Multidimensional Computer Aided Animation Design Based on Virtual Reality Technology

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Abstract. Virtual reality technology is a kind of dynamic virtual environment generated by computer. People can participate in controlling and feeling the simulation model in the environment. It is widely used in the field of the feasibility of simulation animation. The virtual animation research uses the high technology of virtual reality software and a variety of sensors, and comprehensively applies the full digital photogrammetry technology, simulation technology, etc., which can realize the real three-dimensional environment reappearance of animation and the virtual environment prediction of urban planning. The designer uses CAD drawing tools to design and model, and then transforms the database into a virtual reality system through three-dimensional software. As a channel for people to communicate with geospatial information, it provides more convenient and efficient query and analysis functions for people. Making full use of computer aided animation design and virtual reality technology can reduce designer's labor intensity, shorten design time, and improve design quality.

Keywords: Virtual Reality Technology; Animation Design; Interaction; Simulation
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1 INTRODUCTION

Virtual reality technology (VR) is a kind of computer-generated dynamic virtual environment. People can experience through certain media, and can participate in the control and feel the simulation model in the environment. This kind of technology is emerging in recent years and has broad application prospects. With the progress and development of the times, various industries penetrate each other and the competition is more and more fierce. The requirement of service experience is more and more strict. The emergence of VR meets the strict man-machine

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relationship, provides a new tool for intelligent engineering, and provides a new display space for the development of visualization.

VR has brought a new form of expression and audience experience to the animation industry. The biggest feature of VR is the immersion and interactivity it brings to the audience, placing the audience directly in the animation and entering the film as a specific character. However, the current animation production based on VR is not mature, especially in terms of interactivity. Feng [1] said it is often more of a single fusion of hearing and vision. Li et al. [2] proved that due to defects in hardware technology and interaction design, sand window effect and confusion Feeling and so on reduce the viewing effect. Riva, G [3] think it is very important to develop interactive design of VR and animation. At present, Europe, America, Japan, and other countries have carried out in-depth research on the application of VR. For example, the United States has analyzed the hardware foundation of VR and the basic fields of user interface and user perception. The application of VR has achieved good results. Domestic scholars such as Jia L Y, Zhang Y W and related colleges and universities have also carried out research work on the application of VR and have achieved certain results.

Computer aided animation design has always been one of the most urgent fields for the new visual virtual technology. VR can be widely used in all aspects of animation design, and bring considerable benefits. More importantly, it realizes the scientific animation simulation, simulation and prediction of the future change state and development trend of animation design. Using the real data of animation space to establish a three-dimensional and interactive virtual city building animation environment can realize the all-round and automatic design concept of animation design. Virtual animation construction research uses the high technology of virtual reality software and a variety of sensors, comprehensive application of digital photogrammetry technology, simulation technology and so on, can realize the real three-dimensional environment reproduction of animation, as well as the prediction of urban planning virtual environment. Architectural designers use CAD drawing tools to design and model buildings based on relevant urban data, and then transform the generated database into a virtual reality system through three-dimensional software. As a channel for people to communicate with geospatial information, it provides more convenient and efficient query and analysis functions for people.

2 VIRTUAL REALITY TECHNOLOGY

2.1 Technical Architecture of VR

The application interaction of VR mainly includes three parts: user operation, sensor equipment and virtual model. Lau K W [6] found the user conducts interactive operations in the virtual three-dimensional scene model set by the system through the sensor interaction device, and detects and feeds back the difference between the virtual and real environment in real time. Figure 1 shows the interactive process of the virtual reality system.

