Application of Interactive Computer Aided Design in Fractal Art Design

Hui Ji[1] and Yang Shang[2*]

[1]State Property Centre, Zhengzhou Tourism College, Zhengzhou 451464, China, jihui@zztrc.edu.cn
[2]Audit Office, Henan University of Technology, Zhengzhou 450001, China, shang@haut.edu.cn

Corresponding author: Yang Shang, shang@haut.edu.cn

Abstract. With the continuous popularization of computer technology, computer graphics and image aided design provides more efficient, sufficient and all-round technical means for artistic creation personnel. Compared with traditional design, computer graphics and image aided design creates more creative visual effects and innovates the working mode of art design. In order to improve the efficiency of graphic design, a fractal pattern generation method based on interactive computer aided technology was proposed. In this method, binary tree structure is used to represent the iterative function of fractal pattern, and crossover, mutation, selection and other operations are carried out on the iterative function represented by tree structure to generate new descendants. At the same time, the user consensus satisfaction is taken as the fitness function to optimize the evaluation mechanism to achieve the purpose of reducing the subjective evaluation error, which provides help to meet the personalized design requirements of users faster and better. The feasibility and practicability of the algorithm are verified from the application level, which provides a new visual effect and working mode for artistic creation and production, and provides a way for designers to realize creativity and a broad space for artistic expression.

1 INTRODUCTION

With the rapid development of computer technology, computer-aided design is playing an increasingly important role in the field of art design. It plays an important role in industrial design, advertising, web pages, animation, clothing, fabric patterns and other fields of art design [1]. In the digital art design increasingly today, the development of the computer as the main authoring

tools of graphic design gradually become the mainstream design technology, the traditional product modeling design, general in market research, to demand schedule after the first plane diagram conception, form a complete solution, and began to draw 3 d diagram, after fully, then according to the need to draw traditional renderings, three views or simple model. In the process of design, it is necessary to design and engineering and technical personnel and workers work together to express the designer's idea in real samples, but for every solution to make physical sample, to pay a lot of work, there is low accuracy, modify, adjust the hard times, the design cycle is long and the cost is high.

As an emerging art, fractal art, like any other art, has aesthetic characteristics such as symmetry and balance, repetition and rhythm, unity and change. Its exaggerated rhythm and rhythm feature gives people a strong visual impact. The rich color changes and affinity directly shorten the aesthetic distance between it and people [2]. With the emergence of new printing and dyeing technology, fractal art has been applied more and more in costume design, and fractal pattern has become a new subject in the study of modern costume pattern. Fractal art is a new way of creation in modern times. In costume design, it requires costume designers not only to have high aesthetic quality and the ability of reasonable use of color, but also to have certain mathematical knowledge and computer software operation ability. Only in this way, can costume design be harmonious with fractal art.

Fractal art is the art of science and the science of art. Fractal art is created by scientists and artists working together, and there is a wonderful fusion of program and art here. Fractal art comes from the combination of science and art. It is a new artistic practice based on fractal theory in nonlinear science. Rodrigues et al. [3] mentioned that fractal art is the integration of science and art, and the unity of mathematics and art aesthetics. Mathematics is no longer the dry and abstract philosophy of yesterday, but endowing infinite mystery with beauty and inspiring people's reveries. Nowadays, fractal art has been widely used in appearance packaging, computer games, craft decoration, commercial advertisements and film and television works. Campbell et al. [4] mentioned that personalized and creative fractal art design not only gives people aesthetic visual enjoyment, but also has huge commercial value. With the progress of science and technology and the increasingly fierce market competition, the needs of users are personalized and diversified, and the user-centered product design method is gradually paid attention to. How to capture user preferences and design creative works is still a topic worthy of study and discussion.

Interactive computer aided technology is applied to fractal art and design, and the application of interactive CAD in fractal pattern generation is discussed. Add human-computer interaction process on the basis of CAD, so that users' preferences can be better integrated into the CAD process. By introducing more information about customer needs into the algorithm, fractal art can evolve to be more satisfying to users, or more personal. It provides strong support and help for better and faster fitting the design requirements of users.

