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Application of Artificial Intelligence Special Effects in the Design of 3D Stereo Animation

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The progress of computer software and hardware technology has promoted the rapid development of the animation industry from two-plane animation to three-dimensional animation. After entering the 21st century, the rapid development of 3D animation technology offers people both convenience and enjoyment. It provides substantial technical support in the fields of architecture, games, advertising, film and television, exhibitions, medicine and so on. The application of special effects technology to film and television 3D animation will not only help to change the way that film and television content is created content; it also has a significant impact on film art. Special effects in film and television productions are artificially created illusions. Following a review of the relevant literature, this current research study examines the special effects technology used for 3D animation, comprising four different approaches: special effects light and shadow art, lens transition special effects, space dynamic special effects, and interactive special effects. The fusion of it and special effects is discussed, and the application of special effects in three-dimensional animation of film and television is analyzed. It is anticipated that this study has reference value for the special effects creation of 3D animation. This study conducted performance tests of the 3D animation production system, finding that when the data comprises fewer than 10,000 blocks, the terrain data is quite fast from loading to display. However, when the number of block data exceeds 50,000, the processing time of terrain data will increase due to the increase of the index and search time of the block data, and the limited processing capability of the hardware.

Keywords: Special Effects, 3D Animation, Artificial Intelligence, Virtual Worlds

1. INTRODUCTION

With the continuous development of computer graphics, 3D animation design has become an indispensable part of the entertainment industry, including movies and games. In the pursuit of better quality and more realistic effects, more sophisticated special effects technologies are required. Artificial intelligence (AI), as an emerging technology, has brought new possibilities and challenges to 3D stereoscopic animation special effects. Realistic special effects require accurate simulation of natural phenomena and physical laws such as fluid simulation, smoke simulation, fragmentation effects, etc. Traditional numerical calculation methods have the problems of being too time-consuming and having high computational complexity, while deep learning and AI technologies are more effective and quicker in terms of modeling and simulating physical phenomena. Also, AI technology can help artists express their ideas faster and more efficiently when designing creative effects. Through technologies such as generative adversarial networks, special effect elements with various shapes and textures can be generated, providing more possibilities and inspiration for creation. The traditional way of producing special effects requires a lot of time and manual operation. AI technology can help to generate and adjust automated special effects, reducing the workload of artists and improving production efficiency. Importantly, this helps to reduce costs and accelerate the production progress.

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It promotes the development of computer graphics, improves the creative effect and production efficiency, and also offers the audience a better visual experience.

On the one hand, computer graphics are used to draw images that are close to the real world. Montesdeoca proposed a direct stylization system that renders 3D animated geometry into watercolor animations. Featuring real-time low-level art direction, the focus is on letting users paint custom stylized parameters in a 3D scene. These painted parameters drive the watercolor effect in object space, manage local control and mimic the characteristic appearance of traditional watercolors. To this end, these parameters alter the geometric representation of the object space and are rasterized to coherently control and enhance further image space effects. Watercolor effects are simulated with improved and novel algorithms to reproduce hand quivering, paint turbulence, color bleed, edge darkening, paper distortion and graininess. All of these are the basic characteristic effects of traditional watercolors. The proposed direct stylization system scales well to the complexity of the scene, it can be implemented in most rendering pipelines, and can be adapted to simulate a wide range of watercolor looks [1]. The rapid development of digital technology and information technology has brought new opportunities for the protection of traditional art forms. Zhu analyzed the computer-aided 3D ethnic art animation design based on maya software. By means of digital exhibition halls and virtual reality technology, digital technology can provide visitors with real experience and enjoyment. Computer interaction can make people feel immersive. Through 3D animation software, he completed the design of a national art animation and demonstrated the production process [2]. Parkhomenko's research involved the field of theoretical understanding of the emerging development of 3D animation in modern culture, its technical, artistic, and commercial characteristics. He focused on the specific characteristics of character design and the influence of the character's audio-visual image on the aesthetic image of the screen work. He claimed that character design belongs to the field of object design, identifies the main stages of designing the audiovisual imagery of character objects, and defines their structural role in transmedia projects. Taking these aspects into account, the components of the screen art image in terms of the content of the main space are emphasized through a deductive method. In order to address certain issues, a comparative analysis of character combinations in various technologies is carried out using examples of animation from multiple countries. This analysis revealed the main trends in the development of the art space for screen works [3]. With the rapid development of stereoscopic display technology in recent years, the requirements for stereoscopic three-dimensional (S3D) animation in many fields have gradually increased. Sun proposed a stereoscopic effect adjustment method for the early stage of S3D animation production. First, a disparity gradient map is generated according to the relationship between scene depth, stereo image disparity and stereo effect. Then, by analyzing the relationship between disparity and viewing distance, the disparity range for the best visual effect is obtained, and the area of visual fatigue is then marked on the disparity gradient map. In addition, the curve between the stereo parameters and the disparity is obtained, and the influence of the stereo parameters on the disparity is analyzed. This helps animators adjust stereoscopic effects accurately. Experimental results show that the method has a high level of precision and automation, which can significantly improve the efficiency of S3D animation production [4].

