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Fractal Coding Using Gradient Direction Based Tag Matrix And Score Value

Sheeba K*[a], Abdul Rahiman M[b]

[a]Assoc.professor,LBSCE & Phd scholar,Karpagam University Coimbatore, India
[b]Pro. Vice chancellor APJ Abdul Kalam Technological University Kerala,India

Abstract

Reducing encoding complexity and improving the tradeoff between quality of image and compression ratio are active areas of research in the field of fractal image compression. In this paper two techniques are proposed to reduce the encoding complexity and to improve the PSNR of the reconstructed image . The first method is the prediction of affine transformation, based on the gradient direction of domain and range block using a Tag Matrix and the second involves calculation of score value based on the maximum value of intensity difference of range and domain block. An important merits of this new method is that encoding time is highly reduced and PSNR is also improved than the existing fractal coding techniques. This technique will be very applicable in situation where we have limited storage space and bandwidth but have to store and transmit enormous amount of data.

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1. Introduction

Fractal is defined as an object having fractional dimension and self similarity. Self similarity in an image means either a part of the image can be expressed as a geometric transform of whole image or a smaller part of an image can be represented as the geometric transform of any other bigger part in the image. The idea of fractal geometry is put forward by the mathematician Benoid Mandelbrot[1] ·All natural images have fractal geometry. So to represent a natural object in compact form, the technique of fractal compression is most suitable. But this technique has a major drawback of unsymmetrical nature of encoding-decoding phase that prevent it from accepting it as an international standard . In this paper two techniques are proposed to improve the performance of fractal image compression. The concept of fractal image compression is introduced by the scientist Michael Barnsley[2,3] . The mathematical concept of Fractal image compression is based on the principle of Collage Theorem [5] . At present there are a lot of research work on reducing the encoding complexity of fractal coding techniques.

* Sheeba K. Mob.:9447551441 .
E-mail address:sheebaklbs@gmail.com

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Exhaustive search for a best matching domain block is the major drawback of BFIC(Basic Fractal Image Compression) [6]. Some algorithms such as Fisher's 3 classes method and APCC-based block, are based on domain classification, so that searching is restricted in specific classes but the PSNR value is found to be decreased in these methods [7,8].Some researchers adopted the method of Particle Swarm Optimization in fractal encoding phase ,which speed up the encoder efficiency with a little decay in image quality, since this is also a area- restricted searching method [9]. Some fast -fractal coding methods were proposed based on a selected part of the domain pool to improve the efficiency of search phase , for example , searching the matching domain block from the adjacent domain block of the current range block [10,11]. .A lot of hybrid fractal encoding works were done by exploiting the multi-resolution capability of Discrete Wavelet Transform and self similarity of fractal images [12,13].Some research works are based on improvement of search speed to make encoding and decoding phase more symmetric by using tree structured search method [14,15] quad tree partitioning of range block [16,17,18] or parallel search [19,20] A few works were based on affine transformation prediction to reduce the cost of encoding process [21] . But this research paper proposes a new gradient based geometrical transformation prediction algorithm which shows a better performance than the previous existing methods. Fractal image Compression is based on the principle of Collage Theorem.

2. Proposed Method

This is a hybrid encoding technique, where multi resolution property of wavelet and self similarity property of fractal is blended . This new prediction algorithm reduces the encoding time and improves the PSNR of reconstructed image based on gradient direction and maximum value of intensity difference of domain and range block. Affine transformations are predicted using a Tag Matrix to reduce the encoding complexity. Here the self similarity between the sub bands in each level is exploited to predict the affine transformation of each range block defined in each sub-band. The coefficients of the lowest coarser sub-band are encoded directly, i.e. without fractal encoding. Sub bands at higher scale are divided into higher entropy block and chosen as domain block and the adjacent lower scale sub band is divided in to lower entropy block of same size and considered as range block . The affine transformation of range block is predicted using the proposed Tagging algorithm. In this proposed method a six level wavelet decomposition (Haar wavelet) is used. Parameters of the Iterated Function system is converted in to binary stream with an appropriate bit allocation to each parameter

2.1. *Theory of Tagging Algorithm*

In Tagging phase a **gradient matrix** is to be defined and chosen. Gradient matrix is a matrix having gradient in all direction. Gradient direction of range block and domain blocks are determined using this reference matrix (gradient matrix).

Definition of gradient: In an image, gradient is defined as the directional change in image intensity or color.

$$\text{Gradient of an image } f(x,y),\ \nabla f(x,y) = \langle fx(x,y), fy(x,y)\rangle$$

i.e. $$\nabla f(x,y) = \frac{\partial F}{\partial x} i + \frac{\partial F}{\partial y} j \tag{1}$$

Gradient direction gives the direction of maximal change in the intensity.

2.2.Explanation of Tag Generation Technique

The direction of maximum intensity variation in an image can be determined by gradient operator. So in the succeeding step a tag is generated for the domain block and range block by comparing with reference matrix and it gives the relative affine transformation with respect to the reference block. This is stored as tag1 and tag 2 respectively for domain and range block respectively. Tag1 is that relative geometric transformation of the matrix F