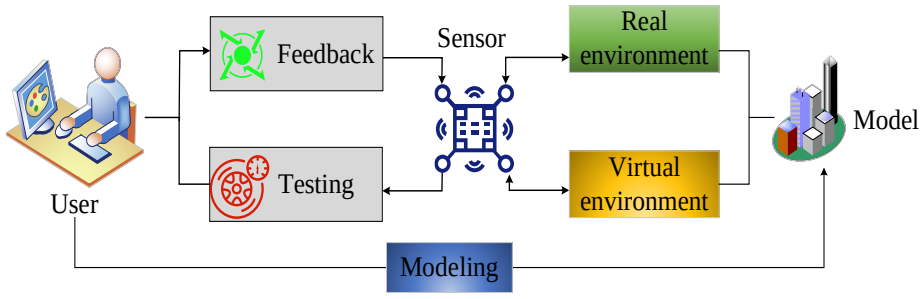

Figure 1: Interactive flow of virtual reality system.

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As the basic unit of interaction, semantic objects include behavioral components, interactive components, graphic components, application components, etc. Feedback and response to user-perceivable objects through certain rules, and to complete specific interactive tasks. Among them, the communication between different components includes two types of commands and responses. Commands mainly implement function calls and rule queries, responses are rules and behaviors of objects. Sampaio [7] found that when the interactive component wants to obtain the object status information, it sends a query command to the query component. After receiving the command, the behavior component feeds back relevant information to the interactive component, and the interactive component executes the exchange behavior according to the status information. Hardware equipment is an important support for the realization of interactive technology and user experience. The application of VR mainly includes three types of input devices, output devices and location tracking devices. Input devices include not only traditional computers, mice, and keyboards, but also various sensors and three-dimensional trackballs. Output devices include various display screens, CAVE display systems, manipulation tracking equipment includes data gloves, position detectors.

2.2 Characteristics of VR

(1) Immersion

It is also known as the sense of presence, is the degree of reality that the audience as a character exists in the animation, and it is the core of virtual reality animation. The creation of immersion is accomplished through two channels: the audience's perspective and the scene. In the world of virtual reality cartoons, the audience can freely choose characters, and through the first-person perspective, they can truly experience the audience's experience as a character in the story, resulting in an immersive sense of presence. The maximum range of sight can reach 360 degrees, and the amount of information that can be obtained is several times that of a fixed lens and picture [8]. This kind of immersive experience of 360-degree observation creates an empathy-like emotional identity that is hard to reach in other media. However, many times, when using the on-site effects of VR to create a sense of immersion, it is easy to have a misunderstanding that only through a special lens and angle to stimulate the audience is the best performance of the on-site effect. But the sensory stimulation without a story is fleeting and cannot attract the audience to watch it again. In creating immersion through the perspective of the character, the story or content should be used to strengthen the emotional link between the character and the audience. Figure 2 shows the process from virtual technology to aesthetic feeling.

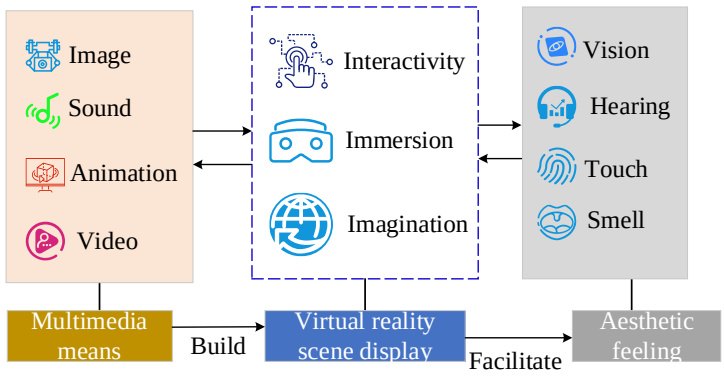

Figure 2: The process from virtual technology to aesthetic feeling.

