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The Application of Virtual Reality Technology and Real-Time Rendering Algorithms in Film Production

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Abstract. With the continuous maturity of film technology, the digital creation and interactive atmosphere design of intelligent technology has become widely popular. The spatial design of film art is not only intended to create an atmosphere and deepen the theme but also to reflect its individual artistic value while serving the plot of the film, providing visual enjoyment. With the continuous development of movies, the public has a deeper understanding and demand for film spatial design. After the substantial role of film art spatial design in movies, spatial design plays an irreplaceable role in the aesthetic expression of film art. This paper embarks on an exploration of virtual reality technology's application in film production, investigating its assistance in three-dimensional image reconstruction and complementing it with research on scene optimization using real-time rendering algorithms. Initially, starting from the concept of virtual reality technology, its characteristics, and global application status are analyzed. Within film production, the enhancement strategy of virtual reality technology in generating three-dimensional images is examined. Traditional three-dimensional image surfaces undergo virtual reality-based reconstruction, followed by leveraging virtual reality technology for minimum distance calculations after the acquisition of three-dimensional image edge feature information, thereby enhancing image resolution and reconstruction success rates. Subsequently, film production's virtual reality scenes are optimized, employing real-time rendering algorithms to enhance spatial rendering quality. The overarching objective is to achieve realism in real-time rendering, with improvements made in terms of local algorithm execution efficiency and rendering speed. Finally, the study presents research findings and analyses pertaining to the application of virtual reality technology in three-dimensional image reconstruction within film production,

alongside exploring audience feedback on the real-time rendering optimization of virtual reality scenes.

Keywords: Film Production; Virtual Reality Technology; Real-Time Rendering; Three-Dimensional Images; Scene Optimization
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1 INTRODUCTION

Movies and television are products of technological advancement, as well as a fusion of the era and art. Alhakamy et al. [1] elaborated on using suspense as a specific type of film as the research object. The construction of spatial visual elements and colour visual elements through visual elements interprets the artistic expression of visual elements in the application of film art spatial modelling. It conducts modelling analysis on visual elements and summarizes its research content and methods by analyzing the characteristics and expressions in suspenseful spatial modelling. Theoretical exposition of visual elements, suspense films, and film art space modelling, combined with actual films as the analysis object, to analyze the expression techniques of film art space modelling. Using real scene images to guide the lighting of virtual scenes especially adds realism and immersion to rendering. Chen et al. [2] proposed a progressive 3D flow method for perception optimization in their research on 3D asset flow under edge cloud settings. They optimized the execution efficiency of algorithms on edge devices to ensure high-quality rendering even on devices with limited computing power. This high requirement poses many challenges for traditional rendering algorithms to execute on edge devices, such as limited computing resources and data transmission delays. In the immersive experience of VR, direct interaction between users and the virtual environment places extremely high demands on the real-time and quality of rendering. This method not only combines advanced rendering algorithms in film production but also deeply optimizes the characteristics of VR applications while ensuring rendering effects. Through progressive streaming technology, users can first see partial rendering effects while waiting for complete data loading, thereby reducing waiting time and improving the user experience. This optimization not only improves rendering efficiency but also ensures that users can obtain a high-quality visual experience.

By changing the number and size of points, as well as the form of aggregation and dispersion, circular shapes can be formed, while the combination of changes in the length and thickness of lines can also form rectangular shapes. The interaction between points and lines forms a surface that conforms to the scene, making the spatial design of the movie more aesthetically and functionally distinctive. The expression of form conveys common spiritual attributes and is a very important visual element in the spatial design of movies. Díaz et al. [3] summarized and summarized the combination of points and lines based on this feature, with points and lines as the basic visual elements. By cutting, splitting, misalignment, deformation, and other morphological changes, the shape of the construction is created, which is the face. Faces exist in a specific space with a relatively large area, causing them to act as obstructions in the application of spatial modelling. From the perspective of communication studies, it refers to the cultural form in which both the communicator and the receiver must be familiar with the communication environment and symbols. Therefore, there will not be much foreshadowing, but rather a postmodern narrative style that is characterized by "short and concise," "hitting the key points," and "results first and causes later," infinitely magnifying the parts that the audience is most interested in. Dilute the secondary plot, highlight and strengthen the climax and ending, which is the accumulation and sudden turn of suspense. In order to achieve rapid emotional resonance with the audience in a short period of time, this is also the personality of the internal narrative structure of microfilms. Therefore, the introduction of hyperspectral textures in film production provides creators with more possibilities. Advanced rendering algorithms can not only simulate realistic lighting effects and physical environments but also delicately capture and express the emotions and actions of characters. Through analyzing characters, narratives, and the use of VR film equipment, we find that empathy is not naturally generated but rather carefully designed and

planned. It is precisely this kind of humanitarian VR film that promotes emotional styles such as empathy through the script of suffering and hope, which also triggers our thinking about its true purpose [4]. From a creative and manufacturing standpoint, virtual reality technology has shifted the core mode of film production from artistic literature to visual experience, transmitting sound and images in scenes to create a more vivid, direct, and tangible experience. This interactive form of film presentation breaks away from the traditional two-dimensional display and allows audiences to immerse themselves in the effects of film production while conveying the filmmakers' conceptual ideas more effectively. This more realistic and real-time approach to film production makes the audience's experience tangible rather than merely a notion.

