Animation Design and Virtual Reality Dynamic Scene Rendering Optimization Based on Transformer Model

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Abstract. Aiming at the problems of low rendering efficiency and the long time-consuming of traditional dynamic scene rendering methods, this study proposes an optimization method of animation design CAD and virtual reality dynamic scene rendering based on a transformer model. Through the construction of the animation design CAD model, the transformer model is used for animation design. Combined with spatial data conversion and graphics, the geometric transformation of animation design CAD model is carried out to realize the geometric transformation of graphics. By using primitive transformation, normal transformation, and lighting models combined with the data characteristics of dynamic scene rendering, the virtual reality dynamic scene rendering optimization model is constructed. Experimental results show that, compared with traditional methods, the proposed method can shorten the rendering time of animation design CAD and virtual reality dynamic scenes and effectively improve the rendering efficiency of animation design CAD and virtual reality dynamic scenes.

Keywords: Transformer Model; Animation Design CAD; Virtual Reality; Dynamic Scene Rendering; Image Optimization
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1 INTRODUCTION

With the continuous development of computer graphics technology, dynamic scene rendering has become an important part of virtual reality technology. The effect of dynamic scene rendering directly affects users' perception and experience of virtual reality, so the performance of dynamic scene rendering has always been an important factor restricting the application of virtual reality. In animation scene design, achieving the transfer of motion style from one animation clip to another while maintaining the original motion content of the scene has always been a challenge for designers. The current data-driven methods, although achieving certain results in animation style transfer, are mostly limited by supervised learning and the dependence on paired data. Aberman et al. [1]

proposed an innovative data-driven motion style transfer framework for animation scene design. More importantly, our framework can directly handle video and 3D input motion without the need for complex 3D reconstruction processes. The content code is responsible for capturing motion information in animation scenes, such as the character's action trajectory, speed, etc. This style transfer not only enriches the visual expression of animation but also helps designers quickly create scenes that meet specific style requirements. Specifically, when the content code is decoded into output motion by a series of time convolutional layers, the style code modifies deep features through time invariant adaptive instance normalization (AdaIN). Because the traditional dynamic scene rendering method uses a single thread program, it has the problems of low efficiency and long time consumption, which seriously restricts the application and development of virtual reality technology. With the rapid development of computer hardware technology and the continuous reduction of costs, the quality of game graphics has been significantly improved, reaching or even surpassing the visual effects of many professional virtual reality engines. Bao [2] proposed an innovative rendering queue management method aimed at improving frame rate and optimizing the rendering efficiency of animation scenes. In animation scene design, skeleton animation is one of the key technologies to achieve dynamic effects of characters and objects. This controller not only accurately controls the playback speed, direction, and loop mode of the animation, but also achieves smooth interpolation between key structures, ensuring the smoothness and naturalness of the animation scene. This system not only supports traditional bone animation and particle rendering but also provides rich animation scene design tools and special effects libraries. This enables our engine to achieve smoother and more realistic animation effects while ensuring high-quality visuals.

For example, dynamic scene rendering has high requirements for processing time and spatial data, but the traditional dynamic scene rendering method uses a single thread program, so the processing time is long, and the rendering effect is not ideal. Facial logo extraction plays a crucial role in animation scene design, as it is one of the fundamental technologies for achieving realism and vividness, especially in applications such as facial expression simulation, character personalization, and real-time facial animation. Bodini's [3] latest survey on facial landmark extraction in 2D images and videos has brought new insights into the field of animation scene design. In animation scene design, facial feature extraction can not only help us capture and simulate the facial expressions of real characters more accurately but also apply these expression data to virtual characters, making them have richer emotional expressions. The facial structure and expressions of virtual characters may differ from those of real characters, so it is necessary to make appropriate adjustments and optimizations to existing facial feature extraction methods. In addition, facial feature extraction can also assist in achieving automation and personalization of facial animation, improving the efficiency and quality of animation production. With the rapid development of virtual reality (VR) technology, it is gradually emerging in the field of computer animation, becoming a powerful tool for animators to seek more efficient and intuitive creative methods. Cannavò et al. [4] delved into the application of VR interfaces in animation scene design, particularly in generating 3D animations through armature deformation. And it provides a customizable VR interface, allowing these operations to be seamlessly integrated into well-known animation suites. VR technology, with its unique immersion and interactivity, has brought unprecedented possibilities for animation scene design. Secondly, the interactivity of VR enables animators to adjust elements in the scene in real-time and observe the impact of their changes on the overall effect, greatly improving work efficiency. The experimental results show that when using a VR interface for animation scene design, the average task completion time is reduced by 35%. The VR interface not only improves the efficiency of animators but also ensures the quality and effectiveness of animation scene design. In recent years, with the rapid development of computer graphics and artificial intelligence technology, computer vision technology based on transformer models has attracted extensive attention. The transformer model is a new type of natural language processing model, which uses two core mechanisms: word embedding and attention mechanism. Because the transformer model can effectively use multiple spatial location information and multiple time information, it can improve the efficiency of dynamic scene rendering.

