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Method for Cell Image Matching Based on Fractal Neighbor Distance Image

Sangita Kumari[1], Prof. Nitesh Gupta[2]

[1]M. Tech. Scholar, [2]Guide and Assistant Professor

[1,2]Computer Science Engineering, NRI Institute of Information Science & Technology, Bhopal, India

Abstract - Based on fractal image coding and fractal neighbor distance (FND), a new method for cell image matching is proposed in this paper. The standard cell image is divided into image blocks with the same size of the object image block, then they are encoded and decoded by fractal in turn. The most optimal matching can be found according to the minimal FND. As the basic research for cell image recognition, this image matching algorithm is proved available and effective by the experiments results.

I. INTRODUCTION

Recently, image matching has become the critical and difficult area in the field of Pattern Recognition and Computer Vision [7]. It is a way to find one or more transformations in the transform space to make two or more images which differ from time and visual angle in the same scene approximating in space. Followed the generation and development of fractal [8], especially its widely application in coding [2, 3,4, 5, 6], it has become one of the most noticeable techniques in image coding. Fractal image coding is a method using partial self-similarity of images to represent them with a set of affine transformation coefficients. In fractal image coding an arbitrary image is encoded into a set of equations. These equations are usually affine transformations that transform a sub-image, called a domain block. An image is divided into non-overlapping range blocks, and a search for a most optimal matching domain block is performed for each range block. Domain blocks are usually larger than range blocks, and are similar to one another under that affine transformation. This paper will propose a method for cell image matching using fractal neighbor distance (FND) based on fractal coding theory [1, 9, 10, 11]. The standard sample images are divided into image blocks with the same size which is determined by the object image blocks. Then the object image blocks are encoded to get a cluster of IFS, and the minimal fractal neighbor distance is obtained while decoding. There exist the following two situations: (1) If one of the domain blocks in the object image block approximates to that inthe standard image block, the FND is minimal; (2) If the object image block is greatly different from the standard image block, the FND will be large. The most optimal matching block can be found According to this theory. It is proved that this image matching algorithm is available and effective by the experiments results.

II. FND

The FND gives a quantitative measure of the input output characteristics of the fractal code ofan encoded image.

The FND is defined as

$$d_{FN}(x_j , p_i) \_ d(f_j(p_i), p_i)$$

where f_j is the j^{th} code in a database of fractal codes with an attractor that is an approximation of thetraining image x_j, $f_j(p_i)$ is the first iteration of the j^{th} code with pi as the input image. For any input image pi, we can get an image approximating the original image x_j via collage theorem after the iteration of f_j, that is, FND is the distance of input image and the decoding image which is generated by decoding thefractal encoding of the object image.

III. INVARIANCE OF ATTRACTOR

Recognition system is based on the invariance of fractal coding attractors. If the input to the fractal code is close to the attractor of the code, then the FND will be small compared to an input that is further away from the attractor. That is, if the attractor of input image pi approximates that of object image x_j, their FND will be smaller than those whose.

Attractors are far away from the input image. Invariance to illumination occurs as a result of the FND measuring the distance between the input image and the resultant image after one decoding process. A fractal code with a large contractively factor implies that the decoding process will take longer to converge. This in turn implies that the resultant image after one decoding process will exhibit more similarities to the input image in terms of illumination levels. This renders the resultant image less sensitive to the actual illumination level in the attractor of the fractal code used to generate it, and more towards the illumination level of the input image. This effect can be described as a sort of automatic illumination adaptation to the input image.

Figure 2 gives an example for invariance of attractor. In Figure 2, the same input images Figure 2(a) and 2(d) are decoded by the fractal encoding of original images Figure

1(a) and 1(b) respectively, while Figure 2(c) and 2(f) are their output images, and Figure 2(b) and 2(e) are middle result images which are the first iteration of decoding process. From Figure 2(b) and 2(e) we can know that if the attractor of input image is greatly different from that of the object image, the FND will be large, whereas FND will be small if they extremely approximate.

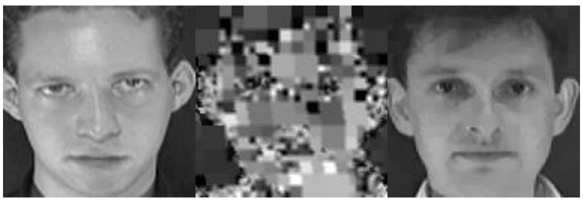
(A) (B)

Figure 1. The original images.

IV. IMAGE MATCHING

The process of fractal coding including encoding and decoding is as follows: 1. Divide the standard image and the object image into blocks, then classify them; 2. Find domain blocks in the same classification by affine transformation, and get the most optimal matching block according to d (the minimal Euclidean distance between matching blocks), then record a cluster of IFS coefficients; 3. Iterate arbitrary images with the IFS coefficients to get the approximated original images while decoding. For standard sample images, we can get a cluster of IFS by self-similarity. With the object image as the input image while decoding, we get the output image after the first iteration of the IFS, then compare this output image with the input image by FND, thus find the most optimal matching block.

(A) (B) (C)



(D) (E) (F)

Figure 2. An example for invariance of attractor.

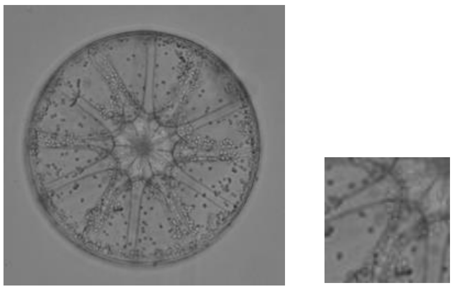
The process of image matching based on FND is (where P is the standard cell image and A is the object image block): 1. Divide image P into blocks with the same size of the object image block which is determined by A. Each block isencoded to get f_i, $i = 1, 2, . . . , N$, where N is the number of blocks; 2. Put A as the input image while decoding, compute FND $d(f_i(A),A)$; 3. Find the most optimal matching image block which is the block with the minimal FND.

V. EXPERIMENT

Take a cell image Figure 3(a) as an example, the standard cell image Figure 3(a) which is 256×256 size isdivided into image blocks with the size of 64×64 the same as that of the object image block Figure 3(b). For each image block, we choose 4 × 4 as the size of domain block and 8 × 8 as the size of range block for fractal encoding, and put the object image block as the input image while decoding, then get the FND after the first iteration. The matching results are shown on Table 1. From Table 1, it is shown that Block No. 14 has the minimal rms (0.2226) in all 16 blocks, which means that the FND between No. 14 block and the object image block is

Table 1. The matching result.

BlockNo.	**rms**	**Block No.**	**rms**
1	0.3087	9	0.6036
2	0.3339	10	0.3615
3	1.8129	11	2.1664
4	0.3252	12	0.3399
5	0.3670	13	0.2999
6	0.3481	14	0.2226
7	0.3617	15	0.3235
8	2.2221	16	0.33



(A) (B)

Figure 3. (a) is the standard cell image, and (b) is the object image block.

the smallest, that is, No. 14 image block is the most optimal matching image block. Actually No. 14 image block exhibits more similarities to the object image block which proves high matching accuracy of this method. Besides, it is also shown that the searching speed is fast as the FND measuring the distance between the input image and the resultant image after only one decoding process. Therefore, the experiment shows the effectiveness of this method for cell image matching.

VI. CONCLUSIONS

This paper proposed a new cell image matching method based on fractal neighbor distance (FND). The experiments results illustrate its availability and effectiveness. As the basic research, this image matching algorithm can help improving the accuracy of cell image recognition.

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