Furthermore, virtual reality technology plays a significant role in various aspects of film production, such as script creation, scene arrangement, shooting, image processing, and post-production rendering. The rapid development of artificial intelligence technology has not only profoundly changed television content and production methods, giving birth to a new generation of artificial intelligence television, but also triggered revolutionary changes in the field of film production, especially in rendering algorithms. Traditionally, these algorithms require a significant amount of computing resources and time to generate realistic lighting effects, complex materials, and dynamic scenes. In FTA teaching, Kathiravan [5] utilizes these advanced rendering algorithms to enhance students' practical and innovative abilities. Secondly, by combining professional rendering algorithms in film production, teachers can guide students to explore different rendering methods and techniques to create unique visual effects. VR technology can not only enhance the basic training and teaching of FTA, such as 3D animation courses but also be combined with professional skills courses to further improve students' learning effectiveness. Through practical operation, students can better understand and master the process and techniques of film production. By creating various forms of virtual content using virtual reality technology, the film production process is streamlined, and costs are reduced, addressing previously challenging technical issues and shortening the time required for film completion. The popularization of artificial intelligence technology is not only beneficial for improving the quality of TV program content, innovating content categories, reducing production costs, and improving efficiency, but it also shows great potential in the field of film production. In the production process of these virtual scenes, efficient rendering algorithms play a crucial role. The rendering algorithm is an indispensable part of movie production, which determines the visual effect and production efficiency of the final image. With the development of artificial intelligence technology, Kivi et al. [6] have seen some machine learning-based rendering algorithms that can generate high-quality images faster and more accurately. For example, students can learn how to design scenes, arrange lighting and materials in a virtual environment, and see the rendered effects in real time. By combining existing VR technologies such as dynamic environment modelling, real-time 3D graphics generation, stereoscopic display, and sensor technology, film production teams can design more realistic virtual scenes. It is expected that students who use VR technology and advanced rendering algorithms will exhibit higher satisfaction, stronger practical abilities, and better learning outcomes.

This, coupled with the assistance of new technologies, presents better prospects for the entire film production market. Additionally, it allows for the recreation of complex scenes and the simulation of various processes, resulting in smoother integration of visual content and more realistic visual effects in certain special scenes. Virtual reality (VR) rehabilitation technology, as an innovative means of recovery, significantly improves patient engagement and rehabilitation outcomes by creating immersive experiences. In VR rehabilitation training, traditional feedback methods may be too direct or mechanical, thereby disrupting the patient's immersive experience. Quintana et al. [7] utilized NPR technology to highlight the motor parts that patients need to focus on while downplaying other irrelevant elements in the scene. This tool supports multiple NPR configuration options, allowing rehabilitation therapists to choose the most suitable NPR plan based on different rehabilitation needs and environments. It proposes a novel feedback strategy that combines non-realistic rendering (NPR) technology with advanced rendering algorithms in film production to achieve more intuitive and effective visual feedback in VR rehabilitation environments. For non-interactive exercise objects, use wireframes or simplified models to maintain clarity. This

method not only helps guide patient attention but also enhances immersion by simulating visual effects in movies. In the experiment, Rodrigues and Loureiro [8] provided corresponding products on YouTube for 2D format movies. Advanced rendering algorithms can more accurately simulate light and shadow effects, textures, and materials, as well as achieve more realistic physical simulations, thereby creating a more immersive viewing experience. For the VR version, they have prepared Oculus Rift headphone devices for participants to experience. A total of 145 participants were recruited to participate in this study. It can not only enhance the visual effect of the picture but also enhance the audience's immersion through more realistic lighting and physical simulations. This immersion is crucial for influencing the audience's empathy and empathy, as it allows them to have a deeper understanding and experience of the characters and situations in the movie. The research results indicate that the combined effect of technological form and film genre has a significant impact on the audience's sense of calmness. Further analysis reveals that advanced rendering algorithms have played a crucial role in VR movie production.

In traditional film production, motion capture of extras often involves the use of green screens and sensors to transmit actor movements, typically utilized for the processing of three-dimensional images of actors' movements. When virtual reality technology is combined with this visual sensor technology, spatial equipment such as cameras can be used to improve the accuracy of motion capture, increasing the success rate and efficiency of three-dimensional image reconstruction within computers. To achieve more realistic scene construction in film production, it is also necessary to combine real-time rendering algorithms, which make virtual reality spaces closer to real-life experiences. Real-time rendering algorithms start from three-dimensional virtual scenes, based on factors such as space, light sources, and images, rendering three-dimensional scenes into stereoscopic visual images and projecting them onto screens for audience feedback. The audience's understanding of the surrounding environment also relies on sensory perception; thus, the stronger the real-time rendering effect, the better the audience's experience of the environment. In conclusion, the application of virtual reality technology and research into real-time rendering algorithms in film production have been popular research topics in recent years. This paper explores the reliable process of three-dimensional image reconstruction in film production using virtual reality technology and analyzes audience feedback on real-time rendering effects in scenes.