The animation industry, as a vast industry chain, not only covers industries such as gaming and digital entertainment but also demonstrates enormous market potential and creative space in the field of animation scene design. In animation scene design, the bipolar emotions of cartoon materials (such as happiness and sadness, excitement and calmness, etc.) are key to shaping the character's personality, driving the story plot, and creating an overall atmosphere. In order to capture emotional information in cartoon images more comprehensively, Cao et al. [5] proposed a deep learning-based bipolar sentiment classification method for cartoon images. These emotional elements can not only be reflected through the facial expressions of the characters, but can also be strengthened through various factors such as scene layout, colour application, and lighting effects. At present, although there are some methods used to recognize the emotions in cartoon images, most of them mainly focus on facial expression recognition and ignore the influence of scene elements on emotional expression. Character animation plays a crucial role in animation scene design, and character pose recognition is an indispensable part of animators in constructing vivid and realistic animation scenes. Ding and Li [6] proposed a real-time 3D pose recognition system based on deep convolutional neural networks. This data structure not only includes the body posture of the character but also details such as facial expressions, providing rich materials for subsequent animation generation. The real-time performance of the system is also one of its major advantages. In the process of animation scene design, designers often need to constantly adjust the poses and expressions of characters to achieve the best results. The system can simultaneously recognize the facial and body postures of characters, providing strong technical support for animation scene design. In the process of animation scene design, designers can use the posture data generated by the system to quickly build character animations that match the story plot and atmosphere. However, most of the current studies only optimize the static scene rendering of the transformer model and do not apply it to dynamic scene rendering. Based on this background, this paper proposes an optimization method of animation design CAD and virtual reality dynamic scene rendering based on a transformer model. Through geometric transformation and data processing of animation design CAD model, the efficiency of animation design CAD and virtual reality dynamic scene rendering is effectively improved, and the rendering effect is enhanced.

2 RELATED WORKS

In animation scene design, precise 3D reconstruction of characters and environments is crucial. This not only requires reconstruction to capture precise geometric details but also to adapt to scene changes to support realistic animation effects dynamically. Feng et al. [7] proposed the DECA (Detailed Expression Capture and Animation) method, which aims to generate 3D shapes that are specific to individuals but vary with the scene while preserving animatable details. In addition, many methods rely on high-quality scanning data for training, which limits their generalization ability when processing wild images (i.e., images captured in non-professional scanning or studio environments). This representation method allows us to independently control the character's expressions and individual specific details, thus synthesizing realistic animation scenes. This gives DECA broad application prospects in animation scene design, especially in situations where high-quality 3D characters and scenes need to be generated quickly and at a low cost.

With the rapid development of computer software and hardware technology, computer 3D animation has gradually become the mainstream in the field of animation production. Building a realistic 3D world on a computer not only requires designers to construct animated character models accurately but also to carefully design animation scenes that match them. A carefully designed scene not only provides a suitable background for characters but also enhances the visual effects of animation through elements such as light and shadow, color, and layout, creating a specific atmosphere and emotion. On the basis of analyzing the market 8situation and combining the author's own creative practice, Jing and Song [8] explored the techniques and principles of 3D animation character shaping and conducted in-depth research on various aspects of animation scene design. Through comparative research methods, the differences in scene design between 3D animation and traditional animation were compared, and the unique features and advantages of 3D animation scene design were summarized. Designers need to master key techniques such as scene modelling, material mapping, and lighting rendering to ensure the realism and visual effects of the scene.

Animation scene design not only requires creating visual aesthetics but also accurately simulating complex surfaces and dynamic curves in the real world to achieve more realistic and captivating visual effects. In order to meet the demand for high-precision curves and surfaces in animation scene design, cubic B-spline curve and surface approximation algorithms have emerged. Whether it is the outline of a building, the physical form of a character, or the natural landscape of the environment, precise modelling is required through curves and surfaces. By adjusting parameters, Li [9] can easily control the curvature of curves and the undulation of surfaces, achieving various complex animation effects. In addition to modelling curves and surfaces, animation scene design also needs to consider how to dynamically present these models to the audience. This algorithm not only inherits the advantages of traditional interpolation and approximation splines but also effectively avoids their drawbacks by introducing the characteristics of cubic B-splines, providing more powerful technical support for animation scene design.

With the rapid development of deep learning and advanced representation technologies, image view synthesis has made significant progress in creating realistic visual effects. Compared with static scenes, dynamic scene view synthesis faces multiple challenges, including the lack of high-quality training data, the complex time dimension of dynamic scene videos, and time inconsistency caused by occlusion removal. Dynamic scenes not only provide viewers with a richer visual experience but also enhance the depth and attractiveness of story narration. Lin et al. [10] developed an innovative algorithm called Deep 3D Mask Volume. In animation scene design, especially in building immersive virtual experiences, view synthesis of dynamic scenes has become the next important development frontier. By utilizing this dataset, animators can simulate the dynamic environment of the real world more realistically and create more engaging animated stories. This algorithm can perform time-stable view extrapolation from binocular videos of dynamic scenes captured by static cameras. It uses 3D mask volume to label and track foreground objects and identifies areas that may cause temporal inconsistency due to occlusion. Image-based animation technology has been introduced to capture subtle expressions and small actions that cannot be explained by geometry alone through dynamic textures. This is because geometry-based animation is limited by its definition, making it difficult to fully simulate the complex dynamics and subtle expressions of living organisms. In order to integrate the advantages of these two technologies and overcome their limitations, Paier et al. [11] proposed an innovative hybrid animation framework. Through interactive control, designers can intuitively edit and modify facial animations without delving into the underlying principles of computer graphics. This framework utilizes the latest advances in deep learning by training a variational autoencoder (VAE) to learn a low-dimensional latent space for interactive facial animations.

