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Procedural Modelling of Auspicious Cloud

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Abstract. Auspicious cloud is one of the most Chinese-style auspicious patterns with a long history in China. However, most of previous research works focus on realistic cloud animation, little effort has been paid to model auspicious cloud in traditional Chinese style. In this paper a procedural modelling method is presented. First, we construct the cloud skeleton curve by use of eclipses, we then arrange a series of primitive circles with different radiuses along with points in the curve and obtain cloud silhouette by union of these circles; We take a dynamic silhouette point as start position and draw a spiral curve along the centre of cloud. Experimental results show that the proposed method is able to generate a wide variety of auspicious clouds in traditional Chinese style.

Keywords: procedural modelling method; cloud skeleton curve; Chinese-style auspicious patterns; eclipses; cloud silhouette.

1. Introduction

In the 1960s, Chinese artists make use of traditional Chinese art forms, such as ink painting, paper-cutting, and shadow-shadowing, they create a number of cartoon animations with distinctive Chinese characteristics, which caused great repercussions in the world. The study of computer-generated animations with Chinese national characteristics is of great significance to the promotion of traditional Chinese art and the improvement of Chinese cartoon competitiveness. Auspicious cloud is an artistic expression of real cloud and smoke. The history of auspicious cloud has a long history. It is one of the most auspicious patterns with Chinese characteristics. It has high aesthetic value, cultural value and application value. As the most common natural phenomenon in nature, clouds and smoke have been painted in a number of classic cartoons such as “The Monkey King” in the form of auspicious clouds on clouds and smoke. Due to the combination of cloud and smoke, there are many morphological changes in different applications. The traditional creative process is mainly drawn by hand drawing, and the production efficiency is low. If you can automatically generate a cloud animation by using a computer, you can shorten the production cycle of related animations and reduce the production cost of animation.

The use of computers to assist in the generation of research with ethnic patterns has received increasing attention from researchers in the world. Research methods mainly generate pattern features such as Persian style floral decorative patterns [1], Islamic style star patterns [2], etc. Matching and process grammar reasoning and other Chinese ethnic patterns, such as paper-cut [3-6], Peking Opera mask [7], bronze surface decoration [8], Chinese animal face pattern [9], Yunnan embroidery [10].

There has been a long history of modeling and mapping clouds and smoke, and most of the research work has focused on the study of realistic clouds [11-15]. These research work mainly solves the motion change process of cloud smoke by solving the fluid dynamics equation. The scattering and reflection process of the light passing through the cloud smoke can generate the photo-real effect. However, the artist simplifies and exaggerates the shape and movement of the cloud in cartoons, so these physics-based control and rendering processes cannot generate auspicious animations with traditional Chinese style.

2. Structure Analysis of Auspicious Cloud Shape

Through the screenshot analysis of the auspicious cloud animation drawn by hand in Figure 1, the whole auspicious cloud is mainly composed of the contour lines, the inner winding lines of the cloud tail and the internal color filling of the cloud. Watching the left part of Figure 1, it can be seen that a group of auspicious clouds are composed of several independent clouds (the gray lines on the right

side of Figure 2, the black lines indicate the inner winding lines of the cloud tail), and the cloud cover in front. Behind the clouds. In the animation, the shape of the clouds and arcs will change.

