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Animation Scene Generation Based on Deep Learning of CAD Data

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Abstract. This article aims to explore new methods of animation scene generation and DM (Data mining) through DL (Deep Learning) technology and provide innovative technical means and valuable data support for animation production. In order to achieve this goal, this article adopts the advanced DL model to generate animation scenes and successfully generates a large number of realistic and diverse animation scenes by training and optimizing Gan (Generative adversarial network). Moreover, this article uses DM methods such as cluster analysis and classification recognition to mine and analyze the generated animation scene data deeply. The results prove the effectiveness and feasibility of DL in animation scene generation and DM. Automatically generating animation scenes through DL and CAD (computer-aided design) data can greatly reduce the workload of manual design and production and improve the efficiency of animation production. Moreover, through DM technology, we can deeply understand the audience's preferences and market trends and provide more accurate market positioning and content innovation direction for animation production. The research results show that the animation scene generation and DM method based on DL have obvious advantages and potential.

Keywords: Deep Learning; Computer-Aided Design; Data Mining; Animation Scene Generation
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1 INTRODUCTION

Due to the rapid growth of computer graphics and AI technology, the animation industry has become an important part of the global cultural industry. Unreal engines are highly anticipated for their powerful graphics rendering capabilities and highly realistic physical simulation effects. In virtual mining animation games, the construction of artificial intelligence scenes is crucial for enhancing the immersion and fun of the game. Abu and Zhironkin [1] discussed how to build artificial intelligence scenes for virtual mining animation games based on Unreal Engine. Develop reasonable behavior plans for characters in the game, such as miners, machines, etc., so that they can respond accordingly to changes in the game state and environment. For example, miners can choose suitable mining tools based on task requirements, and machines can automatically adjust the working path according to the distribution of ore. In virtual mining animation games, multiple characters may need to be assigned tasks and collaborate. This requires the construction of a reasonable artificial intelligence task allocation mechanism to ensure that each role can efficiently complete tasks and achieve collaborative work. Taking a virtual mining animation game based on the Unreal Engine as an example, this game achieves realistic mining environments and character behavior through the powerful physical simulation and graphic rendering capabilities of the Unreal Engine. In the game, miners can independently choose mining tools according to task requirements, and machines can automatically adjust their work paths based on the distribution of ore. In the process of animation production, animation scene generation and DM are two key links. Intelligent algorithms based on deep learning and CAD data have gradually become a research hotspot in order to improve design efficiency and realism. Bao [2] explored the application of this intelligent algorithm in 3D graphics engine animation design. Deep learning technology can extract features by learning a large amount of data, thereby achieving automated model construction and optimization. In 3D graphics engine animation design, deep learning techniques can be used to automatically recognize and extract geometric features, texture information, etc., of objects, thereby quickly generating realistic 3D models. CAD data is a standardized three-dimensional model data widely used in the fields of industrial design and manufacturing. By combining CAD data and deep learning techniques, automated and efficient 3D model reconstruction and optimization can be achieved, providing richer and more accurate materials for 3D graphics engine animation design. Specifically, intelligent algorithms can automatically adjust the details and texture effects of models by simulating human aesthetic standards and visual perception mechanisms, making them more in line with human visual habits. At the same time, intelligent algorithms can also combine kinematic principles and physical simulation techniques to achieve more realistic animation effects, such as bone animation, physical simulation, etc. With the continuous accumulation of animation data, mining valuable information from massive data and providing strong data support for animation production have also become urgent problems in animation production.

With the continuous development of artificial intelligence (AI) and virtual reality (VR) technology, their combination has brought unprecedented possibilities for animation scene systems. Among them, VR technology has shown its unique advantages in training AI models. Bui and Alaei [3] explored the application of virtual reality in training AI-based animation scene systems, particularly in the field of fall detection in animation behavior, through a specific case study. Virtual reality technology can provide a highly simulated environment, allowing developers to simulate various situations and train AI models for accurate behavior recognition. Artificial intelligence, on the other hand, can improve cognition and understanding of complex behaviors through a large amount of data learning and pattern recognition. The combination of the two enables the animation scene system to be more intelligent, realistic, and dynamic. In animation scenes, a character's behavior falling is a common dynamic event. By combining virtual reality and artificial intelligence technology, a system can be constructed that can detect and respond to character fall behavior in real-time. The 3D animation modeling function of AutoCAD is powerful and flexible, including solid Modeling, surface modeling, parametric design, and other functions. These features allow designers to create complex industrial shapes and dynamically simulate and analyze the models. By adjusting the parameters and properties of the model, designers can view the changes in the model in real-time in order to better understand the feasibility and effectiveness of the design. Using the 3D animation modeling feature of AutoCAD, designers can quickly create and modify product models on the computer. Chatzivasileiadi et al. [4] Through the 3D animation modeling feature of AutoCAD, designers can analyze and optimize product structures, thereby improving product performance and reliability. Designers can use the 3D animation feature of AutoCAD to simulate and analyze products dynamically. By simulating the motion and performance of a product, designers can predict its performance and potential issues, thereby optimizing and improving it in advance. Using the 3D animation modeling feature of AutoCAD, designers can create realistic product demonstration animations. In recent years, DL and CAD data have shown great application potential in animation scene generation and DM. DL can automatically learn and extract features from data by simulating the operation mode of the human brain neural network and then realize complex tasks, such as image recognition and voice recognition. Using the 3D animation modeling feature of AutoCAD, designers can quickly create and modify product models on the computer. By constantly trying and optimizing, designers can discover new design ideas and creativity and improve the innovation of product design. In industrial design, structural optimization is crucial. Through the 3D animation modeling function of AutoCAD, designers can analyze and optimize the product structure, thereby improving the performance and reliability of the product. Hu [5] utilized the 3D animation feature of AutoCAD to simulate and analyze products dynamically. By simulating the motion and performance of a product, designers can predict its performance and potential issues, thereby optimizing and improving it in advance. Using the 3D animation modeling feature of AutoCAD, designers can create realistic product demonstration animations. This helps to showcase better product design concepts and effects to customers and team members and improve communication efficiency. CAD data is an accurate three-dimensional model data, which can describe the geometric shape, material, lighting, and other information of objects in detail and provide high-quality data sources for animation scene generation.

