






## Spreading and Application of Digital Media Art to Traditional Handicrafts - Taking Tie Dyeing of Bai Nationality as an Example

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**Abstract.** In recent years, the development and inheritance of China's traditional handicrafts have been relatively slow. The research on traditional handicrafts in China mostly stays at the level of technology and national culture, which makes the essence of many traditional handicrafts not widely spread. With the rapid development and popularization of digital technology, a variety of artistic expressions have emerged, and the expression of interactive art has also been expanded. In the current social environment, it is extremely urgent to combine digital media art with Chinese traditional handicrafts to make Chinese traditional handicrafts widely spread. In view of this situation, this study takes Bai tie-dyeing as an example, and applies the generated new patterns to the interactive display application on tie-dyeing to open up the traditional handicraft communication channel. This study effectively uses computer-aided technology and in-depth learning to accelerate the spread and application of digital media art to traditional handicrafts. At the same time, it provides new methods and new ideas for the development of traditional handicraft products and the protection of intangible cultural heritage with generative confrontation network technology. This paper mainly expounds the dissemination and promotion of Bai tie-dye handicrafts by using digital media art.

**Keywords:** Digital Media Art; Traditional Handicrafts; Tie-Dyed; Computer-Aided System.

**DOI:** <https://doi.org/10.14733/cadaps.2023.S8.147-158>

### 1 INTRODUCTION

Due to the geographical constraints and the family-based way of transmission from generation to generation, its transmission is limited by various factors such as time and space [1]. At present,

the display of most traditional handicrafts in China basically stays at the level of recording their production process.

In the context of strengthening cultural confidence and promoting China's excellent traditional culture, it is an inevitable requirement of the development of the times to inherit and protect China's traditional handicrafts. In the field of design, cultural and creative products derived and developed by using traditional intangible cultural heritage patterns and traditional visual images, online interactive applications and small program applications emerge in an endless stream. How to make good use of the patterns and traditional images of intangible cultural heritage and explore appropriate expression methods and inheritance forms have been hot issues in this field. The deep learning model appearing in the computer field in recent years can quickly complete image processing and text processing [2]. It is worth exploring whether it can be applied to the image processing of traditional handicrafts and the pattern generation experiment of traditional handicrafts in China, and how to carry out the pattern protection of computer-aided intangible cultural heritage.

However, it is known that it is an inevitable requirement of the digital era to use computer technology to carry out the dissemination research of China's traditional handicrafts. In particular, China's traditional handicraft patterns have a wide range of distribution and rich types. The establishment of a modular and popularized iterative generation method of traditional handicraft patterns can be applied to more traditional intangible cultural heritage patterns, which is conducive to the formation of an innovative traditional handicraft protection system. This study takes the traditional Bai tie-dyeing handicrafts as an example, uses the in-depth learning model and computer-aided technology to carry out the research on the protection of Ruichang bamboo weaving, explore the generation method of intangible cultural heritage patterns, and then apply the generated new patterns to the dissemination practice of the traditional Bai tie-dyeing handicrafts, to help the dissemination of China's excellent traditional handicrafts [3].

With the in-depth research in the field of computer technology, computer image processing technology has become more and more closely connected with various industries, helping to promote the progress in these fields, especially in the protection of intangible cultural heritage images and the processing of intangible cultural heritage images. The use of computer technology to process complex intangible cultural heritage images and patterns is more rapid and accurate, with strong timeliness and high efficiency. For example, the use of artificial intelligence and computer-aided technology to carry out the restoration of cultural relics in China, the restoration of Dunhuang murals, and the completion of the virtual reality display of intangible cultural heritage images will help the spread of intangible cultural heritage in China [4]. With the development of computer technology, the connotation of intangible cultural heritage is constantly enriched and the content is constantly improved. How to use computer technology to carry out the processing and generation experiment of traditional intangible cultural heritage patterns, and how to carry out the display and design of traditional intangible cultural heritage patterns is worth exploring.

