3D animation face modeling and feature extraction based on computer graphics and image processing technology

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***Abstract*—After long-term efforts, people have created the era of computer 3D vision technology. In the field of new media, the application of graphics technology in animation industry is very extensive[1]. Through the analysis of computer graphics and image processing technology, this paper accurately expounds the specific process and related algorithms of 3D animation face modeling technology. On this basis, this paper also explains the specific algorithm of feature extraction in 3D design. On the basis of improving animation design, follow the design requirements of realism.**

Keywords—Graphics; computer; Image processing; Animation face; model design

I. INDRODUCTION

With the progress of computer graphics and image processing technology, the visual effect of three-dimensional animation has become more and more powerful, which has produced subversive changes in many new media fields such as animation art, film and television, games and VR. The simulation and artistry of three-dimensional animation character modeling have also become more ideal.

Animation face is the main way to express ideas and communicate, and it is the basic direction of computer graphics research. Based on the application of image processing technology, the production of animation face needs to establish a basic model, determine the basic points, use image processing technology to improve the parameters of the model, and finally complete the animation face model. Feature extraction can make the parameters of the face model more accurate, and improve the curvature of the face model surface to make the model more smooth.

II.GRAPHICS FOUNDATION OF 3D ANIMATION FACE

A.Basic structure

The basic skeleton of the head is divided into brain and face, which constitute the basic framework of the face[2]. According to the coordination of facial muscles, animation characters can make different expressions. Therefore, the design of each muscle needs to follow the specified shape and construction standards(as shown in Figure 1). In the process of animation character design, it is necessary to show the basic structure of human face on the basic appearance.

Figure 1. Head separator

B.Major organs

In the process of face design of animation characters, the design forms of face organs are different, which are set according to the background of different characters. However, the appearance of anthropomorphic organs cannot be changed at will[3]. Moreover, in order to meet people's aesthetic requirements for animation characters, the overall proportion standard of organs cannot be changed at will. For example, width of ears should be half the length[4]. In addition, the wrinkle degree of the skin on the person's face and the traces of scars also need attention(as shown in Figure 2).

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Figure 2. 3D model

III.PREPARATION PROCESS OF FACE MODEL BASED ON COMPUTER GRAPHICS

A.Calibration process of feature points

In the animation industry, there are two kinds of parameters for the special description of human face, one is animation parameters, and the other is the definition parameters of human face. Before making a face model, we need to obtain the specific values of the defined parameters, which depends on the calibration process of feature points[5]. In the expression of characteristic points, Arabic numerals are used as the number of points in turn, and the lowest value is the first place after the decimal point. The main calibration targets are the overall contour, face contour, eye contour, mouth contour, eyebrow contour, ear contour and nose contour (as shown in Figure 3).

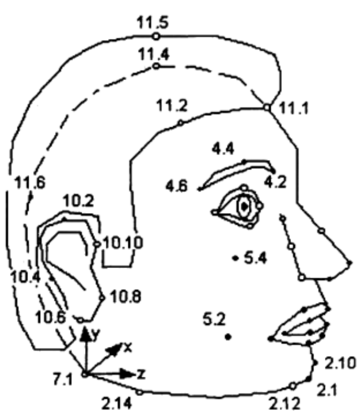

Figure 3. The definition parameters of human face.

Table 1. Statistics of the number of different feature points of facial organs

Position	Characteristic points
Eye	6
Eyebrow	5
Ears	6
Mouth	5
Nose	6

B.Normalization of face image

The horizontal line of the eye center and the horizontal line of the mouth center are relatively accurate, which can be used as the basic axis of coordinate positioning[6]. After setting the coordinate axis, the profile photos of the face can be normalized in the form of coordinate changes (as shown in Figure 4).

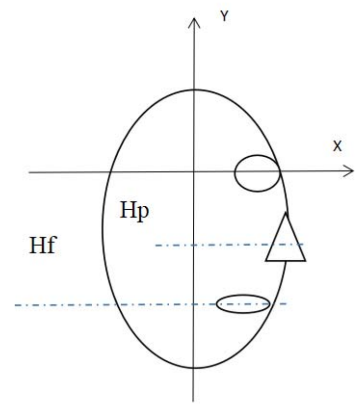

Figure 4. Face coordinates

$$x = k\left(\frac{X}{H}\right) \tag{1}$$

$$y = k\left(\frac{Y}{H}\right) \tag{2}$$

$$H = \begin{cases} H_f & \text{(positive)} \\ H_p & \text{(side)} \end{cases} \tag{3}$$