The purpose of this study is to use DL and CAD data to generate animation scenes and carry out DM. Specific objectives include exploring the application of DL in animation scene generation, realizing automatic or semi-automatic animation scene generation by training the DL model, and improving the efficiency and authenticity of scene generation. The method of animation scene generation based on CAD data is studied, and the quality and detail expression of the generated scene are improved by using the accuracy and richness of CAD data. Mining valuable information in animation scenes, such as audience preferences and popular elements, provides data support and reference for animation production.

This study involves the technical integration and innovation in DL, CAD data processing, DM, and other fields, which is helpful in promoting the further application of related technologies. Its specific innovations are as follows:

㊀ High-quality and diverse animation scenes are successfully generated by the DL model, which verifies the potential of DL in animation scene generation.

㊁ Using the DL method, various laws and patterns in the animation scene are successfully excavated, which provides valuable information and reference for animation production.

㊂ Successfully input CAD data into the DL model. This fusion method makes full use of the accuracy of CAD data and the generation ability of the DL model and provides richer and more accurate data support for the generation of animation scenes.

④ The role of multimodal data, such as images and texts, in animation scene generation and DM is comprehensively considered. Through the comprehensive processing of multimodal data, the performance and generalization ability of the model are improved, the generated scene is more realistic and delicate, and the DM result is more accurate and targeted.

The chapters of this article are arranged as follows:

The first section: Introduction. This article presents the research context and significance, emphasizing the crucial role of animation scene generation and DM in the production of animations.

The second section: Related work. This article reviews the research progress and achievements of animation scene generation and DM, analyzes the advantages and disadvantages of existing methods, and provides theoretical support and references for this study.

The third section: Animation scene generation based on DL. The DL model used in this study is introduced in detail, and the methods of preprocessing and feature extraction of CAD data and how to input CAD data into the DL model are expounded. This article shows the design and implementation process of the animation scene generation experiment, including data set preparation, model training, and evaluation.

The fourth section: Animation Scene DM. This article introduces the DL method for animation scene DM. The process of preprocessing and feature extraction of generated animation scene data is expounded. This article shows the design and implementation process of the DM experiment, including data set preparation, model training, and evaluation.

The fifth section: Experimental results and discussion. Show the experimental results of animation scene generation and DM, including the generated scene, the excavated rules and patterns, etc. Moreover, the results are deeply analyzed to explore the validity and reliability of the experimental results, as well as the potential impact and significance of the experimental results.

The sixth section: Summary and Prospect. Summarize the main work, discovery, and innovation of this study, as well as its contribution and significance. This article discusses the limitations and shortcomings of this study, puts forward the direction and suggestions for future research, and provides references for the research in related fields.

2 LITERATURE REVIEW

3D reality technology and CAD (computer-aided design) have become indispensable tools in animation design. Combining these two can not only improve design efficiency but also provide designers with more intuitive and accurate design solutions. Jing and Song [6] discussed the application of combining 3D reality technology with CAD in animation design. When 3D reality technology is combined with CAD, the advantages of both can be fully utilized. Designers can first use CAD software for preliminary geometric design and parameter settings and then import the design into 3D reality technology for more realistic rendering and visual feedback. In animation design, this combination method has a wide range of applications. For example, in character design, designers can use CAD software to create the basic geometric shapes of characters and then import them into 3D reality technology for detailed adjustments and rendering to achieve more realistic effects. In scene design, this combination approach can help designers better grasp the layout and atmosphere of the scene, thereby improving the overall quality of the animation. The 3D model design method for multi-visual animated characters based on virtual reality technology provides a new creative approach for animation designers, making animated characters more vivid and realistic. Li et al. [7] discussed the principles, advantages, and application prospects of this design method. The multi-visual animation character 3D model design method based on virtual reality technology mainly utilizes virtual reality technology to construct a 3D virtual environment in which designers can perform 3D Modeling of animated characters. Compared with traditional modeling methods, this method has higher degrees of freedom and interactivity. Designers can directly create and modify models in virtual environments through virtual reality devices such as helmet displays and data gloves, achieving true "what you see is what you get." The 3D model design method for multi-visual animated characters based on virtual reality technology has broad application prospects in the field of animation design. Firstly, it can be applied to the production of animated movies. Through this method, designers can create more realistic and vivid animated characters, enhancing the viewing and artistic value of movies. Secondly, it can also be applied to game design. The design of character models is crucial in game development. Through design methods based on virtual reality technology, designers can quickly create high-quality game character models and improve the overall quality of the game.