In animation scene design, the selection and allocation of colours are crucial for conveying the emotions, atmosphere, and storyline of the scene. When the allocation of colours and concepts in an animation scene meets the audience's expectations, the colour palette becomes semantically interpretable. In order to design colour palettes in animation scenes more efficiently and reduce the cost of manual evaluation, automation methods are gradually gaining attention. Animators need to carefully consider how to match colours with elements and concepts in the scene. Rathore et al. [12] evaluated a new automated method that can automatically estimate the best match between colours and animation scene elements based on human colour concept associations. By analyzing the colour distribution and combination in an image, it is possible to identify colour patterns associated with specific concepts. When it comes to simulating dynamic elements in animation scene design, the optimization method of Particle Image Velocimetry (PIV) technology provides us with valuable insights. Creating natural and realistic fluid dynamics (such as smoke, flames, water flow, etc.) has always been a challenge in animation scene design. Xie et al. [13] introduced a method that combines constraint conditions and related peak localization techniques to optimize particle flow or dynamic texture simulation in animation scenes. This function not only considers the continuity of particle motion (similar to spatial smoothness in PIV) but also considers the coherence of animation timelines (similar to temporal smoothness in PIV). Drawing inspiration from the trajectory selection concept in particle tracking velocimetry, they can ensure the temporal smoothness of particle motion in animations. By minimizing this objective function, it can generate a series of optimized particle motion trajectories that can be used for dynamic texture simulation in animated scenes.

Zhang et al. [14] proposed a method called VisCode, which is not limited to traditional information embedding but is particularly applied in animation scene design to implicitly embed key information into visual elements of animation. In animation scene design, sometimes it is necessary to convey additional information to the audience, such as character attributes, environmental details, or clues closely related to the story plot. It is recommended to use visual images of animation scenes and corresponding data information as training data and design a deep encoder-decoder network that is highly adaptable to the characteristics of animation. Through this approach, even if the audience does not directly notice the embedded information while watching the animation, this information can be accurately decoded when needed. This model will consider prominent features such as motion, lighting, colour, and texture in animated scenes to ensure that there is no significant visual loss during the encoding process. Image-driven animation scene design (IASD) is gradually becoming a new trend in animation creation, utilizing image data to construct, render, and dynamically adjust elements in animation scenes. Unlike static image processing tasks, animation scene design faces greater dynamism and variability. Zhang et al. [15] explored the dynamic hyperparameter optimization problem in IASD applications, aiming to dynamically determine the optimal hyperparameter configuration for artificial intelligence-based IASD solutions. These configurations are manually set by animators or AI experts and are difficult to adapt to the complex dynamic changes in animation scene design. This system combines crowdsourcing artificial intelligence and dynamic optimization strategies to dynamically guide the optimal hyperparameter configuration search for each keyframe or scene transition in the IASD process. In IASD, the configuration of hyperparameters is crucial for generating realistic, smooth, and story-oriented animation scenes. To ensure that every element and transition in the animation scene can achieve the expected visual effect.

To sum up, although the existing research results on animation design CAD and virtual reality dynamic scene rendering have made some progress, there is still much room for improvement in rendering efficiency and quality. Therefore, building an optimization method of animation design CAD and virtual reality dynamic scene rendering based on a transformer model from two aspects of data characteristics and geometric transformation can effectively improve the rendering efficiency and quality. Therefore, if we speed up the research in this area, it will help further promote the innovation and innovative application of animation design CAD technology.

3 ANIMATION DESIGN BASED ON TRANSFORMER MODEL

3.1 Dynamic Scene Rendering Optimization Mechanism and Architecture

At present, there are many research results on the application and innovation of virtual reality dynamic scene rendering technology and animation design CAD technology at home and abroad. At this stage, the research on animation design CAD and virtual reality dynamic scene rendering is mainly divided into two directions. One is to analyze the data characteristics of animation design CAD and virtual reality dynamic scene rendering in order to reduce the rendering time. Second, the transformer model is used for animation design CAD and virtual reality dynamic scene rendering to improve rendering efficiency. In these two aspects, researchers mainly study data features and geometric transformation. In terms of virtual reality dynamic scene rendering technology, foreign researchers mainly study from two aspects: model construction and parameter setting. Aiming at the construction of the model in virtual reality dynamic scene, they propose a virtual reality dynamic scene rendering method based on parameterization, classify the moving objects according to the characteristics of the moving objects, and improve the rendering speed and quality of animation design CAD and virtual reality dynamic scene by setting the corresponding parameters. The transformer model is a special neural network structure. By learning a transformation ability, it can realize new features while maintaining the original features and realize the image processing effect in this way. Therefore, the transformer model has important application prospects in the field of animation and 3D image modelling. In order to further improve the combination efficiency of animation design CAD and virtual reality dynamic scene rendering, an innovative optimization mechanism is proposed based on the transformer model. The overall operation idea of this mechanism is to optimize animation design CAD and virtual reality dynamic scene rendering by learning the transformation ability of the transformer model. Animation design CAD and virtual reality dynamic scene rendering are important components of animation and 3D images, which have an important impact on the modelling effect of animation and 3D images. Therefore, when optimizing animation design CAD and virtual reality dynamic scene rendering, need to be combined. The overall operation idea and architecture are shown in Figure 1.