C.Color characteristic analysis

The color characteristics of different faces are different. The study found that the color of skin can show different colors in different spaces, but in most cases it is relatively stable. In this test, Gaussian distribution model probability algorithm is used to calculate the distribution parameters.

$$P = \exp\left[-\frac{1}{2}(x-m)\right]^{T} \sum (x-m) \tag{4}$$

After that, we need to use edge detection algorithm to better determine the contour of the face, and then locate the face region more stably. It is planned to use Sobel algorithm to complete the process of edge detection. However, the image processing function of the computer is only applicable to binarization. Therefore, the determination of pixel value only needs to extract two thresholds.

$$G_i = \begin{cases} 0 & G_i \le \tau \\ 255 & G_i > \tau \end{cases} \tag{5}$$

D.Determination of animation face area

In different backgrounds, the localization of animation face region aims to retrieve the basic range of face, which can avoid the overlap of face and background. On this basis, this test plans to calculate the vertical and horizontal directions by means of gray-scale integral projection.

$$P_v = \sum_{x=1}^{N_1} G_i \tag{6}$$

$$P_h = \sum_{x=1}^{N_2} G_i \tag{7}$$

E.The best proportion of facial organ area

The placement area of eyebrows is located at the middle dividing line between hairline and nose, the placement area of nose is located in the center of face, the placement area of lips is located at the second bisector between nose and chin, and the position of eyes is located at the bisector of the vertical line between hairline and mouth[7]. The width of the eyes is generally three thirds of the width of the face, and the length of the chin is determined by the characteristics of the character[8]. Generally, the length is five thirds of the length of the face. The surface area of the nose is up to 5% of the total area of the face. The width of the mouth of men is generally half the width of the face, and the width of the mouth of women is generally half the width of the face.

$$E_w = \frac{F_w}{3} \tag{8}$$

$$C_L = \frac{F_L}{5} \tag{9}$$

$$N_s = \frac{F_S}{20} \tag{10}$$

$$M_w = \frac{F_w}{2} \; or \; \frac{F_w}{3} \tag{11}$$

IV.FEATURE EXTRACTION ALGORITHM OF ANIMATION FACE MODEL BASED ON COMPUTER IMAGE PROCESSING TECHNOLOGY

A.Eye boundary feature extraction

In the two-dimensional image, the characteristic shape of the eyes of animation characters is similar to the parabola. Therefore, the least square method can be used to fit the curve to obtain the description equation of the eye boundary.

$$Z_1 = a_1\theta^2 + b_1\theta + c_1 \tag{12}$$

$$Z_2 = a_2\theta^2 + b_2\theta + c_2 \tag{13}$$

B.Mouth boundary feature extraction

Similar to the fitting method of eye boundary, the least square method can also be used to simulate the shape of parabola. However, different from the above content, the mouth boundary segmentation should have four parabolas.

$$Z_3 = a_3\theta^2 + b_3\theta + c_3 \tag{14}$$

$$Z_4 = a_4\theta^2 + b_4\theta + c_4 \tag{15}$$

$$Z_5 = a_5\theta^2 + b_5\theta + c_5 \tag{16}$$

$$Z_6 = a_6\theta^2 + b_6\theta + c_6 \tag{17}$$

C.Feature extraction of nose region

Due to the complex structure of the nose region of the face, the change of Gauss map in different parts is uneven, which leads to the fitting curve can not cover the complete region. Therefore, different calculation formulas need to be used respectively. Common formulas mainly cover the points on the upper edge of the nose, the tip of the nose, the left edge of the nose, the right edge of the nose and the lower edge of the nose.

$$N_{top} = \frac{E_{Left} + E_{Right}}{2} \tag{18}$$

$$N_{tip} = MAX(R_i) \tag{19}$$

$$N_l = Left(P_i) \tag{20}$$

$$N_r = Right(P_i) \tag{21}$$

$$N_b = MIN(R_i) \tag{22}$$

V.THE FINAL PROCESS OF 3D ANIMATION FACE MODELING BASED ON COMPUTER GRAPHICS AND IMAGE PROCESSING TECHNOLOGY

A.Fabrication of two-dimensional model

Through the content analysis of the preparation process and feature analysis process, the basic two-dimensional image of animation characters can be established according to the requirements of users. If the structure of the image is relatively simple, a single plan can be made. If the structure of the image is complex, three views need to be made(as shown in Figure 5).