However, the ever-increasing photorealistic capabilities of 3D animation and computer-generated imagery (CGI) pose potential problems for broadcasters, regulators, governments and audiences if a news story is broadcast via the media or website is CGI or a combination of CGI and camera-acquired imagery. Factors that humans use to discern or evaluate photo authenticity include shadow softness, surface smoothness, scene complexity and composition, and the number of light sources. There appears to be no such study with quantitative data or experimental methods to evaluate CGI moving images of humans or computers. Gates proposed possible temporal evaluation factors for human discrimination (motion parameters), computer vision (optical flow), and AI (semantic scene analysis) [5]. Advances in AI and computer graphics and digital technology have contributed to the relative improvement of the realism of virtual characters. This maintains the authenticity of the avatar's communication, especially with the addition of improvements in natural language technology and animation algorithms. Khooshabeh examined quasi-linguistic cues in culturally-relevant nonverbal communication. He modeled the effect of different accents on human interactors (i.e. users) of an English-speaking digital character. His model of cultural influence proposed that paralinguistic realism, in the form of accents, can be effective in promoting culturally consistent cognition only if it is relevant to the user's self. For example, Chinese or Middle Eastern English accents may be considered foreign to those who do not share the same ethnic and cultural background as members of those cultures. However, for those familiar with and connected to these cultures (i.e., bicultural in-group members), accents are more than a sign of shared social identity. It also motivates them to adopt culturally-appropriate explanatory frameworks to influence their decisions [6]. There is no doubt that the Industrial Revolution and the Digital (Information) Revolution have had a huge impact on almost every aspect of our society, life, companies and employment. By studying similar inventions of the industrial revolution, digital revolution and artificial intelligence revolution, Makridakis said the latter is targeted and will bring about broad changes that will also affect every aspect of our society and life. People will be able to use the Internet to buy goods and obtain services from anywhere in the world, and take advantage of the limitless, additional benefits brought about by the widespread use of AI inventions. The conclusion is that those who make extensive use of the Internet and are willing to take entrepreneurial risks to turn innovative products/services into global business success stories will continue to gain a significant competitive advantage. The biggest challenge facing society and businesses is to harness the benefits of AI technologies, which offer enormous opportunities for new products/services and massive productivity improvements, while avoiding the dangers and headwinds of increased

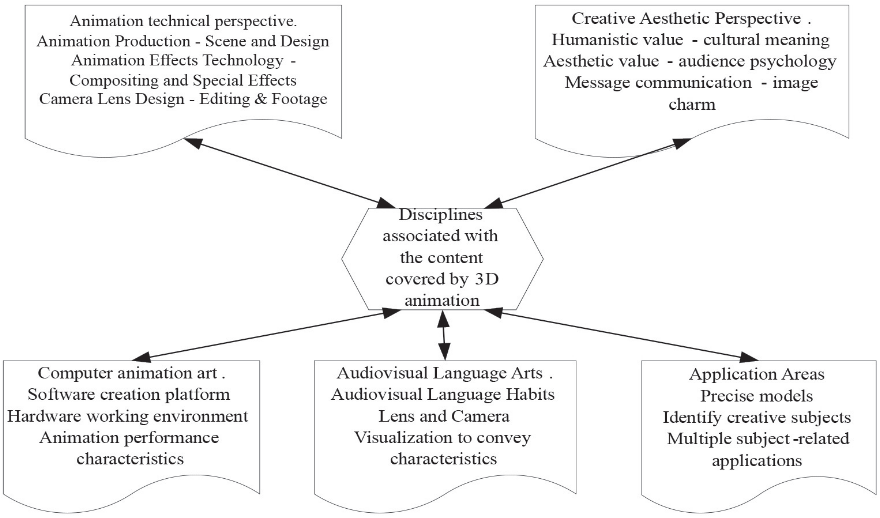

Figure 1 Conceptual split diagram of 3D animation.

unemployment and wealth inequality [7]. These methods provide some references for our research, but due to the short time and small sample size used for the study, this research has not been recognized by the public.

In the research of the performance test of special effects in the 3D animation design system, this paper finds that when the data blocks are less than 10,000 blocks, the terrain data is loaded and displayed very quickly. When the block data exceeds 50,000, the loading speed of terrain data is significantly slower. When all the functions of the system are operating, even if the number of patches in scene 1 is 342 times that of scene 4, the drawing speed does not change much. It can be seen that when the number of lines is 3000, the memory consumption of the sampling algorithm is 210.5MB, and the memory consumption of the optimization algorithm is 176.4MB, which saves 16% of the memory. Also, the time used for rendering is well controlled. In the case of the largest number of tiles (which rarely occurs in the prototype system), the operation time is only about 2.512 milliseconds.

2. APPLICATION OF ARTIFICIAL INTELLIGENCE SPECIAL EFFECTS IN 3D ANIMATION DESIGN

3D animation is a new technology that has emerged with the rapid development of computer technology in recent years. 3D animation software is used to create a virtual world on the computer, and then set the parameters such as the movement trajectory of the virtual object and the movement of the virtual camera according to requirements[8]. Then, the model is given a certain material in virtual reality, a layer of halo is painted on it, and then the computer generates the final image [9] as shown in Figure 1.

3D animation technology refers to the technology and method used to create 3D animation, and includes model making, scene layout, special element making, lighting setting, application of 3D software, etc. [10].

The features of 3D animation technology are: (1) Characters are constructed in virtual 3D space and can be used repeatedly, saving a lot of time. (2) The scene in the real space is simulated. After the light is created, the setting of the parameters will make the scene more realistic and increase the texture of the object [11]. (3) The rich 3D animation lens increases the flexibility of the lens and increases the feeling of space. The use of three-dimensional animation technology makes the image more realistic and gives people a feeling of being there. According to the technical key of “three-dimensional animation”, combined with the aesthetic composition of “video vision”, the subject of three-dimensional animation has been effectively decomposed [12].

Traditional hand-drawn 2D animation is based on the script. Character designers and set designers create characters and scenes on paper, and the director first makes a storyboard. Then an experienced motion designer outlines the main picture on paper, and then the middle designer connects the two important parts of the image, and then copies each picture onto transparent cellophane [13]. After a rigorous review, it will be carried out on the animation production platform. What’s left in the end is editing, dubbing, subtitling, etc. Computer 2D animation is the use of traditional two-dimensional animation production process and related principles, using digital software to complete the creation on the computer, with digital software as the core. The production of 2D animation has transitioned from traditional manual painting to digital technology. Whether it is manual painting or computer painting, the production process is roughly the same, but the production method has changed [14]. As shown in Figure 2, generally speaking, 3D animation production comprises pre-planning, mid-production and post-production phases. First, transform abstract inspirations and ideas into specific and complete visual images, including text scripts, art design, modeling design, screen mirroring, pre-recording, etc. Then it goes through the mid-term model, material, lighting, and animation production according to the previous design. The final rendering output, editing, special effects, music, sound effects, etc., form a complete and continuous 3D animation. Figure 3 is the basic production process of 3D animation [15].