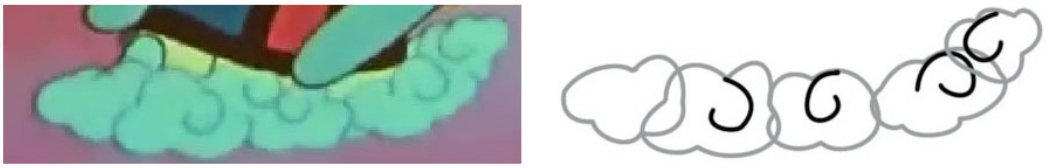


Figure 1. auspicious cloud composition

This paper proposes a Chinese traditional style auspicious cloud animation model, which can not only represent the shape characteristics of auspicious clouds, but also realize the continuous change of auspicious cloud shape through procedural control, and finally get the auspicious cloud pattern which is very close to hand drawing. In the model, we decompose auspicious clouds into three levels of "Auspicious clouds ->Cloud->Arc". Auspicious clouds are composed of clouds in a certain distribution, and each cloud is composed of several arcs. The model first uses the ellipse to represent the skeleton structure of the cloud, and arranges a plurality of basic circles with different radii along the non-uniform distribution points on the skeleton. By summing these basic circles, the contour and inner region of the cloud are generated. The basic circle moves along the circumference centered on each distribution point to generate continuously varying contour lines and cloud shapes, and uses the motion points on the contour line as a starting point to draw the cloud tail inner winding line along the center point direction. Finally, the obtained closed area is triangulated, and the inner area and the line of the cloud are drawn from far to near according to the depth value of each cloud. The various parts of the model are described in detail below.

3. Cloud Shape Modelling

According to the analysis in Section 2, the auspicious cloud boundary is composed of many arcs of different lengths and radii. We use a number of circles of different radii to be stacked along the skeleton curve. The following is an introduction to the modeling process of the contours of auspicious clouds and the winding lines of the cloud tail.

3.1 Auspicious Cloud Contour Modeling

Figure 2 is a schematic diagram showing the shape modeling of auspicious clouds. On the two-dimensional *XOY* plane, an ellipse *E* is established with the origin *O* as the center and *a*, *b* as the long and short axes. In the *E*, non-uniformly take n points O_i ($1 \le i \le N$), and then take the O_i center and R_i as the radius as the center trajectory circle $\odot O_i$ (shown by the blue line in Fig. 2), respectively take the trajectory circle $\odot O_i$ The upper point O_i' is the center of the circle, and the R_i' is the radius $\odot O_i'$ (shown by the red line in Fig. 3). For *E* and all $\odot O_i'$, get a cloud (shown by the semi-transparent thick line in the figure). Triangulate the Cloud area and then color-fill the interior and draw the border lines separately. You will get a cloud (as shown on the right in Figure 2).

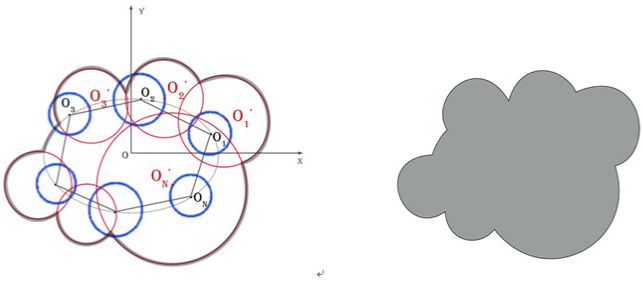
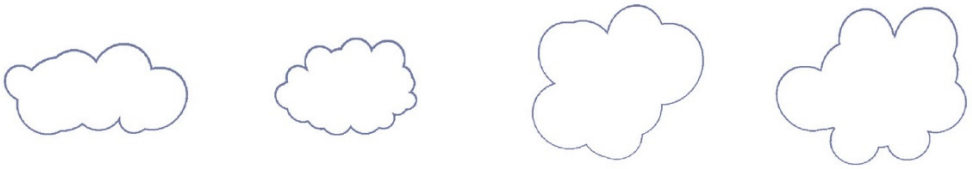


Figure 2. Auspicious cloud contour generation process

In order to simplify the parameter control, we take $R_k = f \cdot |O_k O_{k+1}|, R_k^{'} = f^{'} \cdot |O_k O_{k+1}| (1 \le k \le N, O_{n+1} = O_1)$, $f, f^{'}$ is the coefficient of indentation. After the experiment, we take $0 < f \le 1.0, 0.5 \le f^{'} \le 1.0$. In practical applications, various shapes can be obtained by setting different values of *a, b, N, f, f'* (shown in Figure 3).



