

A Research of Real-time Rendering Potentials on 3D Animation Production

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Abstract

In recent years, with the rapid development of real-time rendering technology, the quality of the images produced by real-time rendering has been improving, and its application scope has been expanded from games to animation and advertising and other fields. This paper analyses the development status of real-time rendering technology in 3D animation by investigating the 3D animation market in China, which concludes that the number of 3D animations in China has been increasing over the past 20 years, and the number of 3D animations using real-time rendering has been increasing year by year and exceeds that of 3D animations using offline rendering. In this study, a real-time rendering and offline rendering 3D animation are selected respectively to observe the screen effect of characters, special effects and environment props, and analyse the advantages and disadvantages of the two rendering technologies, and finally conclude that there is not much difference between real-time rendering 3D animation and offline rendering 3D animation in terms of quality and the overall sense of view, and due to the real-time rendering of the characteristics of the WYSIWYG, the animation designers can better focus on the creation of art performance. Real-time rendering technology has a good development prospect and potential in 3D animation, which paves the way for designers to create 3D content more efficiently.

Keywords: *Real-time Rendering, Offline Rendering, 3D Animation, 3D Content*

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1. Introduction

1.1 Research Background

With the rapid development of real-time rendering technology, the performance improvement of graphics Processing Unit (GPU) and the update of computer graphics technology, especially the application of Realttime Ray-tracing technology, real-time rendering is faster and faster, and the image quality is also catching up with the offline rendering. Real-time rendering technology is not only applied in 3D games, but also in 3D animated short films and 3D network animations with the improvement of video quality.

As shown in Figure 1, by collecting the number of 3D network animations on mainstream video websites (Tencent Video, Youku, iQiyi, Bilbil) in China's Internet, the number of 3D network animations in China in the past two decades is 365, and the number is increasing every year. The total number of 3D network animations from 2000 to 2009 is 7, and the number of 3D network animations in China is 365. Increase to more than 30 3D animations on the network every year from 2016 to 2020.

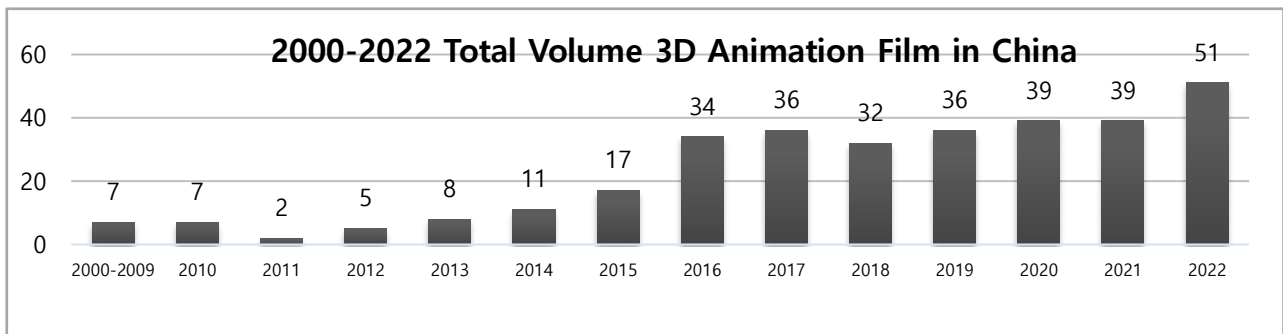


Figure 1. 2000-2022 Total Volume 3D Animation Film in China

As shown in Figure 2, according to the network interviews with animation production companies and screen analysis, the number of TV animations using offline rendering technology began to increase from 2012, reached the peak in 2016-2017, and the number was 59, and gradually decreased from 2018. The number of 3D web animations using real-time rendering technology has been increasing since 2010, and has maintained an annual growth rate of 2-3 since 2015, until 2022, which accounts for half of the total number of 3D web animations in the whole year.

