Process Realization of Fractal Pattern in Computer Jacquard Knitting Fabric

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Received: June 9, 2016 Accepted: June 25, 2016 Online Published: July 5, 2016

doi:10.5430/jbar.v5n2p20 URL: http://dx.doi.org/10.5430/jbar.v5n2p20

Abstract

Pattern is the indispensable artistic language of knitted fabric. Knitted fabric pattern can be performed by structure and color pattern. Color pattern is jacquard. Fractal pattern is a complex and irregular graphics, and we can construct protean art designs with its unique features and obtain inspiration for knitted fabric pattern design. For current knitted fabric pattern is mainly composed by traditional pattern, the paper programs fractal pattern based on unit pictures and escaping time algorithm according to different generating principles with C++ language, then redesigns the pictures in the pattern design software of computerized flat knitting machine and weaves the fabrics with the pattern procedure. The result shows that the unit picture can be applied to knitted jacquard fabrics by rearranging and the fractal pattern based on escaping time algorithm can be applied to knitted jacquard fabrics with the form of block surface.

Keywords: Fractal pattern, Computerized flat knitting machine, Jacquard fabric

1. Introduction

Pattern ,as both ancient and modern decorative arts, plays the role of decoration and embellishment in clothing, and the patterns applied on the clothing through some suitable forms are called clothing patterns (Shan Yufu, 2005). Knitting clothing can't be modified through cutting and folding like woven fabric. Thus, in addition to the application of new fabrics, pattern become an important part of knitted sweaters fabric design. For knitting fabric, pattern can be performed by jacquard ,the color pattern. Jacquard are such patterns woven by yarns with different colors, and the color of jacquard is based on the number of colors in one line.

Fractal theory is a science newly developed in the past 20 to 30 years, and it can describe roughness and irregular geometric shapes in the nature or in non-linear system. Fractal theory is extensive applied to many fields, such as mathematics, physics, medicine, computer science and so on (Wang Shuyin, 2010). We could obtain inspiration for knitted fabric pattern design from fractal pattern which is a complex and irregular graphic, and we can construct protean art designs with its unique features.

The paper programs fractal pattern based on unit pictures and escaping time algorithm according to different generating principles with C++ language. Then some typical patterns are selected for pattern designing according to weave character of jacquard organizations in (Stoll) computerized flat knitting machine program. Finally, Knitted jacquard fabric is wove in computerized flat knitting machine using 48s / 2 cotton / viscose / nylon / cashmere (60/20/15/5) blended yarn.

2. Literature Review

The pattern design of jacquard knitting fabric is always one of the main contents scholars are dedicated to study. It is clearly found that many forms of pattern have applied to the design of knitted garments in recent years. For example, paper "research and application of fractal geometry in clothing pattern design" wrote by Cai Yanyan, researched systematically generation method of fractal images, then fractal graphics are applied to clothing pattern design and gives the specific effect chart. "the study and application of costumes design based on fractal theory" wrote by Wang Shuyin, researched the basic knowledge of fractal theory, the algorithm of fractal graphics design and the application of design research in the clothing pattern generation on the basis of previous research, then using Photoshop, Corel Draw to stroking or rendering the fractal graphics in order to receive the design patterns, and finally put these design patterns in the design of apparel pattern and clothing accessories. "the application of fractal

patterns in costume design" wrote by Yang Zhi, analyzed fractal pattern application in costumes-digital jet printing and the value of fractal in custom Made. "design and application of the fractal graphic art in garment material" wrote by Long Xiaotian and Luo Weiyan, discussed the specific applications of aesthetic values of the fractal graphics art and the modern visual art in fabric design, then the more accurate and specific application of fractal graphics art could be used in the design of the garment fabric. etc. The paper chiefly discusses the application of fractal pattern in jacquard fabric based on unit picture and escaping time algorithm according to the different generating principles.

3. The Features and Generating Principles of Fractal Pattern

3.1 The Features of Fractal Pattern

Fractal is used to describe rough and irregular geometric shapes of the nature, such as animal's blood vessels, rugged mountains and floating clouds, etc. Fractal has been widely used in physics, architecture, art, and other fields because of its unique aesthetic characteristics. Fractal basically has the following several characteristics, self-similarity: fractal produce many parts in the process of generating fractal which similar to itself; harmony: the harmony of fractal pattern is a mathematical harmony and every change of shape, transition of color is a natural flow; fine: fractal pattern has fine structures, contains endless nested structures, and has complicated structures under arbitrary amplification multiple; diversity: fractal pattern is a new design by combining the theory of mathematics and computer, without being limited by the imagination, time and space (Tang Ying & Fang Kuanjun, 2009).

