

Traditional Chinese painting simulation algorithm based on particle system

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Abstract: Based on the analysis of the relationship between painting materials and their interaction, a simulation model system based on particle system is proposed to realize the typical artistic effect of Chinese painting. It can recognize and pick-up edges from input strokes and use them to initialize the particle movement. Furthermore, it uses “layer mixing arithmetic” to realize multi-stroke superposition¹. Experimental results show that the algorithm is successfully simulated the typical effects of traditional Chinese painting.

1. Introduction

The simulation study of Chinese painting is a new subject in the field of computer art. Due to the differences of Chinese and Western art, and the special nature of Chinese painting, computer simulation of the effect of Chinese painting art has a great difficulty. Compared with the western painting art, the most basic art of Chinese painting is dynamic and non - covered.

In this paper, we use the basic idea of particle system to achieve these two typical results. Through a lot of particles of the "pseudo Brown movement", that is, the macro rule movement, the microscopic random movement, the real interpretation of the dynamic movement of Chinese painting process. Through the mixed operation of the layers, it can realize the multi - stack effect caused by the non - covering.

2. Traditional Chinese painting and its features

Traditional Chinese painting has a long history. It roots in the fertile soil of Chinese culture, across time and space, through different stages and integrate national cultural literacy, thinking mode, aesthetic consciousness and concept of philosophy complete art system, it is an exotic flower in the art world and it is also the treasure of our Chinese nation country and pride.

Traditional Chinese painting has formed a unique artistic language and aesthetic features in the long history development. Contemporary Chinese painting is more innovative, diverse forms. But the main features of China painting remain unchanged. The author summarizes the main artistic features of Chinese painting as the following five aspects, including the first and the second aspects are particularly typical and important^[1].

If the western painting is a body, the surface and the color of the symphony, then Chinese painting is point, line and ink Concerto, technique of expression of Chinese painting is to the main line in the pen and ink. The painter through the brush and ink skill to performance art image, convey the thought and feeling, as shown in figure 1. Pen and ink is an important symbol of people's evaluation of the pros and cons of Chinese painting.

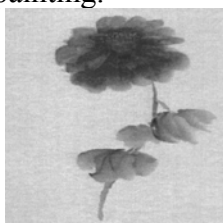


Figure 1 Peony

3. Simulation algorithm based on particle system

The simulation study of western art category began relatively early, some art category of simulation, such as oil painting, watercolor painting, there been more than a dozen or even dozens of years of development. Ink and wash painting are used for the swap, with diffusion and penetration, so the simulation of water color painting is worth learning and reference.

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The existing traditional Chinese painting simulation model is based on the shallow water simulation model, which is to simulate a certain amount of water and pigment through the paper surface. The paper is modeled as a two-dimensional matrix, water particles due to gravity, the flow of water in the adjacent unit flow. The core part of the simulation system is based on the three layer fluid simulation model of the cell automaton theory: the shallow layer, the pigment deposition layer, the capillary action layer^[2], as shown in Figure 2.

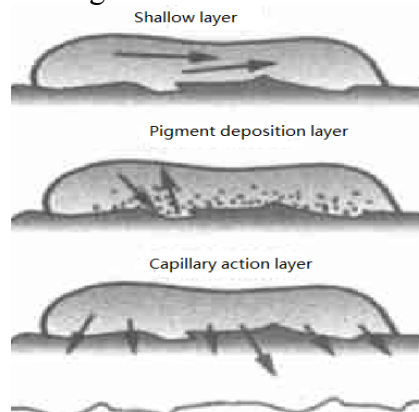


Figure 2 The three layer fluid simulation model

Since the ink is spread on the basis of the original handwriting, the overall direction of the flow of the ink can be determined, which is the normal vector direction of the edge of the handwriting. In the diffusion process, the direction of the ink flow is very strong randomness, which is characterized by a large number of particles^[3]. This phenomenon is called "pseudo Brown". The basic flow of the motion is shown in Figure 3.

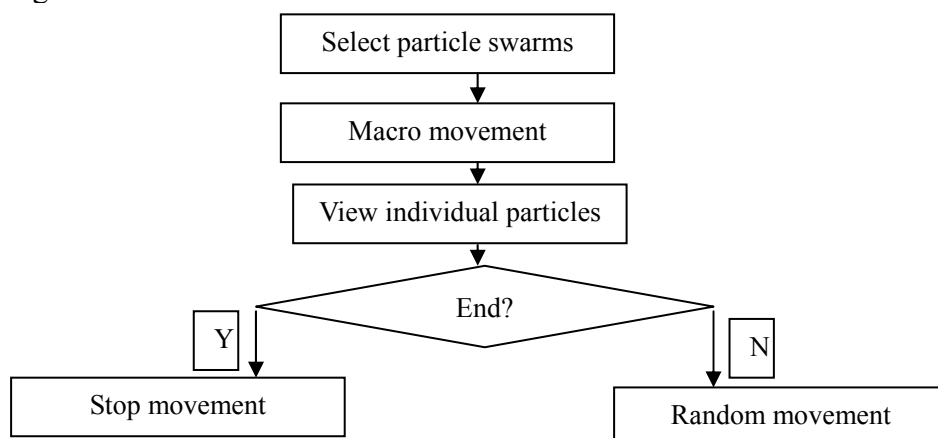


Figure 3 The basic flow of the "pseudo Brown"