The generative pattern design method with computer as the creation tool has gradually become the mainstream technology, and has been successfully applied to the design of fractal art pattern. The application of fractal art pattern design in various fields has also entered a more systematic, practical and software productized development stage. Based on the background of fractal pattern generation or composition, this paper discusses the algorithm-based modeling techniques of computer-aided fractal artistic pattern design, introduces several typical fractal pattern modeling algorithms and their combination with traditional artistic modeling methods, and gives examples of the generation of these modeling algorithms. Integrating fractal art into computer graphics design can not only enrich and expand designers' ideas, but also enrich image design and color application to a certain extent.

2   RELATED STUDIES

Fractal is an important part of nonlinear science, which studies common, unpredictable, unstable and irregular phenomena in nature. The concepts of dynamic change, whole and part, order and

disorder, simplicity and complexity, finite and infinite, quantitative change and qualitative change, certainty and randomness, which exist in the fractal theory as a science, have profound and insightful philosophical connotations. It has been widely and deeply applied in mechanical vibration, chemical engineering, material science, computer visualization and other fields, providing a new scientific epistemology and methodology for the research of natural science and social science.

Fractal art has the advantages of rich colors, natural transition, simple design and easy replication. Fractal art allows us to see art and science finally meet at the top of the mountain after crossing the mountain. From fractal art, we can understand that art and science can be integrated, and mathematics and art have a unified aesthetic standard. Yesterday's dry mathematics is no longer just abstract philosophy, but concrete feelings; it is no longer just to reveal a kind of existence, but a kind of artistic creation. Fractals build a bridge between science and art. Blau and Carello [5] mentioned that with the rapid development of digital era, fractal art not only has profound scientific methodological significance, but also has realistic value of high integration and deep exploration of various disciplines in the new historical era. The most prominent feature of the artistic generation and design of fractal graphics is the use of fractal self-similarity, the introduction of recursion or iteration. Random disturbance to local processes in the process of modeling or composition.

The complexity, gorgeous and changeless of fractal graphic art arouses the magical creativity of the scientific world and makes people feel the magic appeal of the art world. Science depends on analysis, art depends on intuition, and fractal graphic art itself is the perfect fusion of rationality and sensibility, is the unity of science and art. This is not only a new understanding of natural structure, but also the practice of mathematical theory in computer science. In art, fractal pattern retains the traditional plane composition, and makes full use of computer advanced technology providing a new art form for the simulation of creative thinking and its realization. The basic principles of the generation and design of fractal art patterns are the same as those of ordinary art patterns, but the most prominent is the use of self-similarity and self-affine of fractal, the introduction of recursion or iteration in the process of modeling or composition, and the random disturbance of local processes. The definition of fractal art language is shown in Figure 1. Basic techniques include:

(1) The structure of pattern mainly adopts function iteration and repeated application algorithm based on geometric process.

(2) The algorithm and human-computer interaction with the combination of coloring technology.

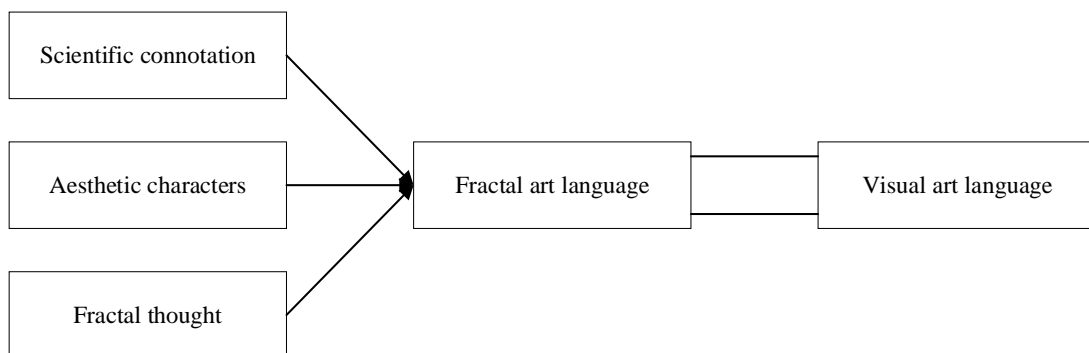(3) The layout adopts the combination of traditional and fractal algorithm composition technology, etc.

Figure 1: Definition of fractal art language.

