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Computer-Aided Design AND APPLICATIONS

Analysis of Key Technologies for Integrated Virtual Reality Technology in Virtual 3D Animation

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Abstract. The complexity of 3D animation is high and time-consuming, which makes it difficult to complete high-quality animation in a short time and the visual effect lacks realism. The study conducted scene construction based on key technologies for automatic generation of different 3D animations, as well as 3D animation optimization system, and verifies the performance of the model and system by applying comparison experiments. The results show that the 3D animation scene construction and automatic generation model based on virtual reality technology has good continuity and can improve reconfigurability while completing the automatic generation target. In addition, the optimization system in this paper can complete the overall optimization of 3D animation in a shorter time compared with other systems, and improve the visual effect and experience of 3D animation.

Keywords: virtual reality technology; virtual 3D; 3D animation
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1 INTRODUCTION

3D animation technology is one of the expressions of cutting-edge technology in the field of computer graphics and images, and its visual expressiveness and expression not only expand the animation ontology form, but also provide outstanding visual effects. The technical, virtual and comprehensive application of 3D animation makes it gradually become an important visual carrier and artistic expression means in comprehensive media culture. The construction of CAD based 3D animation pipeline estimation systems often requires the establishment of powerful controllers. Arshad et al. [1] constructed the animation skeleton of 3D characters and obtained the best technical design by simulating movement and posture in character animation. Doukianou et al. [2] conducted graphic construction for commercial animation information demonstration. It explored the demonstration program through the construction of emerging technologies through CAD virtual animation. The results show that the method based on virtual animation construction is superior to traditional methods. Dvorožňák et al. [3] conducted sketch modeling and animation simulation of 3D organic shapes. By generating 3D grids, the environment model for animation and view work is constructed. Eckert et al. [4] performed corresponding computer image sequence rendering. Effective optimization solutions were simulated and constrained through the capture settings of commodity hardware. It showcases the dataset operation driven patterns of many products. Fitria [5] conducted an applied education review on image elements and new color augmented reality. It has applied virtual reality in the field of teaching and solved related problems. However, the basis of 3D animation is a photo with static nature, which is a 3D animation broadcast based on 2D animation with 3D screen change, so the virtual world constructed through 3D animation lacks realism in terms of immediacy. In addition, the production of 3D animation has high requirements for technical personnel. Guo [6] analyzed the application of computer 3D animation technology in the construction industry. Virtual reality technology can build the simulation environment through the corresponding technical means, which not only greatly restores the real world, but also has the characteristics of immersion, interactivity and subjectivity to improve the realism of the simulation environment.

Based on this, this paper will conduct a corresponding research on the key technology of virtual 3D animation integrating virtual reality technology, which is mainly divided into four parts. The first part briefly introduces its application advantages in 3D animation production, and introduces the research direction and content of this article. The second part is a brief description of the research on the application of virtual technology in 3D animation production. The third part constructs the key technical model of 3D animation production based on virtual reality technology, realizes the design of 3D animation scene construction through virtual reality technology, and proposes the corresponding automatic generation method of animation scene to fit the 3D animation virtual scene. On this basis, this part also builds a 3D animation optimization system based on virtual reality technology, implements calibration of animation image nodes and completes interactive node design by means of precise calibration, so as to achieve the purpose of improving animation presentation effect. The fourth part analyzes the functional application effects of relevant 3D animation simulation models.

The innovation of this paper lies in the integration of virtual reality technology in the key technology of 3D animation production, proposing the automatic generation method of animation scenes and constructing a 3D animation optimization system, through which the method and optimization system can obviously improve the efficiency and quality of 3D animation production and reach the corresponding requirements and demands of 3D animation production.