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At present, when VR is used in other industries, its immersion feeling is not only to use the first-person perspective experience, but also to have a surreal space, which pursues the recovery degree of environment and scene, to restore real life. But for virtual reality animation, this is not necessary. First, the greatest charm of animation lies in the phenomenon of the virtual world, the pursuit of a real life does not exist in the world, if it is for the real to make animation, it will lose the meaning of animation [9]. Therefore, the immersive feeling of scene and space of virtual reality animation should be to establish an artistic space full of animation charm and imagination. In 2016, fire panda studio in the United Kingdom used VR to reproduce some classic scenes of Hayao Miyazaki's animated films, allowing the audience to experience the classic segments and plots in the animation. The audience can choose any work to enter the whole scene and interact with the characters. When the audience communicates with their favorite virtual animation characters, the excitement is irresistible. Therefore, although the effect of these images is not high-definition and delicate, but still received the audience's praise. This fully proves that the combination of VR and animation is not necessary to pursue all the reality, so that animation enthusiasts immersed in the two-dimensional world is the core. Immersive creation can not only rely on sensory stimulation, but also depends on the selection and design of virtual reality animation content.

(2) Interactivity

Interactivity means that the audience's different choices affect the development of animation plot, even change the plot, which is the requirement of virtual reality animation. Such a sense of participation is essential for the narration of virtual reality animation story, so the narrative method of virtual reality animation story must be different from the traditional narrative method. Many authorities believe that the narrative of "self-choosing ending" will give users too many choices, which will make the audience lose the sense of direction, cause the story line to be disconnected or broken, and eventually the story will not be complete. Therefore, in the design of interactive narrative, the setting of the choice point related to the development of the plot should not be arbitrary and unrestrained. The endless choice of plot development is not only a kind of torture for the audience, but also a great technical problem for the producer. The interactive narrative mode of virtual reality animation should use multiple cross story lines to tell the same event [10]. The interactive options are set at the intersection of the story lines, so that the development direction of the story can be controlled, so that different protagonists can return to the same ending after experiencing different things. The audience can choose one role or multiple roles to switch to play and tell the same story. However, due to the different perspective of roles, different experiences will be produced, so that the audience can understand the event from multiple perspectives, comprehensively look at things, and finally understand each other. Interactive diagram of virtual reality scene is shown in Figure 3.

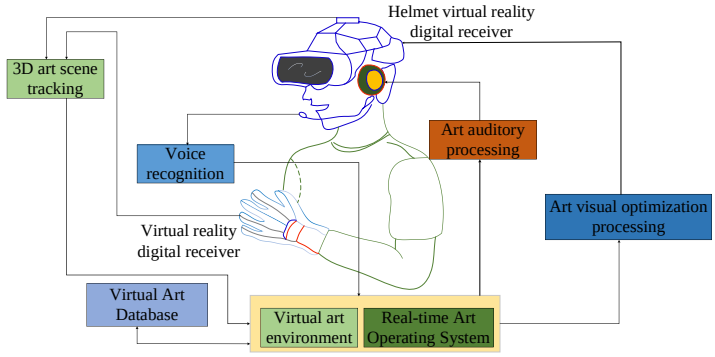

Figure 3: Interactive diagram of virtual reality scene.

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(3) Imaginative

Conceivability refers to the creative activities inspired by virtual reality, which enables the audience immersed in the environment to obtain new information, and at the same time, it can improve their cognition and generate new views. This is the purpose of virtual reality animation. VR can not only reproduce the real environment, but also conceive the environment that does not exist or even impossible [11]. From this point of view, VR and animation creation have inherent commonness, which provides the possibility for the combination of the two. The biggest feature of animation is that it has rich imagination, and the imagination of VR expands the imagination space of animation works and enriches the artistic imagination.