Compared with traditional patterns, fractal art patterns undoubtedly have greater innovation, and fractal art itself is also constantly innovating. There are an infinite number of functions, an infinite number of coloring schemes, and a number of generation methods. The combination of them is almost infinite. Plus, the world of fractal art is infinite. Integrating fractal art into computer graphics design can not only enrich and expand designers' ideas, but also enrich image design and color application to a certain extent. In addition, fractal art is the crystallization of computer technology and aesthetics. Fractal design concept is more fashionable, so it plays an important role in textile design. Compared with the traditional pattern art, the fractal pattern art is obviously more innovative than the former, the main reason is that any effective fractal algorithm can form different fractal patterns, so that the designed fractal patterns become colorful, rich in personality and different styles [6]. For fractal design, morphological modeling can be subdivided into concrete modeling and abstract modeling, such as trees, flowers, snowflakes, etc., all of which belong to concrete modeling. Abstract modeling mainly refers to the geometric pattern generated by combining with computer technology. In short, the application of fractal pattern design in textile pattern design can become the source of its design power, design different styles, highly personalized textile patterns; The textile patterns designed by the designer not only conform to the trend of The Times, but also meet the diversified needs of the market to a large extent and make the fractal pattern design develop towards a benign state.

Fractal is a self-similar form with infinite details in the sense of scale-free is the embodiment of the beauty of disorder and infinite transformation. Using the self-similarity of fractals, it is possible to construct kaleidoscopic art patterns with high resolution structure is an art form that has attracted wide attention and interest in recent years. Creating a computer using fractal images with otherworldly artistic charm, its dynamic images contain a large order of magnitude of visual information, often causes the designer more in-depth thinking activity and richer creativity association, with fractal method of computer aided decorative design, its artistic effect is almost unattainable by hand. The composition structure of fractal art design system is shown in Figure 2.
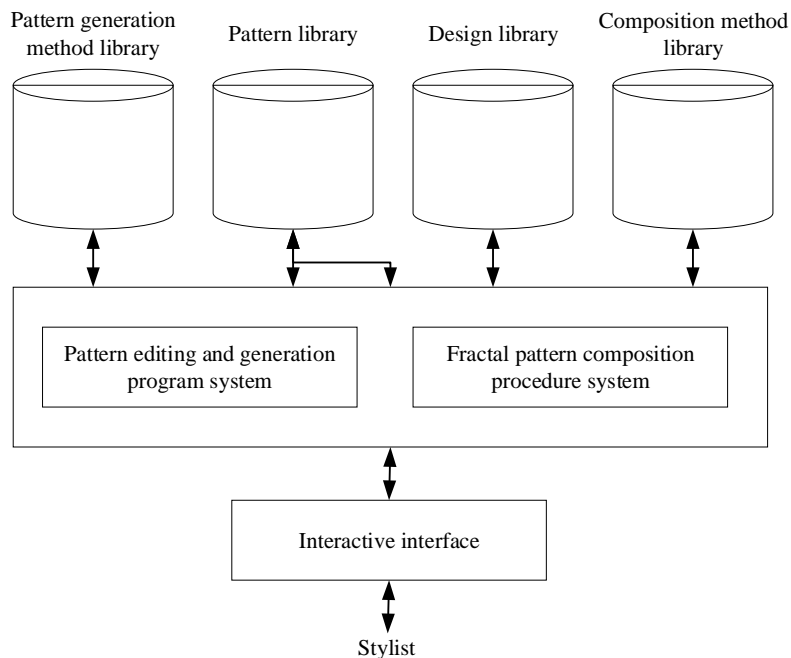

Figure 2: Composition structure of fractal art design system.

