

## The Morphological Characteristics of Fractal Patterns and their Similarities with Textile Patterns

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**Abstract:** In this study, the fractal patterns generated by computer programs are compared with the traditional textile patterns and we find they have many similarities in the aspect of morphological characteristics. Based on the above, the fractal patterns are divided into different kinds according to their morphological characteristics, and the application of fractal patterns in textile field are discussed.

**Keywords:** Fractal pattern, morphological characteristic, similarity, textile pattern

### INTRODUCTION

The word fractal was first proposed by Professor Benoit Mandelbrot who wants to use the word to describe a large quantity of geometry objects which are complex, irregular and cannot be described by the traditional Euclidean Geometry in the nature. For example, glittering and translucent snowflakes, majestic mountains, thick trees, tortuous rivers, and stars all over the sky and so on, they all have the same characteristic that is highly irregular and unsmooth. Benoit Mandelbrot defined the fractal as the shape has self-similarity in some way between the part and the whole (Sun *et al.*, 2003). That means fractal has self-similarity, but with the progress of time and the development of technology, the fractal theory developing to today has a new feature, that is self-affinity. Furthermore, fractal has a more important feature, namely the fine structure. In a word, as long as the part and the whole are linked through some kind of transformations, we can regard them as fractal patterns. Being based on these features of fractal patterns, people naturally think of using computer programs to realize the generation of fractal pattern, such as Fractal Recursion algorithm, L-systems algorithm, Iterated Function System (IFS) algorithm, Newton Iterative method, Julia Set Escape Time algorithm, etc (Sun, 2004).

The fractal patterns generated by computer programs have many similarities with traditional textile designs. Some of them are similar to the plants in the nature (Li and Li, 2008); some are similar to traditional geometric patterns, to animal appearances or features, to natural scenery (Guo *et al.*, 1995) and so on. In this study, we generate some fractal patterns through computer programs, and discuss their morphological

characteristics and the similarities of textile patterns from the point of view of the textile applications (Guo and Song, 2010; Zhang *et al.*, 2008; Shi and Li, 2009).

### THE THEMES OF TEXTILE PATTERNS

Traditional textile patterns have different kinds of themes (Xu and Zhang, 2008), including animal patterns, plant patterns, geometric patterns, landscape patterns, utensils modeling patterns, national traditional patterns and so on.

Animal pattern has a long history. It was widely used in textile patterns since ancient China. When applying, the symbolic meaning of animal pattern is significant. In ancient palace, dragon and phoenix as a representative almost became the most popular pattern in royal. The symbols of their power, status, solemn and noble were shown incisively and vividly. Such like also have fish, peacock, unicorn, red-crowned cranes and other animals. Due to their own profound meanings, they were used in successive dynasties in textile designs.

Plant patterns include the patterns of flower, grass, tree and wood. Flower pattern as a decorative one is widely used in dyeing and weaving process, and has become the theme element and decorative pattern which is the most familiar to us and cannot be ignored. For example, the rose pattern symbolizing sincere and pure love is widely applied in various forms to printing cloth and other silk and brocade products. They will have different meanings if matched with different colors. There are many kinds of flower patterns such as the king of flowers peony symbolizing wealth and good fortune, lotus symbolizing purity, honesty and integrity, and so on. Due to their different moral, they are widely used in textile design. The grass patterns most widely

used in textile design are Tang dynasty flower design and training plant design. The former is dynamic and fluent, soft with hard, and the latter is curling, graceful and fluent. There are some similarities between the two patterns. As for the tall, straight and proudly standing pine, it is always described by the phrase-longevity old pine. Bamboo which is rather break than bend is widely used in the textile patterns. There are a lot of trees just like this.

Geometrical pattern is simple but changeable with intensive abstract beauty. It has wide applications, and is always used as decorative patterns on textiles. There are a lot of geometric patterns such as triangle, hexagon, diamond, circular and others used in Chinese traditional brocade patterns. Points, lines and faces are often used alone or cross to form geometric shapes with endless variations. Furthermore, geometric patterns can be combined with other kinds of patterns to make textile patterns and thus make the geometric patterns full of changes. This characteristic of full of changes in the premise of uniform is the main feature of the traditional geometric patterns.

