



FRACTAL IMAGE CODING A NEW APPROACH WITH CHAIN CODES

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ABSTRACT

Fractal image coding, the traditional approaches which are being used currently, based on dividing the images into blocks. These blocks are known as range blocks and domain blocks. In these approaches after coding the image generally the decoding process is slow as extensive searching is required. In this paper we are going to present a scheme which uses the concept of chain codes through which same type of section of image located in whole image is selected and we will keep them in our memory for further use. Through this proposed scheme coding and decoding can be speed-up.

KEYWORDS: Fractal image coding, Self-similarity, pixel, Chain codes, Image processing.

INTRODUCTION

The need of information is growing day by day. In the changed scenario the information doesn't mean only textual information, it also includes multimedia information to a great extent. Multimedia information contains images, audio, and video and therefore fills much more bandwidth than that of textual information. More often we have wireless channels on the Internet with much lesser bandwidth than wired channels. Therefore to fulfill the need of effective multimedia transmission the efficient handling of images are more and more concerned. Compact encoding of images are required so that the images can be represented internally in the memory of the computer with lesser space. Fractal based methods for encoding the images based on the concept of local self-similarities within the images.

A fractal is generally a rough or fragmented geometric shape that can be split into parts, each of which is (at least approximately) a reduced-size copy of the whole [1], the property is called self-similarity. The term was coined by Benoît Mandelbrot in 1975 and was derived from the Latin fractus meaning "broken" or "fractured."

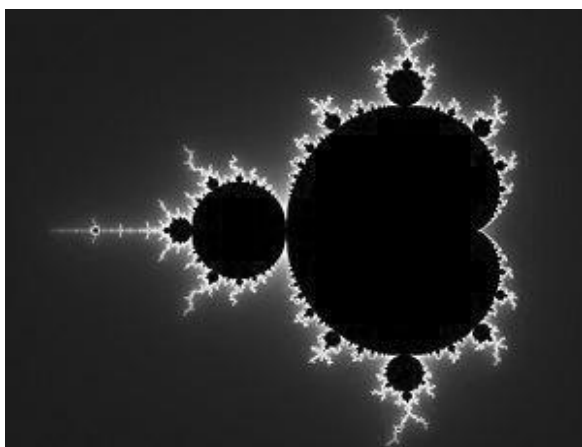


Figure 1: The Mandelbrot Set

Fractal image coding was proposed in about 1988 by Jacquin A. E. and after that since 1990's, fractal image encoding method has been widely studied. Fractal image encoding has many good features. The first is that it doesn't depend on resolution, by which the decoded images of larger size can be got without block effect. The second is high compression ratio. Ratio of 10000:1 was recorded in the article of Barnsley, who is called the father of fractal image encoding. The third important characteristic is that the coding process includes many short finding processes, whereas the decoding process is an iterative process. Furthermore, decoding process is much faster than the encoding process. Although coding process is slow, we can use parallel algorithm to improve the efficiency [2].

All these features of fractal image coding come from Iterated Function System (IFS) which is a fractal image constructing system proposed by M. F. Barnsley of Georgia Institute of Technology in 1985. It's the theoretical foundation of fractal image encoding. In fractal image encoding, an image is partitioned into a set of image blocks called ranges. A pool of larger image blocks called domains is used as a codebook from which ranges are approximated with affine mappings of their intensity values [3].

Fractal image coding has been used in many image processing applications such as feature extractions, image signatures, and texture segmentation. It has the advantage of very fast decoding as well as the promise of potentially very high coding ratios. Another advantage of fractal image coding is its multi-resolution property, an image can be decoded at higher or lower resolutions than the original, and it is possible to "zoom-in" on sections of the image. These advantages make fractal image coding a very attractive method for applications in multimedia [4]. The drawback of fractal image coding is that the block matching process is very time-consuming. Plenty of research focused on how to improve the speed of fractal image coding but cannot satisfy

some real time requirement. The no search scheme proposed by Dudbridge is very fast, but it suffers from the very poor reconstruction quality [4].

