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CAD Modeling Process in Animation Design Using Data Mining Methods

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Abstract. In order to meet the growing demand for animation content, the animation industry has increasingly high requirements for design quality. By mining patterns and patterns hidden within the data, it can provide valuable insights for decision-makers. In animation design, the DM method can help designers process and analyze data more efficiently and discover potential patterns in the design process. This article proposes using the DM method to optimize the computer-aided design (CAD) modeling process in animation design and design optimization methods for capturing and rendering animation character actions. To achieve this goal, we compared and analyzed the improved and traditional methods. Through the display and analysis of the results, it was found that the improved method shortened the time for feature dimensionality reduction and improved the accuracy of classification. These results indicate that the improved method can better handle animation scene feature classification tasks. The research results provide new ideas for optimizing the performance of animation scene feature classification models.

Keywords: Data Mining; Animation Design; CAD Modeling
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1 INTRODUCTION

Animation works are deeply loved by audiences all over the world because of their unique visual expression and infectious storyline. In order to meet the growing demand for animation content, the animation industry has higher and higher requirements for design quality. Traditional animation design methods often rely on designers' experience and intuition, and the design process is cumbersome and time-consuming, so it is difficult to adapt to the rapidly changing market demand. As an advanced computer-aided design technology, CAD intelligent algorithms provide powerful support for animation design in 3D graphics engines. However, traditional CAD intelligent algorithms often have some limitations, such as low computational efficiency and lack of intelligent decision-making. Therefore, utilizing deep learning mining methods to optimize the application of CAD intelligent algorithms in 3D graphics engine animation design by Bao [1] is a worthwhile research topic. It utilizes deep learning techniques to extract and classify features from 3D graphic data. By training deep learning models, different graphic elements can be automatically recognized and classified, improving computational efficiency. Based on deep learning models, learn and predict

3D graphic data to achieve intelligent decision-making and optimization. For example, animation design can be optimized by predicting the performance and user experience of animation effects. Collect user feedback and evaluation data in a timely manner during the optimization process. By analyzing and mining feedback data, understand whether the optimized animation effect meets user needs and make further adjustments and optimizations. Therefore, optimizing the animation design process and improving design performance have become urgent problems for the animation industry. In recent years, the rise of DM technology has brought new opportunities for animation design. DM is a process of extracting useful information from a large quantity of data. Mining the patterns and laws hidden in the data can provide valuable insights for decision-makers. Computer vision technology can accurately measure the size of product images through methods such as image processing and pattern recognition. Accurate dimensional measurement is crucial in the quality assurance process. Through computer vision technology, product size information can be quickly and accurately obtained, providing data support for subsequent quality evaluation and optimization. CAD technology can be used to create three-dimensional solid models of products. In the process of quality assurance, 3D solid models can help us better understand the structure and shape of products, thereby conducting more accurate quality evaluations. Meanwhile, through CAD technology, Bhandari and Manandhar [2] simulated and optimized the product, improving its design quality and manufacturing efficiency. By integrating computer vision and CAD technology, precise size extraction and 3D solid model regeneration can be achieved. In animation design, the DM method can help designers process and analyze data more efficiently, discover potential flaws in the design process, and thus provide targeted optimization suggestions for designers.

The 3D animation CAPTCHA system is based on biometric technology, which collects user biometric information for identity verification. The system utilizes machine learning and artificial intelligence technology to generate challenging 3D animations, requiring users to engage in interactive operations. These operations typically include identifying patterns, clicking on specific objects, or completing certain tasks. By analyzing the user's operational behavior and biometric information, the system can determine whether the user is a real human. Machine learning and artificial intelligence technologies play a crucial role in the 3D animation CAPTCHA system. By using machine learning algorithms, the system can automatically learn the user's biometric information and generate personalized challenge tasks based on this information. The 3D animation CAPTCHA system has high security, accuracy, and user experience. Compared to traditional text or image CAPTCHA, 3D animation CAPTCHA is more difficult to imitate and cracked by automated tools. Meanwhile, due to the use of biometric technology, the system can more accurately identify user identities and reduce the possibility of misjudgment. In addition, personalized challenge tasks can also increase user engagement and loyalty [3]. In the research status at home and abroad, some scholars have tried to apply the DM method to animation design. Traditional animation creation requires a lot of manpower and time, and the production process is relatively fixed and linear. However, artificial intelligence technology can achieve more efficient, flexible, and automated animation creation. Artificial intelligence technology can automatically generate animation scenes, characters, actions, and other elements based on data and algorithms, greatly reducing production time and costs. At the same time, through artificial intelligence technology, various styles of animation creation can be easily achieved to meet the needs of different audiences. Cai et al. [4] use machine learning and computer vision technologies to automatically recognize scenes and characters in images and videos and generate corresponding animated scenes and character images. It uses technologies such as natural language processing and speech recognition to recognize the audience's input and choices, dynamically generating corresponding plots and actions, making the animation more interesting and engaging. And utilize technologies such as big data analysis and machine learning to recommend personalized animation content and viewing experiences based on the audience's historical data and behavioral habits. In today's game development, the design and implementation of animation systems are crucial. An excellent animation system can not only provide realistic character actions but also enhance the immersion of the game and improve the player's experience. Dynamic motion matching and semantic computing are key technologies to achieve this goal. Dynamic motion matching technology refers to matching a character's actions with the context in the game, making their actions more natural and realistic. For example, when a character jumps in a game, dynamic motion matching technology can calculate the most suitable jumping action based on factors such as the character's height, speed, and gravity so that the character's actions match the game context. By combining dynamic motion matching and semantic computing technology, a more intelligent and automated animation system can be designed. This system can automatically adjust the actions and expressions of characters based on the context and dialogue content in the game, making their behavior more natural and realistic. Meanwhile, this system can continuously learn and optimize based on player feedback and behavior, improving the gaming experience [5]. Enterprise information systems play a crucial role in animation video production systems. Huang et al. [6] use artificial intelligence technology to assist enterprise information systems in achieving automated and intelligent information processing and management, improving production efficiency and quality. Artificial intelligence technology can help enterprise information systems automatically screen, classify, and organize materials, reducing manual operations and time costs. Meanwhile, speech recognition and text conversion technologies based on artificial intelligence can also provide more intelligent information input and output methods for enterprise information systems, improving information processing efficiency and accuracy. Enterprise information systems based on artificial intelligence technology can achieve automated information processing, reducing manual operations and time costs. By utilizing natural language processing technology, enterprise information systems can automatically recognize and process text information. By utilizing image recognition technology, image information can be automatically recognized and processed. These technologies can greatly improve the efficiency and accuracy of information processing. Traditional virtual reality technology often has some limitations, such as low computational efficiency and a lack of intelligent decision-making. In virtual reality animation production, data mining technology can play an important role. He and Xiang [7] collected and analyzed data during the process of virtual reality animation production and understood the patterns and trends of animation production. Secondly, use data mining techniques to process and analyze the data and extract key features and evaluation indicators. Comparing the performance and user experience of different animation effects provides a basis for optimization. Using data mining techniques to extract and classify features from virtual reality animation production data. By training classification models, different animation elements can be automatically recognized and classified, improving computational efficiency. Based on data mining models, learn and predict virtual reality animation production data to achieve intelligent decision-making and optimization. For example, animation design can be optimized by predicting the performance and user experience of animation effects.