## **2 RELEVANT CONCEPTS AND THEORETICAL BASIS**

### **2.1 Overview of Bai Tie-Dyeing**

As one of the ancient weaving and dyeing handicrafts in China, Bai tie-dyeing is an intangible cultural heritage. After the long-term wisdom creation and accumulation of production skills of the Bai people, it has rich patterns and exquisite technology, and it contains the profound cultural accumulation and rich national feelings of the Bai people. The patterns of tie-dyeing are different in each period, but they all bear the psychological state and ideals of Bai women. After thousands of years of baptism, tie-dyeing has become a cultural masterpiece, which retains the spirit of the times and national characteristics of the Bai people for generations. However, with the industrialization of modern society, tie-dyeing, a traditional handicraft skill, is in danger. Only by adapting to the trend of the times and using modern technology to inherit and carry forward tie-

dyeing, can we open up a new way to spread it better. The production and dissemination of information, high-speed processing and application of information are developing rapidly, which is based on the increasingly mature digital media [5]. For digital media art, it can integrate modern media and tie-dyeing. With the power of modern media, it can promote the Bai nationality's national culture and tie-dyeing technology, so that people can understand the Bai nationality and also let tie-dyeing go to society and the world. Tie-dyeing, a perfect combination of traditional handicrafts can also better spread Bai tie-dyeing.

The application of digital media in tie-dyeing mainly includes the following levels:

The first is to establish a digital resource database system for tie-dyeing. Then establish a digital database of tie-dyeing patterns, and use the management system to add, delete, query and other aspects of the existing material resources. This method is mainly based on image display and belongs to basic static application.

The second is to use two-dimensional and three-dimensional auxiliary software to visualize and digitize the overall modeling of tie-dyeing, generate three-dimensional and vivid modeling, and then display the production process of various modeling works. For example, the commonly used methods of tie-dyeing include needle binding, binding, etc. It is necessary to use animation software to make various methods and processes into animation for display. Such display effect is more attractive than static picture display, but this only changes static display into dynamic display, and the audience's participation is still not high.

The third is to establish a digital platform digital museum in the form of human-computer interaction. The main idea is to combine the first two applications and add human-computer interaction. Taking the completion of a tie-dyeing work as an example, the user enters the system as a tie-dyer, selects his favorite pattern modeling and tie-dyeing method in the material library, and guides the user to complete the tie-dyeing work in the form of animation simulation according to the characteristics of the pattern and method. This improves the user's experience. Experience is an important way to share cultural values and spread. Each nation has its own cultural attributes. Through digital museums, every process of traditional handicrafts can be more truly reflected, so as to get better dissemination. The application of digital platform can enable anyone to independently complete the whole tie-dyeing process based on different artistic standards, facilitate the transmission and mutual transformation of content and form, and achieve a breakthrough in the sense of communication. The application of this method can make the audience choose according to their own preferences and become the creator, disseminator and receiver of tie-dyeing.

## 2.2 Overview of Digital Media Art

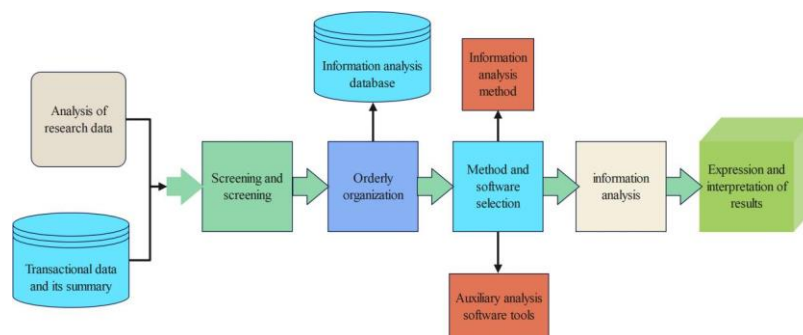
By means of digital audio and digital video, the virtual world constructed by digital media art can be visualized, and people can more intuitively and concretely understand the designer's design inspiration and the deep culture of the product. For example, the highly acclaimed Marvel film is one of the typical representatives. It uses Internet information technology to build a virtual world and a virtual human with digital characteristics, and vividly deduces the plot of the whole story and the author's design inspiration, which is highly praised by the audience.