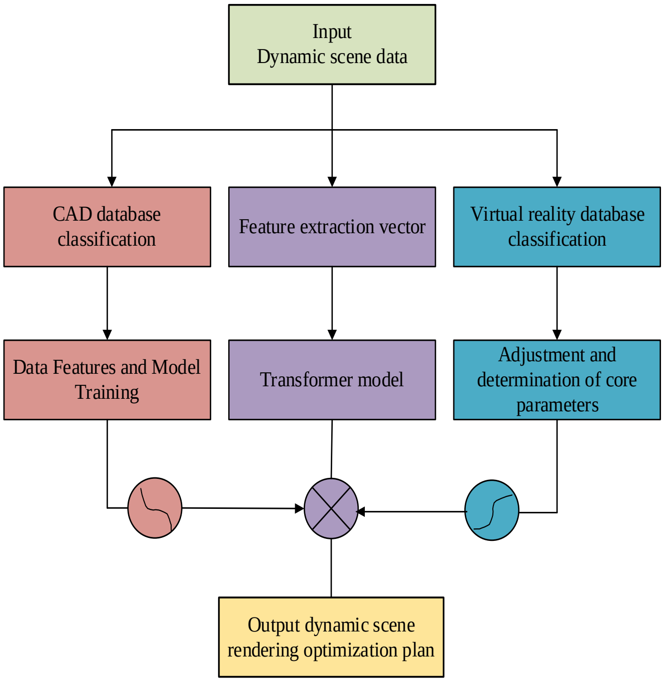

Figure 1: The determination of dynamic scene rendering optimization mechanism and system architecture diagram.

This study uses a transformer model for optimization in the actual operation and operation process. First, it needs to analyze the data characteristics of animation design CAD and virtual reality dynamic scene rendering, establish the dynamic scene rendering optimization model, and then adjust the core parameters of the optimization model so as to realize the optimization of animation design CAD and virtual reality dynamic scene rendering. The relevant theoretical formulas in this process are as follows:

$$A\ y\ = \sum_{i=0}^{k} \varepsilon y_{i-1} + \lambda\varphi y_i\ \ y_{i+1} \tag{1}$$

$$B\ y\ = \frac{y_{i-1} + (y_i - 1)^{\lambda}}{y + \varphi} \tag{2}$$

$$C\ y\ = \frac{\lambda^k y_i + \varepsilon y_{i+1}}{\sum_{i=0}^{k-1} \varphi + y_i\ \ \varepsilon^y} \tag{3}$$

$$D\ y\ = \frac{A\ y-1\ + B\ y+2}{k\varphi + \varepsilon + \lambda} \tag{4}$$

The formula $A(y)$、$B(y)$、$C(y)$、$D(y)$ represents the initial rendering function, model training function, model matching function and random parameter adjustment function in the model, y_i represents the training data set, and $\varepsilon,\lambda,\varphi,k$ represents the initial judgment value, data characteristic value, model reference value and set constant threshold value.

Secondly, the original data of the input model will be preprocessed, including analyzing the image features in the model and then segmenting the image to obtain the corresponding original data. Then, the original data will be inputted into the transformer model, and the transformer model's transformation ability will be used to complete the optimization of animation design CAD and virtual reality dynamic scene rendering. Then, the relevant secondary operation data of the input model will be classified, and the input intermediate data group will be processed to obtain the corresponding output data. Then, the transformer model processes the output data and stores the processed data in memory. At the same time, the transformation ability of the transformer model can be used to optimize animation design CAD and virtual reality dynamic scene rendering. In this process, the relevant theoretical formula is as follows:

$$A'\ y\ = \sqrt{\sum_{i=0}^{k} \varepsilon y_{i-1} + \lambda\varphi y_i\ y_{i+1}} \tag{5}$$

$$B'\ y\ = \frac{y_{i-1} + \sqrt{k\lambda + (y_i - 1)^{\lambda}}}{y+\varphi} \tag{6}$$

$$C'\ y\ = \frac{\lambda^k y_i + \varepsilon y_{i+1}}{\sqrt{\sum_{i=0}^{k-1} \varphi + y_i\ \varepsilon^{y}}} \tag{7}$$

$$D'\ y\ = \frac{A'\ y-1\ + B'\ y+2}{k\varphi + \varepsilon + \lambda} \tag{8}$$

Finally, the corresponding parameters are adjusted according to the dynamic scene requirements, and the relevant output data are dynamically adjusted and output in combination with the control parameters of the time axis. Finally, the optimization of animation design CAD and virtual reality dynamic scene rendering is completed. Therefore, the optimization mechanism of animation design CAD and virtual reality dynamic scene rendering based on the transformer model proposed in this study is theoretically feasible and can effectively improve the efficiency of the combination of animation design CAD and virtual reality dynamic scene rendering.