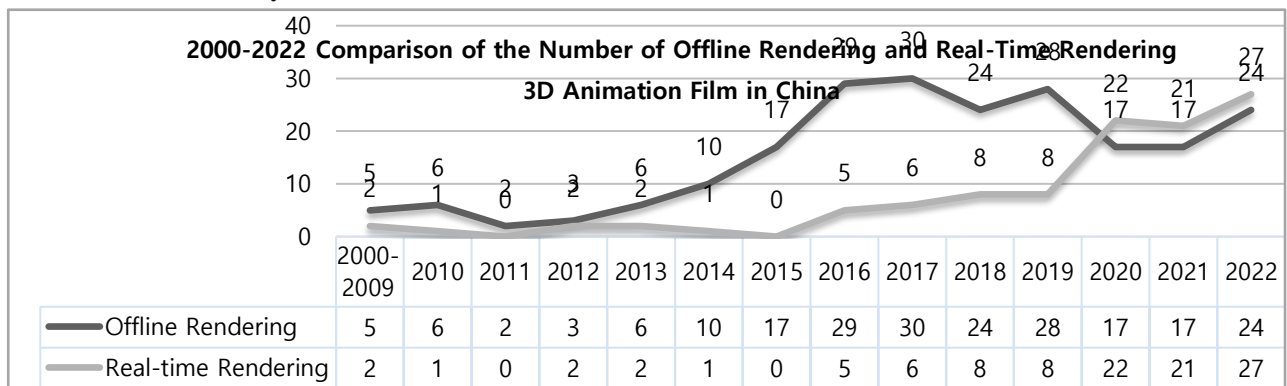


Figure 2. 2000-2022 Comparison of the Number of Offline Rendering and Real-Time Rendering 3D Animation Film in China

1.2 Research Purpose

The purpose of this study is to summarize the advantages and problems of real-time rendering and traditional offline rendering by studying the application cases of real-time rendering in the field of 3D animation, analyzing the network 3D animation images using real-time rendering and offline rendering. This study aims to explore and analyze the application prospects and development potential of real-time rendering in the field of 3D animation by studying the application cases related to 3D web animation using real-time rendering.

2. Theoretical Background

2.1 Offline Rendering

Offline rendering means that the screen is not displayed when the screen is calculated. The computer renders the picture according to the predefined light and trajectory, and then plays the picture continuously after the rendering is completed to realize the animation effect. The typical representative software of this method are 3DMax and Maya, whose main advantage is that the rendering can not consider the influence of time on the rendering effect, and the disadvantage is that the user can not control the object and scene in real time when the rendering screen is played. Often used in animated movies.

2.2 Real-time Rendering

Real-time rendering means that the computer calculates the screen while displaying its output. The typical representative software of this way are unity Engine and Unreal Engine Engine. The advantage of real-time rendering is that it can be manipulated in real time (to achieve 3D games, military simulation, disaster simulation, etc.). The disadvantage is that it is limited by the load capacity of the system, and it is necessary to sacrifice the screen effect (fine model, light and shadow application, fine degree of texture) to meet the requirements of real-time system

3. Real-time Rendering and Offline Rendering Animation Screen Effect Comparison

In this study, we selected two 3D animated series broadcast on Chinese online platforms: A Record of a Mortal's Journey to Immortality and Battle Through the Heavens4y, which were produced using real-time rendering and offline rendering, respectively. Two 3D animations have become the most popular online 3D animations in China in recent years, with "A Record of a Mortal's Journey to Immortality" being played 1.71 billion times and "Battle Through the Heavens4" being played 2.2 billion times. The details are shown in Table 1.