Hutchinson [6] makes the learning environment of students full of information, thus promoting the openness and inclusiveness of digital media art, and achieving an innovation in teaching methods. It has promoted the deep integration of computer technology and digital media art teaching. At present, there is a growing demand for talents of digital media art specialty. So as to achieve a balanced and coordinated development of teachers, students, knowledge and technology. Liu and Liu [7] makes abstract art knowledge more concrete through practical teaching. Effectively improve the understanding ability of digital media art knowledge, so as to create better works. The emergence and application of computer technology has effectively improved the quality of art works. It mainly focuses on the teaching of basic theoretical knowledge and methods, complementing the lack of practical courses in traditional teaching. Mainjot et al. [8]

believes that it is necessary to integrate computer technology with digital media art. Through modern methods, students can improve their deep understanding of digital media art knowledge. At the same time, the digital media art and the traditional culture of the Chinese nation are organically combined, and the professional knowledge of digital media art can be learned through computer technology. Connect these broad knowledge contents with artistic knowledge. The emergence of computer technology in the modern state has promoted the development of all walks of life. By deeply integrating computer technology with other knowledge learned, students can continuously improve their understanding and understanding of art knowledge. Wang [9] effectively integrate computer technology into the teaching of digital media art, create an information-based and technological teaching environment, and use computer technology to set a reasonable course system. Show the art works to students in the form of video pictures, so as to help students better understand the content of art works and improve the effect of classroom art teaching. It is helpful for students to learn professional digital media art knowledge, so as to achieve teaching objectives. Wang [10] enables students to have a deeper understanding of digital media art knowledge through cooperation and sharing. This method allows students to experience a sense of collective responsibility in the team and effectively enhance students' sense of responsibility.

### 2.3 Computer aided system

After inputting parameters, computer-aided adjustment and transformation of various shapes. Computer aided technology has the advantages of efficiency, imitation and foresight, as shown in Figure 1.



**Figure 1:** Computer Aided Analysis Process.

They accurately combine pictures and sounds, effectively solve the problem of the singularity of traditional media art before, and enrich the presentation forms of their works, such as common digital audio, digital video, etc. are all popular digital media art works. In the current creation process of digital media art works, image processing technology, multimedia software technology, etc. are often used to enhance the intuitive and vivid nature of art works.

## 3 RELATED TECHNOLOGIES

### 3.1 Cloud Formula

The cloud effect is a common function of many drawing software. The above functions can be used to obtain clear and dark, natural transition and cloud-shaped graphics without manual operation. In tie-dyeing, there will be different shades of color halo due to the color applied to the fabric. The above results can be simulated with the help of cloud formula (1). That is, with the help of fractal

iterative algorithm, the range of variable  $i$  is  $0 \sim E-1$  according to the provided cloud contour polygon  $M(x_i, y_i, z_i)$ . The corresponding  $E$  polygons are obtained from the  $E$ -degree linear transformation. Define the points before and after the single linear transformation as  $P(x, y, z)$ ,  $P'(x', y', z')$ , and then get the corresponding equations of cloud simulation:

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} + \begin{bmatrix} d_1 \\ d_2 \\ d_3 \end{bmatrix} \quad (1)$$

The logarithmic vertex values of polygonal clouds can be transformed by various transformations (such as scale, translation, rotation, etc.) to obtain the equations in the same form, and the coefficients  $C(a_j, b_j, c_j, d_j)$  ( $j=1, 2, 3$ ) contained in the equations can be obtained by simultaneous solution. The fractal algorithm shows the  $E$  polygon models and the corresponding  $E$  group of linear transformation coefficients  $C_i$ , with the range of variable  $i$  from 0 to  $E-1$ . The linear transformation is selected as the compressed scale form to maintain the convergence of the iterative set. A single set of linear transformation is defined as probability  $P_i$ , which is a cloud geometric model with a total number of  $E$ . It shows that the probability in the fractal dimension image is consistent with the constraint of the following formula (2), and the range of variable  $i$  is  $0 \sim E-1$ .

$$\sum_{i=0}^{E-1} P_i = 1 \quad (2)$$

The probability  $P_i$  value can be set manually or with the help of a random function. The IFS code is composed of the above  $E$  groups of linear transformations  $W_i$  and probability  $P_i$ , where the range of variable  $i$  is  $0 \sim E-1$ .