Currently, there is relatively little research on using DM methods to optimize the CAD modeling process in animation design. CAD modeling is one of the important links in animation design, which involves the three-dimensional modeling process of characters, scenes, and props. Traditional CAD modeling methods often rely on manual operations and experiential judgment by designers, resulting in low modeling efficiency and easy errors. Therefore, the focus of this article's research is how to use the DM method to optimize the CAD modeling process and improve modeling performance. In response to the above issues, this article proposes an optimization scheme for the CAD modeling process in animation design based on the DM method. This plan collects and analyzes a large amount of CAD modeling data, mines useful information, and patterns hidden in the data, and provides intelligent modeling assistance and optimization suggestions for designers. Through in-depth research on the application of DM algorithm and technology in the CAD modeling process, combined with the research and practice of motion capture technology and rendering optimization methods, this article is expected to bring new progress to the field of animation design. This study has the following innovations:

(a) This study systematically applies the DM method to the CAD modeling process in animation design, introducing new technological means for the field of animation design.

(b) This method utilizes motion capture technology to capture real motion data and provide more accurate and vivid references for CAD modeling, optimizing character action design during the modeling process.

(c) This study also introduces the DM method in the rendering process of animation design to achieve intelligent configuration and adjustment of rendering parameters and algorithms.

(d) The optimization plan is not limited to a certain stage of the CAD modeling process but involves comprehensive optimization from multiple aspects, such as data preprocessing, feature extraction, pattern recognition, and optimization suggestions.

Firstly, this article will study and analyze the DM method, extracting key information and patterns related to CAD modeling through data preprocessing, feature extraction, and pattern recognition operations. Secondly, this article will use motion capture technology to collect and process motion data of animated characters. By mining and analyzing motion capture data, the motion characteristics and behavior patterns of characters are extracted, providing guidance for CAD modeling. Once again, this article will study rendering optimization methods to improve the performance of animation rendering. Optimize and adjust rendering parameters and algorithms through the DM method to achieve more efficient and realistic rendering effects. Finally, this article will verify the feasibility of the proposed scheme through experiments. Through comparative experiments with traditional CAD modeling methods, the advantages of the proposed scheme in modeling performance are verified.

2 RELATED WORK

A neural network is a computational model that simulates the working mode of human brain neurons and has strong learning and prediction capabilities. Neural network algorithms can play an important role in animation design. Jing and Song [8] have learned and trained a large amount of animation modeling data, and neural networks can automatically extract the features and patterns of modeling design. Secondly, a neural network model was established to predict and optimize animation modeling data, achieving intelligent decision-making and design. Learn and train a large amount of animation modeling data through neural network algorithms to extract the features and patterns of modeling design. Then, using 3D reality technology, the trained features and patterns are visualized and interactively displayed, enabling designers to understand and modify the design more intuitively. In computer-aided animation design, spline curves are used to describe and control the actions and postures of characters, as well as various object motion trajectories in the scene. However, there are still some challenges in the application of spline curves in computer-aided animation design, such as adjusting the shape and number of control points of the spline curve to achieve the best animation effect. Li [9] discussed how to use data mining methods to optimize the application of spline curves in computer-aided animation design. It utilizes association rule mining algorithms to search for association rules between the position and number of spline control points and the animation effect. Based on the results of association rule mining, a prediction model was constructed to predict the animation effects under different control point positions and quantities. Virtual medical system animation utilizes virtual reality technology to simulate and reproduce medical processes digitally. This technology can not only simulate the medical process realistically but also rehearse the surgical process, helping doctors better formulate surgical plans and improve the success rate of surgery. At the same time, for patients, virtual medical system animations can provide a more intuitive understanding of their condition and treatment plans, reducing anxiety. Doctors can use virtual medical system animations for surgical rehearsals, predict potential problems during surgery, and develop more comprehensive surgical plans. At the same time, this technology can also be used for surgical training to improve the surgical skills of doctors. Virtual medical system animations can be used for medical education and training, enabling medical students and staff to have a more intuitive understanding of the structure and function of the human body, improving their medical knowledge and practical abilities. Through virtual medical system animations, patients can have a deeper understanding of their condition and treatment plan, improving treatment compliance and confidence [10].