Special effects have always been an indispensable part of film and television animation. It can simply make a flat promotional film more attractive, it can firmly capture the

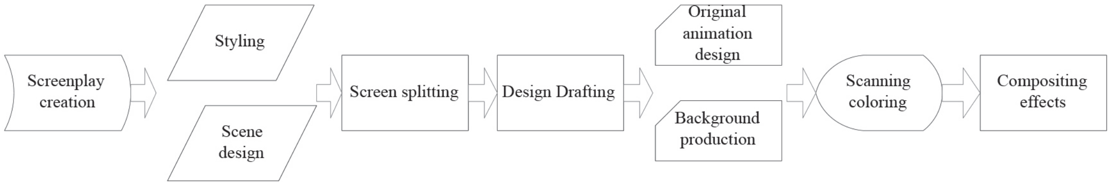

Figure 2 Basic flow chart of 2D animation production.

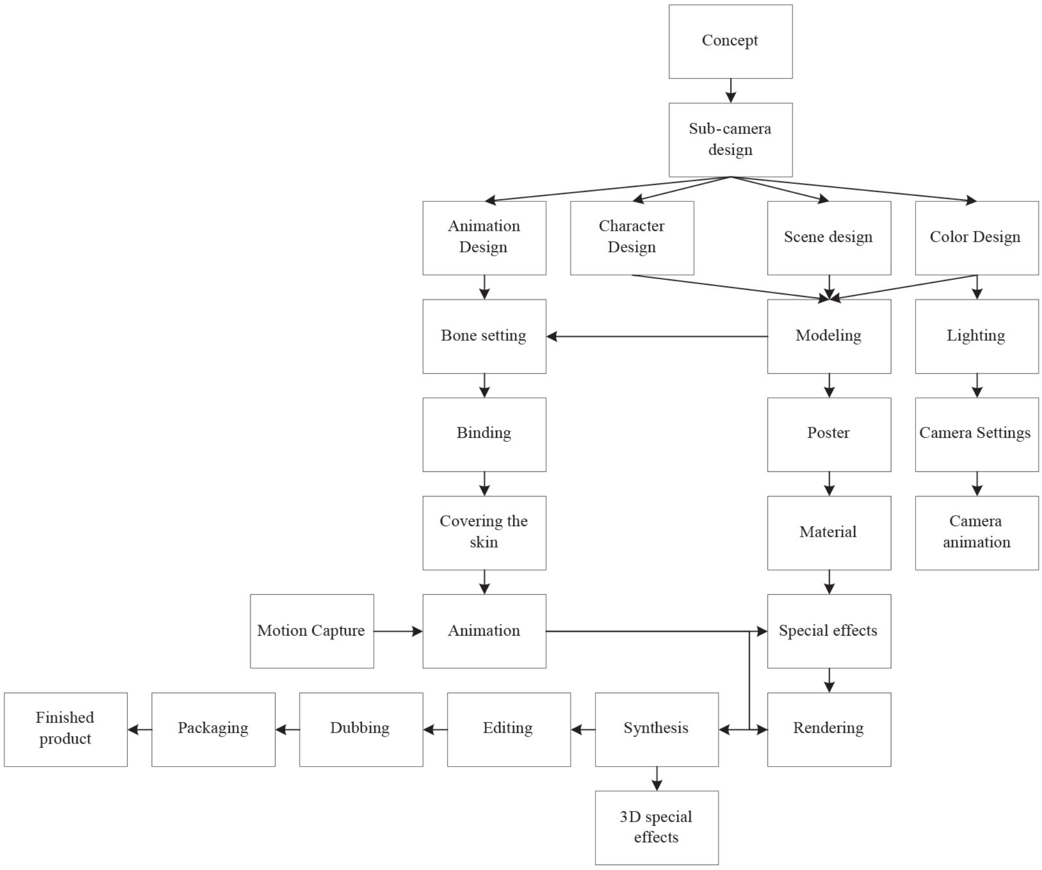

Figure 3 Basic production process steps of 3D animation technology.

hearts of consumers or viewers, and make product promotion easier. From the perspective of the content and process of advertising, we can fully express complex and professional product and brand needs in a simple and intuitive way [16]. However, the owners of many brands do not have the financial resources of some big brands. Although they want effective publicity, they cannot afford the high costs of advertising. This is where 3D animation special effects technology can show its potential. It designs and creates the publicity and dissemination of film and television in the form of animation, and each film and television animation can be regarded as a small-design short film [17]. It reflects both creativity and designer art style. In other words, the integration of three-dimensional special effects animation decreases the cost and increases the benefits of film and television animation [18].

In 3D animation, special effects can be achieved by: special effects light and shadow art, lens transition effects, spatial dynamic effects, and interactive effects. These different methods all play a big role in the creation of 3D animations, making them more realistic [19].

(1) Special effects light and shadow art

The so-called “special effect light and shadow” requires adjusting the light in 3D animation, adjusting and controlling the shadow and light amount through 3D light and shadow special effect technology. Then, each frame in the 3D animation is superimposed with the light curtain to achieve a light and shadow effect in the 3D image [20]. The artistic effects of light and shadows enhance the realism and artistic expression of 3D animations. In the continuous transformation of light and shadow, the mood and atmosphere of 3D animation are enriched so as to better enhance the visual impact and emotional experience of the audience. This has won a series of acclamations [21].