Finite element modeling is a widely used numerical method for engineering analysis and design. It discretizes complex physical systems into a finite number of simple elements and obtains approximate solutions of the system by solving the equations of these elements. In animation production, finite element modeling can be used to simulate the deformation and motion of objects, thereby creating realistic animation effects. Isogeometric reduction is an emerging numerical method that combines the accuracy of traditional finite element methods with the simplicity of reduction methods. Maquart et al. [8] explored the technique of generating topological meshes for animated 3D volumes based on finite element and isometric reduced order modeling. By using higher-order basis functions, geometric reduction can maintain the same geometric accuracy as the original model while reducing computational costs and storage requirements. In animation production, geometric reduction can be used to simplify complex models and improve rendering speed and animation performance. The game animation engine is a core component in game development, responsible for handling tasks such as graphic rendering, physical simulation, and animation playback in games. Traditional game animation engines often rely on manual modeling and animation adjustments, which are not only time-consuming and labor-intensive but also make it difficult to achieve high-quality dynamic effects. In recent years, the development of deep learning and CAD technology has brought new possibilities to game animation engines. Deep learning technology can automatically extract and analyze features from data, while CAD technology provides high-precision 3D modeling tools. Park and Baek [9] explored how to combine these two technologies to build an open-source lightweight game animation engine based on deep learning and CAD data. Deep learning can be used to analyze and understand the three-dimensional structure, lighting conditions, and texture information of game scenes, thereby generating realistic game scenes. In addition, deep learning can also be used to achieve dynamic changes and adaptive rendering of scenes.

With the widespread application of 3D animation in movies, games, and other media, how to generate realistic 3D animation scenes has become an important research topic. Reinforcement learning, as a machine learning method, has been proven to have great potential in solving such problems. Shi [10] explored how to use reinforcement learning to optimize the generation training of 3D animation scenes. Reinforcement learning involves interacting with agents and the environment to learn how to take optimal actions in a given state to maximize cumulative rewards. In the generation of 3D animation scenes, agents can be controllers that control animation objects, while the environment is a 3D animation scene. By interacting with the environment, intelligent agents can learn what actions to take in specific states to generate realistic 3D animation scenes. Decompose the task of generating 3D animation scenes into multiple sub-tasks, such as object movement, camera control, etc. Perform reinforcement learning training on each subtask separately and then combine the results of the subtasks to form a complete animation scene [11]. This hierarchical training method can enable agents to better understand and generate complex animation scenes. Deep learning has achieved significant results in the fields of animation image processing and computer vision. As a structured and standardized data format, CAD data has a wide range of applications in product design, animation production, and other fields. By combining deep learning with CAD data, deep learning algorithms can be used to process and analyze CAD data, extract useful features and information, and provide support for cross-domain animation image production. Self-supervised pose adaptation refers to adjusting and optimizing the pose of animated images and animations through unsupervised learning without annotated data in order to adapt to different fields and needs. This technology can utilize existing animation image animation data for self-supervised learning, automatically learning and adapting to pose changes in different fields by comparing animation image features under different poses. In game development, this technology can be used to transfer real character actions to game characters, improving the realism and immersion of the game. In film production, this technology can be used to transfer the performances of actors to virtual characters, reducing production costs and time. In addition, this technology can also be applied to fields such as virtual reality and augmented reality, providing more flexible and efficient image animation solutions for different fields [12].

The application of motion capture technology in film and animation production is becoming increasingly widespread. Optical positioning and inertial attitude sensing technology, as two important motion capture technologies, play important roles in the real-time virtual filming of film, television, and animation. Wang et al. [13] investigated the application of these two technologies in multi-person motion capture technology. In real-time film and animation virtual shooting, optical positioning and inertial attitude sensing technology can complement each other to improve the effect of motion capture. Firstly, optical positioning technology is used to capture the main actors accurately and obtain their motion data. Then, inertial attitude sensing technology is used to capture other actors and obtain their basic motion data. Finally, merge the two types of data to generate a complete action scenario. Through this application method, it is possible to achieve simultaneous motion capture by multiple people, improve shooting efficiency, and reduce shooting costs. CAD (Computer Aided Design) virtual reality modeling and fractal deformation technology have brought new dimensions and possibilities to animation design. Wang et al. [14] explored how to utilize these technologies to inject innovative elements into animation design. CAD virtual reality modeling technology provides animation designers with a highly free creative platform. Through CAD software, designers can create, modify, and optimize 3D models in a virtual environment and import them into animation production software. This technology not only improves design efficiency but also allows designers to identify and correct design issues in the early stages, reducing the need for later modifications. Fractal deformation technology is a shape transformation method based on mathematical fractal principles. In animation design, fractal deformation technology can be used to create natural, organic, and constantly changing shapes and textures. Through fractal mode, designers can simulate natural phenomena such as waves, clouds, mountains, etc., adding realism and dynamic beauty to animations.

In film and animation production, 3D facial Modeling is a key technology that requires efficient Modeling while maintaining realism. However, existing modeling methods often face challenges in accuracy and efficiency. To address this issue, Xu [15] proposed a fast 3D facial modeling algorithm based on deep learning and CAD data. It utilizes deep learning techniques, especially convolutional neural networks (CNNs), to learn and model preprocessed data. Through training, the network can learn the inherent patterns of facial features and generate preliminary 3D facial models. According to the needs of film and television animation production, post-processing and optimization are carried out on the models generated by deep learning. This includes adjusting model details, enhancing texture effects, and performing lighting rendering. By combining CAD data and deep learning techniques, the generated model has a high degree of realism and can meet the high-quality requirements of film and television animation production. This algorithm can be widely applied to various film and television animation production scenes, providing powerful modeling tools for creators. Ocean animation is an important branch of computer graphics. It requires the realistic simulation of various natural phenomena in the marine environment, such as waves, tides, foam, etc. Traditional ocean animation production methods often rely on manual modeling and animation adjustments, which are not only time-consuming and labor-intensive but also make it difficult to achieve high-quality dynamic effects. In recent years, with the emergence of advanced game engines such as the UE4 engine, the automatic generation technology of 3D animation has been widely applied, bringing new possibilities for the production of ocean animation. Zhang [16] explored the application of 3D animation automatic generation technology based on the Unreal Engine 4 (UE4) engine in ocean animation. Through the particle system and AI behavior tree tools of the UE4 engine, complex marine ecosystems such as fish swimming and seaweed swaying can be simulated. The experimental results show that this technology can significantly improve the production efficiency and quality of ocean animation and reduce the workload of manual intervention and post-adjustment.