2 RELATED WORKS

In today's pursuit of higher realism and stronger immersion in film and television works, the dependence of film production on technology is becoming increasingly significant. Tong et al. [9] proposed a two-dimensional human motion image recognition system and a three-dimensional human motion recognition system that combines the DL convolutional neural network (CNN) algorithm. In terms of two-dimensional image recognition, the computational performance of the algorithm they use on actual datasets is 7-9 times that of existing open methods. In the field of 3D motion recognition, its system has shown significant advantages. Its running time is only 44.3ms, far lower than the 874.5ms and 126.7ms of the open pose method. Furthermore, by combining movie production rendering algorithms, two-dimensional and three-dimensional human motion data can be transformed into realistic visual representations. This means that in virtual reality scenes, the audience can feel the actions and emotional changes of the characters in real-time and smoothly, further enhancing the immersion of watching movies. Advanced rendering algorithms can simulate light and shadow effects, material textures, and dynamic scenes in the real world, making virtual characters and scenes more visually realistic and vivid.

Film art and technology are closely connected, and the application of virtual reality technology in movies has changed the form and nature of movie images, thereby affecting the artistic effect of movies. Especially in the field of movie scene design, with the development and application of virtual reality technology, magnificent and stunning movie scenes can be created. However, at present, the scene design of domestic movies is still mostly expressed through traditional on-site settings or 3D modelling, and the technology lacks deep integration. The traditional film scene design methods and

workflow are obviously no longer able to meet the aesthetic and efficiency requirements of contemporary films [10].

Nowadays, the application of virtual reality technology in film scene design, character design, and special effects design has become one of the main production contents of science fiction, magic, disaster and other themed films. The movie scene design of virtual reality technology deeply integrates digital landscape technology, 3D scene modelling, 3D scene texture projection, and post-production synthesis into one design and production method. Wang et al. [11] analyzed the development of film technology and the current status of virtual reality technology and studied and elaborated on the technical characteristics and processes of virtual reality technology in contemporary film scene design. Virtual movie scene design and virtual preview shooting applications can significantly improve the efficiency of movie shooting and production, reduce setting and transition costs, and save resources. The application of a virtual preview shooting system has changed the traditional "shoot first, make later" mode commonly used in movies. The new model of "post-production pre-production" for virtual filming and production of movies will become a future industry trend. It can also improve the on-site control ability of directors and photographers, making actor performances more intuitively integrated into virtual scenes. At the same time, creating visual wonders and continuously improving the viewing experience. Virtual reality technology covers the entire production process of film creation, from pre-production and on-site filming to post-production. Summarize the advantages and shortcomings of virtual reality technology in movie scene applications. Based on the author's years of experience in the film and television industry, Young et al. [12] used the application of virtual scene design in several films they participated in as the argument for the innovation of this study. With the advent of the digital age, more and more movies are applying virtual reality technology to the filming and production process, especially in surreal-themed movies such as science fiction and fantasy. The combination of virtual reality technology and film art has changed the form and nature of film images, thereby affecting the artistic effect of movies. Throughout the history of film development, film art and technology have been closely linked, and the development and application of virtual reality technology in the field of film have created the brilliance of contemporary cinema. Virtual reality technology has brought unprecedented shock effects to the audience in terms of audio-visual experience, and to some extent, it is even more imaginative and artistic than traditional movies [13].

In order to significantly improve the design effect of 3D film and television animation, Yuan and Huixuan [14] deeply explored the integration of virtual reality (VR) technology and 3D film and television animation design. Firstly, based on the established 3D film and television animation scene, they carried out fine texture mapping, giving each element in the scene a vivid appearance and texture. This algorithm can accurately identify and optimize redundant and irregular parts in the model, thereby reducing computational complexity and improving rendering efficiency while ensuring model details. In addition, it also combines advanced rendering algorithms in film production, adding new dimensions to the entire design process. We utilized Unity3D software to achieve roaming interaction in 3D film and television animation scenes and constructed highly realistic 3D film and television animation scenes through precise manual modelling. Carefully adjusting various rendering parameters and algorithm settings ensures that the rendering effect of the scene and characters reaches the best state. With the rapid development of big data and artificial intelligence technology, digital media technology has ushered in unprecedented innovation opportunities. By constructing realistic virtual scenes, VR technology enables film production teams to preview and modify scene effects in real-time, greatly improving production efficiency. In film production, virtual reality technology combined with advanced rendering algorithms has brought revolutionary changes to film and television production. The application of these algorithms makes the movie visuals more vivid and realistic, making the audience feel as if they are immersed in the world depicted in the movie. Especially the integration of virtual reality (VR) technology has not only opened up new development paths for digital media technology but also demonstrated enormous potential and value in film production and rendering algorithms. The development of digital media technology, especially the application of VR technology, has not only brought technological breakthroughs to film production but also further shortened the distance between audiences and movies. In order to deeply study the role

and value of virtual reality technology in digital media technology, Zhao et al. [15] established an evaluation model using data analysis methods. This immersive viewing method has taken the development of digital media technology into a new fast lane, further improving the efficiency of digital media information dissemination.