(2) Lens transition effects

Lens transformation special effects, as the name suggests, is to use the transformation of the lens to flexibly describe the animation language when making 3D animations. This improves the visual effect of the image, thus making the 3D animation more expressive [22]. When using lens transition effects, practitioners should pay attention to the processing

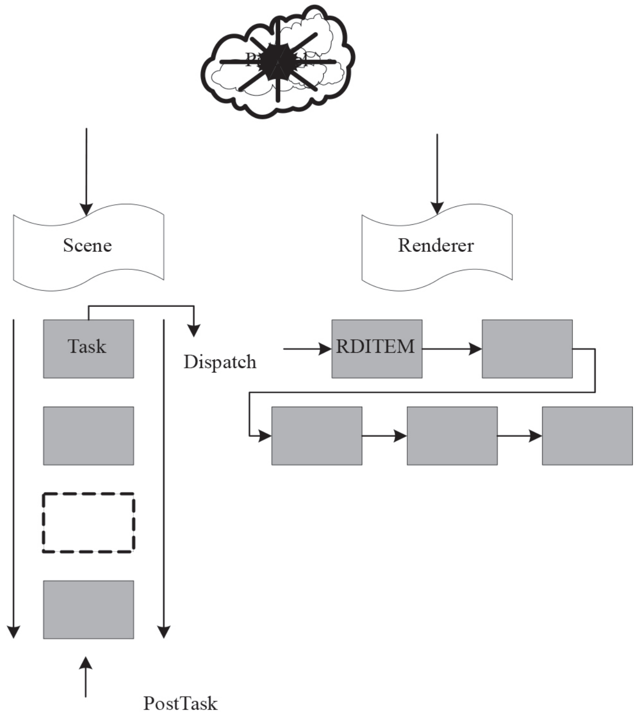

Figure 4 Schematic diagram of task-driven structure.

of the lens. According to the general abnormality of the 3D animation and the content of the script, a detailed analysis is conducted of the location where it is generated. This places it in a reasonable, prominent position, thereby improving the overall performance of the 3D animation.

(3) Space dynamic special effects

In the production of 3D animation, the quality of the spatial dynamic effect directly affects the performance of the 3D animation, and it also directly affects the overall performance of the 3D animation.

(4) Interactive special effects

Interactive special effects involve the fusion of 3D animated characters and animation scenes to generate the behavior of animated characters in specific scenes, thereby improving the visualization of 3D animations.

Through the componentized design, the model geometric relationship and the rendering relationship can be separated out to form a specific loosely coupled component module, so that the scene module and the rendering module are placed in different threads. In this way, the computing performance of the central processing unit can be fully utilized. From a thread perspective, the task-driven mode provides a communication protocol between scene threads and rendering threads so that the scene or animation can be rendered correctly. Similarly, the animation module and the rendering module can be integrated into the overall parallel design to achieve the design purpose. Through task-driven communication design, the problems of data consistency and rendering state change can be solved. Task-driven means that the scene module wraps tasks such as synchronizing data or changing the rendering state by means of a predefined data structure (as shown in Figure 4), and submits it to the task queue. It is sent to the task handler via the allocation function, and the task handler completes the update of the rendering data or the state transition of the rendering module. Through this design, the rendering module is responsible only for the rendering body. When the scene needs to query or set the rendering state, it only needs to send the corresponding task to the rendering task queue.

The surface consists of a line that moves uninterruptedly in the three-dimensional space to form a trajectory according to specific movement rules. Similar to how curves are expressed, surfaces can also be expressed in explicit, implicit and parametric forms. Surfaces are most commonly expressed parametrically in computer graphics, using rectangular domains as their parametric domains. Usually, the following parameters are used to define the surface:

$$S(m,n)=\begin{bmatrix} x(m,n) \\ y(m,n) \\ z(m,n) \end{bmatrix} \tag{1}$$

$$S(m,n)=\sum_{i=0}^{q}\sum_{j=0}^{p} c_{ij} m^i n^j \tag{2}$$

Quadric surfaces, which are a special case of NURBS curves, are described by implicit algebraic formulas. Each of these is in $x^i y^j z^k$ form, and

$$i+j+k \leq 2 \tag{3}$$

Hyperboloids, ellipsoids, etc. belong to this category of surfaces. The representation of the quadratic surface is as follows.

$$t(x,y,z)=a_{11}x^2+2a_{12}xy+a_{22}y^2+a_{33}z^2+2a_{23}yz + 2a_{13}xz+b_1x+b_2y+b_3z+c=0 \tag{4}$$

The geometry defined by the parametric (u,v) surface must use two parallel mappings. The first step is to map texture coordinates to geometry coordinates. The second

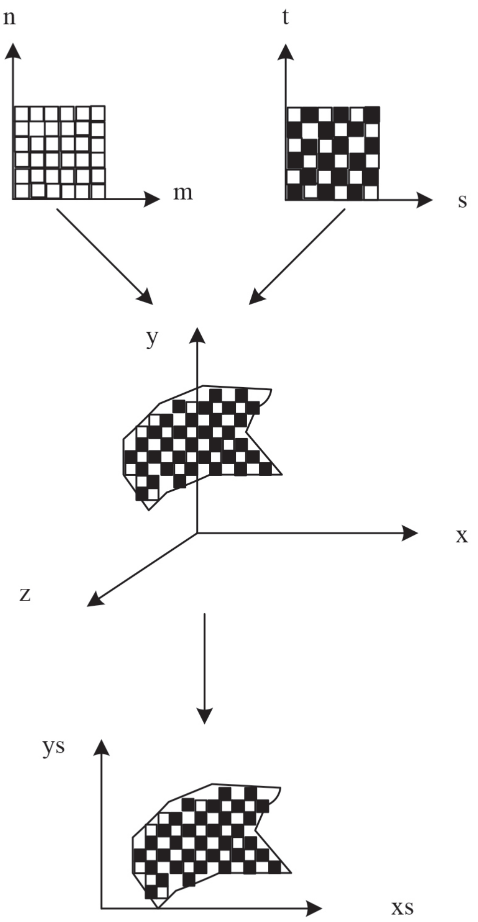

Figure 5 Texture mapping for parametric surfaces.

step is to map the corresponding parameter coordinates to geometric coordinates, and finally map the coordinates to screen coordinates as shown in Figure 5.