3   INTERACTIVE COMPUTER AIDED TECHNOLOGY

The generative pattern design method with computer as the creation tool has gradually become the mainstream technology and successfully moved into the fractal art pattern design. The application of fractal art patterns in various fields has also become more systematic. With the rapid development of computer technology, the method of using computer aided design to draw wax printing pattern has gradually become the research direction of designers at home and abroad. Computer aided wax printing pattern design overcomes the limitation of traditional wax printing pattern design. First of all, with cad, the design process is visible and the design pattern can be adjusted at any time. Secondly, designing batik patterns with the help of computer software allows designers to focus more on the creation of patterns themselves. Third, through the computer aided wax printing pattern design can greatly shorten the creation cycle, the producer can put the main energy on the design and creation of patterns, not only improve the production efficiency and product quality, but also meet the current personalized requirements of consumers, improve the market competitiveness. The application of computer graphics aided design in graphic design, visual design, interior design, etc., can not only reduce the practical training of drawing tools, but also greatly improve the accuracy and standardization of the drawing image, at the same time, the drawing speed has been greatly improved. Singh et al. [7] mentioned that the teaching advantages of computer graphics and image aided design are also reflected in different design and production work in different fields such as advertising design, visual communication design, digital video, environmental art design and animation design, which are incomparable to the traditional production process. The interactive optimization process is shown in Figure 3.
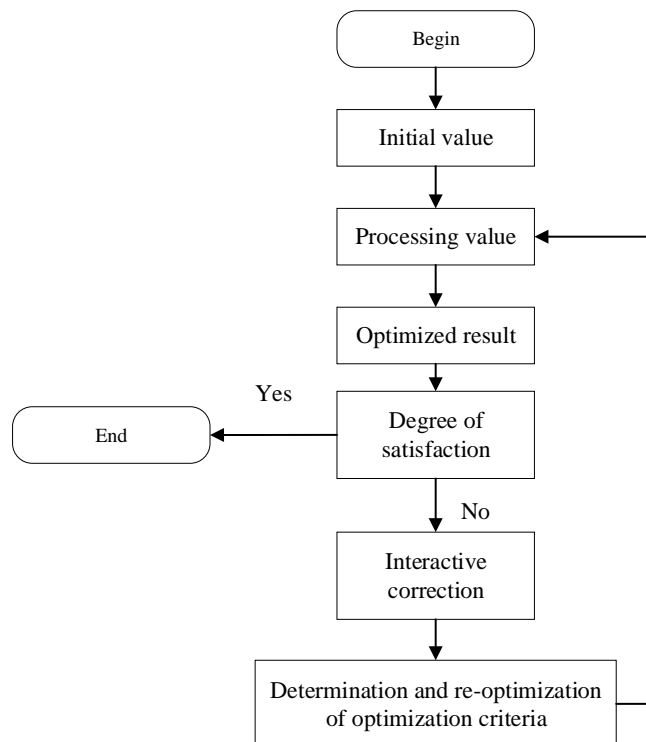

Figure 3: Interactive optimization process.

Man-machine interface refers to the operation mode of interaction between human and machine, that is, the media through which users and machines transfer information including the input and output of information. The main problem to be solved in the study of human-machine interface is expression and control. That is, how the machine communicates information to the human, and how the human controls the machine. Interactive design refers to information processing. The operator sees the input information and operation commands in the input and output system through the terminal device. Kasik and Dill [8] mentioned that the system processes the information immediately after receiving it and displays the processing result through the terminal device. Operators can further input information and operation commands based on the processing results. The system and the operator in man-machine dialogue to ask and answer, until the final processing results. In this way, the programmer can design, adjust, modify, make mistakes and deficiencies in time to correct and supplement. With the application of computer technology and automation technology in textile, such as texture CAD technology, textile patterns generated by fractal can be reproduced on the fabric. Because the fractal pattern is a digital figure, it can be handled directly in weaving software. With the gradual popularization of weave CAD technology, computer embroidery, electronic jacquard loom and digital printing technology in the field of textile application, this kind of textile fractal pattern generated by computer program can be directly transmitted to the relevant production machine through the computer, rapid response and no distortion. This not only shorted the craft, but also realized the digital design of textile art pattern. Combining with the existing texture CAD technology (or digital printing), fractal art can be reproduced on textile fabrics. In the graphics system, the most intuitive difference between the general drawing technologies is that after the general drawing technology is finished, it cannot be modified immediately, while the interactive drawing technology is finished, through the handle, positioning and picking technology to achieve the purpose of real-time modification of the graphics, making the drawing work more convenient.

The purpose of interactive design is to consider and solve problems from the perspective of users as far as possible. On this level, interactive should follow the following basic principles: reduce the workload of user input data as far as possible, and provide default values as far as possible; The way of data input should be as simple and convenient as possible, and provide data interface with other software; Igarashi [9] mentioned that the system has memory function, including recovery and re-operation function; Drawing process with visible, make full use of rubber band technology between the user and the system real-time display pixel drawing process; Provides a variety of graphical operation modes, such as menu mode and command input mode; Have a more perfect help system, including training help and context help; With fault tolerance function, can deal with all kinds of extreme situations and timely feedback to the user response information on all kinds of errors.