2 RELATED WORK

Herlandy et al. [7] combined virtual information with the real world through computer technology. Its research uses cameras to capture real-world scenes, and on this basis, virtual elements are added to generate enhanced virtual images. Augmented reality technology includes gesture recognition, virtual object tracking, human motion tracking and other technologies, which can provide a more realistic and rich experience in augmented reality applications. Li and Li [8] analyzed the application of virtual reality technology in computer 3D image sound. In order to make users feel like they are in a virtual world, it analyzes technologies such as 3D modeling, dynamic capture, and stereo sound in virtual reality technology. These technologies can provide a more immersive and realistic experience in virtual reality applications. And based on this, designed a virtual medical system. Kumar et al. [9] designed a 3D virtual animation simulation program. It tests the impact of CAD virtual reality on students' learning. Its research focuses on active analysis and training practices in the simulation analysis of 3D animation and virtual reality. Kellems et al. [10] taught social skills for people with disabilities based on CAD virtual animation technology. To achieve the teaching purpose of disability development action by setting virtual dynamic parameters. Lamberti et al. [11] believe that creating computer animation packages is a computationally complex task. It constructs a heterogeneous subset solution for the user's native immersive VR interface by adding components. Mustami et al. [12] conducted a practical augmented reality biology textbook development model test. Through model data analysis, the results of the augmented reality 4D model demonstrate its efficiency. Nayak et al. [13] carried out the script dynamic program analysis of the transition from 2D animation to 3D animation. By constructing models with complex structures, a series of image scene rendering were performed. And program analysis is carried out on the assumption of engineering visualization. Qiu [14] identified the goals and constraints for CAD simulation. Firstly, it is necessary to determine the simulation objectives and constraints that need to be met, such as establishing mathematical models for simulating motion, physical laws, material properties, etc. Afterwards, a corresponding mathematical model is established based on the simulation objectives and constraints, which is the foundation for achieving the simulation. When establishing the mathematical model, it takes into account the geometric shape, material properties and other factors of the mock object. Rahatabad et al. [15] conducted software integration analysis of CAD virtual technology. Tai [16] conducted learning and training on 3D animation through CAD virtual technology. By drawing and searching for key sketches, he sketched the scene and analyzed the geometry of the hologram. Zhang et al. [17] proposed a framework for building scene modeling in augmented reality. It utilized a 3D model to construct the technical features of the algorithm scene. And the CAD framework was used to promote the immersion of architectural scenes. Zhang et al. [18] wrote corresponding computer programs. Implement mathematical models and algorithms using appropriate programming languages and tools. When writing a program, it takes into account factors such as program efficiency, readability, and maintainability. The functions of the integrated system were optimized through computer-aided debugging. Zhang and Weber [19] provided guidance on movie production in CAD language, where they edited and swapped the keyframes set in the movie.

3 METHODOLOGY

3.1 Virtual Reality-Based Animation Scene Modeling and Automatic Generation Method

The virtual reality-based animation scene modeling and automatic generation method is a method that utilizes virtual reality technology to construct animation scenes. This method combines virtual reality technology with animation production, and achieves automation of animation production by establishing virtual scenes. The image is represented as shown in (1):

$$I(x,y)=avg\sum_{b}\alpha(m,h) \tag{1}$$

where the domain range of the image in the 3D animation scene is denoted as avg and b is the image linear distortion parameter. After that, based on the geometric information of 3D animation and the coordinate position of the nodes of virtual reality technology.

$$f=\frac{1}{N}\sum_{m} j\left\|y_m-(r+t)\right\| \tag{2}$$

The number of all midpoints in the image domain of the 3D animation scene is N, the feature points are denoted as r, the 3D vector sample points are denoted as y_m, and the merging factor of the point cloud data in the animation scene is denoted as t.

In order to reduce the number of redundant feature points generated in the depth information alignment process, the merging of the image point clouds in the 3D animation scene can be achieved by virtual reality technology. Let the sample points of any 3D vector in the 3D space of the animation scene image be represented as d, and its total number of point clouds is shown in (3):

$$ds(E,s)=\phi\in D\left|s-i\right| \tag{3}$$

The total number of image point shipments is denoted as $ds(E,s)$, where a point cloud value is denoted as ϕ, and the image point value is denoted as s,i.

After the processing of the above virtual reality technology, the 3D animation modeling coordinates and world coordinates can be transformed, i.e., the corresponding information transformation of the vertex coordinate values and the plane equation in which the polygon is located, as shown in equation (4) for the plane equation:

$$D = AX + BY + CZ \tag{4}$$

where any point contained in the plane can be represented as AX, BY, CZ.