### 3.2 Common Fractal Geometry Technology

Julia set is a complex fractal in expression. Its shape represents the characteristics of Julia set. The overall shape is point symmetry about the origin, and it also has two main centers. Julia's collection has a complex structure, scientific connotation and artistic aesthetics. Its morphological changes and scientific theories have attracted more and more attention and in-depth research. The typical way to generate Julia sets is to consider an iterative process on the complex plane:

$$z_{n+1} = z_n^2 + \mu \quad (3)$$

Among them,

$$z = x + yi \quad (4)$$

$\mu$  is a variable;

$$\mu = p + qi \quad (5)$$

$Q, P$  is constant. When  $\mu$  When the value is fixed, the complex number  $0z$  is given as the initial value for iterative operation. For each different  $\mu$  Value,  $f$  can generate different and wonderful fractal graphics.

Mandelbrot set is currently the most commonly used fractal, and is the most popular and widely studied fractal theory in contemporary mathematics. Mandelbrot set is obtained by iterative process on the complex plane. The iterative rules are as follows:

$$z_{n+1} = z_n^2 + v \quad (6)$$

$$v = p + iq \quad (7)$$

P and q are variables. When the value of z is fixed, the given complex number 0v is used as the initial value for iterative operation. The characteristic of Mandelbrot set graphics is that its interior is solid without any structure, but its boundary is very complex, with infinite different shapes.

In the 17th century, Newton created a method to solve the root of the equation  $f(x)=0$  by simple calculation. It transformed the problem of solving the equation into a dynamic process. The solution process is related to the initial value selection. Newton set is obtained by successive approximation of Newton algorithm. Newton algorithm is also an iterative method. Its iterative formula is formula (8):

$$x_{n+1} = x_n - \frac{F(x_n)}{F'(x_n)} \quad (8)$$

Determine an initial value point 0x and iterate repeatedly with the iterative formula.

### 3.3 Fractal Simulation Batik Pattern

It is the division of the space position. Applying the properties and theoretical system of Voronoi diagram's nearest neighbor, in-depth research has been carried out in the fields of machinery, image simulation, meteorology, urban planning and molecular biology.

The definition of Voronoi diagram is to select a group of point sets  $P=\{p_1, p_2, \dots, p_n\}$  on the plane, where any 2 points are not in the same place, that is,  $p_i \neq p_j$  ( $i \neq j$ ,  $1 \leq i \leq n$ ,  $1 \leq j \leq n$ ), and any 4 points are not in the same circle. Each point in P is called a base point.

For any 2 nodes in the region), ( $y_{xii}$  P and), ( $y_{xjjj}$  P, they are calculated by Euclidean distance, namely:

$$d(i, j) = \sqrt{(i_x - j_x)^2 + (i_y - j_y)^2} \quad (9)$$

Each node is connected to its nearest neighbor, dividing the entire region into independent small regions. Voronoi diagram has a relatively uniform grid structure, and the generated grid structure has a good consistency, which is very consistent with the ice texture in the manual batik pattern. Mould uses the weighted Voronoi diagram to simulate the crack effect based on a specific pattern, which not only simulates the realistic crack, but also integrates the pattern with the crack. Voronoi Coloring in Ultra Fractal is based on Voronoi diagram method to generate network structure patterns, and then combine it with other algorithms to change parameter values to obtain realistic batik patterns.

The fractal flame algorithm is an outstanding and innovative algorithm composed of three IFS: nonlinear function, logarithmic density display, and structure coloring. Each function of fractal flame has the following form:

$$f_i(x, y) = \sum_{V_k \in \text{Variations}} \omega_k V_k (\alpha_i x + b_i y + c_i, d_i x + e_i y + f_i) \quad (10)$$