EXISTING APPROACHES

The previous approaches of fractal image coding schemes follow the following process:

- i. Partition of images based on range blocks
- ii. Pool of domain blocks
- iii. Types of transformation imposed on domain blocks
- iv. Search process to find appropriate domain block
- v. Transformation parameters representations

The above mentioned processes have the following schemes of partitions for fractal image coding

i. Fixed Size Square Block

The simplest form of range partition consists of fixed size square blocks [5]-[7]. This type of block partition is very applicable in transform coding of these individual blocks.

ii. Quadtree

This technique is a very well known image processing technique based on a recursive splitting of selected image quadrants [8]-[10].

iii. Horizontal-Vertical

The horizontal-vertical partition produces a tree structured partition of the image. In this partition approach used is splitting of image in to two section one by horizontal line and other by vertical line. [11].

iv. Irregular Regions

A tiling of image by right-angled irregular-shaped ranges may be constructed by a variety of merging strategies on a initial fixed square block. [12]- [15].

v. Polygon Blocks

Polygonal partitions have been constructed by recursive subdivision of an initial coarse grid by the insertion of line segments at various angles [16], as well as by merging triangles, in a Delaunay triangulation, to form quadrilaterals [17].

vi. Overlapped Blocks

Overlapping range blocks have been used to reduce blocking artifacts [18].

As a general concept the fractal image coding is done by using range blocks and domain blocks where an image is partitioned into the same sized range blocks and then some domain blocks are made from image.

CONCEPT OF CHAIN CODES

For our new approach in fractal image we are going to use the concept of chain codes for describing the logic first we are going to give brief introduction. The first approach for representing digital curves using chain code was introduced by Freeman in 1961 [20]. Classical methods for processing chains are referred to [5]. Freeman [5] states that in general, a coding scheme for line structures must satisfy three objectives:

- (1) It must faithfully preserve the information of interest;
- (2) It must permit compact storage and convenient for display; and
- (3) It must facilitate any required processing.

Also the VCC comply with these three objects, and has some important differences. E. Bribiesca [1] states some important characteristics of the VCC:

- The VCC is invariant under translation and rotation, and optionally may be invariant under starting point and mirroring transformation.
- Using the VCC it is possible to represent shapes composed of triangular, rectangular, and hexagonal cells.
- The chain elements represent real values not symbols such as other chain codes, are part of the shape, indicate the number of cell vertices of contour nodes, may be operated for extracting interesting shape properties.
- Using the VCC it is possible to obtain relations between the bounding contours and interior of the shape. In this paper we will compute the chain code of an image using the classical methods and the VCC method. The images considered here are binary images with outer contour. In other words there are not any holes in the objects. Also, we will show how we can use these chain codes to recognize to the object and store the similar type objects.

Proposed Process of fractal image coding.

Before proceeding towards the process of fractal image coding, first, the binary image is divided into equal fixed size block, known as range blocks as shown in figure (2).

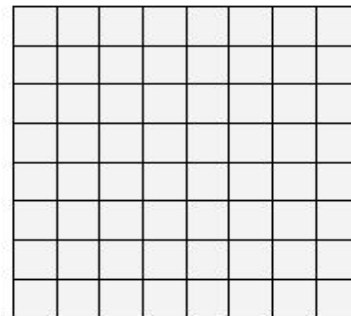


Figure (2)

The first step of the construction of the chain code, for fractal image coding, is to extract the boundary of the image. Chains can represent the boundaries or contours of any discrete shape composed of regular cells. In the content of this work, the length l of each side of cells is considered equal to one. These chains represent closed boundaries. Thus, all chains are closed. Extracting the contour depends on the connectivity. In the content of this paper we use pixels with four-connectivity.

The simplest *contour following* algorithms were presented by Papert [22] and Duda and Hart [21]. Thus using these algorithms it is possible to represent shape contours by only two states: left turn (represented by "1") and right turn (represented by "0"). The abovementioned process produces

a chain composed of only binary elements. Figure (3) illustrates the contour following on an image composed of pixels.

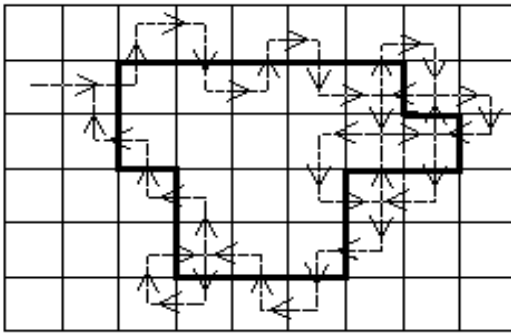
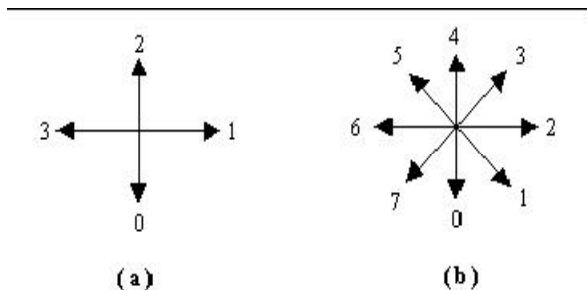


Figure (3)

In fractal image coding we take smallest or same part throughout the binary image and store it in memory for further use. For extracting these smallest parts we use here the concept of chain code for extracting the contour of the image in every cell of fixed size block as shown in figure (2).