Character modeling design is the core of 3D model design for animated characters, which needs to be combined with factors such as animation storyline and character traits for design. In multi-visual animation, character modeling needs to consider the visual effects from multiple perspectives, therefore requiring a more detailed design. Li et al. [11] conducted detailed planning and design on the proportions, structure, details, etc., of the characters to ensure that good visual effects could be presented from different perspectives. Material texture is one of the important factors affecting the visual effect of 3D models of animated characters. In multi-visual animation, it is necessary to consider the lighting and shadow effects from different perspectives, so a more precise design of material textures is needed. Skeleton binding is one of the key techniques for achieving the movement of animated characters. In multi-visual animation, it is necessary to consider the motion effects from different perspectives, so a more precise design of bone binding is needed. In the process of bone binding, it is necessary to consider the motion and visual effects from different perspectives to ensure that good animation effects can be presented from different perspectives. The traditional animation action capture process may be affected by factors such as environment and equipment, resulting in errors or anomalies in the captured data. Through data mining techniques, these data can be optimized and repaired to improve the accuracy and reliability of motion capture data. Inertial motion capture is a new type of motion capture technology that achieves precise capture of human motion by measuring and analyzing inertial data during human motion. Compared with traditional optical or acoustic motion capture technologies, this technology has advantages such as device portability and no need for special environmental settings. By applying inertial motion capture technology to data mining, human motion data can be better extracted and utilized. By using data mining techniques, key motion parameters of characters, such as joint angles and velocities, are extracted from inertial motion capture data, thereby generating natural and realistic character animations. This method can greatly improve the efficiency and realism of animation production [12]. In the current era of digital media, the development momentum of the animation industry is strong, especially in the fields of entertainment, education, cultural dissemination, etc., and has broad application value. Integrating folk stories into animation production can better inherit and promote traditional culture while also providing rich materials and inspiration for the animation industry. Mayowa [13] explored how to use data mining methods to develop narratives for folk stories and optimize the production process of 2D digital CAD animations. It conducts data mining and analysis on the themes, plots, characters, and other elements of folk stories to gain a deeper understanding of the content and structure of the story, providing a powerful story framework for animation production. Secondly, data mining can also analyze the needs and preferences of the audience, guiding the direction and strategy of animation production and improving the market acceptance of animation. Data mining techniques can also analyze and extract the sound effects and musical elements of folk stories. These elements can provide valuable materials and inspiration for the sound effects and music design of animations, making the sound effects and music more in line with the story theme and atmosphere.

Data mining is an important branch of modern information technology that processes and analyzes large amounts of data through specific algorithms and tools to discover hidden patterns, trends, or associations. Data mining methods can be classified into various types according to different classification criteria. Meanwhile, in animation production, the definition of a character's upper and lower body structure is also crucial, as it determines the basic form and motion characteristics of the character. Pak et al. [14] discussed the classification of data mining methods and the definition of the upper and lower body structures of animated characters. In animation production, the definition of a character's upper and lower body structure is crucial as it determines their basic form and motion characteristics. In animation production, defining the upper and lower body structures of characters in a reasonable way can make them more vivid and realistic and improve the viewing and artistic value of the animation. Meanwhile, by combining different data mining methods, the motion characteristics of animated characters can be analyzed and optimized, further improving the quality and expressiveness of animation. Savić [15] explored how to use data mining methods to optimize the media architecture of animation design and elaborated on the technical optimism and optimization concepts reflected in it. By mining scene rendering data, key factors affecting rendering performance were identified, and rendering algorithms and parameters were optimized to improve rendering efficiency and quality. By analyzing user interaction behavior through data mining techniques, user preferences and behavioral habits can be discovered, thereby optimizing interaction design and improving user experience. Technological optimism emphasizes in the theory of animation design media architecture that continuously introducing new technologies and methods can promote the sustained development and progress of animation design media architecture. This concept encourages designers to actively explore new technologies and methods, applying them to animation design media architecture to achieve better effects and experiences. 3D animation design has been widely applied in many fields. In this process, deep learning and information security technologies provide new methods and perspectives for 3D animation scene graphic design. Tang [16] explored how to use deep learning and information security technologies to optimize and enhance the graphic design of 3D animation scenes. Through deep learning, we can train models to recognize and extract style elements from images and apply these elements to new images to achieve style transfer. This method can provide rich visual elements and styles for the graphic design of 3D animation scenes. Using deep learning, we can train models to learn and optimize image layout automatically. By inputting the layout information of the image and the target layout information, the model can automatically generate images that match the target layout. This method can effectively improve the efficiency and accuracy of 3D animation scene graphic design.