3.2 One-Way Optimization Strategy of Animation Design

In the actual optimization process of animation design CAD and virtual reality dynamic scene rendering efficiency, according to its underlying logic operation principle and the characteristics of the transformer model, this study designed a one-way optimization strategy, which mainly includes the following aspects. The first step is to optimize the spatial transformation in the process of animation design CAD and virtual reality dynamic scene rendering and realize the geometric transformation of animation design CAD and virtual reality dynamic scene rendering through the transformer model. Then, the transformer model is used to optimize the morphological transformation in the process of animation design CAD and virtual reality dynamic scene rendering and realize the geometric transformation in the process of animation design CAD and virtual reality dynamic scene rendering through the transformer model. Then, the deep optimization of animation design CAD and virtual reality dynamic scene rendering is realized by combining the entity transformation, normal transformation and lighting model. The relevant theoretical formulas in this process are as follows:

$$A''\ y\ = \sqrt{\frac{\sum_{i=0}^{k} \ \varepsilon y_{i-1} + \lambda\varphi y_i \ \ y_{i+1}}{\lambda\varphi + \varepsilon k + \lambda k}} \tag{9}$$

$$B''\ y\ = \frac{k y_{i-1} + \sqrt{k\lambda + (y_i - 1)^{\lambda}}}{\lambda y_{i+1} + \varepsilon\varphi} \tag{10}$$

$$C''\ y\ = \frac{\lambda\varepsilon}{k} + \frac{\lambda^k y_i + \varepsilon y_{i+1}}{\sqrt{\sum_{i=0}^{k-1} \ \varphi + y_i \ \ \varepsilon^y}} \tag{11}$$

$$D''\ y\ = \frac{A''\ y-1\ + B''\ y+2}{k\varphi + k\varepsilon + \lambda\varphi} \tag{12}$$

Secondly, according to the requirements of animation display in different scenes, in the CAD environment of animation design, combined with virtual reality technology, the parameters calibration rules of dynamic scene rendering are used to adjust the corresponding time axis control parameters accurately, and then by carefully adjusting these parameters, the rendering process can be effectively optimized, so as to improve the quality and realism of animation effect. This dynamic adjustment not only helps to maintain the continuity and fluency of the scene but also ensures that every detail is accurately presented, enabling the audience to immerse themselves in a realistic virtual world and enjoy a visually stunning experience. The relevant theoretical formulas in this process are as follows:

$$A'''\ y\ = 1 + \frac{\sqrt{\sum_{i=0}^{k} \ \varepsilon y_{i-1} + \lambda\varphi y_i \ \ y_{i+1}}}{\varepsilon\varphi + k\lambda} \tag{13}$$

$$B'''\ y\ = 1 + \frac{y_{i-1} + \sqrt{k\lambda + (y_i - 1)^{\lambda}}}{\sqrt{y + \varphi}} \tag{14}$$

$$C'''\ y\ = 1 + \frac{\sqrt{\lambda^k y_i + \varepsilon y_{i+1}}}{\sqrt{\sum_{i=0}^{k-1} \ \varphi + y_i \ \ \varepsilon^y}} \tag{15}$$

$$D'''\ y\ = \frac{A'''\ y-1\ + B'''\ y+2}{k\varphi + \varepsilon + \lambda} \tag{16}$$

Moreover, after completing the precise adjustment of various parameters in animation design CAD technology, the next step is to check and correct the key parameters that can theoretically achieve the best visual effect in the virtual reality environment one by one. This process is not only a simple adjustment of parameters but also an in-depth analysis and understanding of the working principle behind each parameter and how they work together on the final dynamic picture. Through this secondary proofreading process, we can ensure that all parameter settings are optimized so as to create a more realistic and vivid visual experience in the virtual world of virtual reality. In addition, this closed-loop control mechanism also helps to find and solve possible problems and further improve the quality and efficiency of animation design. At this time, the corresponding preliminary optimization results are shown in Figure 2.

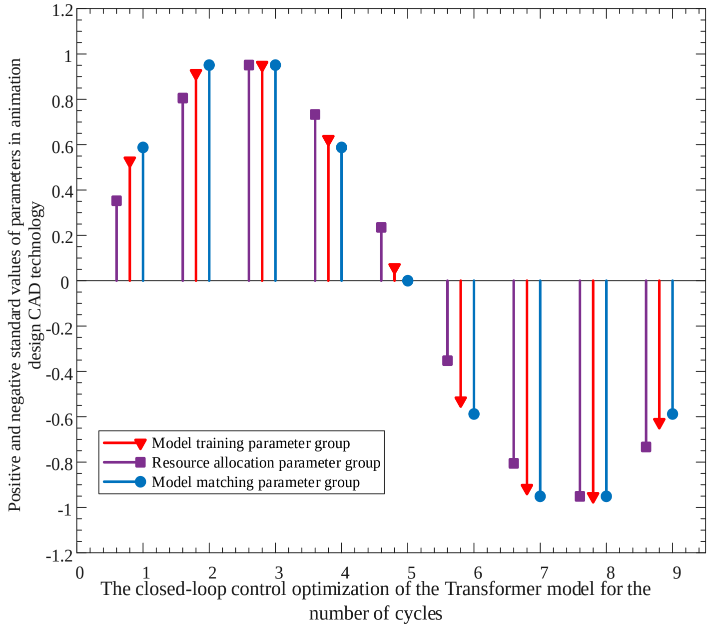

Figure 2: The positive and negative standard values of the parameters corresponding to the initial optimization of the Transformer model.