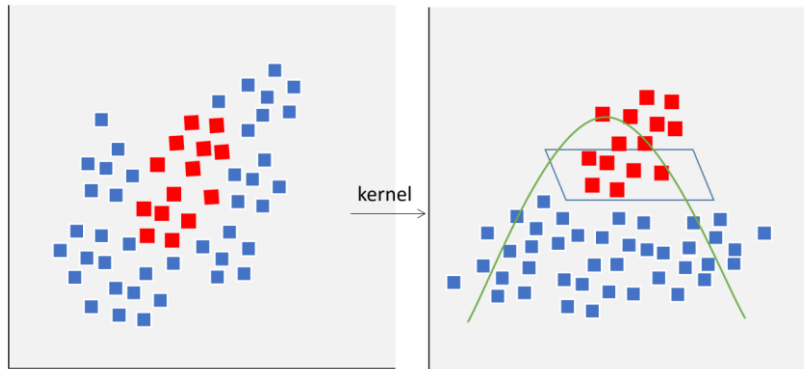
Among them,  $\omega$  K is the weight;  $V_k$  function is a set of predefined nonlinear transformation functions, which can be more than 20. Compared with ordinary IFS, fractal flame can produce varied and fascinating graphics, but at the same time, its computational complexity is very high. Apophysis is an open-source free software originally developed by Mark Townsend. Apophysis uses IFS fractal model system based on fractal flame algorithm, and the fractal image generated has very strong light and shadow effect.

The most basic Linear parameter, the applied mathematical formula is as follows (11):

$$V_0(x, y) = (x, y) \quad (11)$$

Formula (11) shows that the pattern generation is linear and gradually increasing.

### 3.4 Application of Gaussian Integer function



**Figure 2:** Introduction to Gaussian integer function.

As shown in Figure 2, Gaussian function is normal distribution, and the normal distribution equation in N-dimensional space is:

$$G(r) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-r^2 / (2\sigma^2)} \quad (12)$$

Gauss integer is the complex number of both real and imaginary numbers. All Gaussian integers form a whole field, written as  $Z[i]$ . It is an Euclidean domain that cannot be converted into an ordered ring.

$$\{a+bi \mid a, b \in Z\} \quad (13)$$

Gaussian integers are elements of a set. The norms of Gaussian integers are all non-negative integers, defined as  $N(z \times w) = N(z) \times N(w)$ . The norm of the unit of  $Z[i]$  (1, -1, i and -i) is 1. Gaussian integers form a unique decomposition ring, with invertible elements of 1, -1, i, and -i. In mathematics, a unique factorization domain is an integral ring that makes every element in it uniquely represent the product of prime elements, that is, an integral ring that satisfies the basic theorem of arithmetic. The prime element of  $Z[i]$  is also called Gaussian prime number. The selection probability formula is as follows:

$$P_i = \frac{f_i}{\sum_{i=1}^N f_i} \quad (14)$$

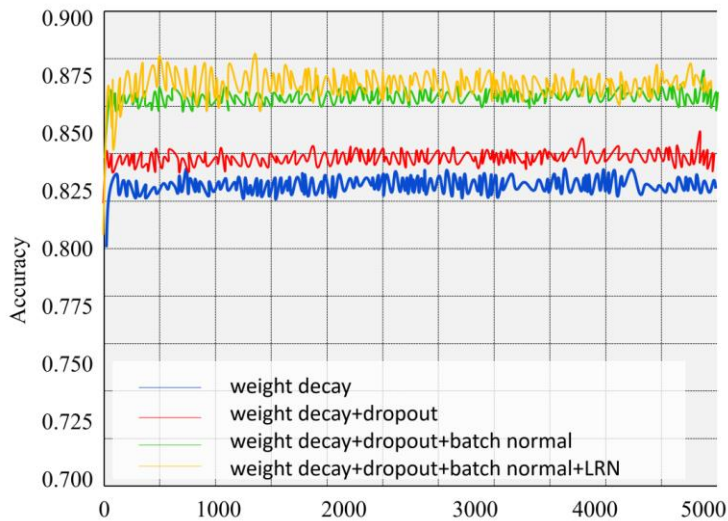
In the above formula,  $P_i$  is the selection probability;  $I$  is the chromosome number. It can be seen from the Gaussian integer theory that this function can be used to generate circular closed patterns, which can be used to simulate discharge patterns. The application of Gaussian function to external shading in Ultra Fractal can generate some dense patterns with different sizes, which can also be used to simulate discharge patterns.