Vitse et al. [17] explored how to conduct virtual design and optimization of structural experiments for multi-view animation systems. For multi-view animation systems, the optimization of structural experiments mainly involves optimizing the various components of the system to improve its overall performance. The virtual design and optimization method for structural experiments of multi-view animation systems can be simulated by establishing virtual models or using simulation software to simulate the system's operation. This method can predict and solve potential problems during the design phase. Meanwhile, by using virtual design and optimization methods, the number and cost of physical experiments can be greatly reduced. It greatly reduces the number and cost of physical experiments by using virtual design and optimization methods. Traditional animation design methods often rely on the experience and intuition of designers, lacking scientific basis and data support. Data mining technology can play an important role in the animation design of smartphone user interfaces. Xu and Xu [18] analyzed user interface usage data, user feedback, etc., to understand user preferences and behavior patterns for animation effects. Secondly, by exploring the relationship between animation effects and user behavior, key factors affecting user experience are identified, providing a scientific basis for optimizing animation design. It also optimizes animation design based on user needs and animation effect evaluation results. By adjusting parameters such as animation speed, delay, and duration, as well as improving animation interaction and visual effects, the user experience can be improved.

ACM animation graphics, as an advanced computer graphics technology, provide new solutions for motion vectorization and transformation editing. Zhang et al. [19] explore how to use ACM animation graphics technology to achieve motion vectorization and transformation editing of CAD graphic videos, improving video quality and efficiency. Animation graphics technology is a computer graphics technology based on mathematics and computer science. It establishes mathematical models to accurately describe and calculate graphics, thereby achieving operations such as graphic generation, transformation, and rendering. Animation graphics technology has the characteristics of high efficiency, accuracy, and flexibility, providing new ideas and methods for motion vectorization and transformation editing of CAD animation graphics videos. Motion vectorization editing refers to the precise description and extraction of moving objects in a video in order to achieve editing and processing of moving objects. In CAD animated graphics videos, motion vectorization editing can help us achieve precise control and editing of moving objects, improving the quality and efficiency of the video. Specifically, it utilizes ACM graphics technology to accurately describe and extract moving objects in CAD animated graphics videos and then achieves precise control and editing of moving objects through editing and processing. Information modeling, as the core of digital technology, can provide powerful data support and model-building capabilities for landscape animation. Zhao et al. [20] used professional modeling software to create landscape models that were completely consistent with the real world in a virtual environment. Hybrid reality technology has brought a new way of presentation to landscape animation. Create an immersive viewing experience by combining virtual landscape models with real shooting scenes. The audience is no longer a passive receiver but a participant and experiencer. In a mixed-reality environment, viewers can see a seamless integration of virtual landscapes and the real world. For example, designers can arrange virtual buildings or vegetation in an actual site, allowing the audience to observe and experience from various angles, thereby better understanding the intention and effect of the design. In addition, mixed reality can also be used for the display and promotion of landscape animation, allowing viewers to experience the charm and value of the landscape in an immersive experience.

3 ANIMATION CHARACTER ACTION CAPTURE TECHNOLOGY

3.1 Overview of Motion Capture Technology

DM combines theories and methods from multiple disciplines, such as statistics, machine learning, and database technology, aiming to discover patterns, trends, and patterns hidden in data. The main tasks of DM include classification, clustering, association rule mining, time series analysis, etc. DM technology has been widely applied in various fields, such as finance, healthcare, education, and e-commerce. It helps enterprises and organizations discover potential business opportunities, optimize business processes, and improve decision-making efficiency by processing and analyzing massive amounts of data. Animation design involves character design, scene design, story plot, and many other aspects, which require a lot of creativity and decision-making. DM technology can support animation design in many ways. Through the DM of a large number of animation works, we can find the similarities and differences between different works, thus providing new creativity and inspiration for designers. Through the DM of the audience's viewing behavior and feedback, we can analyze the audience's preferences and preferences. This is helpful for designers to create animation works that are more in line with the audience's taste and improve the market acceptance of the works. Through the DM of historical animation works, we can find the development trend and popular elements of animation design. This is helpful for designers to grasp the direction of future animation design. DM technology can also be applied to specific processes of animation design, such as role modeling and scene rendering.

CAD modeling is one of the core links in animation design, involving the creation, modification, and optimization of 3D models. Traditional CAD modeling methods often rely on the experience and skills of designers, and the modeling process is cumbersome and time-consuming. DM technology can discover key parameters and configurations related to modeling quality by analyzing historical modeling data. During the CAD modeling process, errors or unreasonable designs may occur due to various reasons. DM technology can identify these errors or unreasonable aspects through mining and analyzing modeling data and provide corresponding corrective measures. There are often implicit design rules and experiences in the CAD modeling process, which play an important role in improving modeling quality and efficiency. Action capture technology is a technique that records and analyzes the motion data of a human body or object and applies it to fields such as computer graphics, animation production, virtual reality, etc. The emergence of this technology allows animators to capture the motion data of real actors or objects and then apply it to animated characters to achieve more realistic and natural action performance. The basic principle of motion capture technology is to place a series of sensors on actors or objects to record their motion trajectory and posture information in three-dimensional space. After processing, these data can be used to drive the 3D model in the computer to perform corresponding movements. According to the different types of sensors and capture methods, motion capture technology can be divided into various types, such as optical, mechanical, electromagnetic, and acoustic.

3.2 Optimization of Motion Capture Technology Based on DM

Although motion capture technology has made remarkable progress, there are still some problems in practical application. For example, due to sensor error, data noise, and other reasons, there may be some errors in the captured motion data. Aiming at these problems, DM technology can provide strong support for the optimization of motion capture technology. DM technology can preprocess and filter the captured original motion data, remove the noise and abnormal values, and improve the accuracy and usability of the data. Through the in-depth analysis of motion data, DM technology can extract the key features related to the action performance of animated characters. These characteristics can include motion trajectory, speed, acceleration, angular velocity, etc. DM technology can use pattern recognition methods to classify and identify the captured motion data. DM technology can discover the sports characteristics and styles of different actors or objects through the mining and analysis of historical sports data. Then, use these characteristics and styles to create a personalized action library and performance style for animated characters.

