THE STUDY ON SCALE AND ROTATION INVARIANT FEATURES OF THE LACUNARITY OF IMAGES

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Abstract: It has been shown that the fractal dimension has a strong correlation with human judgment of surface roughness. Besides the fractal dimension, which is the most important fractal feature, lacunarity describes the characteristics of fractals. This feature is used in some fields and has good performances. In the field of image processing and recognition, it is important to study the scale and rotation invariant features. In this paper, the` scale and rotation invariant features of the Lacunarity are studied and the rule of varies is proposed.

Key words: Lacunarity, Invariant Feature, fractal, image processing

1. INTRODUCTION

It is well known that the fractal geometry is suitable to describe the feature of irregular natural image owing to the fact that fractal theory has been studied in the field of image processing and has achieved success in many areas. It has been shown that the fractal dimension has a strong correlation with human judgment of surface roughness. Besides the fractal dimension, which is the most important fractal feature, lacunarity describes the characteristics of fractals that have the same fractal dimension but different appearances(Marie-Pierre Dubuisson et al.,1994; Yueh-Min Huang et al.,

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2005). This feature is used in some fields and has good performances such as partial discharge defect identification(Candela, R. et al., 2000), locating address blocks in postal envelopes(Jacques Facon1 et al., 2005), etc. In the field of image processing and recognition, it is important to study the scale and rotation invariant features. In this paper, the scale and rotation invariant features of the Lacunarity are studied and the rule of varies is proposed.

The remainder of this paper is organized as follows. The Lacunarity Feature Extraction is explained in section II. Section III includes the Scale and Rotation Invariant features of Lacunarity. Finally, the Conclusions and discusses are given in section Ⅳ.

2. LACUNARITY FEATURE EXTRACTION

Lacunarity was initially introduced by Mandelbrot to describe different textures which has the same fractal dimension. To compute the Lacunarity feature, there are several methods such as box counting, fuzzy C-means clustering(C. R. Tolle et al., 2003), etc.

Traditionally, Lacunarities are derived from the box counting algorithm by computing the following moment, in addition to M(L):

$$M^2(L) = \sum_{m=1}^{N} m^2 \cdot p(m, L) \tag{1}$$

the lacunarity for a box of size L is defined as:

$$\Lambda(L) = \frac{M^2(L) - (M(L))^2}{(M(L))^2} \tag{2}$$

where M(L) is the mass of the fractal set, $p(m,L)$ is the probability that m points fall within a box of side length L centered at a box of side length L centered at a point.

3. SCALE AND ROTATION INVARIANT FEATURES OF LACUNARITY

Scale and Rotation Invariant features are very important to pattern recognition. Including Lacunarity, fractal features usually have the property of scale and rotation invariant in theory, especially for the ideal fractal model. But in practice, there are differences between the signal and the fractal model. In order to study the invariant feature of Lacunarity, five kinds of different texture images from Brodatz texture image databases are selected shown in Fig.1. The five kinds of images are sand, water, brick, grass and straw, the size of the image is 512×512.

grass *sand* *water* *brick* *straw*

Figure 1 Sample texture images collected from Brodatz

In order to improve calculation efficiency and reduce calculation chanciness, when calculating the feature of images, 10 blocks of pixels in the image are selected randomly and the mean of their calculated Lacunarity feature are used as the Lacunarity feature of the whole image. In the progress of computation, let size L=7. One of the calculated results of the scale variant for the sand image is shown in figure 2.

From experiments, it is clearly shown that the Lacunarity's value become higher when the image's scale become bigger.

On the other hand, one of the calculated results of the rotate angle variant for the sand image is shown in figure 3.

From experiments, it is clearly shown that the Lacunarity's value hold invariant when the image's rotated.

4. CONCLUSIONS AND DISCUSSES

The experiment result shows the scale and rotate feature of the Lacunarity for images. In order to e, other conditions must be considered such as image interpolation method, window's size used in the computation of Lacunarity, etc. and these are the next work need to do in the further study.

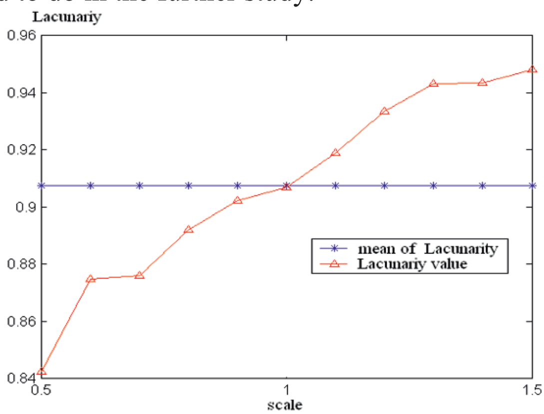

Figure 2 Zoom influence of Lacunarity feature (sand)

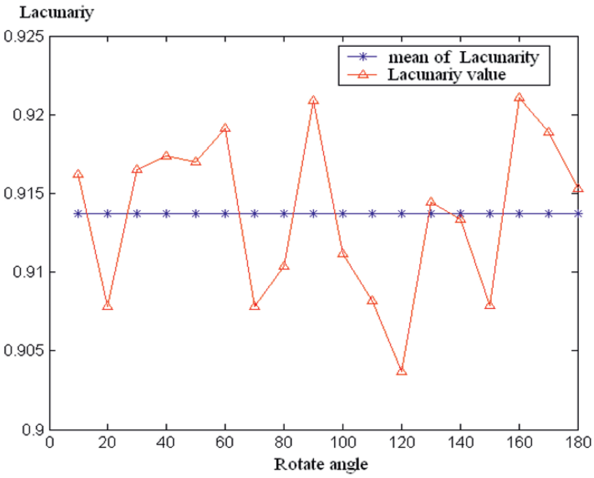

Figure 3 Rotation influence of Lacunarity feature (sand)

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