3.2 The Generating Principles of Fractal Pattern

There is a wide variety of fractal and its generating principles in computer are different. The paper mainly studies the following two generating principles of the fractal pattern.

3.2.1 The Fractal Pattern Based on Unit Picture

Generating element is one of the basic elements, based on which colorful and infinite fractal pattern can be produced by certain rules after repeated recursion and iteration (Lu Lisha& Song Xiaoxia, 2016). Generating element can be a straight line or a simple geometry. The curve shown in figure 1 is a general designation of a self similar curve, which is called dragon curve because of its similarity to the shape of a dragon.

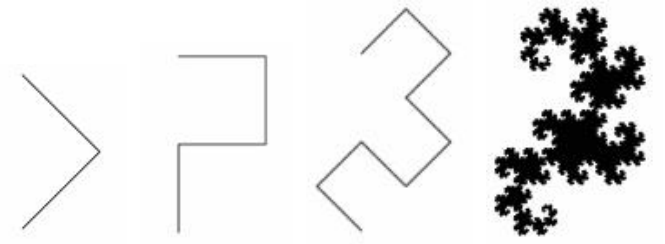
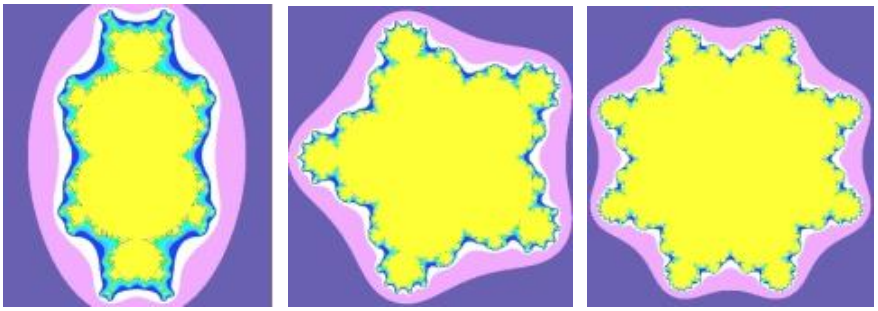


Figure 1. Dragon curve

3.2.2 The Fractal Pattern Based on Escaping Time Algorithm

Escaping time algorithm is a drawing method based on iterative method. Assuming that f is a transformation, f_n is n times-iteration of f, then $f_0(x)=x, f_1(x)=f(x), f_n+1(x)=f(f_n(x)), n=0,1,2\ldots$Classic Julia set, Mandelbrot set and Newton iterative fractal can be realized by escaping time algorithm. Using the escaping time algorithm to draw the fractal pattern mainly has the following four steps.

Determine the graph area and establish a coordinate system in the computer, to overlay the origin of coordinates with the screen center; The pixel coordinates of the area are substituted in corresponding iterative formula successively, and convergence or divergence of the coordinates of the pixels are calculated in a given number of iterations; Convergent and divergent pixels are marked in different colors in the area, because convergent and divergent iteration times of different pixel points are different in a given number of iterations, so by adding different colors for different pixels we can get bright and colorful fractal pattern, Mandelbrot set fractal pattern is shown in figure 2.



$f(z)= z^3+c$ $f(z)= z^6+c$ $f(z)= z^9+c$

Figure 2. Mandelbrot set fractal pattern

4. Application of Fractal Pattern in Knitted Jacquard Fabrics

4.1 Weaving Techniques and Main Points of Computerized Flat Knitting Machine

The paper achieves the application of fractal pattern in jacquard fabric by computerized flat knitting machine. Computerized flat knitting machine is a electromechanical integration machine, by which the woven fabric is a weft knitting, and it is a high technology content clothing equipment with high efficiency, rich pattern change (Ding Lingcong & Zhang Yu, 2015). Stoll -CMS530HP computerized flat knitting machine is used in the paper, by which jacquard fabric woven mainly includes the following steps.