Changing roles and complex scenes in animation design will have a negative impact on recognition. The use of an attitude estimator can reduce the influence of scene change and clothing occlusion on motion recognition. The human motion area is divided by the human joint coordinates identified by the motion capture device, as shown in Figure 1.

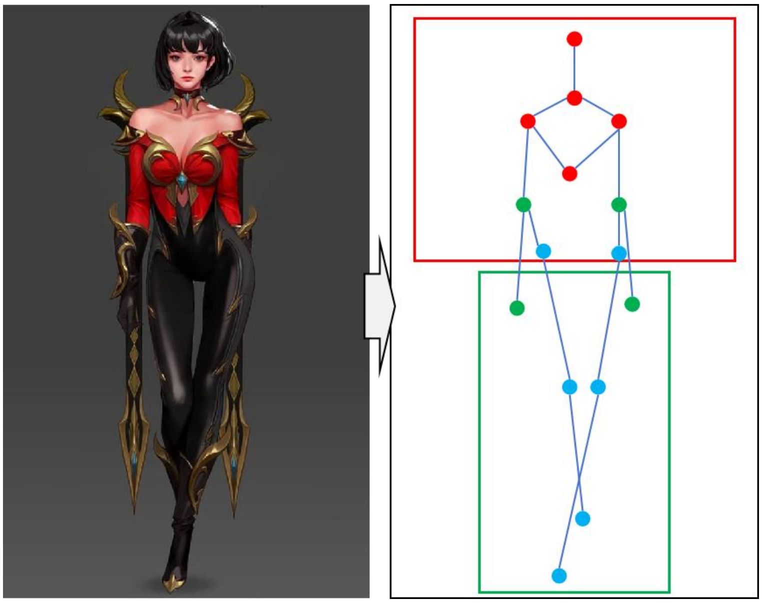


Figure 1: Dividing human body regions according to joints.

$$N = \frac{\sum n_k a_k}{\sum a_k} \tag{1}$$

$$n = \frac{N}{|N|} \tag{2}$$

$$x = \frac{\sum x_k a_k}{\sum a_k} \tag{3}$$

The offset between point P in 3D space and mesh model TM is defined as:

$$d(P,TM) = \min d(P,X) \tag{4}$$

Where $d(P,X)$ is the Euclidean distance from point P to point X ?

If there are vectors $a_1,\cdots,a_n$, $a_1^T,\cdots,a_1^T$ they can be obtained by connecting them together. The optimization problem of 3D reconstruction can be expressed by the following formula:

$$\min \sum_{k=1}^{m} \sum_{i=1}^{n} D\left(m_{ki}, P_k M_i\right)^2 \quad (5)$$

Given a representation function $\Phi: R^{H\times W\times D} \to R^d$ and a target code $\varphi_o \in R^d$, the depth visualization method aims to find an image $X \in R^{H\times W\times D}$:

$$\min_{X\in R^{H\times W\times D}} R_\alpha(X) + R_{TV\beta}(X) + Cl(\Phi(X), \Phi_o) \quad (6)$$

3.3 Analysis of Experimental Results

The results in Figures 2 and 3 provide a comparison of the performance of the improved algorithm with traditional algorithms in action recognition. Figure 2 shows that compared to traditional algorithms, the improved algorithm reduces the error by about 18%. The reduction of error is directly related to the performance of the algorithm in practical applications, as smaller errors mean less misidentification and more accurate action capture. According to Figure 3, the improved algorithm has an action recognition accuracy of over 95%, significantly higher than traditional algorithms. This improvement in accuracy means that the improved algorithm has higher reliability in identifying various actions.

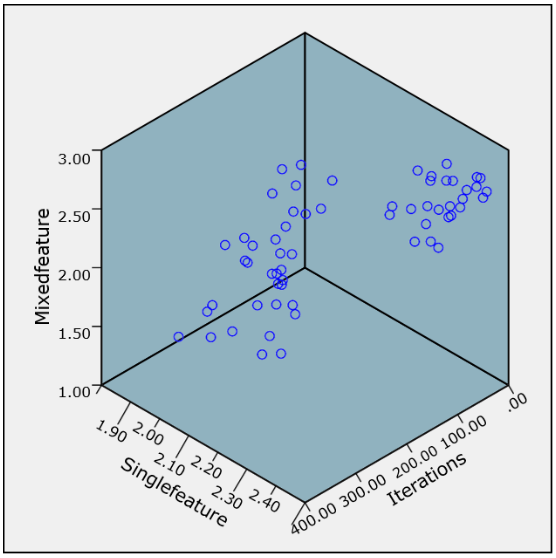


Figure 2: Algorithm error test.

Both high accuracy and low error show that the improved algorithm is more robust. The improved algorithm seems to be able to handle various variables and potential interference factors better, thus providing more consistent and reliable results. In animation production, more accurate motion capture can create more vivid and realistic character animation. In game development, higher accuracy and lower error can enhance the immersion of the game and the player's experience.

The system load test results shown in Figure 4 reveal some key characteristics of the prototype system in load balancing. The in-depth analysis of these characteristics can help us better understand the behavior of the system under different conditions and optimize its performance.