In order to improve the efficiency of three-dimensional animation production, three-dimensional animation scene automatic generation technology is its inevitable development. On the basis of the constructed 3D animation scene automatic generation model, combined with virtual reality technology can realize 3D animation scene automatic generation optimization by means of 3D virtual reconstruction and image information fusion. The 3D virtual reconstruction is the reconstruction of animation scene features completed by alternate analysis and adaptive iteration at that time, and its projection degree function can be detected by fuzziness, as shown in equation (5):

$$V = e_1 e_2 - \varepsilon e_1^2 \tag{5}$$

Where, the transmittance function is recorded as V, the moving image transmittance is expressed as ε, the parameter fusion of which can obtain the white bright spot parameters, after matching and reorganization to establish the source image fusion model of the 3D animation scene, as shown in equation (6) for the fusion error function:

$$L = \nu - \nu_r \tag{6}$$

where the white bright spot parameter is denoted as ν and the fusion error function is noted as L.

The source images are chunk matched and adaptively fused in the process to obtain grouped feature matching parameters as shown in Equation (7):

$$\theta_r = b(\cos\theta + V\nu) \tag{7}$$

After that, the three-dimensional animation scene generation random probability distribution model is constructed by means of root mean square error estimation, and the three-dimensional animation scene virtual reality reconstruction model is obtained by combining the information entropy estimation method, and the results of the joint probability density distribution of gray-scale similar feature distribution are obtained, as shown in Equation (8):

$$k^p(\lambda) = (\sum_{d=1}^{N} a_d^p)(\sum_{d=1}^{N} a_d^{p+1}) \tag{8}$$

In which, the random probability distribution model of animation scene generation is denoted as λ, and the virtual reality reconstruction model is denoted as $k^p(\lambda)$. The total amount of 3D animation generation is a, the actual number of generation is denoted as N, the random probability of generation is denoted as d, and the joint probability density is denoted as p.

Parsing the above model yields information on the edge details of the joint probability distribution model of the 3D animation scene, as shown in Equation (9):

$$\begin{cases} \lim_{p\to+\infty} k^p(\lambda) = \max_d a_d \\ \lim_{p\to-\infty} k^p(\lambda) = \min_d a_d \end{cases} \quad (9)$$

The 3D virtual reconstruction can be realized and its automatic generation enhanced based on the obtained edge information distribution.

In order to try under the 3D animation scene automatic generation optimization, can rely on the image enhancement method to enhance its information fusion processing, with the help of transmittance estimation method to complete the 3D animation scene fusion, as shown in formula (10) for the 3D animation scene virtual visual reconstruction output model:

$$I(i_1,i_2) = \sum_{s_1=0}^{1}\sum_{s_2=0}^{1} I-(2i_1+s_1, 2i_2+s_2) \quad (10)$$

Where, the coordinates of the 3D animation scene pixel points are expressed as i , and the quantization of the coordinate change is expressed as s . According to the analysis results of fuzzy noise distribution area for 3D animation scene point matching, the distribution model can be obtained, as shown in equation (11):

$$\lambda(i_1,i_2) = \frac{1}{U}\sum_{h=1} R_x e \quad (11)$$

where the feature difference value between the fused image and the source image is denoted as U , and the amount of animated scene similarity features is obtained based on the calculation of the point tracking model as shown in (12):

$$D(y_1,y_2) = e^{\cos\varphi(y_1,y_2)} \quad (12)$$

where the 3D animated scene similarity feature quantity is denoted as $D(y_1,y_2)$, and the angle formed by (y_1,y_2) is noted as φ . If the adaptive-based weighting control method is performed for any pixel in the virtual visual image of the 3D animated scene, the obtained row and column frequencies are obtained in the fused image point distribution region to obtain the detail feature quantity of the focus range, as shown in (13):

$$\begin{cases} \lim_{p\to+\infty} k_B^p(f)(m,n) = \beta_B(f)(m,n) \\ \lim_{p\to-\infty} k_B^p(f)(m,n) = \delta_B(f)(m,n) \end{cases} \quad (13)$$

The arbitrary pixel is denoted as (m,n) , the row and column frequencies are denoted as $B=\{B_z\}_{z=1}^{N}$, and the 3D animation scene image information fusion similarity and blur coefficients are denoted as β,δ , according to the obtained results, the animation scene can be automatically generated and reorganized.