At the same time, the use of VR, so that the creator's ideas through the interactive experience of the audience to get better play. Due to the different social environment and life experience of each audience, there are differences in their psychological bearing capacity. For the same plot, there will be different choices, resulting in different results and effects. Before the production of virtual reality animation, we can use the virtual interaction design to collect the physical examination of different levels of personnel, and then integrate the ideas in the artist's mind with the real existence, so as to produce an animation experience more in line with the needs of real people, and trigger the audience's emotional recognition. The purpose of using VR in animation is to introduce the audience into the animation film world, enhance the appeal of traditional animation, strengthen the idea transmission of creators, and inspire the audience's thinking. When we combine the two, we should make clear the relationship between technology and content. It is a big mistake to emphasize the advantages of technology and ignore the construction of story content. Virtual reality is just technology, technology should serve the design of content [12]. Applying technology to animation creation, we should not only use the immersive experience of 360-degree observation to stimulate the audience's senses, but also use the content of animation to touch the audience's heart. All effects and means are used to establish emotional links between the characters and the audience, so that the story of the characters becomes the story of the audience. Therefore, let VR serve animation, from the nature of animation, design narrative means and scene effect around the story and character. The interactivity, imagination and immersion of VR are to make the story more complete and fuller, to make the audience and the characters have emotional resonance, immerse themselves in the character's world, react out of the same feeling, and make the fictional world closer to the audience itself. Diagram of media communication between virtual and reality is shown in Figure 4.

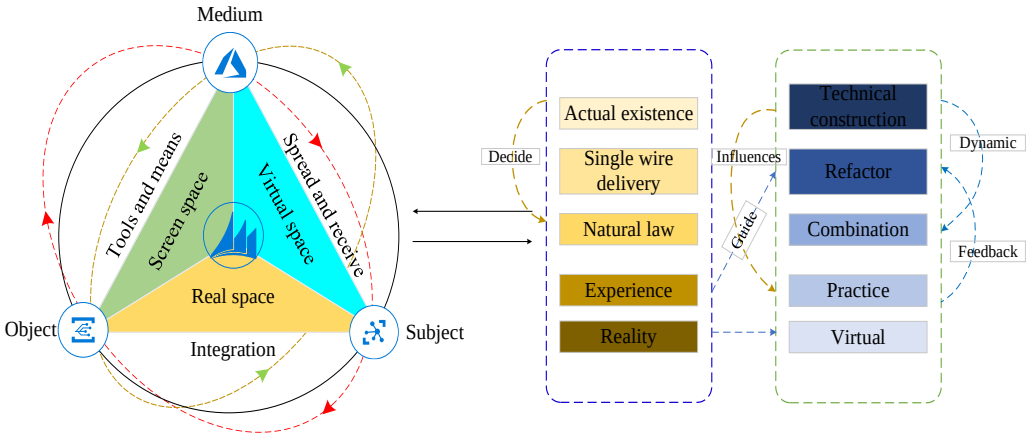

Figure 4: Diagram of media communication between virtual and reality.

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3 ANALYSIS OF ANIMATION DESIGN TECHNOLOGY BASED ON VR

3.1 Animation Interactive Node Design

Suppose (α,β) and x_a, y_a, z_a are the sub-pixel coordinates of point P in the scene image and the corresponding single world three-dimensional coordinates, respectively. According to formula (1), the normalized coordinates of camera coordinates in radial and tangential distortion are obtained from the sub-pixel coordinates in the animation scene.

$$\begin{bmatrix} x_t(1) \\ x_t(2) \\ 1 \end{bmatrix} = \begin{bmatrix} \varphi_x & 0 & \mu_0 \\ 0 & \varphi_y & \nu_0 \\ 0 & 0 & 1 \end{bmatrix}^{-1} \begin{bmatrix} \mu \\ \nu \\ 1 \end{bmatrix} \tag{1}$$

When the initial estimated value of x_n is x_t, it is expressed by formula (2).

$$x_n = \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} x_t(1) \\ x_t(2) \end{bmatrix} \tag{2}$$

The tangential vector can be expressed as follows:

$$\vartheta = 1 + \vartheta_1 r^2 + \vartheta_2 r^4 + \vartheta_3 r^6 \tag{3}$$

$$\tau = \begin{bmatrix} 2\vartheta_3 xy + \vartheta_4 (r^2 + 2x^2) \\ \vartheta_3 (r^2 + 2x^2) + 2\vartheta_4 xy \end{bmatrix} \tag{4}$$