Table 1. 3D Animation Information Comparison

	A Record of a Mortal's Journey to Immortality	Battle Through the Heavens4
Rendering mode	Real-time rendering	Offline rendering
Broadcasting platform	Bilibili	Tencent Video
Country	China	China

Production company	Original Force	Motion Maglc
Total number of plays	1.71 billion	2.2 billion
Playout time	2020	2021
Source of creation	Web novel adaptation	Web novel adaptation

3.1 Establishing Shot

By observing Figure 1, the 3D animation using real-time rendering technology in the indoor screen part of the effect of performance, and offline rendering 3D animation is not much different, and even real-time rendering 3D animation of the indoor screen part of the more detailed, better performance. The author speculates that it is due to the rendering time of the two rendering technologies, offline rendering 3D animation can be more detailed than real-time rendering animation, but due to the rendering time is too long and the production cost of the problem, can only be in the effect of the performance of the production time and cost of the production of the choice between the results of the rendering of the degree of detail is not as good as the real-time rendering. The real-time rendering of the rendering time is relatively short, you can put the creative focus on the screen performance.



Figure 3. Comparative Analysis of Establishing Shot

3.2 Character

3.2.1 Character Face

In this study, two middle-aged and two elderly characters were selected, and through observation and comparison, as shown in Fig. 4, the difference between real-time rendering and offline rendering of the characters' facial performance is not obvious in the overall image perception, but in the close-up shots, the sub-surface scattering effect of offline rendering of the character's face is more obvious, which is more realistic than that of the real-time rendering of the character's face, and the real-time rendering of the character's face is weaker, and the performance of the character's face is paler, especially the effect of the character's facial nose, ears and cheeks. The effect is weaker and the character's face is paler, especially the nose, ears and cheeks, the offline rendering is better and closer to the real human's facial texture. The real-time rendering of the character's face needs to be improved..



Figure 4. Comparative Analysis of Character Face

3.2.2 Character Hair

In this study, four groups of character hairs were selected, namely, young female character hairs, elderly male character hairs, character long hairs and middle-aged male character hairs. Through observation and comparison analysis, as shown in Figure 5, in the close-up scene, the young female character long hair effect performance gap is relatively small, the hair gloss and hair number effect is basically excellent; in the close-up scene, the middle-aged and elderly male character short hair hair effect performance in the details of the gap is larger, real-time rendering of the character short hair is not as detailed as the offline rendering, and there is a sense of grainy hair and hair boundary clarity; and in the close-up scene, the character long hair performance, real-time rendering vs. In the close-up scene, the performance of the character's long hair has a smaller gap between the real-time rendering and the offline rendering, and the real-time rendering of the character's long hair has a better quality of performance in both the distant scene and the close-up.



Figure 5. Comparative Analysis of Character Hair

3.2 Special Effects

In this study, a total of four different groups of special effects are selected, namely, flame effects, ice effects, smoke effects and cloud effects. As shown in Figure 6, the difference between real-time rendering and offline rendering is not large and does not affect the viewing experience of the animation, but in the details of the quality of the special effects, the quality of real-time rendering is not as fine as offline rendering.



Figure 6. Comparative Analysis of Special Effects

3.3 Props

In this study, four different groups of environment props are selected, namely flame effects, ice effects, smoke effects and cloud effects. As shown in Figure 7, there is not much difference between real-time rendering and offline rendering in terms of the effect performance of the four different environment props. Whether it is close-up or close-up environment props, the real-time rendering has not much difference with the offline rendering in terms of reflection, bump detail and roughness of the 3D objects, but the real-time rendering of the transparent material and refraction is still not as good as the offline rendering.



Figure 7. Comparative Analysis of Props

4. Conclusion

Through this study, we explore the advantages and disadvantages of real-time rendering 3D animation and offline rendering 3D animation, and identify the advantages of real-time rendering technology, and real-time rendering has a great potential for development in the field of 3D animation. Real-time rendering technology can not only be applied in the field of games, but also can be better extended to the field of animation. The process of combining real-time rendering techniques with 3D animation is an evolving area of research where there is much to explore and learn. We hope that this initial exploration will pave the way for future 3D digital art designers so that more 3D digital art designers can focus on artistic creativity and push the field of 3D animation forward.

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