(a) (b) (c) (d)

(a)a=2b, N=8, f=0.5, f'=0.75 (b)a=2b,N=16,f=0.5,f'=0.5 (c)a=b, N=8,f=0.5,f'=1.0

(d)a=b, N=16, f=1.0, f'=1.5

Figure 3. Various auspicious cloud shapes generated by different parameters

3.2 Cloud Inner Tail Modeling

The inner winding line of the cloud is one of the important signs of auspicious clouds. The line looks like a spiral, but in the hand-painted cloud it does not strictly follow the standard spiral equation. If it is modeled by the standard spiral equation, it will give people Mechanical sense, while it is difficult to control its overall shape. We use a simple and easy to control method, which is connected by multiple semicircles, as shown in Figure 4. Taking *O* point as the starting point, the angle with the X axis is θ_t ($\theta_t=\omega t$, ω is the rotational angular velocity) for the ray *OA* cloud contour and point A_1, the length $l=|OA_1|$, with OA_1 as the diameter, in OA_1 The lower half arc is C_1, taking $|OB_1|=d*l$ (*d* is the inner winding coefficient, $0<d<1$), and the diameter OB_1 is used as the semicircle C_2 on the upper side of the *OA*. Similarly, the diameter of the i-th semicircle for $d^{i-1}l$, the semicircle is C_i, and the spiral is composed of m semicircles. For all C_i ($1 \le i \le m$), the inner winding line of a cloud can be obtained. By changing the parameters *d, ω, m*, etc., the shape of the involute line of the cloud can be further changed.

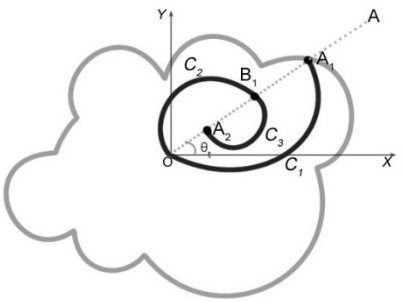


Figure 4. shows the generation of internal inner winding lines

4. Experiments

The system is implemented on Intel(R) Core (TM)i7-6700 3.41G, 8G RAM, NVIDIA GeForce GTX 960 graphics card, desktop computer under Window7 operating system. The development software is Visual C++ 2012 and DirectX 9.0 SDK. The following are the three auspicious cloud patterns generated by the system. The animation clouds in these examples are generated by the system in real time.

The system can realize the shape of various auspicious clouds by setting the number and distribution of clouds, and realize the shape and animation of the clouds by setting the skeleton shape of each cloud and the number of base points. In Figure 5(left), the skeleton radius and radius of motion of the cloud are relatively small to show a relatively gentle change, while maintaining a relatively stable shape. The number of clouds is 6, and the front and back are two layers. The number of arcs in each cloud in front is 8-10, including the cloud tail inner winding line, the movement speed is slow, followed by a large cloud. Figure 5(middle) shows a cloud chair shape around the character by setting the position and direction of each cloud. The number of clouds is 8, each cloud contains 10-12 arcs, and some clouds contain cloud tails. The movement speed is faster. In Figure 5(right), the skeleton radius and radius of motion of the cloud are relatively large to show a relatively dramatic movement change, without the cloud-tailed inner winding line, the number of clouds containing is 6, and the number of arcs contained in each cloud is 6-9. The movement speed is medium.

Figure 5. Cloud pattern generated by experiment

5. Conclusion

This paper proposes a method for modeling and drawing auspicious clouds. The generated auspicious clouds maintain the hand-drawn features in the shape, and at the same time can realize the natural deformation of the auspicious cloud shape in the animation. By setting a small number of parameters, it is convenient to control the shape, position, number, animation mode, etc. of auspicious cloud. The model can be used as an auxiliary production tool in the field of digital entertainment such as animation production, games, and advertising. In the next step, the model is intended to extend to more complex aerodynamic animations, including three-dimensional cartoon lighting effects, interaction between auspicious clouds and character objects.

Acknowledgments

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