By solving equations (2) and (4) simultaneously, the normalized dynamic animation scene image coordinates x_n can be obtained.

$$x_n = \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} (x_t(1) - \varepsilon(1))/\vartheta \\ (x_t(2) - \varepsilon(2))/\vartheta \end{bmatrix} \tag{5}$$

The values of $\varepsilon(1)$ and $\varepsilon(2)$ in formula (2) are tangent distortion values respectively. The convergent x_n value is obtained by iterating x_n with ϑ and ε for many times. Since x_n is the normalized coordinate of camera coordinate system in linear model, when the camera field coordinates are X_D, Y_D, Z_D, the transformation of world coordinate system and camera coordinate system is realized by formula.

$$Z_D \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = Z_D \begin{bmatrix} X_D / Z_D \\ Y_D / Z_D \\ 1 \end{bmatrix} = R \begin{bmatrix} x_a \\ y_a \\ z_a \end{bmatrix} + t \tag{6}$$

3.2 Modeling of Animation Design

Visual simulation plays an important role in the research of virtual reality technology. It is a very difficult task to realize computer modeling of various surface textures, gorgeous color changes, shadows, reflections, and various irregular shapes in the real world. The image-based rendering method developed in recent years has aroused great interest and become a new research hotspot in the field of computer graphics. The data model used in image rendering is composed of optical image sets, and the required views are synthesized from these images.

The main content of virtual character animation design is virtual interaction. The skeleton animation is designed based on the virtual task model made in the early stage, and the details of the character model are modified through the editing polygon, so as to create a series of virtual

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character action model library. The model library mainly includes the actions of talking, running, walking and standing, which can improve the simulation of character model making. Then, the produced characters are imported into the virtual interactive development environment to realize the design of the gravity value of the virtual characters, and set a series of parameters such as the distance in the process of object collision detection and the speed of the people in the process of walking, and set the path parameters, and set the walking path and interactive action of the characters through the interactive editor, and finally realize the operation Add the control. In the three-dimensional simulation modeling platform, the modeling technology is used to make the shape model of the figure, such as the head, hand and spine, and the skin material of the character is designed. Using bone binding technology to make character walking animation, realize the design of action library, store user-defined character color in VR character library, so that it can be called at any time. After making characters in this scene, place them in the scene, and then set the gravity value to simulate the gravity virtual environment. Then, the task path animation is designed to realize the design of bone action fusion, which can fully show the basic actions of the characters, realize the design of material refinement, moving speed and collision environment, walking camera, etc. The camera group in the motion capture system is evenly designed on the top of the building, the stereo projection system is installed in the center of the top of the room, and the 3D scanner is installed in the corner of the building. Using the design concept of this paper, using the movement step display and interpersonal interaction technology, create a real, clear and interactive experience environment of animated characters.

3.3 Motion Capture of 3D Animation

In the 3D scene, the most important part of the created human model is the simulation of the task action. Considering the current mature motion control technology, we choose to use motion capture technology and footprint animation plug-in to realize the motion production of 3D animation, the motion capture system module, that is, tracking the key point motion of each body firmware on a continuous event, describing the three-dimensional space motion process. Track through motion capture technology, optimize the processing of the motion data, and load the motion into character studio, adjust the unreasonable motion posture, and create the 3D character skeleton animation source file.

After the motion capture system is established, it is necessary to realize the design of the animation model touch detector. The touch detection is used to realize the user's operation perception, such as movement, flying, etc., to meet the three-dimensional object interaction of the viewer in the virtual world. The time sensor can defend and control the time according to a certain law to complete the change control of the animation character. Realize the creation of virtual time through the time sensor node, control the change process time of animated dynamic objects, and realize the deformation and displacement of the space object shape. The time sensor does not produce any visual effects, but rather produces node demand animation effects for the interpolator output time.