The textured space is equalized with the parameterized space through a certain affine change, and the texture mapping and the parametric surface are equalized through the inverse mapping defined by itself. However, due to the difficulty of having a high-order parametric surface, its own inverse mapping is often unable to be parsed and expressed, and it is usually solved discretely by numerical method. However, the mapping function of the texture pattern of the quadratic surface parameters can be expressed analytically. For example, the parametric expression for a cylindrical surface with radius r and height h is:

$$x = r\cos\alpha \tag{5}$$

$$y = r\sin\alpha \tag{6}$$

$$z = h\varphi \tag{7}$$

Among them

$$0 \le \alpha \le 2\pi, 0 \le \varphi \le 1 \tag{8}$$

The texture space $[0, 1] \times [0, 1]$ is equivalent to the parameter space $[0, 2\pi] \times [0, 1]$ after being transformed in a linear manner by the formula:

$$m = \frac{\alpha}{2\pi} \tag{9}$$

$$n = \varphi \tag{10}$$

Then the texture mapping expression of the cylinder is obtained.

For the global terrain scene, the method of organizing the global terrain scene into a quadtree structure can also be used. To calculate the geometric error of each node, a tile subdivision condition judgment algorithm based on screen space error SSE (Screen Space Error) is used. In a 3D visualization program, because all objects are ultimately displayed on the screen, the screen space projection error can be used as one of the important parameters for calculating the visual effect of an object.

In regard to perspective projection, when the camera angle of view is fixed, the further the object is from the viewpoint, the smaller it is after being projected on the screen, and the wider the camera "sees". As shown in Figure 6, it is assumed that the field of view angle of the viewpoint is *fov* and the screen size is a. When the distance from the viewpoint is d, according to the geometric relationship of perspective projection, we can obtain:

$$\frac{e}{R} = \frac{a}{2d * \tan\left(\frac{fov}{2}\right)} \tag{11}$$

The screen space error e can be understood as "one pixel on the screen", and R represents a factor equivalent to "one pixel" in the scene under the condition of distance from the viewpoint d. Formula 11 can also be written as

$$e = \frac{a}{2d * \tan(fov/2)} * R \tag{12}$$

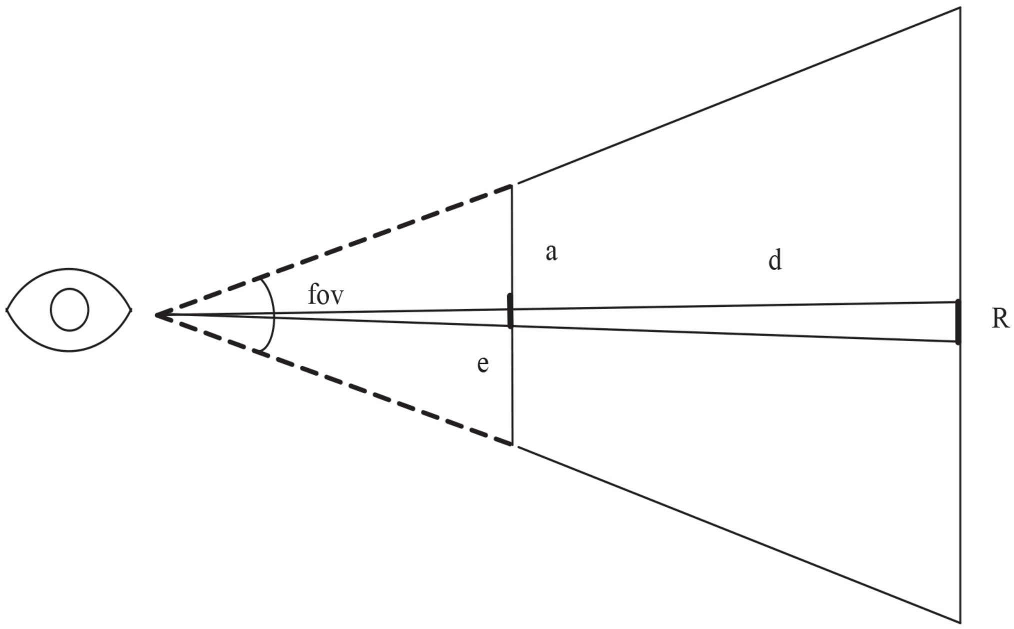

Figure 6 Perspective projection.

This paper defines the equivalent factor R as texel

$$R = \frac{2\pi l}{pixel * X_{lod}} \tag{13}$$

In the formula, l is the length of the semimajor axis of the reference ellipsoid, and X_{lod} represents the number of tiles in the X direction of the lod layer. $Pixel$ is the size of each node texture in the system, which is generally 256. At this time, the actual meaning of the screen space error is in the direction of the center of the viewpoint, a piece of texture that is orthogonal to the direction of sight, and the number of texture pixels that correspond to one pixel on the screen.

It should be noted that at this time, the angle between the projection vector and the line of sight and terrain fluctuations are not taken into account. Assuming that the angle between the projection vector and the line of sight is θ, without considering the influence of terrain tolerance, formula 13 is modified to obtain:

$$e = \frac{a}{2d * \tan(fov/2)} * \frac{2\pi l}{pixel * X_{lod}} * \cos\theta \tag{14}$$

At this point, we have obtained the complete calculation formula for the screen space projection error. During the system simulation drawing process, the position of the viewpoint is constantly changing. For each terrain node, its screen space projection error also changes with the viewpoint, and needs to be calculated in real time for every frame. Therefore, the formula can be simplified, and some invariants can be calculated in advance to reduce computational redundancy.