3.2 3D Animation Optimization Model Based on Virtual Reality Technology

There is a gap between the quality of traditional 3D animation production and the increasing demand for regulations, virtual reality technology can realize the overall reconstruction and optimization of 3D animation production results to improve the quality and effect of animation, as shown in Figure 1 is the overall framework of 3D animation optimization model. As can be seen from the figure, the 3D animation optimization model is mainly divided into three parts, namely, animation image import imaging, image pre-processing and reconstruction, and virtual reality technology is mainly applied to the pre-processing and reconstruction of 3D animation images. In the guide module of the model, the model obtains several independent small regions by segmenting the 3D animation image, and calibrates the node coordinates to complete the interactive node design. After that, each region in the 3D animation image is filtered to reduce the noise, and the optimization of 3D animation is realized by reconstruction.

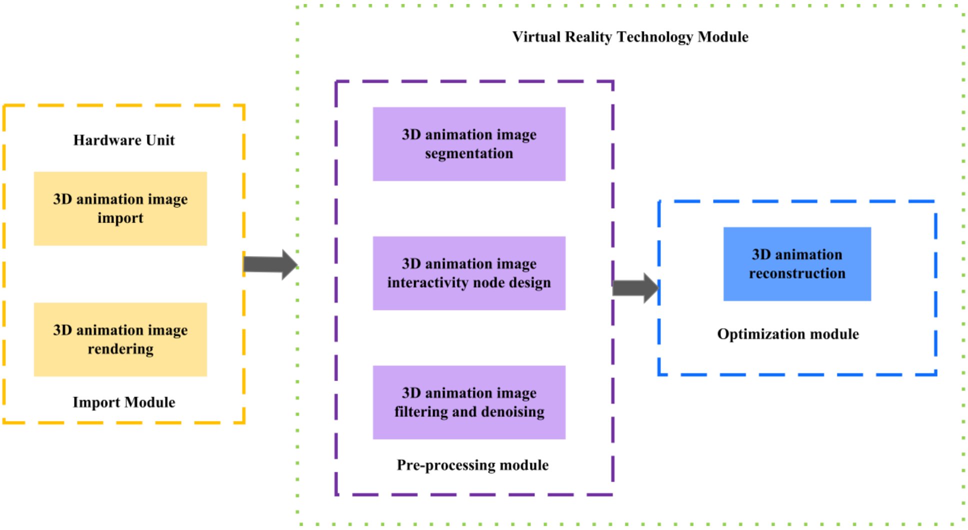

Figure 1: The overall architecture of the 3D animation optimization model integrating virtual reality technology.

Let the virtual reality technology use bias described as l, the need to segment the 3D animation image value range is $[m,n]$, image segmentation criteria as shown in Equation (14):

$$C = \frac{\sum_{n=1}^{m} \chi_n^2 - b\overline{e}_n^2}{l(\eta - 1)} \tag{14}$$

The 3D animation image segmentation weight is χ_n^2, the corresponding key information parameter is $\overline{e}_n^2$, the total segmentation area is always the real part value is b, and the corresponding real part value of the virtual reality technology processing operator is η .

When 3D animated images are designed for interactivity nodes, the normalized 3D coordinates of the animated image camera coordinates need to be calculated from the sub-pixel coordinates, as shown in Equation (15):

$$\begin{bmatrix} x_d(1) \\ x_d(2) \\ 1 \end{bmatrix} = \begin{bmatrix} c_x & 0 & q_0 \\ 0 & c_y & w_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} q \\ w \\ 1 \end{bmatrix} \tag{15}$$

The sub-pixel coordinates are denoted as (q,w), the single-world 3D coordinates are described as (X_v, Y_v, Z_v), the scale factors of the horizontal and vertical coordinates in the coordinate system are denoted as c_x and c_y, the normalized coordinate points are $x_d(1)$ and $x_d(2)$, and the center pixel coordinates of the 3D animated image are denoted as (q_0, w_0).

4 RESEARCH ANALYSIS AND DISSECTION

4.1 Virtual Reality-Based Animation Scene Construction and Automatic Generation of Validation Results

In the experimental process, five groups of 3D animation scenes were selected and the data contained in each group gradually increased, and the continuity of the traditional method of 3D animation modeling and the construction method of incorporating animation, and the results are shown in Figure 2. The experimental results show that when the number of 3D animation scenes is relatively small, both construction methods can show a good continuity and the difference is small. However, as the number of scenes increases, the gap between the continuity shown by the two construction models gradually increases, and the continuity of the traditional model appears to gradually decrease. This indicates that the 3D animation scene construction model can show better continuity and accomplish the goal of accurate matching of animation no matter the number of scenes is large or small.