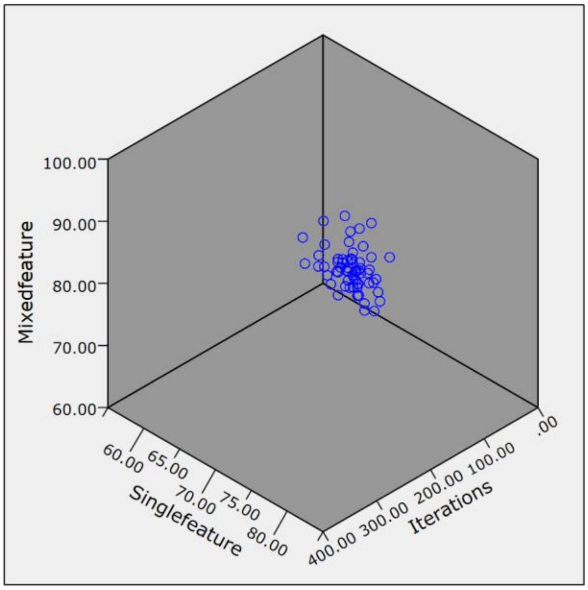


Figure 3: Algorithm accuracy test.

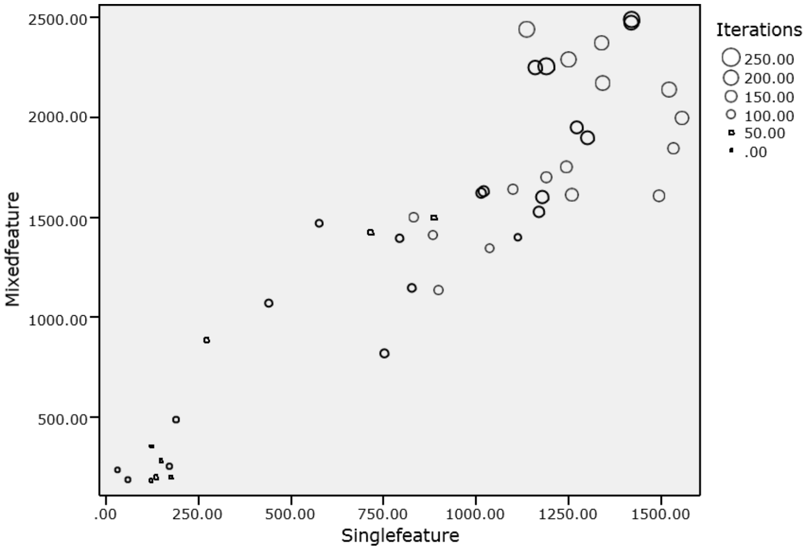


Figure 4: Load situation of the system.

When the load balancing mechanism is turned off, the system load increases rapidly with the increase of user visits. This shows that the increase in user activities will directly lead to the shortage of system resources without payload management. In contrast, when the load balancing scheduling algorithm is adopted, although the server load will still increase with the increase in the number of visiting customers, the overall load level is lower than when the load balancing mechanism is turned off. This shows that the load-balancing algorithm can effectively allocate and manage system resources and ensure that the performance of the system remains relatively stable when multiple users access it at the same time. By reasonably allocating tasks and resources, the load-balancing algorithm can prevent any single server from being overloaded, thus improving the reliability of the whole system.

4 RENDERING OPTIMIZATION METHOD

4.1 Overview of Rendering Technology

Rendering is an important link in the process of animation production, which involves combining three-dimensional models, textures, lighting, and other elements to generate an image that is finally presented to the audience. In animation, the goal of rendering is to create realistic, artistic, and visually attractive images. In order to achieve this goal, rendering technology needs to consider many aspects, including lighting models, material properties, camera settings, environmental effects, and so on. Moreover, in order to improve the rendering efficiency, various optimization methods are needed.

4.2 Optimization of Rendering Technology Based on DM

In the process of rendering, different parameter settings will have a significant impact on the final image quality and rendering time. DM technology can find the key parameters related to image quality and rendering time by analyzing historical rendering data. Then, these key parameters can be used to build an optimization model to predict and optimize the parameters of the new rendering task. Through the mining and analysis of a large quantity of rendering data, we can find the problems and bottlenecks in the existing algorithms. Then, aiming at these problems, corresponding improvement measures or new algorithm design ideas are put forward.

The purpose of deblurring animated images is to recover clear and high-quality images from blurred images. First of all, it is necessary to establish a mathematical model for blurred images to determine the causes and types of blur. Blur may be caused by camera shake, object motion, inaccurate focus, or optical problems. For motion blur and defocus blur, it is necessary to estimate the fuzzy kernel. After obtaining the fuzzy kernel, the deconvolution technique can be used to remove the ambiguity. Deconvolution is a method to restore the original clear image from the blurred image. It involves the inverse process of convolution operation on an image and fuzzy kernel. Through an iterative solution of optimization algorithm, the solution closest to the original clear image can be found. The principle of deblurring animation images is shown in Figure 5.