3.4 Results

In order to verify the accuracy of the experiment, the 3D scanner can be used to scan the object and create the 3D data of the surface. The surface 3D data is the 3D coordinate point set of the physical surface, and a large number of coordinate point sets are point clouds. R time sensor is in the real world. Everything in the world changes automatically and regularly, and it is not changed with the will of human beings. It is required to create automatic changes in the virtual world without manual intervention. Can use the implementation settings, according to a certain law changes to control the change of animation character modeling, control time changes according to a certain law, mainly using time sensor. The main function of time sensor node is to create virtual clock and send time value for other nodes. Control the time of the beginning, result and changing process of the dynamic object in virtual reality animation, and realize the automatic change of

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space object modeling movement, deformation and color change. Time sensor will not produce any modeling and visual effects in virtual reality animation. Its main function is to output events for the interpolator, so that the interpolator node can produce the animation effect required by the node. This node mainly includes the child nodes in any group node, but is independent in the coordinate system used. This kind of 3D model is fast and has high precision. Figure 5: shows the comparative analysis of computational efficiency.

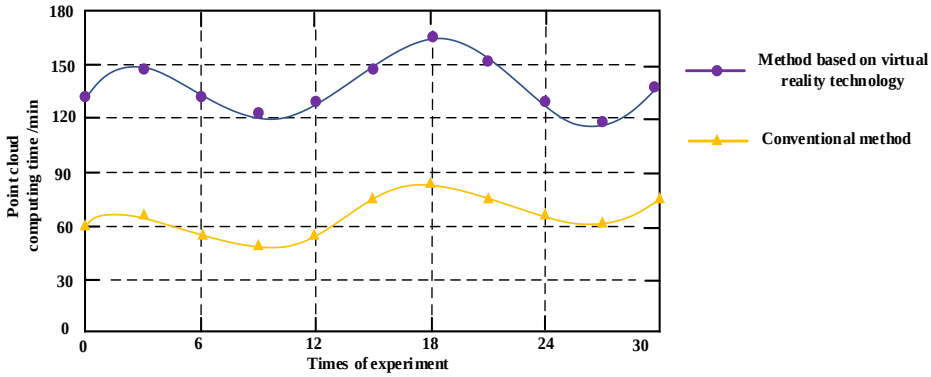

Figure 5: Comparative analysis of computational efficiency.

Using the method based on VR and the conventional method to do animation scene graphic design experiments, and compare the positioning distance mean square error of the performance index parameters of the two different methods for animation scene graphic design. Figure 6: shows the comparative analysis of positioning error.

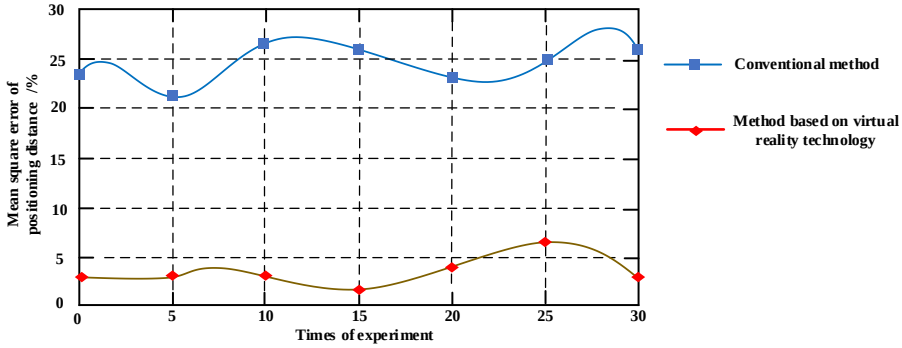

Figure 6: Comparative analysis of positioning error.

Through the analysis of Figure 6, it can be seen that the positioning error of performance index parameters of animation scene graphic design based on virtual reality technology is lower than that of conventional methods, Using the method based on virtual reality technology and the conventional method to carry out the animation scene plane design experiment, two different methods are used to compare the reconstruction accuracy of animation scene plane design, and the number of point clouds is used to compare the reconstruction accuracy of animation scene plane design under different methods. The comparison results are shown in Table 1.