The structure is complex and color is complicated of fractal pattern generated with C++ program. The pictures are saved as bmp format and be desaturated, spliced, symmetrical, flipped in the Stoll-M1plus pattern design software, that is jacquard pattern design. Because a guide mouth represents a color yarn in computerized flat knitting machine, so we should ensure that the number of color of each row is the same in design pattern, otherwise thickness of fabric woven will be unevenness. But the color of each row can be different, and the overall color number cannot exceed the number of the guide mouth of corresponding flat knitting machine. But the number of color of each row is not the same in actual pattern design. Mandelbrot set shown in figure 3 is fabric view in Stoll-M1plus pattern design software. The first few lines of figure 3 only contain light blue and yellow, in the next two lines contain three colors-white, light blue and yellow, the others contain four colors-blue, light blue, white and yellow. Obviously the number of color of each row is not the same, but we can add one or two other colors to the required number of columns at the edge of the rows that the number of color is fewer. It not only does not affect the overall effect, but also ensure the same color number of each row.

Defining jacquard structure is to determine the organizational structure of basketwork, because there are float lines on the back of single jacquard, so the paper choose double jacquard weaving. The back of double jacquard can be expressed by a variety of organizations, because the pattern woven in the paper are complex, so the air layer and sesame seed are adopted to weave which demands on yarn strength is low. Finally, process the separation yarn and sealing yarn in the program. Separation yarn should be done in the first two lines of woven fabric and it plays a role of transition when knitting by computer. While sealing yarn should be down in the last two lines of the weaving body and end of any panel knitting should be sealed the mouth. Then Click “start” button and export MC program after the completion of yarn mouth distribution (make sure that the color of the yarn on the flat knitting machine is in accordance with the color of pattern designed). After it is inspected right, deposited in the U disk and imported to the computer flat knitting machine, when make sure “TP” test is right, we can knit normally.

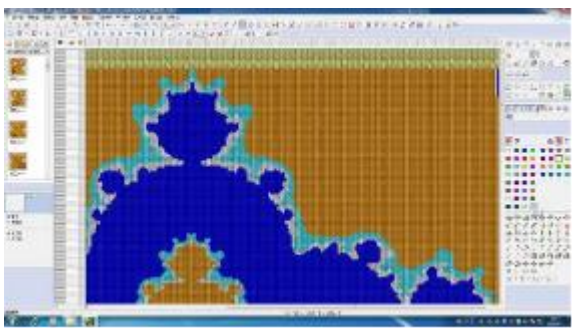


Figure 3. Mandelbrot set fabric view

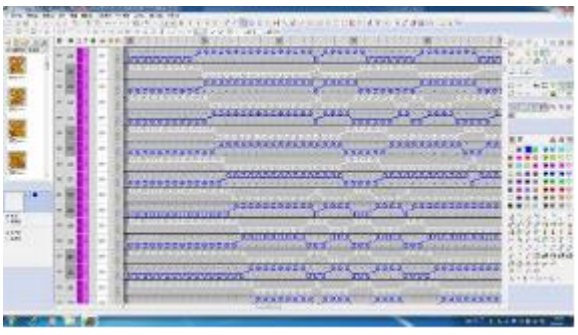


Figure 4. Dragon-shaped curve technology view

4.2 The Application of Fractal Pattern Based on Unit Pictures in Jacquard Fabrics

4.2.1 Fractal Pattern Based on line

Line as generating element can generate a lot of fractal pattern. Dragon-shaped curve is based on a line, which is folded from the midpoint into two segments with a angle of 90 °for the first time and the two segments are folded respectively in the opposite direction with a angle of 90 °for the second time, after several folds dragon-shaped curve is formed.

After the type of pattern is generated, as the local part is amplified and the overall structure is relatively simple, therefore two colors can display its main features. The characteristic of two-color double-sided jacquard knitting yarn: one color yarn is woven on some needles, while the other color yarn is knitted on other needles (QiuYuying & Chen Tianli, 2013). Double jacquard front pattern can be designed at random and the back may be composed of different types, but the air layer of organizational structure pattern of back is employed in the paper (Wan Ailan, Miu Xuhong & Cong HL, 2015). Air layer is that a color is knitted on the front of needle bed and other colors are knitted on the back of needle bed, which can be seen from the "process view". "Process View" is a window in which we can draw and display pattern needle selection. Knitting needle movement shows knitted fabric, as shown in figure 4. The larger the organization color of air layer, the greater air layer between the fabric. The pattern of front and back is the same but the color is different, as shown in figure 5.