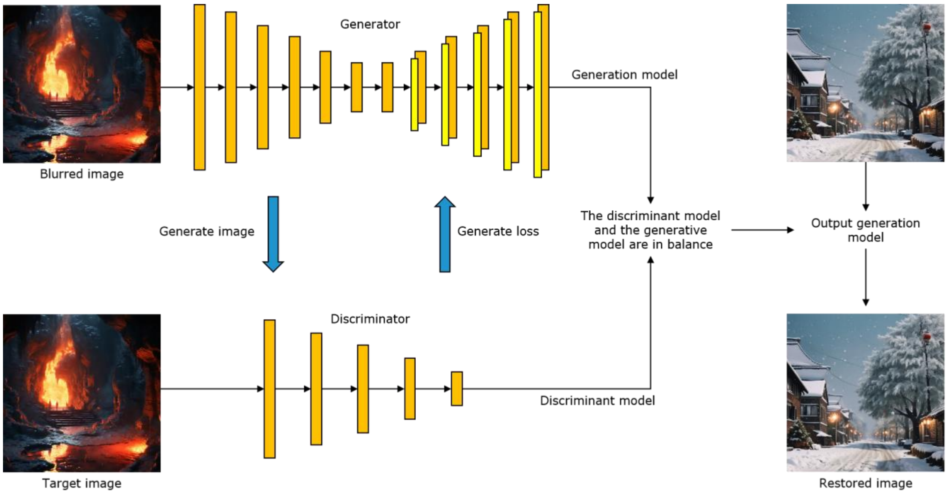


Figure 5: Deblurring principle of animated images.

In large-scale animation projects, rendering tasks usually need to be processed in parallel on multiple computers or clusters. Through the mining and analysis of historical rendering data, DM technology finds the utilization law of computing resources and the dependence between tasks. Then, use this information to build a resource scheduling and load balancing model to achieve more efficient resource utilization and task allocation. Assuming that the sampling sample value of data clustering features is $S = \overline{X_1}, \cdots, \overline{X_k}$, the related directional features distributed in the time interval $T_1, \cdots, T_k$ are as follows:

$$\rho_{XY} = \frac{\text{cov}\ X,Y}{\sqrt{D\ X}\sqrt{D\ Y}} \tag{7}$$

X,Y is the attribute set for micro-cluster classification in the data stream.

The saturation of useful information within a signal is aptly represented by the maximum entropy of data, making it a potent indicator of the distinctive traits of animation data stored in the database. Consequently, the resulting characteristic information flow during database access is acquired as follows:

$$WT_f\ \alpha,\tau\ = \frac{1}{\sqrt{\alpha}} \int x\ t\ \psi^* \left(\frac{t-\tau}{\alpha} \right) dt \tag{8}$$

The characteristics of information flow during database access are associated with two parameters denoted as α,τ .

The disparity between a single dimension and the remaining dimensions in multidimensional data is not merely attributed to the varying attribute meanings they represent but also to their distinct contributions toward class separation. Therefore, it is imperative to introduce a balancing coefficient, denoted as λ_i to address this issue.

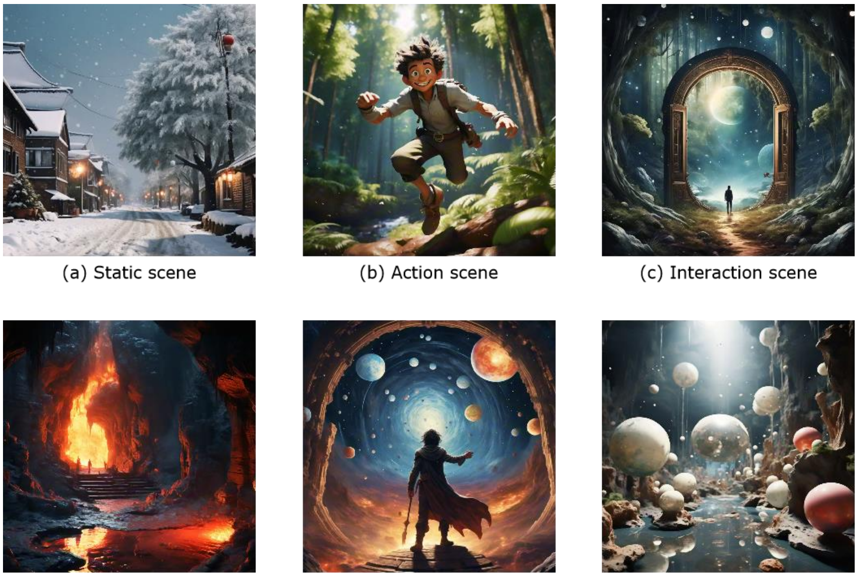
$$\lambda_i = \frac{\max\left\{ \sum_{i=1}^{k} c_{il}, l = 1,2,\cdots,s \right\}}{\sum_{i=1}^{k} c_{ij}}, j = 1,2,\cdots,s \tag{9}$$

$$Cdist = \sqrt{\sum_{i=1}^{k} c_{ij} - \overline{c}_j^{\ 2}}, j = 1,2,\cdots,s \tag{10}$$

4.3 Analysis of Experimental Results

In the experimental process of animation design, it is very important to classify and test different scenes carefully. Each scene in animation has its own unique visual characteristics and design requirements. Static scenes may emphasize background details and color matching; action scenes need to capture the fluency and accuracy of dynamic elements; interactive scenes pay attention to the interaction and reaction between characters; special effects scenes emphasize the shock and creativity of visual effects; changing scenes requires smooth transition effects; while abstract scenes challenge designers to make innovative use of shapes, lines, and colors. In order to effectively evaluate the performance of the animation design algorithm, it is necessary to divide the material image of each scene into a training set and a test set. The training set is used to "teach" the algorithm to identify the characteristics and laws of specific scenes, while the test set is used to verify the algorithm's ability to generalize to new data. A representative example of the material image of each scene is shown in Figure 6.