Number of trials	Virtual reality technology-based method	Conventional method
5	56548	23726

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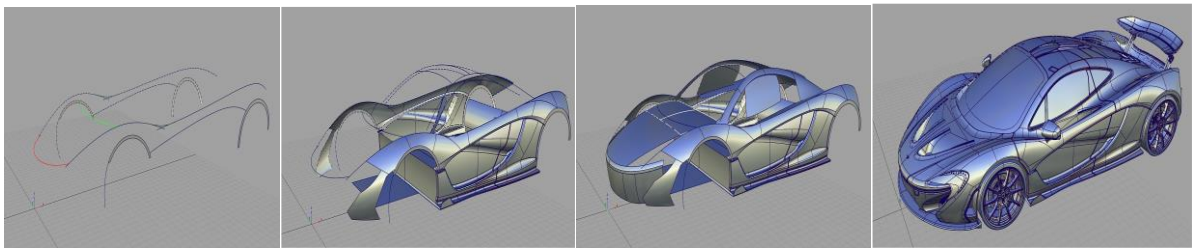
10	54783	26235
15	55548	24492
20	53527	23857
25	52852	25847

Table 1: Comparison of point clouds under different methods.

The number of point clouds of animation scene graphic design based on virtual reality technology is more than that of conventional methods, which makes the improved method can effectively improve the accuracy of reconstruction. Application Analysis of Virtual Reality Technology in 3D Animation Production.

3.5 Application of Virtual Reality Technology in 3D Animation Modeling

Before making 3D animation, we must first determine the animation magic. The animation model mentioned here can be a few static pictures or a short 2D video. The choice of 3D animation model is very important for 3D animation production. In this link, the relevant technical personnel should arrange a corresponding animation background and animation production scene according to the selected animation magic heart. However, in the production of animation models, VR does not coarse-grain the prepared picture models. It only incorporates some human-computer interaction animation character models through computer technology, so that the animation effects can be rendered vivid. The state satisfies people's visual experience, the relevant operation steps are as follows: First, the technicians collect relevant materials according to the animation effects they want to create. The collection of materials is generally based on on-site materials. For some important materials, aerial photography and other related technologies can also be used as model construction. Provide more information for the application of VR to achieve the improvement of the level of 3D animation production. Secondly, use VR to carry out 3D animation modeling. The actual modeling process of 3D automobile is shown in Figure 7.



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

Figure 7: The actual modeling process of 3D automobile.

3.6 Application of VR in Motion Capture System

VR can be applied to all the details of life. The more classic is the related system used in motion capture. When applied to the motion capture system, it can track the motion trajectory of related objects in real time and capture its related dynamics. When VR is applied to the capture system, it is necessary to rely on the computer to perform the necessary processing of the relevant images. The processed image must be fine-tuned on the surface where necessary according to the specific object characteristics. The adjusted image can make the director in the later stage. In video production, you can switch to different lens positions at will. After the application of the capture system, the experiencer can experience a clearer scene in the virtual reality world, and random

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lens switching will also bring people a better experience. Application examples of VR in motion capture is shown in Figure 8.

(a) (b)

Figure 8: Application examples of VR in motion capture.

4 CONCLUSIONS

In summary, with the rapid development of animation design, the application of VR in this field will inevitably receive high attention. From the analysis of this article, the application of VR to animation design can not only make abstract things concrete and clear, but also make the scenes and characters in the animation more realistic and improve the vividness of animation works. In the future, as the scope of animation applications continues to expand, the optimization and perfection of computer virtual simulation technology will inevitably be very important. Only by continuously improving the VR can we produce better three-dimensional animations and better play its role. With the help of VR, it has a great impact on people's vision, so that people can truly feel the content conveyed by animation. VR can not only enhance the effect of animation production, but also better promote the development of animation design technology.

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