Reconstruction can be accomplished by partitioning the original image in a suitable manner that will obtain the suitable transformation *T* to meet the requirement of compression rate and computational issues. So the task of compressing an image includes three important parts:

1) Partition the image and find transformations for each partitioned part;
2) Encoding (compressing) the image; and
3) Decoding (decompressing) the image.

a. Partitioning Images

It is crucial to choose a suitable way of partitioning images or a suitable image data structure, because the method of partitioning images is closely related to the next step: algorithm development issue. The format of the data determines the manner of obtaining the data and the processing methods most effectively used upon the data. If an accurate method of partitioning image data is chosen for a specific issue, then the solution of the issue will be simplified. For the issue of fractal image compression, we choose the quadtree method to partition images because of its orderliness, simplicity, and efficiency.

Quadtree Partition

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A quadtree is a finite set consisting of several nodes which are either empty or consist of a root and at most four non-overlapping quadtrees.

To get a quadtree of an image, the procedure of evenly decomposing the image is:

Suppose we have a 2n x 2n binary image in which points with value “1” represent the “feature” points as black ones and points with value “0” represent background points as white ones. First, the whole image is served as the root node. If the node does not consist of all “1” value or all “0” value points, it is called a gray node and needs further decomposition. As the first step, divide the whole image into four 2n-1 x 2n-1 sub-images, then decide if further decomposition is needed. The sub-images are not only son nodes of the whole image but also the root nodes of its own. If one node consists of all “1” value points or all “0” value points, then stop decomposing the node; if the node has both “1” value points and “0” value points, then decompose it again until all sub-images consist of points with the same values.

Determining Parameters

Once the image is partitioned, we need to determine the transformation coefficients for each partition. Given two squares containing n pixels intensities, *a*1, …, *a*n (from *D*i) and *b*1, …, *b*n (from *R*i). We can seek *s* and *o* to minimize the quantity.

$$R = \sum_{i=1}^{n} (s.)^2$$

This will give us a contrast and brightness setting that makes the affinely transformed ai values have the least squared distance from the *b*i values. The minimum of *R* occurs when the partial derivatives with respect to *s* and *o* are zero, which occurs when

$$s = [n^2 \ (\sum_{i=1}^{n} a_i)(\sum_{i=1}^{n} bi)]/[n^2 \sum_{i=1}^{n} a_i^2 - (\sum_{i=1}^{n} a_i$$

Encoding (Compressing) Algorithm

Based on the three key concepts described in the three theorems, the fractal image compression and decompression algorithms are developed in Matlab code and implemented in this study. The image compression is named fractal because the method used to encode images shares many features in common with fractal generating algorithms (Fisher 1992).

The basis for the encoding procedure is like this: an image is partitioned into parts that can be approximated by other parts after some scaling operations (Figure 3.7). The result of the procedure is a set of transformations, which, when iterated from *any* initial image, possess a fixed point approximating the original image. In the restored image, fractal characteristics can be seen: ‘zooming’ into the restored image, finer and finer details will appear. Accordingly, ‘self-similarity’ (a part of the image can be approximated by other part of the same image), and recursive subdivision, which are the important characteristics of fractals, are put into use in the encoding procedure. This is why the procedure is named ‘fractal’.

Decoding (Decompressing) Algorithm

Decoding an image consists of iterating *W* from any initial image. The quadtree partition is used to determine all the ranges in the image. For each range Ri, the domain Di, which maps to it is shrunk by two in each dimension by averaging non-overlapping groups of 2 x 2 pixels. The shrunken domain pixel values are then multiplied by si, added to oi, and placed in the location in the range determined by the orientation information.This constitutes a decoding iteration. The step is iterated until the fixed point is approximated, that is, until further iteration does not change the image or until the change is below some small threshold value.

III. RUNLENGTH ENCODING

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Run length encoding (RLE) is based on a simple idea: to encode strings of zeros and ones by the number of repetitions in each string. RLE has become a standard in facsimile transmission. For a binary image, there are many different implementations of RLE; one method is to encode each line separately, starting with the number of 0's. So the following binary image.

0 1 1 0 0 0
0 0 1 1 1 0
1 1 10 0 1
0 1 1 1 1 0
0 0 0 1 1 1
1 0 0 0 1 1

would be encoded as
(123)(231)(0321)(141)(33)(0132)

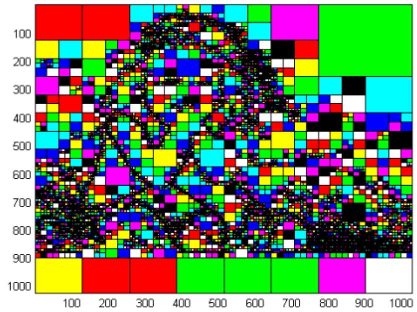
IV. Proposed Work

This section describes various types of compression algorithms and their performance analysis, the compression results after the compression of the image.

The algorithm steps are as follows.
1. Divides the original image using Quadtree decomposition of threshold is 0.2, minimum Dimension and maximum dimension is 2 and 64 respectively.
2. Record the values of x and y coordinates, mean value and block size from Quadtree Decomposition.
3. Record the fractal coding information to complete encoding the image using Runlength Encoding and calculating the compression ratio.
4. For the encoding image applying Runlength decoding to reconstruct the image and calculating PSNR.

Results and Discussion

a



b

c

a)Original image b) quadtree encoded image c)Reconstructed original image

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Conclusion

From the analysis carried out in the paper the following conclusions can be drawn

The Quadtree decomposition and Run length techniques can be applied for achieving high compression ratios and better PSNR values for satellite Imageries. This techniques mainly used for satellite images

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