Figure 5. Dragon-shaped curve object picture

4.2.2 Fractal Pattern Based on Geometric Pattern

Geometric pattern as generating element regard a graph as a constituent element, based on which a series of patterns are generated in accordance with certain rules after repeated iterations, such as regarding a star as the constituent element, and then generate 5 stars on its each end point according to the iterative, and so on. Finally we can form beautiful pattern, as shown in figure 6. The pattern is very regular, consistent with characteristics of jacquard woven fabrics, and similar to the geometric patterns of knitted fabric, suitable for single pattern. Figure 7 is a double-sided color Jacquard with the air layer on its back (Zhu Wenjun & Zheng Jianlin, 2011).

n=0 n=1 n=2

Figure 6. Sierpinski star

Figure 7. Sierpinski star object picture

4.3 The Application of Fractal Pattern Based on Escaping Time Algorithm in Jacquard fabrics

Mandelbrot sets, Julia sets, Newton iteration pattern based on escaping time algorithm have characteristics of gorgeous colors and complex structures. When the local part is amplified, Complex patterns will appear. Mandelbrot sets fractal pattern internal structure is simple, but the outer contour has fine details; Julia Sets fractal pattern assumes the shape of petals as a whole and marginal areas is distinct, yet the inside structure is complex; Newton iteration fractal depends on the function selected and different pattern is corresponding to different functions, interior design has intricate details. Since a coil represents a pixel in the knitted fabrics, if the image pixel is too low, its details cannot be displayed and also cannot reflect the characteristics of intricate fractal pattern, therefore the type of pattern is suitable for the form of block surface.

4.3.1 The Application of Mandelbrot Set

Mandelbrot set is found by Mandelbrot in 1980 and the main principle is based on the equation $z_{n+1}=z^m_n+c$ (z is a complex variable, c is a complex constant).Changed track of c was observed over the entire screen. The main feature of M set is as the iterations increase, pattern gradually tend to a circular, as shown in figure 2. Take the sixth power of the Mandelbrot for example, in order to show the details of the pattern more clearly, double-sided four-color jacquard structure with the air layer on its back is used, as shown in figure 8.

Figure 8. Mandelbrot set object picture

4.3.2 The Application of Julia Set

Julia set is based on formula same as the Mandelbrot set. As complex constant c is fixed, changed track of z0 (x_0, y_0) in complex plane is observed. By changing real and imaginary parts of parameter, different patterns can be got. Figure 9 is a Julia set of $f(z)=z^2 + 0.29+0.012i$. While retaining the main internal details, double-sided color jacquard is designed with sesame point on the back. The so-called sesame point resembles the distribution of sesame and color arrangement is staggered on the back, as shown in figure 10.

Figure 9. Julia set fractal pattern

Figure 10. Julia set object picture

4.3.3 The Application of Newton Iteration Pattern

For continuously differentiable function f (x), according to Taylor's formula we can get f (x) ≈ f (x_0) + f '(x_0) (x-x0), order f (x) = 0 approximate roots is $x_{n+1}\approx x_n-f(x_n)/f'(x_n)$. When x is replaced by the complex number z, the Newton iterative formula $z_{n+1}=z_n-f(z_n)/f'(z_n)$ is got. figure 11 is the pattern of f (x) = f(x)=x^5-1,which is more complex and knitted with double-sided four-color air layer structure, the edge portions reflect asymmetry of the color segmentation, as shown in figure 12.

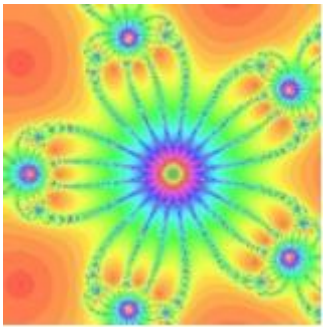


Figure 11. Newton iteration fractal pattern

Figure 12. Newton iteration fractal object picture

5. Conclusion

In the paper, various fractal pattern are generated by C ++, and the generated fractal pattern are designed as program of jacquard knitted fabric using computer flat knitting machine design software, finally weave the fabrics. By applying fractal pattern in jacquard fabric pattern designing, not only breaking the limitations of traditional design ideas, providing a new design method and creative inspiration with the advantage of more innovative and aesthetic for knitted fabric pattern, but also exploring a new way for fractal pattern being applied to the field of knitting fabric.

6. Limit and Future Research Directions

This article which simply introduces the knitted jacquard fabric extended from fractal pattern is a bit shallow. It will be more persuasive if complete sets of clothes can be woven. The application of fractal pattern on the knitted jacquard fabric provides a new thought and method for the pattern design of knitting clothing, but it is only under study at present. A complete set of clothing can be seen in the market in the near future and the clothing will really play the role helping people pursue personality. At the same time, we should realize the source of knitting clothing pattern design can be obtained from every field and breaking the routine is a good method for finding new things.

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