Here we will use certain mechanism to find the contour of a binary image and use this contour to obtain the chain code. As we use pixels with 4-connectivity, the four neighbors of any point can be represented by directions as illustrated in figure (4a).

Figure 4. Directions of the neighbors :
(a) 4-connected; (b) 8-connected.

For extracting the contour of binary image's cell we use the following steps:

- Step 1.** For all pixels with value 0 (black) in the image, set the pixel that has the direction 2 in 4-connected to 0.
- Step 2.** In the new image (i.e., image obtained from Step 1), also, for all pixels with value 0, set the pixel that has the direction 1 in 4-connected to 0.
- Step 3.** Remove the old pixels (in the original image) that have 8-connected as shown in figure (4b) and do not satisfy the conditions shown in figure (5).

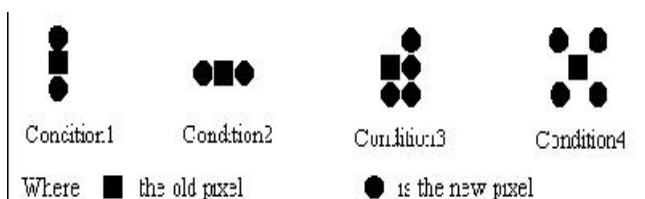


Figure 5: Four conditions to remove the old pixels.

if we apply the previous approach or steps to the three images shown in figure (6), we will obtain the contour of the images as depicted in figure (7). Figure (7a) shows Step 1 of the algorithm, figure (7b) represents Step 2 to find the contour of a binary image, and figure (7c) shows Step 3 of the algorithm.

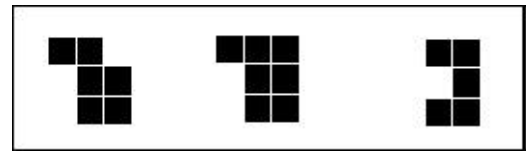


Figure 6: Three simple binary images.

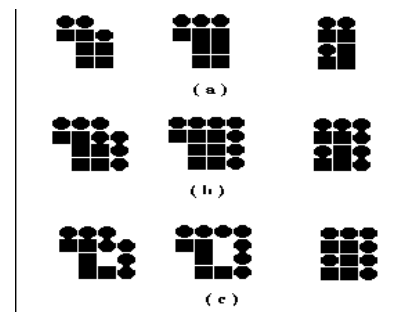


Figure 7: The three steps for finding the contour of the binary images shown in figure (6).

Now from above process we can find the contour of the binary images. As we know that chains can represent the boundaries or contours of any image. Here for image coding with fractal we need the chain codes for the extracted contour and these chain codes are stored in the computer's memory.

An element of the chain codes indicates the number of cell vertices, which in touch with the bounding contour of the shape in that element position [19].

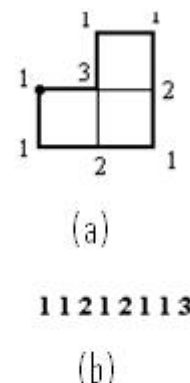
Figure 8: (a) shape with pixel and chain code elements
(b) chain code of the shape

Figure (8a) presents a shape composed of pixels with its chain codes elements. Figure (8b) shows the chain code of the shape. Note that when we are using pixels; the chain

code has only three different numbers of cell vertices for the bounding contour: 1, 2, and 3 [19].

Chain code may be invariant under starting point and rotation by using the concept of the shape number.

The shape number of the chain code can be obtained directly by rotating the digits of the chain until the number is minimum. Also, the shape number of the chain code shown in figure (8b) is 11212113. Note that, the shape number is invariant under rotation. It means that, if the object is rotated with $k \Pi/2$ where k is an integer, the shape number is the same.

Now after having the chain code we are going to work on this chain codes we only store the single chain code pattern for all same chain code pattern.

As we know that from above detail that chain code of same pattern is same whether we apply the transformation or rotation we will find the same piece of shape of binary image. So by using this technique we code and decode the image very effectively.

CONCLUSIONS AND FUTURE SCOPE

In this paper we have tried to explore the new possibilities in the field of fractal image coding with chain codes. Through our this new approach a binary image can be coded and stored in memory take very small space. And also the image can be decoded using chain codes of the shapes very easily and fastly. In the future his approach can be implemented on colored images.

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