It can be seen from Figure 2 that when the number of cycles increases, the standard value of parameters in animation design CAD technology also shows a periodic rule, and when the number of cycles is 5, the corresponding standard value is just around the value of 0, which also shows that the cycle period is 5, which is consistent with the theoretical estimate.

Finally, the parallel optimization of multithreaded tasks is the key to improving rendering efficiency and picture quality. In this study, the transformer model is used to optimize the multi-threaded tasks in the process of animation design CAD and virtual reality dynamic scene rendering in parallel, and the task allocation rules are used to realize the efficient allocation of different hardware resources, so as to improve the efficiency and quality of the whole rendering process. With its powerful computing power, the transformer model shows excellent performance in processing complex multidimensional data and provides a new solution for optimizing the rendering process. Therefore, after the transformer model is used for multidimensional calculation, those data groups with low priority or weak timeliness must be further eliminated to reduce unnecessary waste of resources. At this time, the corresponding secondary optimization results are shown in Figure 3. It can be seen from the results in Figure 3 that when the number of secondary cycles reaches 8, it can basically reach the highest value of rendering efficiency (110/80/60), showing a trend of first increasing, then decreasing and then increasing. Therefore, the animation design CAD and virtual reality dynamic scene rendering optimization mechanism based on the transformer model can effectively improve the efficiency of dynamic scene rendering, and has the advantages of simple structure, high computational efficiency and strong scalability. This is because this study uses the allocation rules in the above key steps to achieve accurate scheduling of various tasks, ensure that each work can be executed at the best time, and also ensure the efficient operation and high quality of the overall rendering process. This method not only improves the rendering speed but also greatly reduces rendering errors and delays so that users can enjoy a more smooth and real virtual experience. With the continuous progress of technology, this multi-threaded task optimization strategy based on the transformer model will undoubtedly play a greater role in the field of digital content creation and display in the future.

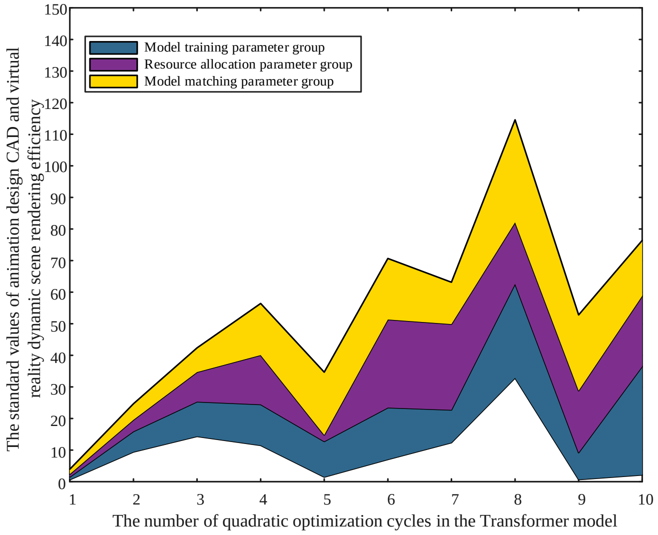

Figure 3: The rendering efficiency results corresponding to the second optimization cycle of the Transformer model.

3.3 Circular Optimization Strategy Based on Transformer Model

In order to further improve the rendering efficiency of animation design CAD and virtual reality dynamic scenes, according to the classification of different types of animation design CAD databases and virtual reality common scenes, this study constructs a circular optimization strategy based on the transformer model, which mainly includes the following two aspects.

In the technical framework of cycle optimization, an advanced threshold control mechanism is introduced, which skillfully solves the problem of how to call different animation CAD databases efficiently. The core of this mechanism is to accurately classify the various animation design scenes in the CAD database. Through in-depth analysis and understanding of the differences between these scenes, this study uses the powerful gating loop unit of the transformer model to realize the seamless migration of data between different types of animation design scenes. This data migration is not simply copy and paste but is carefully designed to ensure that each data flow can maintain the integrity and fluency of the original design to the greatest extent. Furthermore, this study also adopts a circular optimization strategy based on threshold judgment conditions, which not only considers the commonness between animation design scenes but also fully reflects the unique differences between them. This study marks these differences by setting an appropriate threshold and then dynamically adjusting the processing flow of this study according to the threshold. When the scene types are similar, a relatively loose threshold can be used. For those scenes with obvious differences, it needs to be handled more carefully to ensure the accuracy and consistency of the data. The purpose of this is to shorten the time cycle of animation rendering as much as possible so as to improve the rendering efficiency. The analysis process of the animation rendering effect at this time is shown in Figure 4.