In the rapid development of modern technology, virtual reality technology, as an independent discipline with unique characteristics, can create more immersive virtual spaces relying on various advanced electronic devices, with computers as the operating platform. The comprehensive application of virtual reality technology can provide more convenient assistance to society. Completing various operations in a virtual space can optimize the experience of indirect simulation. Devices such as virtual environment perception, natural language processing, visual communication, and sensors collectively constitute the core of virtual reality technology. At the current stage, advancing reality technology can provide users with more direct and natural real-time interactive functions, achieving the goal of interacting with virtual space. It possesses several important qualities: firstly, perceptiveness, where virtual reality technology can utilize various inducement media to enhance the audience's perception of multiple senses such as hearing and touch. Secondly, presence, also known as scene presence, can directly present the spatial effects in virtual scenes, allowing users to experience the interaction between reality and virtuality. In this simulated environment, most users find it difficult to distinguish between reality and virtuality. Lastly, interactivity, where users can customize any object or object in the virtual scene and respond to them in a natural environment through an operable console.

3 APPLICATION OF VIRTUAL REALITY TECHNOLOGY AND REAL-TIME RENDERING ALGORITHMS IN FILM PRODUCTION

3.1 Research on the Application of Virtual Reality Technology in Three-Dimensional Image Reconstruction in Film Production

Virtual reality has made significant progress in the United States, which is also the birthplace of virtual reality technology. In the 1980s, universities conducted in-depth research on projects such as virtual visual environments and developed workstations mapping virtual reality technology interfaces and computer interfaces. Utilizing this test project, the exploration of space could be conducted in a virtual environment. They also achieved the overlay of virtual environments with real scenes in the aviation field. In the United Kingdom, more attention is paid to providing clients with realistic editing environments in virtual reality technology research. They divide the natural language driving program into different tasks using virtual reality software and implement distributed parallel processing and haptic feedback functions in software development.

Real-time rendering algorithms differ significantly from offline rendering in terms of feedback results. Real-time rendering requires a system frame rate of at least 60 and optimizes scene simulation based on user input feedback. Offline rendering does not have the high efficiency of real-time rendering and often prioritizes higher-quality images. In recent years, countries like Japan have conducted in-depth research on real-time rendering algorithms from different perspectives, such as optics, space, and specific scenes. They found that real-time rendering algorithms can improve the realism of shadow generation in virtual reality scenes. By considering the distance between occluders and shadow receivers, the scene becomes more realistic and logical. Additionally, they have incorporated global illumination and ray tracing technologies into real-time rendering algorithms, enhancing the reliability of real-time rendering in practical applications. According to their research results, real-time rendering algorithms can play a good auxiliary role in optimizing virtual scene spaces and have certain effects in handling both static and dynamic spaces. As an integral part of the film industry and entertainment sector, film production places increasing emphasis on the application of virtual reality technology. Virtual reality technology offers robust functionality in film production, enabling diverse presentation methods and enhancing immersive viewing experiences for audiences. We conducted a statistical analysis of research on the application of virtual reality technology in film production across different countries, as illustrated in Figure 1.

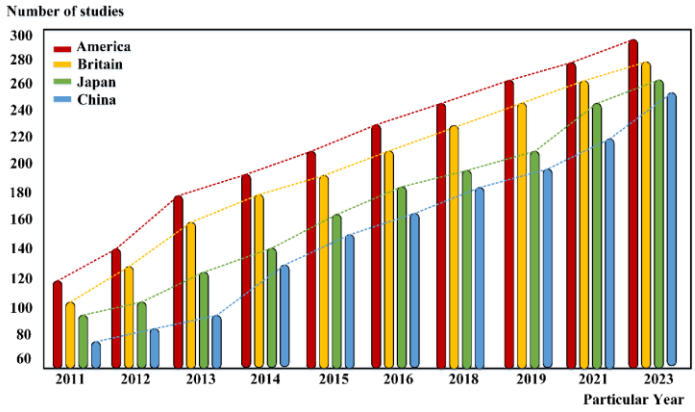

Figure 1: Changes in research on the application of virtual reality technology in film production in different countries.