From the perspective of development, the future trend is to combine computer simulation and industrial design technology. And with the continuous improvement of computer performance and the rapid development of computer networking, the available computer resources are gradually rich, computer simulation in the design of the position is becoming more and more important. The popularization of technology in various industries is becoming more and more widespread. Technology is rapidly developing towards the direction of openness, integration, intelligence and standardization. Tsai et al. [10] mentioned that the research on the software user interface and the improvement of the interactive system will play an important role in improving the quality of our software products, enhancing the competitiveness of the domestic software market, and better promoting the rapid development of the software industry. It is also of great significance to develop and promote our own industry software.

4 CASE ANALYSIS

Computer graphics and image aided design has the advantages of being relatively simple to learn and easy to operate, which greatly facilitates the designers. Not only can various basic effects be produced through computer graphics and image aided design, but also various special effects can

be produced, which can be designed and modified at any time. You can edit, adjust, splice, synthesize, mix and arrange images and graphics, make overall idea, interior design, mix and clip digital video, synthesize digital video special effects and other operations at any time. The application of fractal pattern in textile industry mainly includes T-shirt pattern design, decorative cloth pattern design, embroidery pattern design, silk square pattern design, fashion pattern design, carpet pattern design and wall carpet pattern design. As a combination of digital art, science and art of fractal pattern is nonlinear graphics entity, has the strong ability to explain nature, at the same time, the fractal pattern is the important exploration, development pattern geometry can be created to express human complex feelings of abstract art, is scientific and artistic value. The study of fractal design and implementation can provide technical support for the use of computer technology to assist artists in the design of purposeful complex patterns and colorful patterns. The regular skeleton of combinatorial fractals is shown in Figure 4.
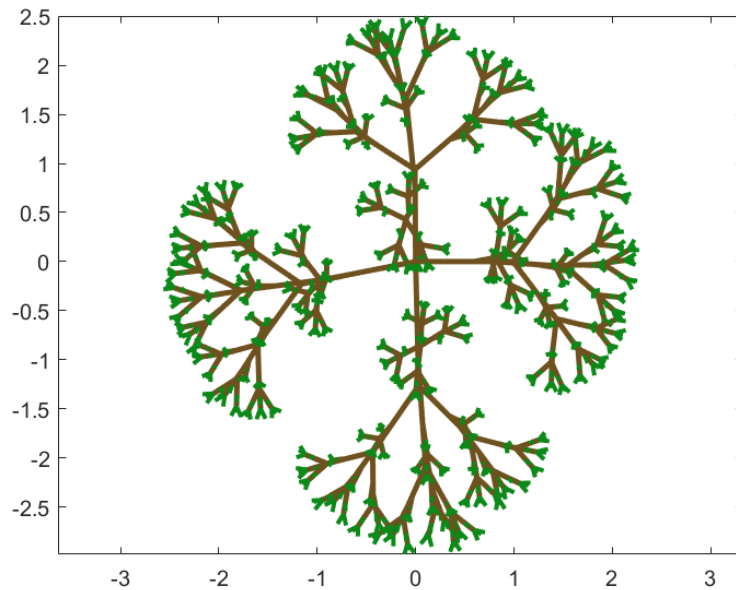

Figure 4: Regular skeleton of combinatorial fractals.

The application of fractal art in pattern design is to combine fractal theory with computer application and construct form by computer graphics algorithm, so that the fractal program can produce component figure. After combining with graphic processing software, we finally get colorful artistic images. The in-depth development of fractal research in computer graphics and its application in pattern design enable artists to create in more ways and bring new elements to pattern design. As a combination of mathematical technology and aesthetics, fractal art is a model of perfect combination of science and art, which is of great significance to textile design, especially in the application of textile printing and weaving pattern design. Fractal art works are very decorative. If according to the need of the environment, to choose the appropriate scenes fractal algorithm or software specialty, beautiful picture contains elements of fractal art of decoration, not only in terms of visual effects has the function of the icing on the cake, but with the passage of time fractal art more and let the audience appreciate the fractal art contained beyond the limits of beauty. The fractal distribution composition is shown in Figure 5.
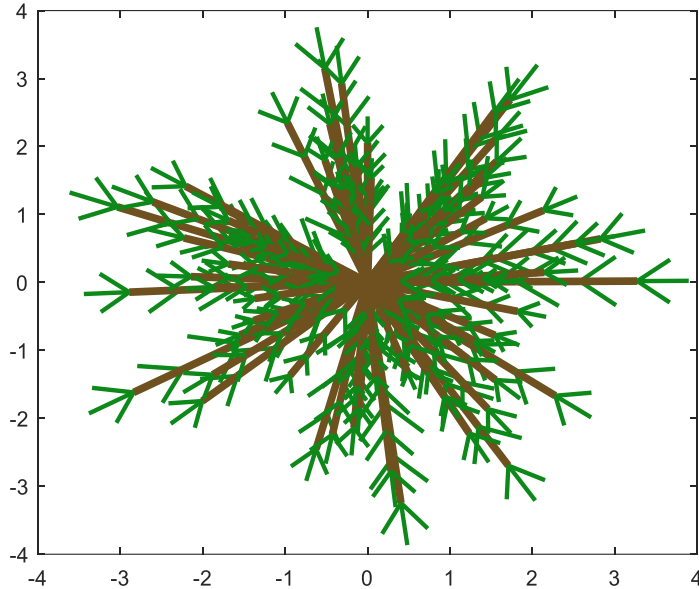
Figure 5: Fractal distribution composition.