Scenery pattern as textile pattern has been the subject of stylist favour. In nature, each object has its own characteristics. They have not only strong beat beauty but also beautiful rhythm beauty. Each object being combined together make nature itself to be an ever-changing, colorful landscape picture.

### THE MORPHOLOGICAL CHARACTERISTICS OF FRACTAL PATTERNS AND THEIR SIMILARITIES WITH TEXTILE PATTERNS

We generate many fractal patterns through computer programs in this study. Some of them are similar to the flowers, trees, wood and animals in the nature in concrete morphology; some are similar to the geometrical patterns in abstract morphology (Yan, 2004). These accords with the subject matter of the textile patterns.

#### The fractal patterns similar to animal patterns:

Figure 1 shows that the fractal patterns are similar to animal patterns, in which (a) and (b) are similar to peacock pattern, while (c) and (d) are similar to dragon pattern. Figure 1a is the fractal pattern generated by IFS algorithm. It looks like a side view of peacock's tail; Fig. 1b is generated by Newton Iterative method, and it also has some similarities with the male peacock's feather which is colorful and beautiful. Especially the multicoloured dizzy oval in the picture looks much like the big and rich luster round spots on the male peacock's feather. Figure 1c is generated by classical secondary Julia set. This is a typical computer-generated dragon. All the little dragons are roaring and making a faint green light in the backdrop of a black background. It gives people a feeling of mystery. Figure 1d is generated by Julia amplification set. There are a

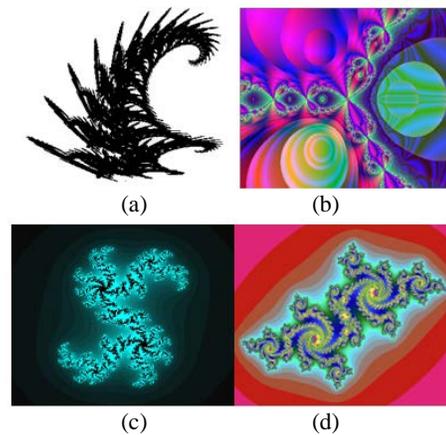


Fig. 1: Fractal patterns similar to animal patterns

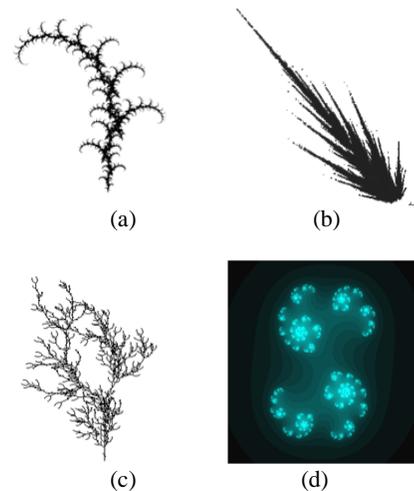


Fig. 2: Fractal patterns similar to plant patterns

few roaring dragons tangled together at every tangled place. They are roaring in all directions and trying their best to struggle, no one yielding.

#### The fractal patterns similar to plant patterns:

Figure 2 shows the fractal patterns similar to plant patterns. Figure 2a is generated by IFS, with each leaf blade creeping up and the tail of the leaf pointing and bending backward. It is very similar to a plant named Long Zhao Lan in real life; Fig. 2b is also generated by IFS. Its full appearance and with the golden color are very similar to the shape of the grain (Zhong and Yu, 2003). It gives people the feelings of harvest joy; Fig. 2c is generated by random L-System which can be regarded as realistic pattern. It has the characteristics of nature and lifelikeness. These characteristics are very similar to the natural plants such as mugwort or some trees having many branches; Fig. 2d is generated by classical secondary Julia set, which seems like the plum flowers blooming in winter. Each size of plum flowers arranged in a curved and assembled together is like rows of waves rolling forward.