From Figure 1, it is evident that the United States leads in research on virtual reality technology, resulting in more mature application research in film production with a higher quantity of studies. Following the United States is the United Kingdom, with research on the effectiveness of virtual reality technology in film production second only to that of the United States. Finally, Japan and China trail behind. Japan's animation industry extensively employs virtual reality technology, applying it to the production of animated films. With the rapid development of computer technology and artificial intelligence in China, virtual reality technology is also gradually maturing. The research outcomes of the integration of virtual reality technology and film production have been increasing in recent years. Since three-dimensional images are crucial components of film production and presentation, we focus on exploring the process of virtual reality technology in completing three-dimensional image reconstruction. In traditional image construction, when spatial objects are imaged, the transition from three-dimensional to two-dimensional results in the loss of some data, affecting scene information acquisition and the depth perception rate of images. To obtain the information described by the image scene accurately, virtual reality technology is utilized for three-dimensional reconstruction to enhance the accuracy and reliability of image content. Virtual reality technology, as a simulation system in computers, can create and improve virtual scene effects, providing audiences with better experiences. Under virtual technology, users and designers can rearrange images using virtual equipment according to their preferences and integrate various elements to enhance the resolution of three-dimensional image reconstruction. To obtain depth information from three-dimensional images, we first estimate the shooting scene and visual principles, adjust the camera positions for image acquisition, and determine the specific motion trajectory of three-dimensional images in film production shootings. The formula for the real coordinates in three-dimensional space is:

$$[x, y, z, 1]^T \tag{1}$$

When extracting three-dimensional images using information collection devices, the trajectory of the device's movement changes with the movement of the object. The equation for the motion trajectory at a certain moment can be expressed as:

$$S(t+1) = C \bullet A(T) \tag{2}$$

$$Y(o) = G \bullet s(t+1) \tag{3}$$

The formula C represents the matrix of motion changes of the target point at this moment, which contains trajectory variation data of the target. Through multiple data transformations, the relative spatial position of the target object captured by the collection device can be obtained. Subsequently,

utilizing the imaging principle of the camera, the derivative calculation of the target's posture is performed:

$$f(C)=\frac{1}{z^2}\begin{bmatrix}-xy,-(z^2+y^2)\\ x^2+y^2,xy\end{bmatrix} \tag{4}$$

$$f(C^{'})=\frac{1}{u^2}\begin{bmatrix}-yz,-(x^2+y^2)\\ y^2+z^2,xz\end{bmatrix} \tag{5}$$

$$f(C^{''})=\frac{1}{h^2}\begin{bmatrix}-xz,-(t^2+s^2)\\ x^2+z^2,0\end{bmatrix} \tag{6}$$

Using the imaging principle, the changing matrix is rotated to reconstruct the image scene and pixel distribution, completing the projection and mapping correspondence. Within the same target point, the projection positions of the three-dimensional images are mutually constrained. According to geometric algorithm principles, coupled with image original coordinates, the calculation formula for their relationship is obtained:

$$a_2^T\zeta a_1=0 \tag{7}$$

$$\zeta a_1=L_2+u^2 \tag{8}$$

In the formula, L_2 represents the mapping point of the three-dimensional image. The relationship between the essence matrix of the image and the imaging space matrix is represented as:

$$B=K^T\zeta L_0 \tag{9}$$

By estimating the above formulas, each frame of the image can obtain the position and posture at the corresponding moment during virtual reality technology reconstruction. The resolution of the image and the pixel of feature points depend on the minimum numerical calculation. To ensure the integrity of information during the reconstruction process, the formula for describing feature points is defined as:

$$\Delta(P_f,W)=\ x_1,x_2,\ldots,x_n \tag{10}$$

The formula W represents the feature dimensions describing the image. We compare the three-dimensional images reconstructed using virtual reality technology, as shown in Figure 2.

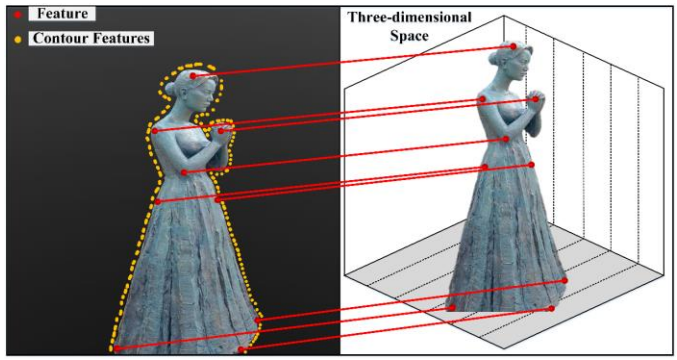

Figure 2: Reconstruction of 3D images using virtual reality technology.

From Figure 2, it can be observed that after extracting the original image, reconstruction is carried out based on the feedback positions of the feature points. This transformation converts the original

two-dimensional image into a three-dimensional stereoscopic image. Additionally, in the reconstructed scene, the surfaces of objects can become more refined, which contributes positively to the presentation effects in film production.