After the screen error is obtained through the simplification of the above formula, it is necessary to compare the error result with the threshold value to determine whether the node needs to be subdivided. When the texel corresponding to a screen pixel is greater than the threshold, it means that the resolution of the current node is too low, and it may appear mosaic. Therefore, it is necessary to subdivide the nodes to improve the resolution.

$$\begin{cases} e > \varepsilon, & \textit{Need further breakdown} \\ e < \varepsilon, & \textit{The error has been satisfied, no further breakdown} \end{cases} \tag{15}$$

3. EXPERIMENT PREPARATION FOR THE APPLICATION OF SPECIAL EFFECTS IN 3D ANIMATION DESIGN

3D animation production has relatively high requirements regarding the stability and hardware of the machine operating system. Because there are many elements in the animation scene, some 3D models such as buildings and terrain are fine and the number of faces is very large. Later, a high-performance graphics workstation is required to complete the heavy-load rendering and post-processing synthesis work to improve work efficiency; at the same time, it also guarantees smooth animation and optimal results. Therefore, compared to 2D animation, hardware and operating system support for creation is critical. According to the animation requirements and actual conditions, the most important performance indicator of the real-time rendering system is the frame rate: that is, the number of frames per second. In the experiment, two machines were used for performance testing. Table 1 lists the parameters set for the machines.

The scene parameters used for testing are shown in Table 2.

After the testing and analysis of the technical indicators of the machine results show that it not only meets the normal use of the project's three-dimensional, plane, and post-production software, but also has enough room in terms of machine performance. This is essential to ensure that the project is completed within a short time.

For the software solution, we analyze the production process of 3D animation, which comprises four modules: pre-

Table 1 Machine parameters.

Machine Name	Machine 1	Machine 2
Operating system	Windows XP	OS X
Processor	3.1GHz Intel Core i3	1.6GHz Intel Core i3
Video card	NVIDIA GeForce GTS 450	Intel HD Graphics 6000
Memory	8GB	8GB

Table 2 Performance parameters.

Scenes	Number of face pieces	Number of vertices
1.box	94215	74520
2.apple	12630	1536
3.house	562	920
4.lemon	275	220

Table 3 Software solutions adopted for animation.

Serial number	Software Name	Functions used in animation production
1	AutoCAD 2008	Edit and modify the original planning drawings for importing into 3ds Max
2	3ds Max 2010	Animation scene modeling, material assignment, lighting settings, animation production, animation rendering
3	Aftereffects CS4.0	Post-production effects processing
4	Premiere pro1.5	Post-production video editing, subtitling, transitions and special compositions
5	RPC	Holographic 3D model plug-in according to the needs of the model into 3ds Max for further editing and use

planning, macro-design, mid-term animation production, and post-synthesis. Pre-planning involves research materials, the regularization of software and hardware equipment, a preliminary feasibility study, and the deployment of production materials. Macro design includes scripting, shot design, art style design, and content element coordination. Mid-term animation production comprises model creation and material assignment, animation settings, lighting and rendering. Post-compositing involves the inclusion of special effects, editing, and final output of the animation. Software is used for the mid- and post-synthesis parts. The software scheme adopted for this current study is shown in Table 3.

In the system, the underlying rendering function is the basis of other wiring and edge extraction modules, which provide color buffering and 3D information. The wiring layer, the outline layer and the color sampling layer are processed separately to ensure that the real-time sampling and edge extraction use the data of the underlying scene, eliminating the interference of the historical wiring color and shape. The result of the underlying rendering can be displayed directly on the screen, or it can be rendered with a translucent effect to accentuate the lines. The result of the functional module of the contour module system contains a variety of components. Not only are there different types of lines due to definitions and algorithms, but also different edges are formed by the same type and algorithm using different perturbation parameters. All edge lines are given different levels of credibility. The edge pixel values are superimposed according to the reliability, the overlapping parts of the edges are shown as repainting, and the non-overlapping parts are shown as light painting, which is consistent with the actual painting skills. Finally, the line, outline and paper texture effects are superimposed by Alpha fusion technology and presented to the user.

4. DATA IN 3D ANIMATION DESIGN

In order to test the processing ability of this system for massive large-scale terrain data, on the premise that the size of fixed data blocks remains unchanged, the number of terrain blocks is continuously increased and each scene switch is recorded. The time taken to display the new terrain data is shown in Figure 7 below.

It can be seen from Figure 7 that when the data comprises fewer than 10,000 blocks, the terrain data is loaded and displayed very quickly. When the number of block data exceeds 50,000, the processing time of terrain data will increase due to the increase of index and search time of block data and the limited processing capability of hardware.

FPS (frame per second) is the number of screen updates per second, typically known as the refresh rate (in Hz). The refresh rate also indicates the number of times the screen is scanned per second. When the refresh rate is too low, the screen will flicker and be incoherent, the display effect will be greatly reduced, and the human eye will feel uncomfortable. Generally speaking, as long as the refresh rate of the picture reaches 24 frames per second, it can basically meet people's visual needs. If the refresh rate of the picture is less than 24 frames per second, the picture display is relatively slow and not smooth enough. The resolution of the scene in the performance test is 1920 $\times$ 1280. First, the performance of rendering the original scene is counted, and then the performance of the contour algorithm and the alignment algorithm are calculated accordingly. Finally, the performance of the system running all functions is given, including the original scene, contour lines, lines and paper textures. The results are shown in Figure 8.