The macro rules of particle system need to boundary extraction, and then calculate the boundary normal vectors, so as to determine the basic direction of movement. To calculate the graphic boundary, first of all the pixels in the image of edge detection, the commonly used method is Sobel

edge detection, image binarization and edge extraction. According to Literature [4] to extract edge information and complete the particle initialization. The process is shown in Figure 4.

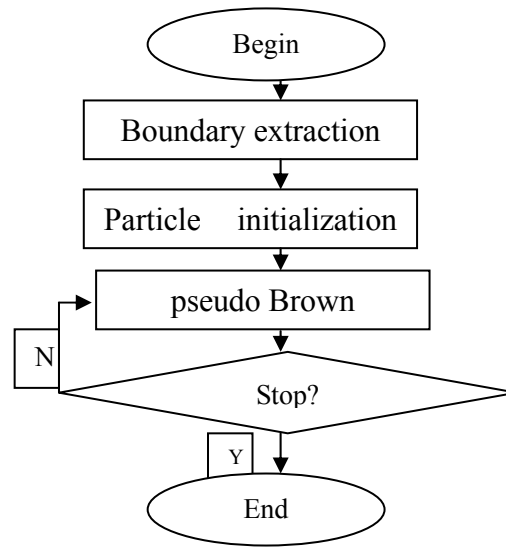


Figure 4 The basic flow of the simulation system

In order to express the randomness of the particle system, some very simple stochastic processes can be used to control the shape, characteristics and motion of particles in the system. The parameter of each particle is determined by its variation range, determine their value in the range, its variation range is determined by the average expected value and the maximum variance. The basic expression of Literature [5] is:

$$Parameter = Meanparameter + Rand() \times Varparameter$$

The properties of particles can be expressed by the following structures, including coordinates, color, speed, direction of movement, life value and life decay value.

```

Struct PARTICLE {
Float x;
Float y;
Byte Color;
Float Angle;
Float Speed;
Float Life;
Float Decay;
}
  
```

The diffusion speed of water on paper determines the diffusion of water. In the simulation model, it is indicated by the vitality of ink particles, the maximum value of water absorption is $A = Life$. Specific results are shown in Figure 5.

Shading effect is determined by harmonic proportion of ink. It reflect the ratio of the particle initial color and true pixel color in the simulation model, this value generally is fixed in the model, it is determined directly^[6]. The true pixel color of humidity $H = Color$ is -1, the specific effect is shown in Figure 6.

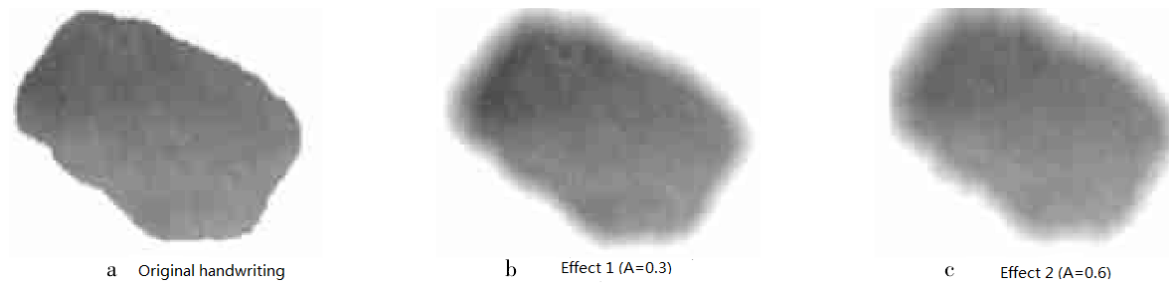


Figure 5 The original handwriting simulation of different water absorption

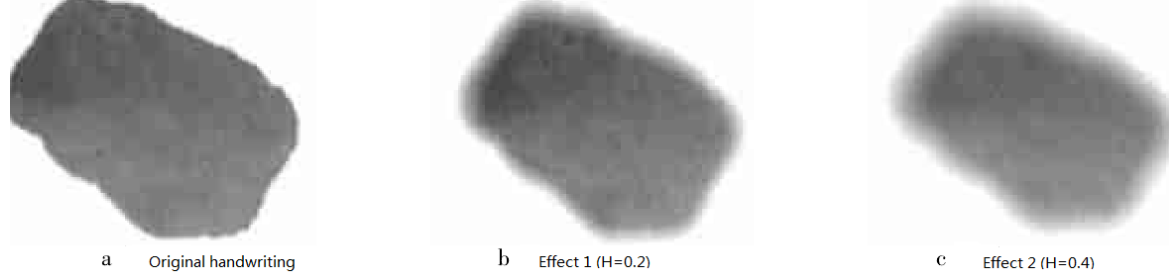


Figure 6 The original handwriting simulation of different humidity

The influence of paper texture determines the effect of water and ink. According to the shape and color of the paper texture, a matrix of paper texture is firstly established, and then the number and color of each pixel is given according to the matrix^[7]. Figure7 shows a simulation effect when the paper texture is 1.