3.2 Research on Optimization of Virtual Reality Scenes and the Effect of Real-Time Rendering Algorithms in Film Production

In film production, a variety of virtual reality scenes are needed, which involve not only computer and smart technologies but also environment modelling, real-time rendering algorithms, sensor technologies, and more. Real-time rendering algorithms render realistic effects for given virtual reality spaces and three-dimensional object surfaces, starting from three-dimensional scenes. The efficiency and flexibility of real-time rendering algorithms address the issue of poor realism in traditional rendering environments. In conventional rendering methods, the sensitivity of the audience's visual system is often overlooked, resulting in uneven distribution of feature points in virtual reality scenes and consequently reducing the overall realism of the space. To enhance the sensitivity of the audience's visual experience and the quality of rendering, we combined virtual reality technology with real-time rendering algorithms to build a real enhancement system. Taking a specific region in a three-dimensional image as an example, multiple images are transformed into three dimensions in real-time rendering, involving algorithms that solve calculations for different requirements such as central angle and solid angle. The formulas are as follows:

$$\theta = \frac{l}{r}[r] \tag{11}$$

$$\Omega = \frac{A}{r^2}[sr] \tag{12}$$

Assuming that each axis of the three-dimensional coordinate system is facing upwards, the three-dimensional angle determines a direction for stereoscopic imaging during rotation. When the directional angle changes, different trajectories will be generated in the virtual reality scene. By connecting these trajectories, the rendered area can be obtained. Since the degree of curvature of multiple trajectories varies, the resulting rectangular area also differs. Therefore, the area can be represented as:

$$dA = (rd\theta)(r\sin\theta d) = r^2\sin\theta d\theta \tag{13}$$

$$dw = \frac{dA}{r^2}\sin\theta d\theta \tag{14}$$

By recombining three-dimensional space and defining it using mathematical formulas, real-time rendering of optical propagation can enhance the realism of the scene. This physics-based rendering technique can change the simulation process of light propagation, making the colours of objects and objects in the virtual scene adapt to the environment, thereby achieving simulation results. If the actual intersection between light and objects is close, then considering the target object as a feature element in the rendering device can greatly reduce the time consumption of real-time rendering algorithms during runtime. Using mathematical theorems to represent the power of light reflection brightness:

$$E(x) = \frac{d\Phi(x)}{dA}[\frac{w}{m^2}] \tag{15}$$

All the calculations made during the rendering process are aimed at obtaining the specific coordinates of each target feature point in the virtual scene in order to match the lighting rendering effect that is more suitable for the scene space. We will map the reflections and spatial angles involved in the rendering process to an image representation, as shown in Figure 3.

From Figure 3, it can be seen that in three-dimensional space, the mapping process of image regions can be calculated using spatial angles and has a certain relationship with the direction of human visual capture. Due to the fact that three-dimensional virtual space itself is a three-dimensional image, it is necessary to pay attention to the simplicity of rendering during the

rendering process, in order to reduce the running cost of real-time rendering algorithms. The simplified pixel data changes using virtual reality technology and real-time rendering algorithms can be represented by comparative calculation, as shown in Figure 4.

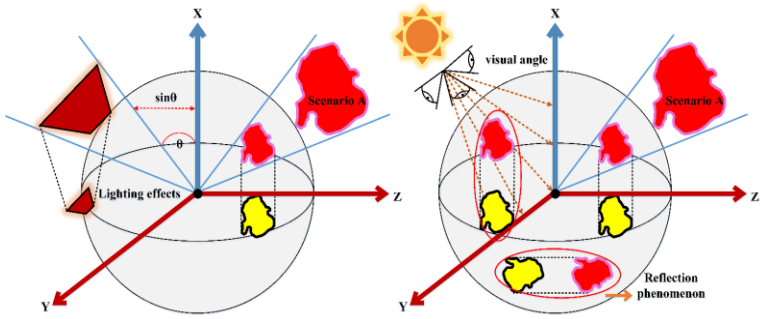

Figure 3: Reflection and spatial angle mapping during the rendering process.

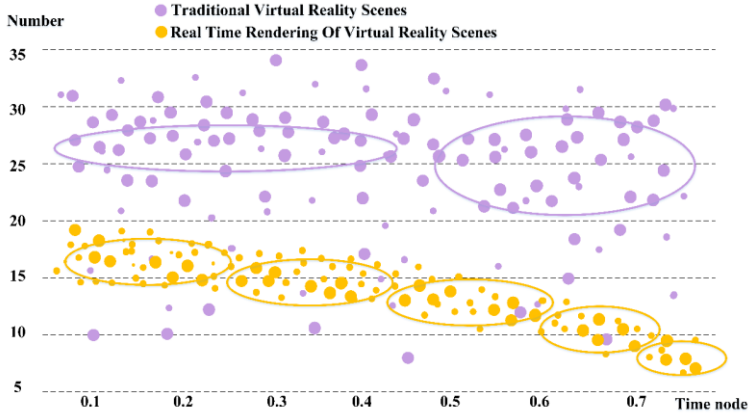

Figure 4: Changes in pixel data volume in two ways.

As shown in Figure 4, in traditional virtual reality scenes, pixel data is widely distributed and has a large amount of data. The pixel distribution of virtual reality scenes optimized using real-time rendering algorithms is relatively regular, and the dynamic changes generated are also relatively small, which can reduce some pressure for building movie production scenes.