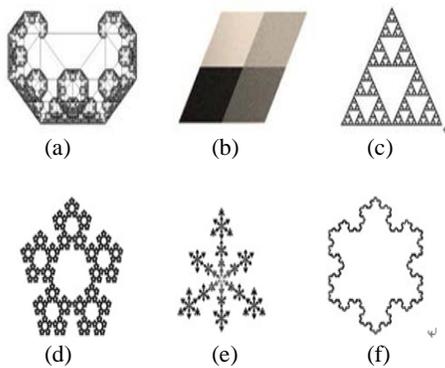


Fig. 3: Fractal patterns similar to geometrical patterns

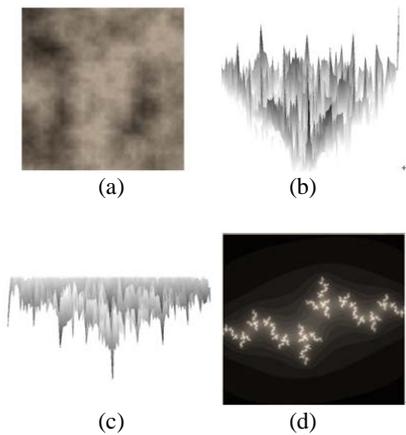


Fig. 4: Fractal patterns similar to plant patterns

**The fractal patterns similar to geometrical patterns:**

Figure 3 are the fractal patterns generated by different IFS codes. They all have somewhat similarities with traditional geometrical patterns (Zheng and Song, 2003). For example, Fig. 3a is very similar to the English letter C. Figure 3b is accordant with a geometrical parallelogram pattern; Fig. 3c is very similar to a triangle pattern, where the whole is a big triangle constituted with many small internal triangle patterns; Fig. 3d to f all have some similarities with snowflake which is a kind of beautiful crystal formed through the growth and changes of little ice crystals. Usually the ice crystals are thought of hexagonal or pentagonal, and then the snow can be thought of hexagonal or pentagonal. The fractal patterns formed by IFS vividly demonstrate the growth progress of snowflakes growing from little ice crystals, where each pattern is formed by the growth of the same little patterns.

**The fractal patterns similar to scenery patterns:**

Figure 4 shows that the fractal patterns are similar to scenery patterns. Figure 4a is a cloud image generated by fractal interpolation method. The flickering tone in the image is like the overcast sky before the storm

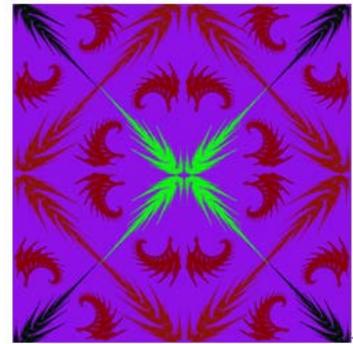


Fig. 5: Textile design

comes and everywhere is shrouded in gloomy atmosphere. It gives people a kind of depressive feeling; Fig. 4b and c are generated by random midpoint displacement method in which Fig. 4b is like the mountain looking from a distance, high and low, rolling, full of fantasy color and it is very similar to the fantastic mountains in cartoons; Fig. 4c has somewhat similarities with the lava. It incisively and vividly shows the falling characteristic of water droplets and rocks; Fig. 4d is generated by classical secondary Julia set. The line-shape light against the backdrop of a black background looks like the shy covered with dark clouds and lightning frequently at Midsummer Day encountering thunderstorm.

**THE PROSPECT OF THE FRACTAL PATTERNS APPLIED TO TEXTILE PATTERNS DESIGN**

Fractal patterns have many similarities with traditional textile patterns in style and they are finer than traditional textile patterns on structure. The production of the patterns is fast and changeful. Fractal patterns can be widely used in the design of textile patterns. They can be applied to textile patterns not only as a stand-alone pattern, but also by scattered-point and other continuous methods to convert into textile patterns used in the design of decorative fabrics or clothing. Figure 5 is a textile pattern designed by using fractal patterns shown in Fig. 1a and 2b as the elements with Photoshop.

**CONCLUSION**

There are many similarities between traditional patterns for Fractal patterns with the characteristics of infinite circulations and self-similarity. Some of them look like animal patterns; some like plant patterns; some like geometric patterns; and some like scenery patterns. They can be used in textile design as stand-alone patterns or proper combined patterns, making the textile patterns more diverse and more variable either from the view of the pattern itself or from the colors. Nowadays, in both the decorative textile patterns and the clothing ones, individuality, difference, unique, and oneness are more and more emphasized. Therefore, the

fractal patterns used in textile patterns (Yang *et al.*, 2004) will be favored by designers.

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