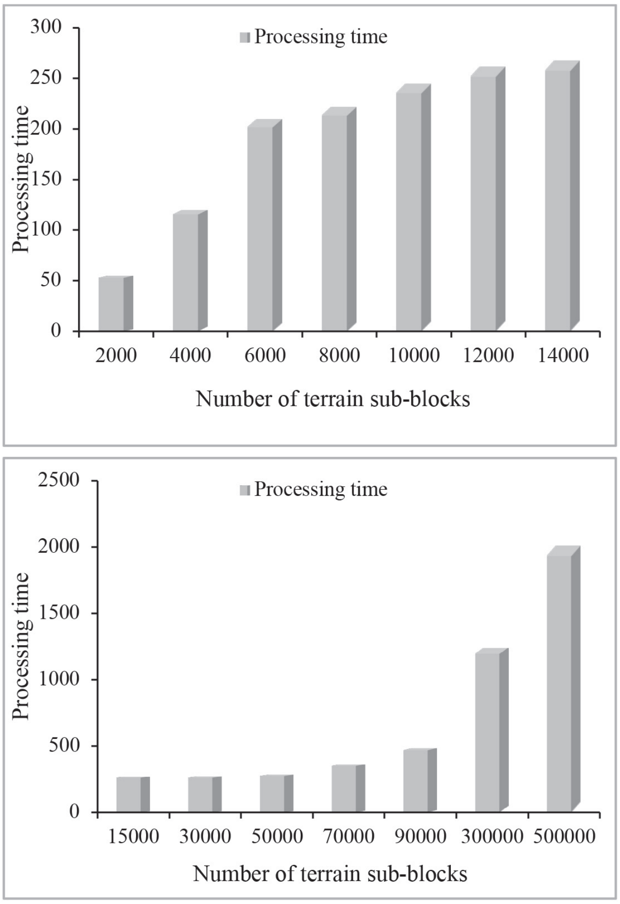

Figure 7 Terrain data volume processing time.

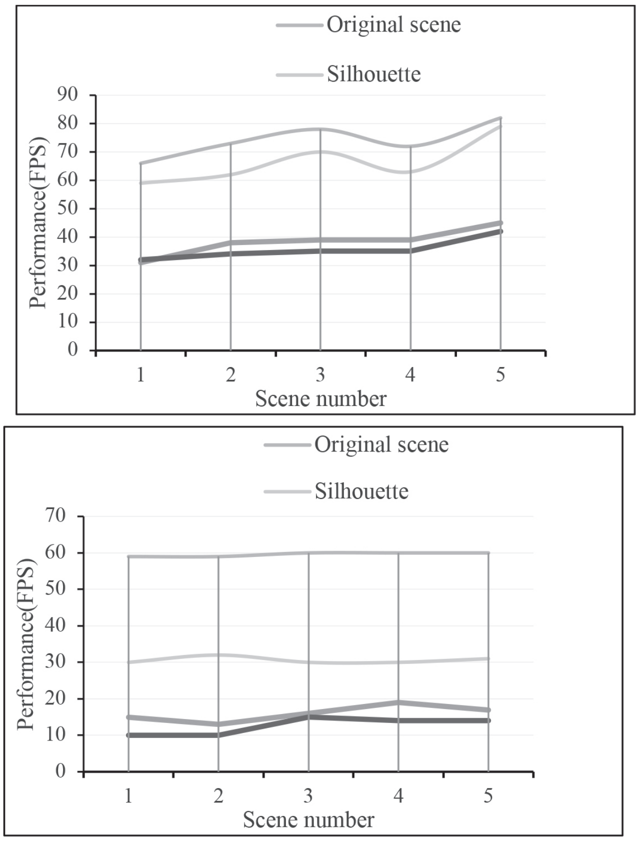

Figure 8 Performance test results.

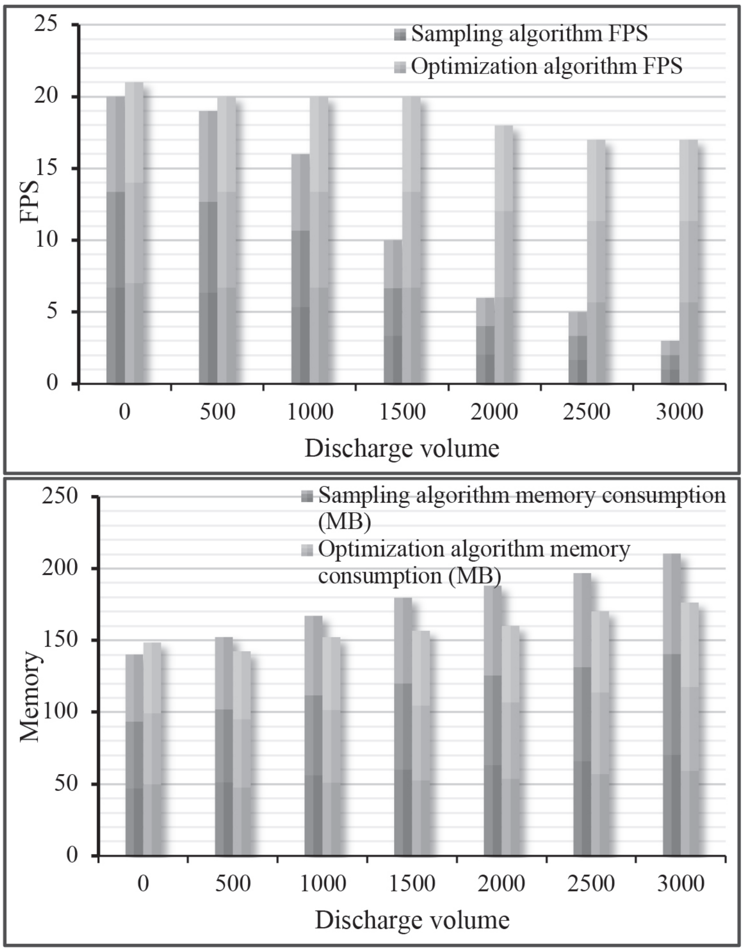

Figure 9 Comparison of optimization algorithms.