With the rapid development of computer graphics and animation technology, 3D animation has become an important component of multimedia fields such as film and television, games, and advertising. In order to improve the quality and efficiency of 3D animation, researchers are constantly exploring new technologies and methods. Among them, computer-aided design technology based on spatial variation and convolution algorithms has shown great potential in 3D animation design and enhancement. Zhang [17] discussed the application and advantages of this technology in the field of 3D animation. The spatial mutation algorithm is a technique that generates three-dimensional animations by simulating the spatial deformation process of objects in nature. It can automatically calculate the shape changes of objects in space based on preset deformation rules, thereby achieving realistic animation effects. In 3D animation design, spatial mutation algorithms can be used to simulate complex dynamic processes such as elastic deformation, plastic deformation, and fluid motion of objects, greatly enriching the expressive power and visual effects of animation. Neural animation mesh is a neural network-based representation method used to represent three-dimensional human motion data. It achieves high-precision human pose estimation and behavior modeling by representing the human body as a three-dimensional mesh and using neural networks to learn human motion patterns. Compared with traditional keyframe-based animation representation methods, neural animation meshes have higher degrees of freedom and flexibility, which can better represent complex actions and scenes. Zhao et al. [18] used neural animation meshes to model human behavior scenes. It requires collecting a large amount of three-dimensional motion data, including various behaviors of different people in different scenes. Then, deep learning techniques are used to learn these data and obtain a neural network model that can generate human posture. By adjusting the input conditions, different postures of human models can be generated, thereby constructing complex behavioral scenes.

3 DL-BASED ANIMATION SCENE GENERATION

3.1 DL Model Construction and CAD Data Processing

As accurate 3D model data, CAD data is widely used in engineering design, machinery manufacturing, and other fields. In recent years, with the growth of computer graphics and AI technology, the application of CAD data in animation production, virtual reality, and other fields has gradually increased. Using the accuracy and richness of CAD data and computer graphics technology, researchers have achieved high-quality animation scene generation and rendering. Through the analysis of CAD data and the application of optimization algorithms, the automatic optimization and improvement of product design are realized, and the performance and competitiveness of products are improved.

In the aspect of animation scene generation, the traditional methods mainly rely on manual design. With the growth of DL technology, the animation scene generation method based on DL has attracted more and more attention. Researchers use the DL model to learn the distribution and characteristics of real-world scenes and then generate realistic animation scenes. Moreover, the animation scene generation method based on CAD data has also achieved certain results. By combining the accuracy of CAD data with the generation ability of DL, high-quality animation scene generation is realized. In DM, with the continuous accumulation of animation data, how to mine valuable information from massive data has become a research hotspot. Using DM technology, researchers analyze animation data by classification, clustering, and association rule mining and find valuable information such as audience preferences and popular elements, which provides data support and reference for animation production. Although some research achievements have been made in DL, CAD data, animation scene generation, and DM, there are still the following problems and shortcomings: Model generalization ability: Existing DL models often face the problem of insufficient generalization ability when dealing with complex and changeable animation scenes, which leads to the lack of diversity and innovation in the generated scenes.

CAD data processing: CAD data usually contains a lot of detailed information. How to effectively process and use this information to improve the efficiency of animation scene generation is still a problem to be solved.

Multimodal data fusion: At present, most of the research focuses on single-modal data. How to effectively fuse multimodal data and improve the fidelity of animation scenes and audience experience remains to be further studied.

DM depth: Existing DM methods can only dig out the surface association rules and information when dealing with massive animation data. How to dig deep into the potential values and trends in the data and provide more accurate data support for animation production is a challenging problem.

Based on the above shortcomings, this article explores new methods of animation scene generation and DM through DL technology, providing innovative technical means and valuable data support for the animation production field.

In this article, the advanced DL model is considered to generate animation scenes, and a large number of realistic and diverse animation scenes are generated by training and optimizing GAN. GAN has been a major breakthrough in the DL field in recent years. It consists of two parts: generator and discriminator. The generator's responsibility is to create novel data samples, whereas the discriminator's duty is to discern whether the inputted data is authentic or synthetic. Through a rigorous training process, the generator and discriminator engage in a competitive dynamic, ultimately arriving at an equilibrium where the generator produces data that closely resembles actual samples. In the context of animation scene generation, GAN can be harnessed to learn the data distribution of genuine scenes and generate fresh animation scenes resembling the real ones. The architecture of the GAN model is delineated in Figure 1.

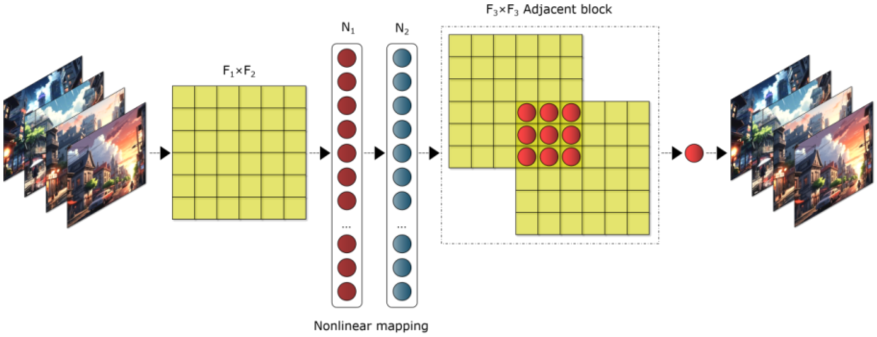

Figure 1: GAN model structure.