$$X = (a_1, \dots, a_{j-1}, b_j, \dots, b_k, a_{k+1}, \dots, a_n) \quad (15)$$

## 4 EXPERIMENTAL RESULTS AND ANALYSIS

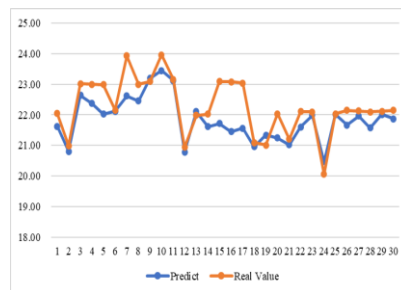
### 4.1 Ultra-Fractal Simulation

After the IFS code is formed, the E-order linear transformation of group E with parameter  $C_i$  is completed one by one. Therefore, the initial iteration will lead to the transformation of group E geometric model into E2 form, and the set iteration upper limit has been completed according to the above transformation form. The control button in the Ultra Fractal defines many procedures for forming cloud graphics. Figure 3 shows the S.F.B.M.II that can use fractal to build clouds, where Formula is pixel and outside is S.F.B.M.II.



**Figure 3:** Comparison of accuracy of cloud generated by S.F.B.M.II.

Figure 4 shows that the mapping is kaleidoscope, the formula is pixel, and the outside is S.F.B.M.II simulation tie-dyeing graphics. The reason for the difference is that the difference settings are made in the gradient editor, which makes it possible to gradually correct the parameter values to achieve a more perfect condition.



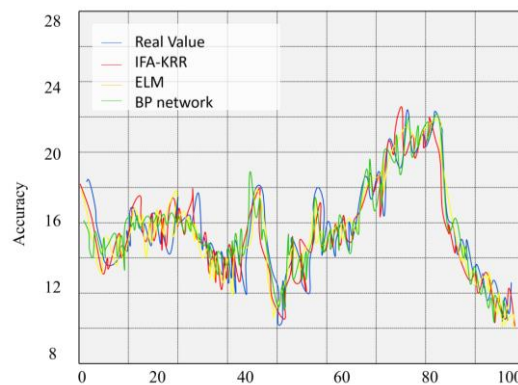
**Figure 4:** Comparison of simulation tie dyeing results of Ultra Fractal.



For the hand-drawn tie-dye patterns in real life, the software with fractal theory can also be used to simulate the skeleton of tie-dye patterns. Combined with some graphic design software to assist the subsequent processing of patterns, the patterns made are similar to the actual tie-dye patterns in style and have gorgeous effects. Ultra-Fractal has many function formulas and rich transformations. Its control page can also perform layer composition like Photoshop and edit each layer separately. This feature makes it more convenient for designers to apply, and the page is more flexible, which can put the images that designers think of into practice.

#### 4.2 Fractal Simulation of Rainbow Thread

For the simulation of the current popular rainbow thread, multiple layers with different parameters and different color values are used for composite, and the composite mode is Overlay. By comparing with the actual hand-dyed patterns, it can be seen from Figure 5 that the simulation pattern simulates the thread skeleton and color style of the rainbow thread produced by hand-dyed, and the theme feeling is endowed with tie-dyed style.



**Figure 5:** Parameter values under different models.

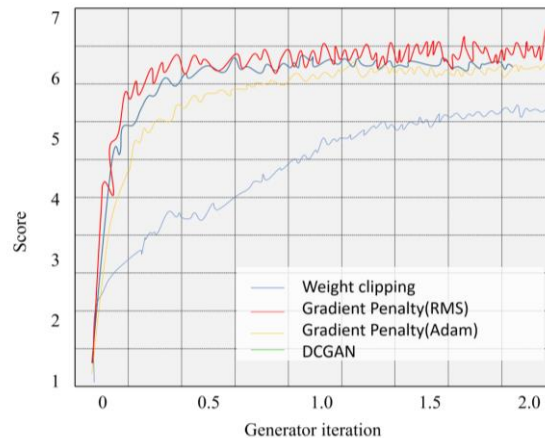
As can be seen from Figure 5, by changing the values of  $a$ ,  $b$ ,  $m$ ,  $n_1$ ,  $n_2$ , and  $n_3$ , the pattern can be changed, and then combined with the change of the control point values of the gradient editor to form patterns with different colors and styles. In the later stage, Photoshop and other graphic design software will be used for more detailed processing to make the pattern style closer to the hand-dyed pattern. Fractal software can simulate tie-dye patterns with halo effect. Extract the color values of hand-dyed patterns or some popular colors and apply them to the patterns generated based on fractal theory. The resulting patterns have variable color styles and have the color halo effect of tie-dyed patterns. Later, the tie-dyed patterns are formed through the adjustment of Photoshop and other image processing software. The computer simulation of tie-dyeing with this method is easy to operate, intuitive to reflect and changeable in pattern. The preview of the material library obtained from the tie-dyeing pattern generated by fractal theory.