It can be seen from the performance test results that when all the functions of the system are operating, the rendering speed has little relationship with the complexity of the scene (the number of patches in scene 1 is about 342 times that of scene 4). The contour drawing algorithm and the line drawing algorithm respectively have a certain impact on the performance. Contour extraction degrades performance by around 11% (machine 1) and 50% (machine 2), respectively. The computational overhead is mainly incurred by the extraction of depth and normal maps and the calculation of contour lines. At the same time, because the flat line itself is not included in the contour calculation, an additional contour camera is used, and the drawing of the camera also leads to poorer performance. The line drawing algorithm has the greatest impact on the running efficiency, which is close to the final performance. Among the various factors that affect the performance of the cable module, real-time color acquisition is the most important one. Real-time color capture applies two projections to each line in the scene, and uses an additional camera port to capture the scene's real-time color, all of which have a large performance impact. Although the algorithm of each part of the function needs a certain time overhead to complete, the efficiency can be maintained within an acceptable range. In the application of non-intensive wiring, the final performance of the two machines can ensure the smoothness of the picture without visual delay.

In the color-choosing algorithm, each stroke itself does not store color information. In each display, the scene other than the line will be dyed in a separate color buffer using an additional camera, and the stroke will sample the color buffer to obtain its own color. In this process, projected sampling adds time and space overhead. Corresponding to performance, increasing the time overhead leads to a decrease in system FPS, and increasing the space overhead leads to an increase in memory usage. The approximate optimization algorithm adopts another method to calculate the color of the stroke. The main idea is to give the basic color and material to the stroke. By using the material's lighting model to colorize the strokes, this avoids the color sampling process.

Figure 9 shows the impact of the sampling algorithm and the approximate optimization algorithm on FPS and the memory overhead of both algorithms. It can be seen that the optimization algorithm significantly improves FPS. When the number of lines is 3000, the memory consumption of the sampling algorithm is 210.5MB, and the memory consumption of the optimization algorithm is 176.4MB, which saves 16% of the memory.

Figure 10 shows the experimental data for the tile rendering time, the number of tiles and the number of feature points in the 3D scene.

It can be seen from Figure 10 that the time used for rendering is well controlled. For the largest number of tiles,

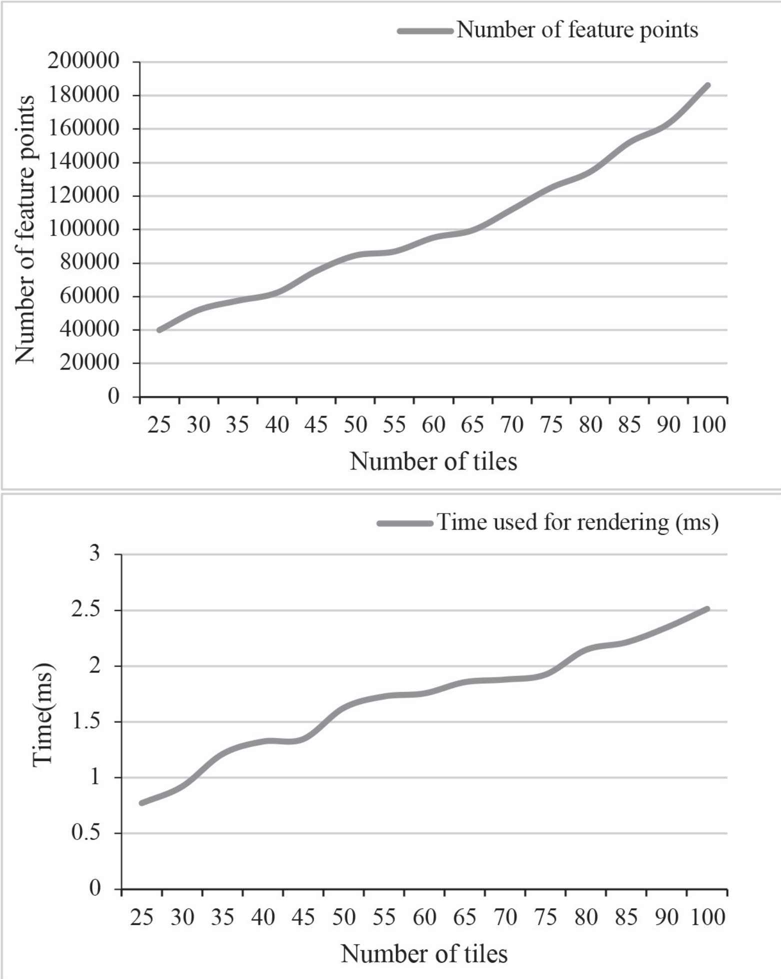

Figure 10 Experimental data on rendering time and number of tiles in a 3D scene.

the operation time is only 2.512 milliseconds (which rarely occurs in a prototype system).

5. CONCLUSION

In recent years, the rapid development and increasing popularity of computer technology and film animation have enabled the development and success of computer-generated animation. Computer technology is also widely used to create animation. It can expand the expressive power and viewing space of the film, and provide the audience with an innovative virtual world and visual effects. 3D animation also appeared with the rapid development of computer software and hardware technology. With its unique artistic effect, 3D animation offers the audience a new visual experience. For film and television works with humanistic and natural factors that cannot be achieved with special effects, the production of 3D special effects is a huge innovative development in the film and television industry. Applying special effects technology to film and television 3D animation is an important means of improving the quality of film production. Therefore, to conduct in-depth research on the application of special effects, we must begin with its meaning and proceed to acquire a thorough understanding of its connotations. The knowledge and understanding of special effects applications are deepened, thereby deepening the knowledge and understanding of the application of special effects technology in 3D animation production so as to combine special effects technology with three-dimensional animation design of film and television.

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