CAD data usually exists in the form of a three-dimensional model, which contains a lot of information such as geometry, material, and illumination. In order to input CAD data into the DL model, a series of preprocessing and feature extraction operations are needed. In this article, firstly, CAD data is cleaned and standardized to remove noise and redundant information, and the data format is converted into a format acceptable to the DL model. For image data, operations such as scaling and cropping are also carried out to meet the input requirements of the model.

According to the characteristics of CAD data, it is very important to design a special feature extraction method. CAD data usually contains rich geometric, topological, and material information, so it is necessary to extract these features effectively for the subsequent DL model. Among them, shape is one of the most basic attributes of CAD data. In order to accurately describe the shape of a three-dimensional object, various shape features can be extracted. Material characteristics are very important for rendering and simulating the realism of objects. Color and texture features are two main aspects to describe materials. In this article, color is represented by numerical values in RGB, HSV, and other color spaces, and texture can be obtained by calculating the statistical differences between pixels or vertices on the surface of the object. In this article, the design of the filtering method considers both the suppression of noise and the effect of texture extraction. After smoothing the image with the Gaussian function, this method combines the Laplacian operator and the zero-crossing principle of the second derivative of the function to detect the texture boundary of the image. The second-order Gaussian function is:

$$G(x,y,\sigma)=\frac{1}{2\pi\sigma^2}\exp\left(-\frac{1}{2\sigma^2}(x^2+y^2)\right) \tag{1}$$

Because it is equivalent to first calculating the convolution of an image and a Gaussian function and then finding the Laplacian differential of the convolution result, the LOG (Laplacian of Gaussian) filter is in the form of calculating the second-order partial derivative of the Gaussian filter function. The form of the LOG filter is as follows:

$$\Delta^2 G(x,y,\sigma)=\frac{1}{\pi\sigma^4}\left(\frac{1}{2\sigma^2}(x^2+y^2)-1\right)\exp\left(-\frac{1}{2\sigma^2}(x^2+y^2)\right) \tag{2}$$

The range of gradient direction $\theta(x,y)$ is 0~360, so it can be divided into four regions, namely 0, 1, 2, and 3. It can be expressed by the following formula:

$$\xi(x,y)=\mathrm{Sec}tor(\theta(x,y)) \tag{3}$$

$$\xi(x,y)=0,1,2,3 \tag{4}$$

Where $\xi\ x,y$ represents the region where the gradient direction of each pixel is located. Then, each pixel in the image is subjected to non-maximum suppression, and the mathematical expression is as follows:

$$N\ x,y\ = NMS\ \ G\ x,y\ ,\xi\ x,y \tag{5}$$

Lighting characteristics determine how objects are presented under different lighting conditions. Shadow and reflection are two important lighting effects. Shadow can be obtained by calculating the occlusion relationship between the light source and the object, while reflection needs to consider the incident and emergent angles of light on the object's surface.

In order to extract these features effectively, this article adopts the following methods:

Manual design: according to domain knowledge and experience, a set of feature extractors are designed manually. This requires a deep understanding of the characteristics of CAD data and the needs of the problems to be solved, but it may be affected by human subjectivity and design complexity.

Automatic learning: Using the DL model, we can automatically learn useful feature representations from original CAD data. This method needs a lot of training data and depends on the model architecture and training strategy, but it can reduce the burden of artificial design and may find new features that are difficult for human beings to detect.

The extracted features can then be used as the input of the DL model for various tasks, such as classification, regression, generation, and so on. By reasonably designing and selecting feature extraction methods, the performance and efficiency of the DL model in processing CAD data can be greatly improved.

3.2 Experimental Results and Analysis

GAN, a representative DL model, was selected for the experiment, and the open CAD data set was used for training and testing. In order to evaluate the performance of the model, this section uses a variety of evaluation indicators, including the authenticity, diversity, and speed of the generated content. Figure 2 shows the authenticity of the generated animation content. Figure 3 shows the diversity of the generated animation content, and Figure 4 shows the generation speed of the animation content.

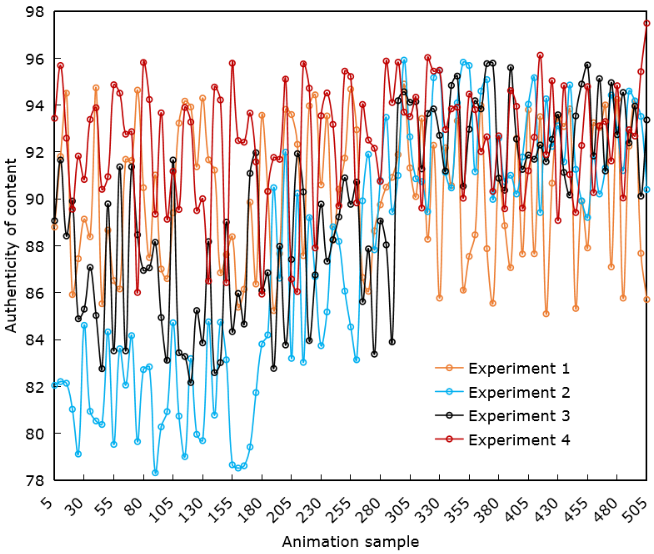

Figure 2: Authenticity of generated animation content.