Therefore, it is necessary to further improve the flexibility of textile design CAD system in China through the research and improvement of relevant algorithms, improve the fabric mold effect and three-dimensional display technology of CAD system, enhance the weave pattern processing and editing function of CAD system, form a CAD system with Chinese characteristics, with the world's advanced level, better meet the needs of Textile design CAD technology in China's textile industry. Such as textured CAD and inkjet printing, textile patterns generated by fractal can be easily reproduced by textured or inkjet printing. Because the fractal pattern is a digital figure, it can be directly processed in the weave software, and can be directly applied in inkjet printing. With the gradual popularization of electronic jacquard loom, computer embroidery and digital printing technology in the field of textile application, this kind of textile fractal pattern generated by computer program not only has a wide variety of patterns, but also can be directly transmitted to the relevant production machine through computer, rapid response and no distortion. This not only shortens the craft, but also realizes the digital design of textile art pattern. Fractal art works designed based on fractal theory have the characteristics of rich colors, changeable patterns, easy to copy and beneficial to network communication. Compared with traditional pattern design, fractal art works depict more prominent design details, no matter the infinite details of fractal graphics or the gorgeous colors of fine nature. It can be said that the description of the details of fractal has exceeded the thinking of the human brain. The overall fractal composition is shown in Figure 6.

Fractal art graphics contain certain logical meanings and have harmonious colors and beautiful formal rules, such as balance and symmetry, harmony and unity, specificity and change, etc. Although the traditional graphic aesthetic form has a long history and a wide range of application, it is difficult to achieve the innovation of modern design art only by classical principles and methods. The graphic design that can arouse the audience's visual interest and enlighten the audience's wisdom at the same time of communicating visual information undoubtedly needs to emphasize the aesthetic value and application research of fractal art graphics. Although most works of fractal art are abstract, this pure art form is pleasing to the eye. Fractal art make full use of the computer operation speed, suitable for repetitive working characteristics, the fractal mathematical formula numerous recursion and iteration on the computer, the most lifetime composition form of art creation process, greatly reduce the workload of designers, work efficiency