#### 4.3 Computer Aided System Simulation Results

After using DCGAN model to generate the results, we analyzed the tie-dye samples. In order to further improve the image quality of the generated pattern, the generative countermeasure network model is improved in the experiment, and the WGAN-GP model is used for the improvement experiment. The experimental environment configuration is as follows: experimental hardware: the computer uses the Ubtunu system; CPU: i7; Video card: Nidia; Operating

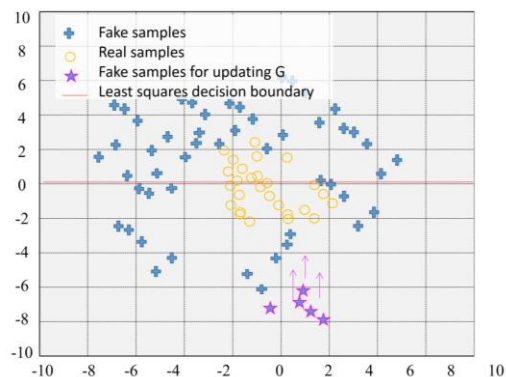
memory: 16G. Python chooses to prepare data sets for February 2019 (Professional Edition): put the pictures used for training.

The computer generated 825 tie-dyeing pattern images. Compared with DCGAN model, the image quality of tie-dyeing pattern output by WGAN-GP model is higher. The image of the new tie-dyeing pattern generated by the improved in-depth learning model appears circular pattern and arc pattern. The representative new tie-dyeing pattern image is shown in Figure 6.



**Figure 6:** Representative tie-dyeing patterns generated by WGAN-GP model (generated by experiment).

When the WGAN-GP model is used to train the computer, the model is relatively stable and not easy to collapse. In order to improve the quality of the generated pattern image and make it easy to apply in the subsequent tie-dye pattern display design, this improvement experiment will generate the traditional tie-dye pattern collected in the field survey together with the tie-dye pattern sample image. Prepare 10 tie-dyeing patterns and 300 samples after the first round of experimental treatment, a total of 310 experimental samples. Using the Python deep learning framework, the GPU is still trained for 500 rounds (as shown in Figure 7), and the iterative experiment is repeated.



**Figure 7:** Training process results.

After improving the depth learning model for many times, 1950 tie-dyeing pattern images were generated by computer in this experiment. Innovative and integrated tie-dyeing patterns have emerged. Compared with the previous generation experiment of iterative algebraic wheel, the new tie-dye pattern image generated in this experiment has higher quality, but the color is relatively single.

## 5 CONCLUSION

The human-computer interactive digital platform will better display the production methods and patterns of traditional handicrafts, and the methods such as picture display, video interpretation, animation demonstration, platform interaction, etc. can make the audience better understand the whole production process of tie-dye, provide them with different visual experience, and further spread tie-dye. Although digital media art has been used to better promote tie dyeing, tie dyeing also needs to follow the most traditional production methods, such as hand tie flower and dip dyeing, because this is the handicraft inherited by the Bai nationality for thousands of years and the essence of tie dyeing. On the basis of adhering to traditional handicrafts, develop a variety of tie-dyeing products to meet the market demand. At the same time, the state should formulate corresponding laws and regulations to protect traditional handicrafts, and popularize these systems to all sectors of society, so that digital media art can more effectively protect and disseminate traditional handicrafts.

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