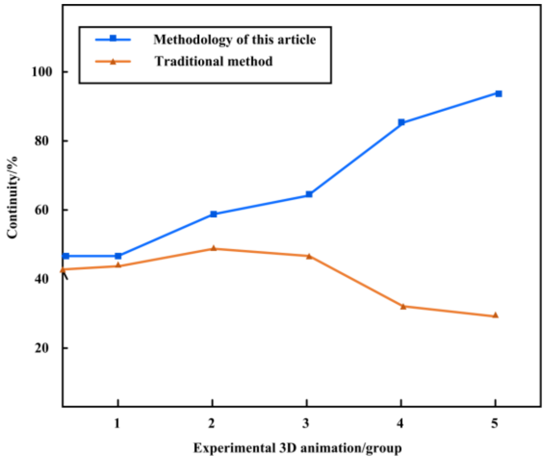

Figure 2: Two kinds of three-dimensional animation scene construction comparison experimental results.

In the 3D animation scene automatic generation model comparison experiment, the grayscale generation method, pixel reorganization method and the 3D animation scene automatic generation model are compared. In the experiment, the pixel grayscale of the 3D animation scene automatic generation model is set to 0.25, the edge blur coefficient is 0.28, the mean filter coefficient is 0.58, and the brightness and softness are 1.88. The results are shown in Figure 3. The data in the figure shows that the output error of the three generation methods gradually decreases with the increase of the number of iterations, and the output error of the automatic generation method in this paper is substantially smaller than that of the other two generation methods regardless of the number of iterations. This shows that the model in this paper can not only effectively complete the automatic generation of 3D animation scenes, but also improve the virtual reconstruction performance.

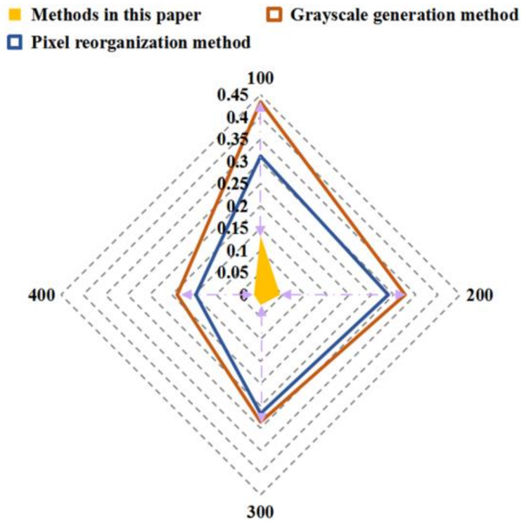

Figure 3: 3D animation scene automatic generation model output error comparison results.

4.2 Validation Results of 3D Animation Optimization Model Based on Virtual Reality Technology

This article outputs the simulation and simulation results in the form of text, images, and audio, and evaluates and analyzes the results to evaluate the performance of the model and optimize the space. Based on the evaluation results, optimize and improve the model to improve its performance and expressiveness. The comparison results of the average import rates of the three systems are shown in Figure 4. This process includes repairing details of the model, adjusting materials and textures, optimizing motion and interaction, etc.

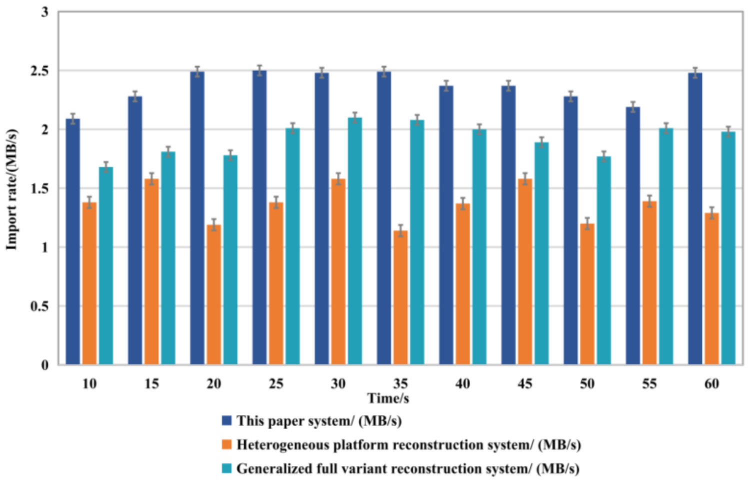

Figure 4: Comparison results of the average import rate of the three systems.