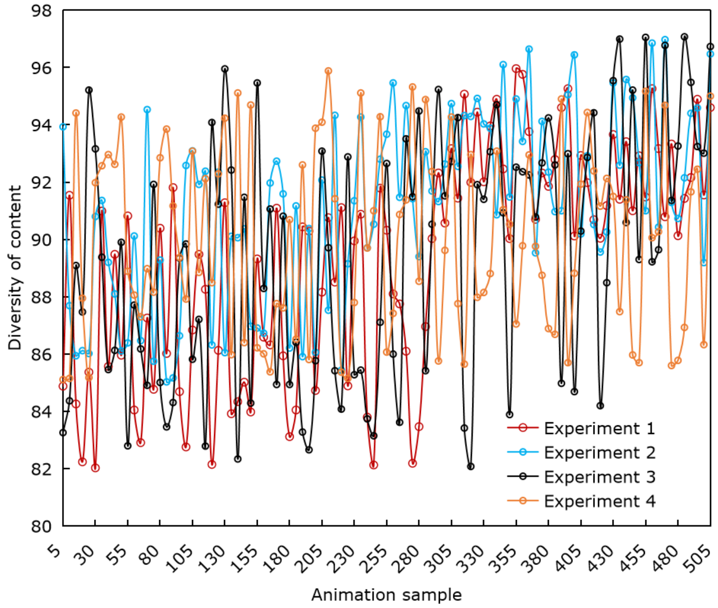

Figure 3: Diversity of generated animation content.

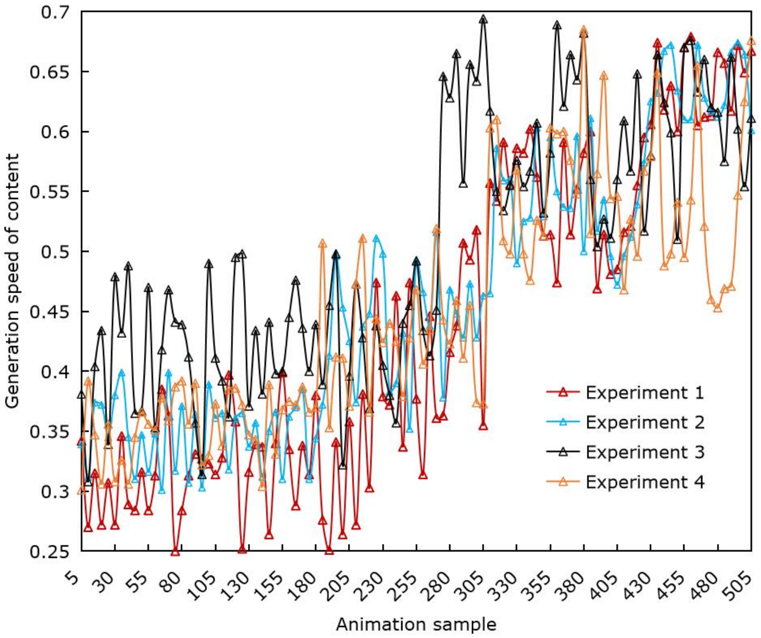

Figure 4: Generation speed of animation content.

Through experiments, a large number of generated animation scene samples are obtained. From the visual effect, the generated scene has a high sense of reality and detailed performance. Moreover, through the comparative analysis with the real scene, the scene generated by this method also has a certain performance in diversity. In addition, the generation speed of the model is evaluated, and the results show that the DL model has high generation efficiency.

4 DL-BASED ANIMATION SCENE DM

4.1 DM Method and Data Preprocessing

In the animation scene DM, clustering analysis can be used to find similar elements or patterns in the scene, such as similar character modeling, scene layout, and so on. Classification recognition is a supervised learning method that establishes a classifier to predict the labels of new samples by learning the characteristics of known samples and the relationship between labels. In the animation scene DM, classification recognition can be used to identify specific elements or attributes in the scene, such as identifying characters and objects in the scene.

Before DM, it is very important to preprocess the generated animation scene data because it directly affects the accuracy and reliability of subsequent data analysis and mining results. First, you need to check whether there are invalid or duplicate data samples in the dataset. Invalid data may be caused by errors in data collection or processing, while redundant data may increase the Complexity of calculations without providing additional information. By deleting these data, the quality and consistency of the data can be improved. Secondly, animation scene data may contain various forms of noise, such as wrong labels and incomplete scene information. For the wrong label, we can use the methods of majority voting and label smoothing to correct it. For incomplete scene information, we can try to use interpolation or DL-based methods to complete it.

The characteristics of animation scene data determine the need to design a special feature extraction method to better describe the content and attributes of the scene. Shape is one of the key features to describe objects in an animated scene. In this article, the contour of the object is extracted by a contour detection algorithm, and the geometric properties of the contour are calculated as shape features. The principle of the edge detection algorithm is that the first derivative at the edge point has a maximum, or the second derivative is zero. The gradient of the function is the first derivative of the function. For a continuous function $f(x,y)$, its gradient at (x,y) a point is defined as:

$$G(x,y) = \left[G_x, G_y\right] = \left[\partial f / \partial x, \partial f / \partial y\right] \tag{6}$$

The magnitude of the gradient is expressed as follows:

$$\left|G(x,y)\right| = \sqrt{(\partial f / \partial x)^2 + (\partial f / \partial y)^2} = \sqrt{G_x^2 + G_y^2} \tag{7}$$

For the convenience of calculation, the absolute value of the gradient function is used to approximate the gradient amplitude:

$$\left|G(x,y)\right| \approx \left|G_x\right| + \left|G_y\right| \ or \ \left|G(x,y)\right| \approx \max(G_x, G_y) \tag{8}$$

The direction angle of the gradient is:

$$a(x,y) = \arctan(G_x / G_y) \tag{9}$$

4.2 DM Experiment

Representative methods of clustering analysis and classification recognition are selected in the experiment, and the generated animation scene data set is used for testing. In order to evaluate the performance of the algorithm, various evaluation indexes are adopted, including accuracy, recall, and F1 score. Figure 5 shows the accuracy of DM, Figure 6 shows the recall rate of DM, and Figure 7 shows the F1 score of DM.