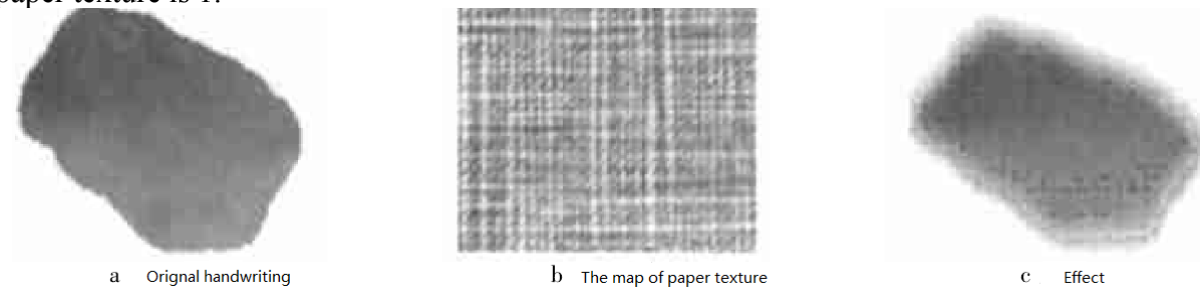


Figure 7 The original handwriting simulation of paper texture

The parameters of particle number, age, ink concentration, original handwriting contour are determined by the corresponding single pen handwriting, and stroke order and transparency is specified by the user, two parameters identified the relationship between the pens. The coverage degree of the next pen coverage the front pen can control through transparency, the coverage range can obtain through the handwriting and contour of the different layers of the object^[8], it is shown in Figure 8.

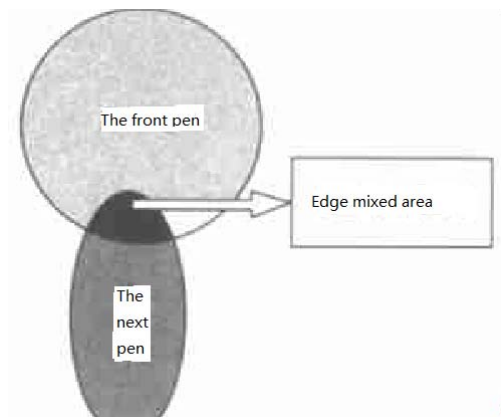


Figure 8 The hybrid area of multiple pens

The algorithm is represented by a pseudo code:

Layer A, Layer B is the input layer object, Layer C is the result layer object.

For (all Pixel)

```

If (A1edge=true)
If (B1edge=true)
    C=mix Layer (A, Transparent (B));
    Edge Scale ();
else
    Cal Single ();
End if
End for

```

According to the algorithm, we can make a little attempt to the comparison of the effect of a simple stack. Figure 9 shows the simulation results of water absorption and moisture are 0.2, the transparency is 0, 20% and 40%.

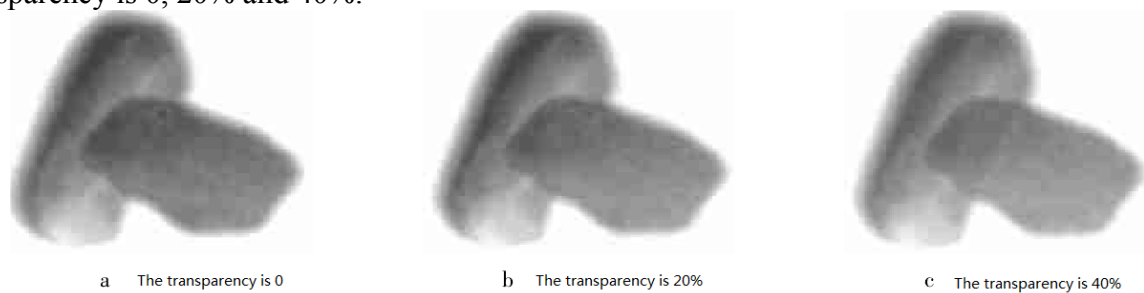


Figure 9 The Simulation results of multiple pen and superposition

4. Conclusions

A traditional Chinese painting simulation algorithm based on particle system is proposed in this paper. “Pseudo Brown movement” as the driving force of particle movement to achieve the typical effect of Chinese painting. According to a large number of experiments, some controllable parameters are summarized, which can be used to generate the simulation results from the external control. Figure 10 is a complete works using this algorithm in this paper.



Figure 10 A complete works----- the pond

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