As shown in Figure 5, the comparison of the coordinate calibration results of the three systems importing the same animation images shows that the 3D animation images is lower than that of the other two systems, and with the increase of the number of animation images.

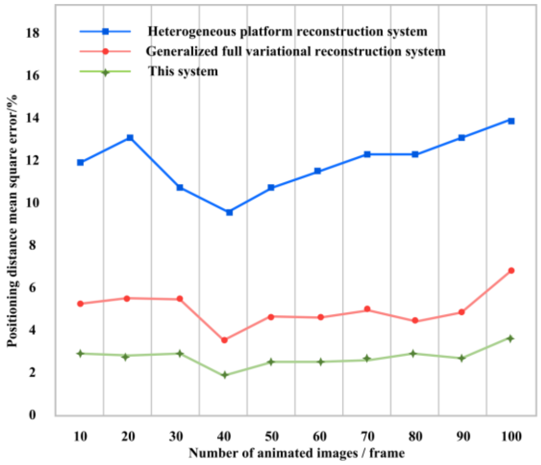

Figure 5: Comparison of coordinate calibration results of three systems importing the same animated image.

As shown in Figure 6, the overall optimized time consumption results of the three systems are compared. One hundred 3D animated images were selected for this comparison experiment, and the time consumption of import, positioning and reconstruction of the systems were compared and analyzed. The experimental results show that the time difference between the reconstruction time of the three systems is relatively small, while the time consumption of this system in each process is lower than the other two systems, and the overall time consumption has obvious advantages. This indicates that the system in this paper can achieve the optimization purpose through shorter time while ensuring the optimization accuracy of 3D animation.

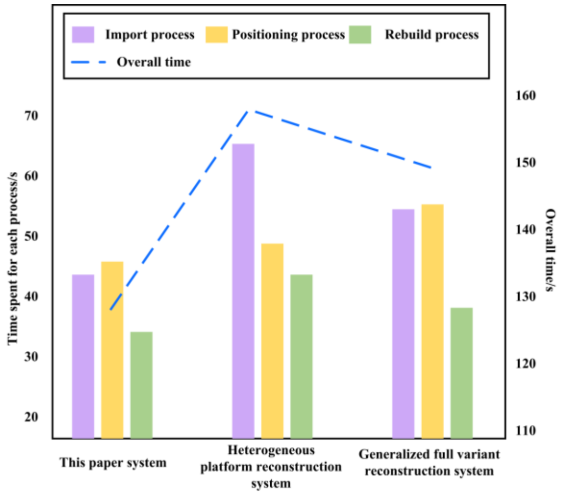

Figure 6: Comparison results of the overall optimization time of the three systems.

Figure 7 shows the comparison of 3D animation image optimization results among three systems. The results show that the system not only has good comprehensive optimization performance, but also can improve the sense of animation visual and interactive experience through high precision optimization.

(a)This paper system

(b)Heterogeneous platform reconstruction system

(c)Generalized full variant reconstruction system

Figure 7: Comparison of optimization results of 3D animation images of three systems.

5 CONCLUSION

The production of 3D animation not only has high requirements for the relevant technical personnel, but also needs to consume a lot of time for operation, so there is a problem of contradictory time and quality. Based on this, this paper proposes a key technology research of 3D animation production integrating virtual reality technology, constructs a 3D animation modeling, automatic generation and image optimization model based on virtual reality technology, optimizes 3D animation scene modeling, scene automatic generation and image respectively, and verifies the performance of the model through comparison experiments. The experimental results show that the 3D dynamic scene modeling model based on virtual reality technology has good continuity and can accomplish the goal of accurate matching of animation. Compared with other models, the automatic scene generation model in this paper has smaller output error and the output error decreases gradually with the increase of iterations, and the automatic scene generation is more effective and reconfigurable. In the system optimization performance comparison experiments, the system in this paper has faster and stable import rate, which can complete the optimization purpose in a shorter time and improve the visualization and interactivity of 3D animation.

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