4 ANALYSIS OF RESEARCH RESULTS ON THE APPLICATION OF VIRTUAL REALITY TECHNOLOGY AND REAL-TIME SCENE RENDERING ALGORITHMS IN FILM PRODUCTION

4.1 Analysis of Research Results on the Application of Virtual Reality Technology in 3D Image Reconstruction in Film Production

This article extracts the application scope of virtual reality technology in film production from the literature review. Firstly, interactive film production is the field where virtual reality technology is most frequently used. Whether in shopping malls, memorials, museums, or daily life, it is common to see people using head-mounted virtual reality devices to interact with movie content using virtual controllers. This virtual technology breaks through traditional visual methods and allows viewers to directly participate in film and television works. By changing one's own behaviour, it influences the development of the movie plot. With the increasing maturity of virtual reality technology, this

interactive film production method allows more real-time images to be presented, and the masses are no longer simply the audience and receiving group, but the main objects that can directly participate in control. Next is the reconstruction of virtual characters. In film production, virtual characters are generally divided into two types. One type is the main characters in script production, who are designed by filmmakers and have their own unique personalities and appearances, making it convenient for businesses and organizations to promote their image and achieve the goal of pyramid schemes. Another approach is to use real avatars to capture behavioural trajectories. The advantage of reproducing the real form of actors in computers is that this virtual character has high entertainment and commercial value. Finally, the construction and display of virtual scenes can be achieved through the use of 3D production software generated by virtual technology, which can make virtual scenes more relevant to the real environment. Through visual tracking, visual recognition, and computational processing, real-life scenes can be perfectly presented in virtual space. Not only does it break through the limitations of time, space, and venue in production, but it also provides more imaginative space for filmmakers. The above three applications all reflect the impact of virtual reality technology on the production of three-dimensional images in movies. To verify the effectiveness of 3D image reconstruction, we randomly selected 8000 pieces of data from movie production and divided the data into two parts for reconstruction training. Differentiate images of different categories, structures, and complexity using traditional film production methods and virtual reality technology-optimized film production methods. The accuracy changes of 3D images with different processing methods are shown in Figure 5:

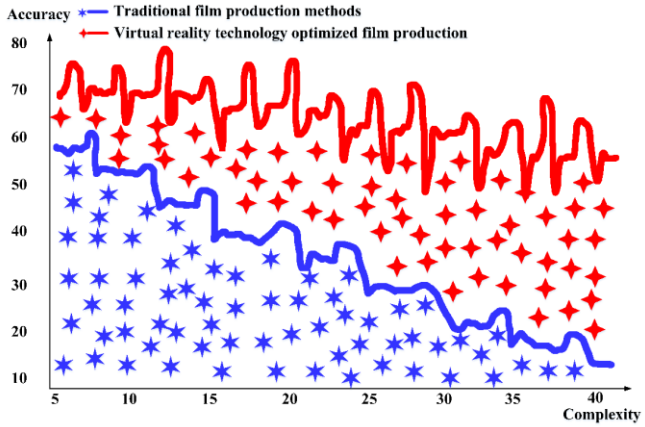

Figure 5: Changes in accuracy of three-dimensional images using different processing methods.

From Figure 5, it can be seen that in traditional film production, the accuracy of 2D images after 3D image reconstruction decreases as the complexity of image features increases. The accuracy of 3D reconstructed images optimized using virtual reality technology is high, which can effectively avoid interference caused by complex feature points. Next, we will analyze the success rate of 3D image reconstruction in movie production, as shown in Figure 6.

As shown in Figure 6, we divide the image into two aspects: portrait and scene. The success rate of ordinary image reconstruction methods in both aspects is relatively low, while the success rate of 3D image reconstruction achieved using virtual reality technology is relatively high. The research results obtained by the two comparative methods are basically similar, and the structural similarity of the test results also meets the testing requirements. Therefore, the application of virtual reality technology in film production can improve the effect of image generation and make the construction of 3D scenes more realistic.

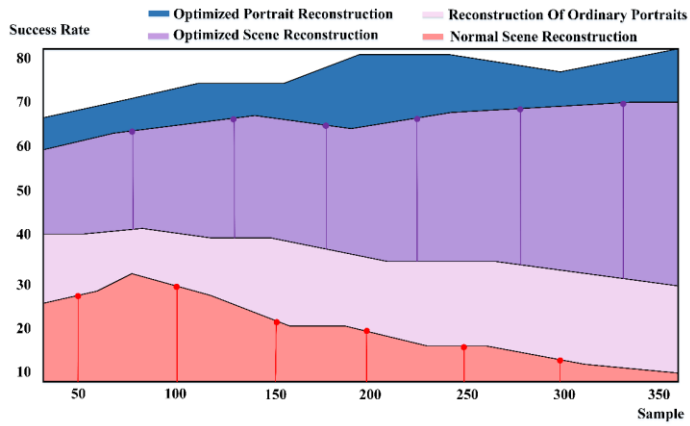

Figure 6: The success rate of 3D image reconstruction in movie production using different processing methods.