at the same time, the design is unique, the manual design. The art pattern automatically generated by computer using fractal theory is shown in Figure 7.
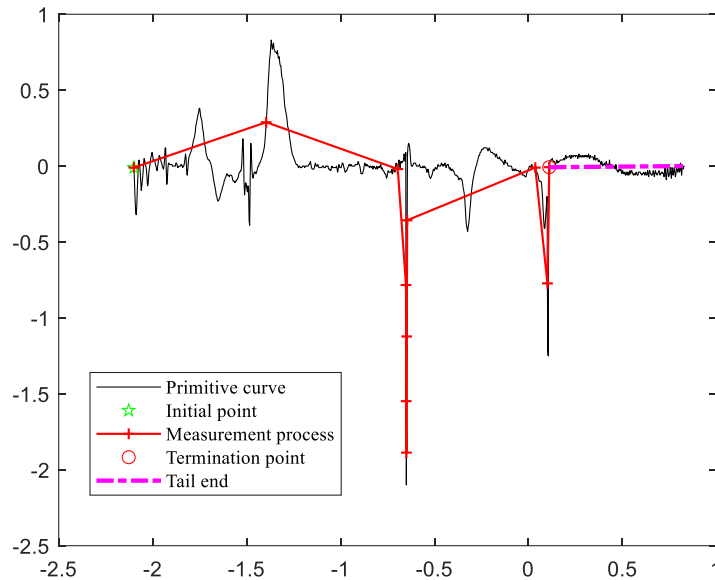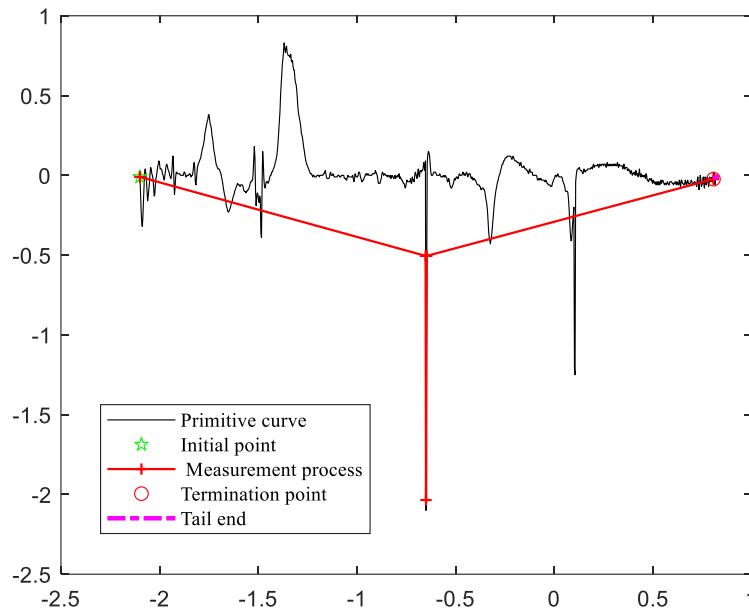

Figure 6: Overall fractal composition.

Figure 7: Art pattern automatically generated by computer using fractal theory.

5   CONCLUSION

Fractal art is widely applied, including natural philosophy, architectural art, computer graphics, musicology and other disciplines. The elements in fractal geometry language are not directly visible, they are visual graphics that can be obtained by numerical calculation according to certain algorithms and rules. Meanwhile, the iterative nature of fractal graphics determines that it is

infinite in depth and breadth. At present, there are more and more creators engaged in fractal design in China. If you log in the relevant websites, you will see a large number of fractal design, fractal movies and fractal music. Many special software related to computer fractal art design have been developed. In general design software, there are parameters adjustment, modification, setting and dynamic picture capture functions, which provide a broad space for the second creation of fractal art patterns. Because of this, the study of fractal art in graphic design will make its unique aesthetic value get strong development. The interactive computer aided technology is applied to the professional design field of fractal art, and the diversified and personalized fractal design works satisfied by users are generated. Using the powerful graphics display and human-computer interaction function of the computer, designers can achieve the pattern modeling and combination design according to various algorithm models, so as to generate a variety of forms of artistic patterns. Here, the algorithm plays a key role, it abstracts the image thinking to the relation of number, and transforms the number into the relation of color and form through the computer. The algorithm is the embodiment of the unity of number and form, and at the same time makes the image thinking into the reality that can be described. Further exploration of the logical representation of image thinking and the development of more modeling algorithm models will be the focus of computer aided art pattern design in the future.

The research and development of interactive system is a very complicated and difficult research topic, the development of perfect and practical software needs a lot of work and rich knowledge in interface design and image processing. Due to the problem of time, the depth of discussion on the theory and practice of various algorithms is limited in this paper. Therefore, there are still some deficiencies and defects in this paper, which need to be further improved, mainly in the following aspects:

1. Interface design. In this system, the property bar is mainly used for the input and output of the attributes of the basic primitives. In the process of using the property bar, there are still some problems. Further research is needed to improve the design of the property bar. Meanwhile, the multi-viewports in the document also become the content of the next step.

2. Multi-document design. In this paper, multi-document mainly refers to the system can open multiple documents at the same time and operate on them respectively. How to perform real-time operation between multiple documents needs further study in the future.

3. Graphics and graphic information. At present, graphics mainly include point, straight line, polysemy line, circle, arc, etc. How to provide more graphics for the system becomes the content of future research.

4. Interactive design of basic graphics. The core content of the system includes the interactive design of basic graphics such as positioning, selection, pick up, rotation and other operations, how to increase and improve more interactive operations become an important content in the future work.

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Hui Ji, https://orcid.org/0000-0003-3079-0931
Yang Shang, https://orcid.org/0000-0002-9723-9602

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