Secondly, the core of this research is to introduce an innovative virtual reality scene parameter automatic matching mechanism, which uses intelligent algorithms to deal with different types of animation design CAD databases. The original intention of this mechanism is to integrate and utilize these data more effectively so that users can design animation in a more intuitive and interactive virtual environment. Specifically, when users use their input animation design CAD database in a highly realistic virtual reality scene, the system will use advanced AI technology to analyze the user's behaviour pattern.

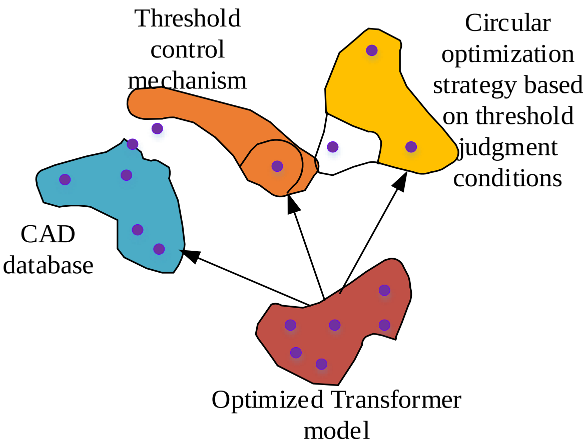

Figure 4: Analysis process of animation rendering effect of optimized Transformer model.

This process involves complex pattern recognition and behaviour prediction algorithms, which can intelligently distinguish whether the user's operation in the virtual scene matches the information recorded in the database. If it is found that the user's operation mode is consistent with the preset or specification in the animation design CAD, the behaviour will be regarded as valid and automatically applied to the existing database. This not only improves the efficiency of the design process but also greatly enhances the predictability of the design results. On the contrary, if the user's operation behaviour is inconsistent with the content stored in the database, or contrary to the best practices specified in the database, the system will automatically mark this abnormal behaviour. In this way, both designers and managers can immediately detect any possible deviations or inconsistencies, and then have the opportunity to adjust or correct these problems to ensure the quality and consistency of the whole design process. The analysis results of the animation rendering effect are shown in Figure 5.

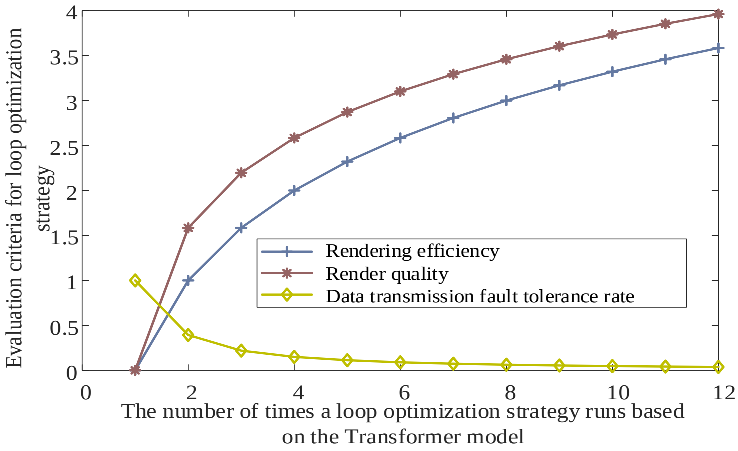

Figure 5: Analysis results of animation rendering effects under different loop optimization times.

It can be seen from the experimental results in Fig. 4 and Fig. 5 that when the number of runs increases, the rendering efficiency and rendering quality show an increasing trend, and the fault tolerance rate of data transmission shows a decreasing trend, and when the number of cycles reaches 8, they all reach a relatively stable state. Therefore, by using the cycle optimization strategy method based on the transformer model, not only the efficiency is improved, but also the potential error risk is greatly reduced, and each call to the animation design database, whether it is cross-scene or cross-file data transmission, can be optimized and accelerated. This is because compared with the traditional optimization strategy, this method can find and correct any possible data deviation or format problems faster, and in this way, It can also effectively reduce the potential risks caused by data transmission errors between different devices. Therefore, the application of this technology has greatly improved the data management ability in the animation design workflow, enabling designers to complete their creative tasks faster and more accurately, and also providing a more smooth and coherent experience for animation production.

4 EXPERIMENTAL RESULTS AND ANALYSIS

4.1 Experimental Design Process and Results

In order to further verify and analyze the effect of animation design CAD based on transformer model and virtual reality dynamic scene rendering optimization mechanism, this study combined different animation design needs and works and carried out several groups of confirmatory experiments. In this study, the effect of animation design CAD and virtual reality dynamic scene rendering is taken as the evaluation standard, and the effectiveness of the proposed method is verified by comparing and analyzing the rendering time of animation design CAD and virtual reality dynamic scene under different methods. The experimental results are shown in Figure 6.