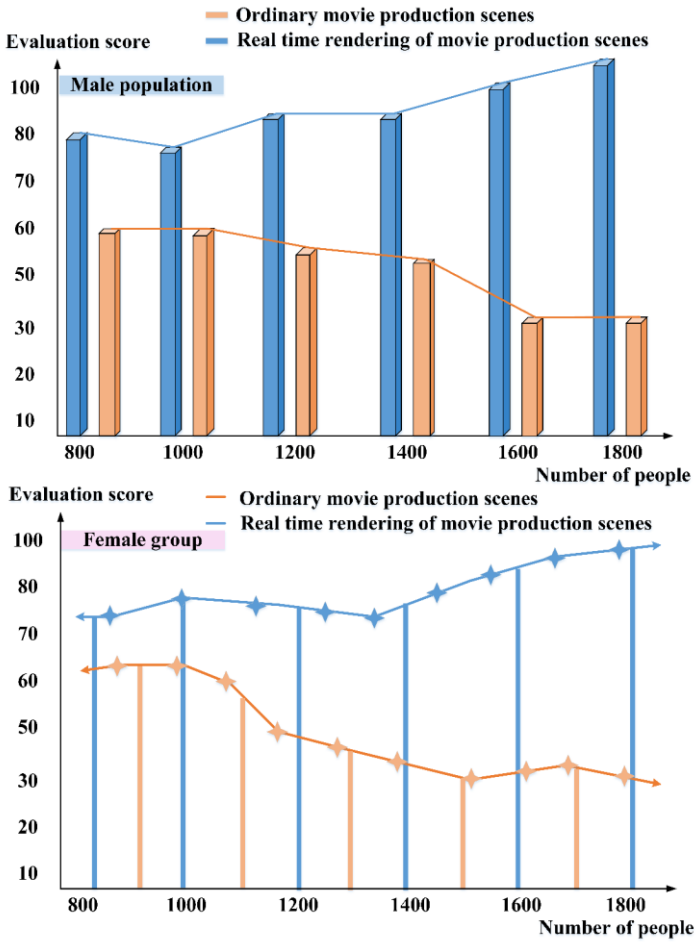

Figure 7: Comparison of feedback from audiences of different genders.

4.2 Analysis of Research Results on Virtual Reality Scene Optimization and Real-Time Rendering Algorithm Effects in Film Production

The virtual scenes in film production can to some extent influence the audience's viewing atmosphere. With the development of technology, the production effect of movies is no longer what audiences expect, and most audiences are more concerned about whether the movie scene and atmosphere match the real situation. How to use virtual space to convey movie content and emotions, while enhancing the aesthetic of image art, to enhance the audience's experience and feedback evaluation. We use real-time rendering algorithms to optimize virtual reality scenes, focusing on the use of light during the rendering optimization process. We calculate the spatial coordinates corresponding to virtual reality scenes based on different light angles and overlap them with real scenes. In order to further verify the optimization effect of real-time rendering algorithms in virtual reality scenes, we randomly interviewed a portion of movie audiences and used this questionnaire survey to improve the reliability of the research results. The feedback and evaluation from the public are shown in Figure 7.

It can be seen that we divide the audience into males and females. Based on their feelings towards the virtual reality scenes produced in ordinary movies and the evaluation of the virtual reality scene experience optimized by real-time rendering algorithms, it is found that audiences of different genders prefer the optimized virtual reality scenes (Figure 7). They believe that real-time rendering algorithms can improve the realism of virtual reality space, so they give a higher rating. In the feedback from the public, we also learned that they have found that the application of virtual reality technology and real-time rendering algorithms can convey more delicate cultural elements in films, showcasing the thoughts of filmmakers through clips, animations, and other forms. Therefore, this film production method is no longer just a media communication model, but an interactive product that satisfies the audience's immersive experience through the application of virtual reality technology.

5 CONCLUSIONS

Virtual reality technology has fully penetrated the film production process and gradually formed a large-scale industrial form in this industry. The emergence of virtual reality technology and real-time rendering algorithms has fundamentally opened up new ideas for film production, not only improving the creative quality of filmmakers but also breaking the limitations of traditional film production, allowing the public to truly participate in virtual space interaction. This article studies the application of virtual reality technology in film production and real-time algorithm effects, exploring the process of virtual reality technology in 3D image reconstruction and virtual reality scene optimization. Firstly, utilizing the characteristics of virtual reality technology, pixel data in 3D images is processed, and image feature transfer is completed based on the formula of scene coordinates. With the help of virtual reality technology, the success rate of 3D image reconstruction is enhanced. Secondly, utilizing the characteristics of virtual reality scenes for analysis, real-time rendering algorithms are used as the core technology to enhance the shadow change effect in virtual space. By combining real-time detection systems and dynamically balancing virtual scene feature requirements, global scene light and shadow rendering can be achieved. Finally, using data comparison and public feedback survey results, verify the reliability and effectiveness of virtual reality technology applications and real-time rendering algorithms. The research results indicate that the application of virtual reality technology in film production is effective, and real-time rendering algorithms can also enhance the authenticity of virtual reality scenes, allowing the public to have a more immersive experience while watching movies.

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