In this section, a large number of DM results are obtained through experiments. According to the results of Figure 5, Figure 6, and Figure 7, the performance of the DL method in animation scene DM can be evaluated as a whole. The experimental results show that the DL method is excellent in accuracy, recall, and F1 score. Therefore, it can be concluded that the DL method is effective in animation scene DM and has high application potential.

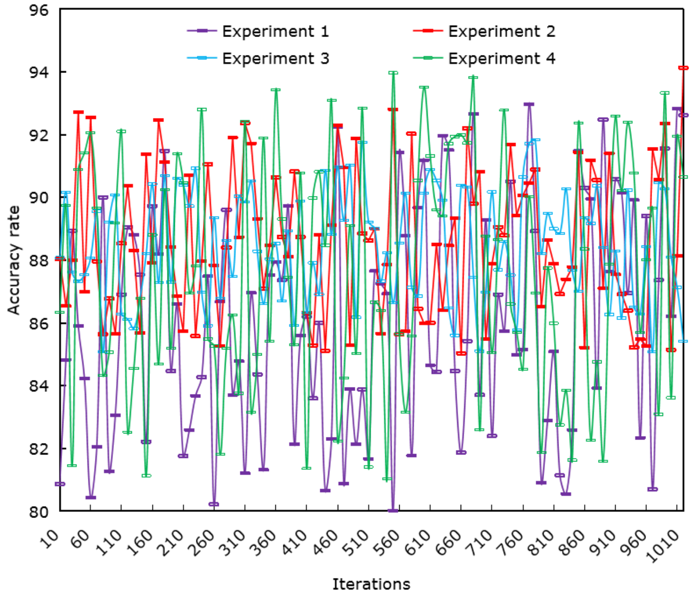

Figure 5: Accuracy rate of DM.

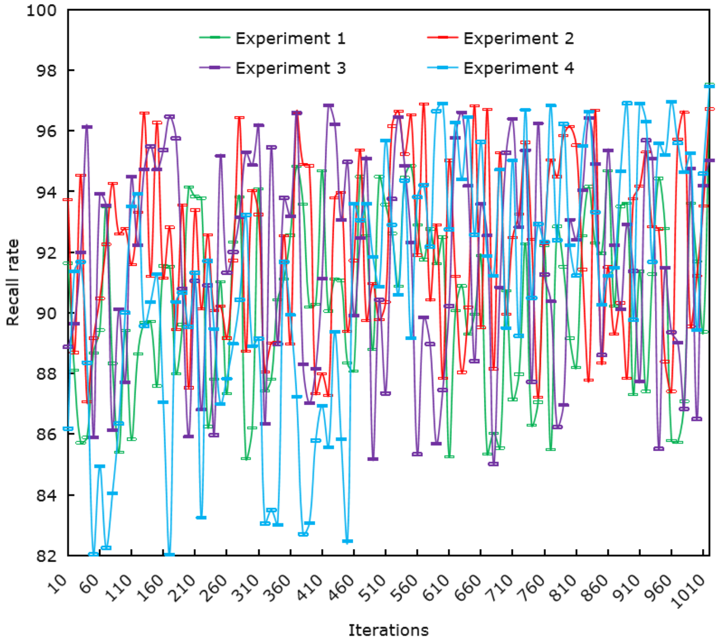

Figure 6: Recall rate of DM.

For cluster analysis, many similar elements and patterns in the scene, these results can provide inspiration and reference for animation. For classification and recognition, this article successfully identifies specific elements and attributes in the scene, such as characters and objects, and these results can provide detailed data support for animation.

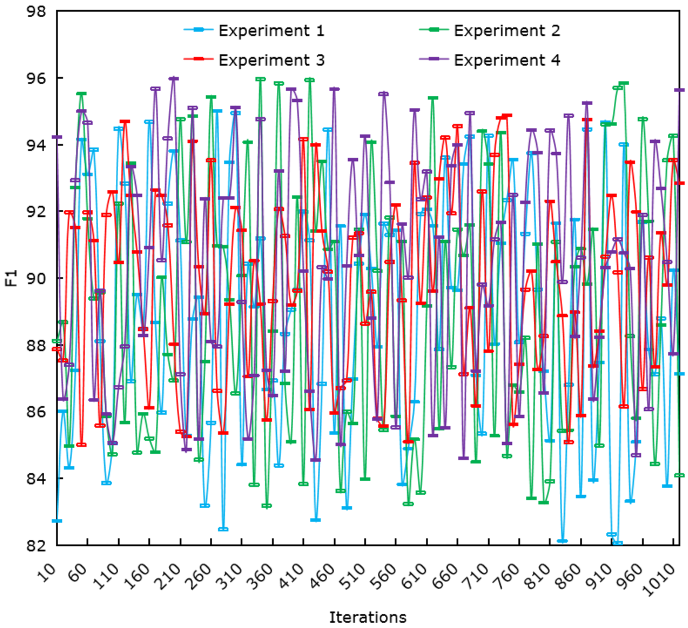

Figure 7: F1 score of DM.

5 MODEL EXPERIMENT AND RESULT DISCUSSION

5.1 Experimental Results Show

Through the animation scene generation method based on DL, this article successfully generated a series of high-quality animation scenes. These scenes are very realistic in visual effect, rich in details, and show diversity and innovation. Specifically, the generated scenes cover various styles and types, including natural scenery, urban landscape, indoor scenes, and so on. See Figure 8 for details. In addition, the quality and diversity of the generated scenes are verified by qualitative and quantitative evaluation.

In the aspect of animation scene DM, this article successfully digs out various laws and patterns in the scene by using the DL method. Through cluster analysis, some similar scene elements and layout patterns are found, which can provide inspiration and reference for animation. Moreover, the classification and recognition method also successfully identified the specific elements and attributes in the scene, which provided detailed data support for animation production.