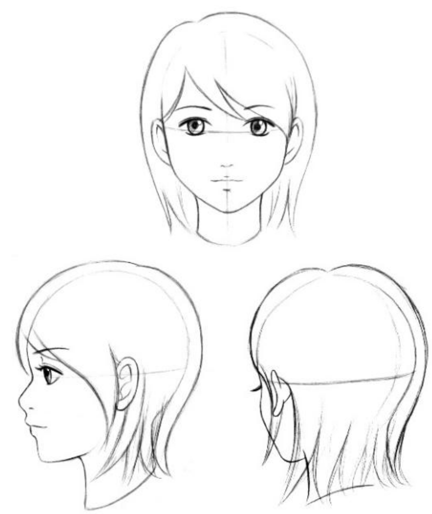

Figure 5. Three views

B. Extracting information from two-dimensional pictures using three-dimensional software

Extracting the information of three-dimensional graphics from two-dimensional graphics belongs to the category of computer image processing technology, which aims to use machine vision to shape the three-dimensional sense of human face[9]. Therefore, this experiment plans to use virtual camera method to extract three-dimensional information. Virtual camera method is a hypothetical method, which refers to using two virtual cameras to shoot from different perspectives of two-dimensional images, and then calculate three-dimensional information according to the algorithm.

$$U_1 = \frac{L}{D - X} Y \tag{23}$$

$$V_1 = \frac{L}{D - X} Z \tag{24}$$

$$U_2 = \frac{L(Ycos\alpha - Xsin\alpha)}{D - (Xcos\alpha + Ysin\alpha)} \tag{25}$$

$$V_2 = \frac{L}{D - (Xcos\alpha + Ysin\alpha)} Z \tag{26}$$

D refers to the shooting distance of the camera, l refers to the focal length of the camera, and α refers to the rotation angle. The above three parameters can be set artificially.If the rotation angle is 90 degrees, the above formula can be expressed as:

$$U_1' = \frac{L}{D - X} Y \tag{27}$$

$$V_1' = \frac{L}{D - X} Z \tag{28}$$

$$U_2' = -\frac{L}{D - Y} X \tag{29}$$

$$V_2' = \frac{L}{D - Y} Z \tag{30}$$

C.Overall deformation of animation face

Global deformation refers to the expansion and contraction transformation of the three coordinate directions of the model, which can also be called scaling up or down (as shown in Figure 6). After converting 2D graphics into 3D models, the specific coordinate transformation algorithm is as follows:

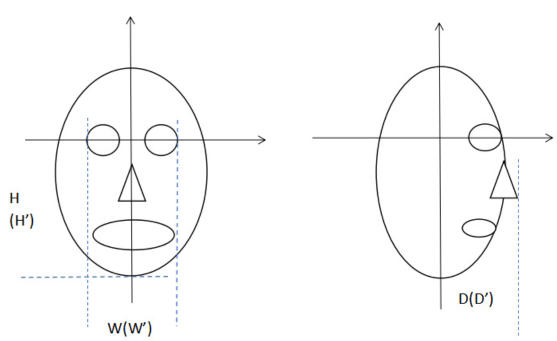

Figure 6. Schematic diagram of coordinate transformation

$$R_x = \frac{W'}{W} \tag{31}$$

$$R_y = \frac{H'}{H} \tag{32}$$

$$R_z = \frac{D'}{D} \tag{33}$$

After a specific stretching ratio is adopted, the above formula can be rewritten as follows:

$$X' = x * R_X \tag{34}$$

$$Y' = y * R_y \tag{35}$$

$$Z' = z * R_z \tag{36}$$

D.Final model design

Through the calculation of different algorithms, the face area of animation characters is evenly divided, and the proportion of five organs can be determined. The basic two-dimensional graphics can be made in the form of fitting curve, and then the three-dimensional model can be created according to the steps of virtual camera method.

VI. Summary

According to the description of this paper, the combination of computer graphics and image processing technology can depict the two-dimensional graphics of animation characters[10]. Through the analysis of feature extraction, we can accurately get the distribution proportion of face area and organ distribution proportion. Among them, the least square method and three-dimensional production technology play a great role. However, the shortcomings of this test are also obvious. The algorithm used in this experiment is theoretical, and the practical effect in practical application is not ideal. Secondly, the design of animation character model is static, and the application effect is not ideal under the background of dynamic. In the future, we need to put forward specific methods to improve the above problems for the design of animation characters. Only in this way can we improve the design process of computer animation models.

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