In the context of animation design, basic functions may correspond to different visual elements, dynamic effects, or design principles. By using the sample images in the training set, this set of basis functions can be trained to identify and reproduce the core features of various scenes. Once the basis function is trained, you can use the test set to evaluate its performance. Based on the results of the test set, the basic function or the whole algorithm can be adjusted and optimized as necessary.



(a) Static scene (b) Action scene (c) Interaction scene

(d) Special effects scene (e) Converting scene (f) Abstract scene

Figure 6: Representative examples of animation materials in different scenes.

As can be seen from the resulting image in Figure 7, choosing the weight ratio of different contents and styles has a great influence on the result. When the weight of the style image is large, and the weight of the content image is small, the color of the generated image is similar to that of the input style image, but the detail loss is very serious, and there is an obvious blurring phenomenon; When the weight of the style image is small and the weight of the content image is large, the details of the generated image remain more and more, and the color tends to the original color of the content image more and more, which deviates from the color of the style image. The results show that there is no completely clear boundary between image content and style, and it can be carefully processed according to the specific input image and application scene.

For different style target images, different style models are generated by training, and the stylized image effects generated during testing also have different tones, forming similar but different styles. Some results are shown in Figure 8.

In the process of training the same batch of iterations, random processing of the same batch of samples will lead to changes in the output. This means that the prediction results of the model will be affected by random factors, which may increase the instability and unpredictability of the model. Table 1 shows the calculation time of different feature dimension reduction methods. Compared with the traditional method, the improved method shortens the dimension reduction time. This shows that the improved method has advantages in computational efficiency and can complete the task of feature dimension reduction faster.

The improved method adopts a more efficient algorithm or data structure, thus reducing the computational Complexity. Moreover, the improved method is optimized in algorithm implementation, reducing unnecessary calculation steps and memory consumption.

In the classification task, accuracy is a very important evaluation index. It represents the ratio between the quantity of samples correctly classified by the model and the total quantity of samples. A high accuracy means that the model can identify different animation scene features more accurately. According to the data in Table 2, the improved method improves the accuracy compared with the traditional method. This means that the improved method makes fewer mistakes in classifying animation scene features and can identify various scenes more accurately.

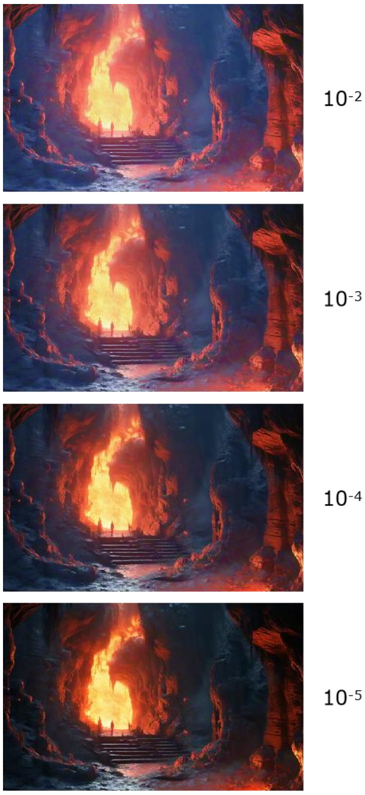


Figure 7: Influence of different weights of content and style on migration results.

Figure 8: Migration effect of different animation styles.

Animation scene	*Training sample*		*Test sample*	
	Traditional	*Modified*	*Traditional*	*Modified*
Static scene	6.85	6.77	6.31	4.38
Action scene	8.14	7.85	7.66	4.25

Interactive scene	7.66	6.95	7.89	4.92
Special effects scene	6.35	5.99	6.98	5.07
Change scene	7.18	7.01	7.55	6.24
Abstract scene	8.21	8.11	7.94	5.98

Table 1: Dimension reduction time of animation scene feature classification model.

Animation scene	*Training sample*		*Test sample*	
	Traditional	*Modified*	*Traditional*	*Modified*
Static scene	89.44%	93.61%	84.44%	94.64%
Action scene	83.39%	94.22%	85.46%	95.39%
Interactive scene	87.86%	93.79%	86.89%	95.84%
Special effects scene	88.85%	94.86%	83.55%	95.77%
Change scene	86.34%	91.65%	85.26%	93.28%
Abstract scene	88.78%	92.62%	87.78%	93.36%

Table 2: Accuracy of animation scene feature classification model.

5 CONCLUSION

Animation works are deeply loved by audiences all over the world because of their unique visual expression and infectious storyline. The rise of DM technology has brought new opportunities for animation design. Through the in-depth study of different types of animation design images such as static scenes, action scenes, interactive scenes, special effects scenes, transformation scenes, and abstract scenes, and the evaluation of the algorithm performance by using training sets and test sets, it is concluded that the improved method has significantly improved the calculation efficiency and classification accuracy compared with the traditional method. In terms of computational efficiency, the improved method successfully shortens the time of feature dimension reduction by optimizing the algorithm using efficient data structure or parallel computing technology. In the aspect of classification accuracy, the improved method improves the accuracy of the animation scene feature classification model by optimizing feature selection, adopting a more complex model structure, or introducing more advanced algorithms.

Although the improved method shows advantages in calculation efficiency and classification accuracy, there are still some potential research directions worthy of further exploration. For example, we can study how to further improve the calculation efficiency and classification accuracy while ensuring the output stability. In addition, it is also an important research direction to pay attention to the interpretability of the model, which can increase the transparency and trust of the model decision-making process.

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