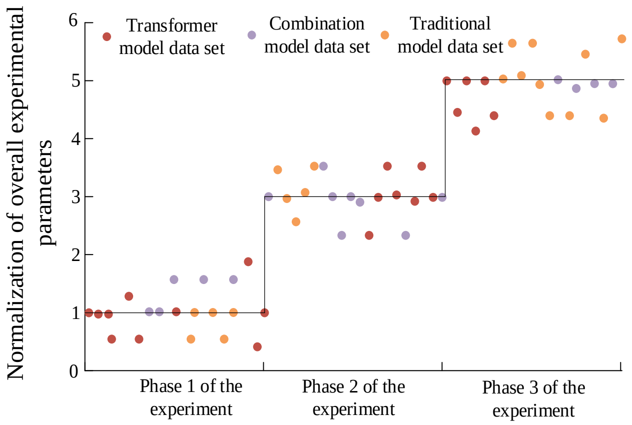

Figure 6: Compared with the traditional rendering optimization methods.

It can be seen from the results in Figure 6 that, compared with the traditional rendering optimization methods, the animation design CAD based on the transformer model and the virtual reality dynamic scene rendering optimization mechanism have significantly improved in terms of rendering efficiency, rendering quality, time-consuming, and colour perfection. This is because, in the process of constructing the optimization mechanism, this study introduces a distributed loop optimization strategy for data transmission and conversion to ensure the correctness of data transmission and conversion. Its principle is to ensure the consistency of data between different devices through the optimization of data transmission and conversion and to further improve the efficiency of data management in the animation design workflow. In addition, in order to avoid errors in data transmission between different devices, this study configured an independent storage system for each device, and each storage system deployed multiple servers to manage these files to ensure that in the distributed storage system, they can cooperate with each other to maintain data consistency jointly. This can not only effectively avoid errors in the process of data transmission but also greatly reduce the potential risks caused by different devices in the distributed system.

4.2 Discussions

In order to further verify the reliability and objectivity of the experimental results, this study uses Animal 2 and Hornet to test the proposed animation design CAD and virtual reality dynamic scene rendering optimization methods and related results. The experimental results of animation design CAD and virtual reality dynamic scene rendering effects under different methods are compared and analyzed and different weights are assigned in terms of rendering efficiency, rendering quality, the time required, colour perfection, etc., to build a normalized vertical evaluation system. The analysis results of the experimental results are shown in Figure 7.

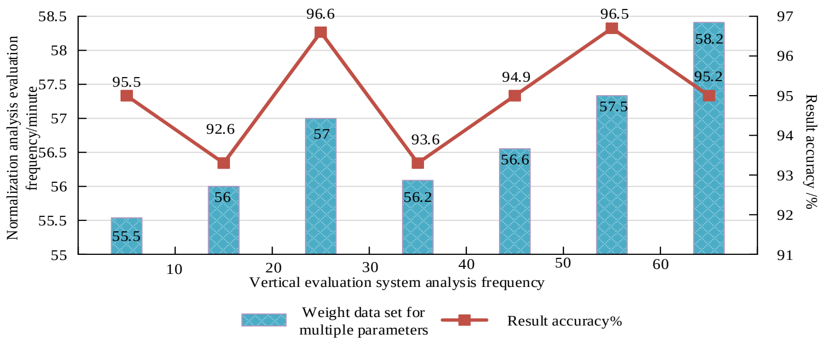

Figure 7: Normalization analysis and evaluation results of experimental data.

From the experimental results in Figure 7, it can be seen that when the number of analyses increases, the corresponding evaluation times show a trend of first increasing, then decreasing and then increasing, and reaching the peak (58.2) when more than 60 times and the corresponding analysis accuracy can also be stabilized at more than 93.6%. Therefore, the animation design CAD and virtual reality dynamic scene rendering optimization mechanism based on the transformer model has a significant improvement in rendering efficiency, rendering quality, time-consuming, colour perfection and other aspects (normalized analysis and evaluation results). This is because the transformer model can effectively process multiple pixels in the image without sacrificing the image quality, thus reducing the processing time, so it can improve the rendering efficiency. Therefore, it can be further concluded that when using a transformer model to render animation design CAD and virtual reality dynamic scenes, it can effectively improve the rendering efficiency.

5 CONCLUSIONS

Because the traditional dynamic scene rendering method uses a single thread program, it has the problems of low efficiency and long time consumption, which seriously restricts the application and development of virtual reality technology. Based on this, this paper proposes an optimization method of animation design CAD and virtual reality dynamic scene rendering based on a transformer model. The transformer model is used to transform the geometry of the animation design CAD model, and the transformation results are fused with the depth information of three-dimensional images to construct a three-dimensional image depth feature representation method based on the transformer model. The three-dimensional image is optimized by using primitive transformation, normal transformation and lighting model, and the feature information of the processed three-dimensional image data is fused with the animation design CAD model to realize the optimization of animation design CAD and virtual reality dynamic scene rendering. The experimental results show that the proposed method can shorten the rendering time of animation design CAD and virtual reality dynamic scenes, and effectively improve the rendering efficiency of animation design CAD and virtual reality dynamic scenes. However, this study only conducted experiments on limited data in the field of animation design, so other optimization methods and technologies can be tried in the follow-up study to optimize the mechanism further to improve the rendering effect of animation design CAD and virtual reality dynamic scene.

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