5.2 Result Analysis

Through the analysis of the results, the validity and reliability of the animation scene generation and DM method based on DL are verified. The generated animation scene has achieved remarkable results in visual quality and diversity, which proves the potential of the DL model in dealing with complex animation scene generation tasks. Experiments show that the DL method has good accuracy; that is, the curve is stable and higher than other comparison methods. Therefore, the DL method can be considered effective for the classification of animation scenes. Moreover, the recall curve of the DL method remains high and stable, which means that this method can identify the key information in the animation scene comprehensively. In addition, the F1 score curve of the DL method is above that of other methods and remains stable, which shows that this method has a highly comprehensive performance in animation scene DM. These DM results also reveal a variety of laws and patterns in the scene, providing valuable information and reference for animation.

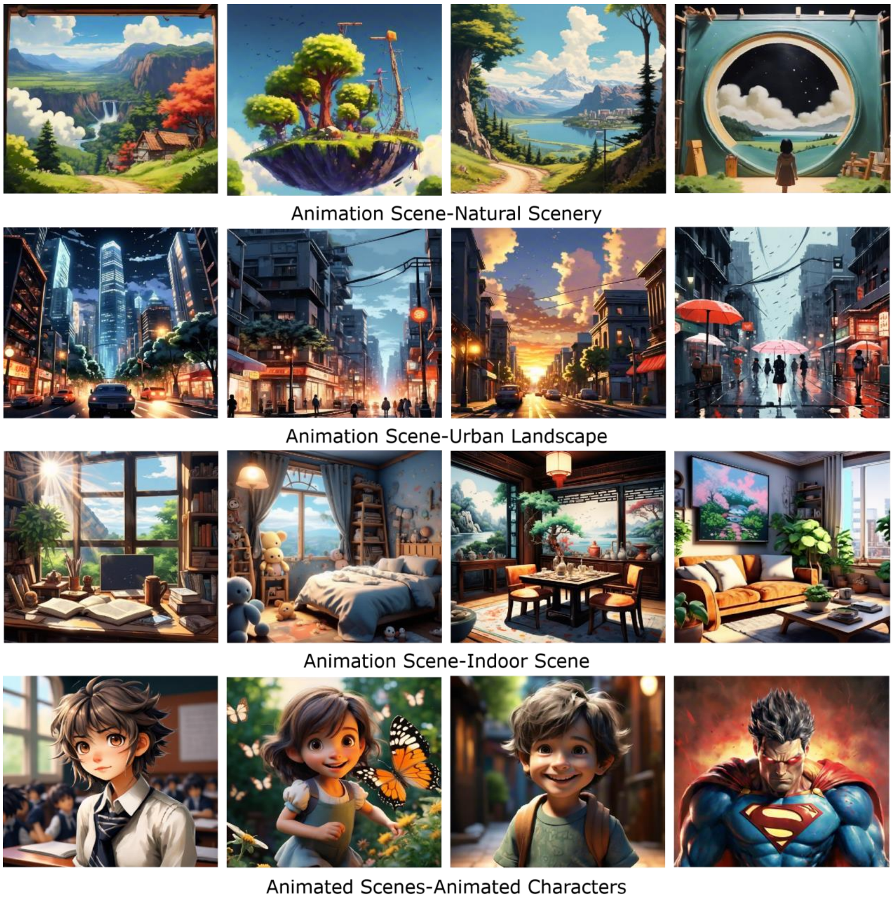

Figure 8: Animation scene generation.

The results of this study have important potential influence and significance in the field of animation production. First of all, the animation scene generation method based on DL can provide high-quality scene materials for animation production, reduce the workload of manual design and production, and improve production efficiency. Secondly, DM results can provide inspiration and data support for animation production and help producers better understand audience preferences and market trends, thus making animation works more popular.

Compared with existing studies, this study has innovations and advantages in the following aspects:

Model innovation: In this study, the advanced DL model is used for animation scene generation and DM, which has higher generation quality and mining accuracy than traditional methods.

Multimodal data processing: This study comprehensively considers the role of multimodal data, such as images and texts, in animation scene generation and DM, which improves the performance and generalization ability of the model.

Verification of experimental results: This study verified the reliability of the proposed method through a large number of experiments and made a detailed comparison and analysis with the existing research, highlighting the advantages and contributions of this study.

6 CONCLUSIONS

DL can learn and simulate complex textures and lighting effects in the real world, and combined with the accuracy of CAD data, it can generate more realistic and delicate animation scenes. This research is devoted to exploring the method of animation scene generation and DM based on DL and has achieved a series of important research results. Firstly, this article puts forward the method of animation scene generation based on DL and discusses the methods of preprocessing and feature extraction of CAD data so as to input CAD data into the DL model. Moreover, an experiment in animation scene generation is designed, and a large number of high-quality animation scenes are generated by the DL model. The results are evaluated and analyzed. Secondly, the DL method for animation scene DM is introduced, the generated animation scene data is preprocessed, and features are extracted for DM. Moreover, the DM experiment is designed, and the data of the animation scene is mined by the DL method, the rules and patterns are found, and the mining results are evaluated and analyzed.

This study provides high-quality scene materials and inspiration for the animation production field, reduces the workload of manual design and production, and improves production efficiency. Reveals the audience's preferences and market trends for animation scenes and helps producers better understand the audience's needs and market trends. Additionally, it fosters the advancement and application of Deep Learning in animation production, serving as a valuable resource for investigations in related domains. Despite the notable progress made in this research, certain constraints and shortcomings exist that necessitate refinement and enhancement in subsequent investigations. Looking ahead, further examination and refinement of the DL model's structure and algorithm will be undertaken to bolster the model's proficiency in handling intricate scenarios and finer details.

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