# Modeling of Virtual Characters in the Animation Design Instructional System Based on Deep Learning

Gang Hao[1], Ling Cao[2] and Zhenghong Xiao[3]

[1]School of Computer Science, Guangdong Polytechnic Normal University, Guangzhou, Guangdong 510665, China, haogang@gpnu.edu.cn
[2]Information Engineering School, Guangzhou Vocational College of Technology & Business, Guangzhou, Guangdong 511442, China, xiaoyu@gzkmu.edu.cn
[3]School of Computer Science, Guangdong Polytechnic Normal University, Guangzhou, Guangdong 510665, China, zhxiao@gpnu.edu.cn

Corresponding author: Ling Cao, xiaoyu@gzkmu.edu.cn

**Abstract.** With the growth of computer technology, 3D animation character modeling technology has become an important part in the field of animation production. However, the traditional modeling method needs a lot of time and manpower, which becomes the bottleneck in the animation production process. This article introduces an animation design instructional system based on deep learning (DL), which involves the technology of animation role CAD modeling. The system can use DL algorithm to model automatically, which provides a convenient and efficient animation role modeling platform for learners. This article introduces the implementation stage of the algorithm in detail, and verifies the effectiveness and feasibility of the algorithm through simulation results. The results show that this method has high precision and low error. The error is reduced by more than 25%, and the highest precision can reach 97.66%. The algorithm can well restore the shape and details of animated characters, and has high precision and robustness. The animation design instructional system can provide valuable technical support and instructional tools for animation industry and education, which is helpful to improve the efficiency of animation production and reduce the cost.

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## 1 INTRODUCTION

The vividness and verisimilitude of character animation are very important, whether in the game production industry or in the simulation field of urban traffic planning. With the rapid growth of computer technology and AI, animation design instructional system has gradually become an important tool in the field of education. The application of intelligent algorithms in 3D graphics engine animation design is of great significance for games and computer simulations. Bao [1] utilized genetic algorithms to optimize the behavior of characters and used neural networks to learn and simulate their behavior. In games and computer simulations, artificial intelligence characters can be used to enhance the gaming experience or as part of the simulation. By using intelligent algorithms, the behavior and actions of these characters can be better controlled. For example, using genetic algorithms to optimize character behavior, or using neural networks to learn and simulate character behavior. In games and computer simulations, physics engines are used to simulate physical behaviors in the real world, such as collisions, gravity, motion, etc. Intelligent algorithms can be used to optimize the performance of physics engines, such as using proxy-based models to predict object motion, or using machine learning to predict collision results. In games and computer simulations, animation is an important means of achieving the representation of characters and objects. Intelligent algorithms can be used to create more natural and realistic animations. For example, using reinforcement learning to optimize character animation, or using machine learning to predict intermediate frames of animation. Among them, the animation role CAD modeling technology, as an important part of animation design, reflects important significance in improving animation quality and efficiency. Jing and Song [2] analyzed the application of combining 3D reality technology and CAD in animation design. This enables animation designers to design and create more efficiently. Using CAD software, designers can create complex 3D models that can be directly imported into a 3D real world environment for animation design and testing. In CAD software, designers can add materials and textures to 3D models to present a more realistic effect in a three-dimensional real-world environment. Designers can use animation tools in CAD software to design the actions and behaviors of characters, and then test and adjust them in a three-dimensional reality environment to achieve smoother and more natural effects. In a three-dimensional reality environment, designers can simulate the interaction between users and animated characters, such as conversations, actions, etc., in order to better design and adjust the behavior and reactions of characters. However, the traditional animation character modeling method needs a lot of time and manpower, and it is difficult to meet the needs of modern animation design. As an important link in animation design, the quality of animation character CAD modeling is directly related to the presentation effect of the whole animation work. Traditional modeling methods mainly rely on manual operation, which not only consumes a lot of time and manpower, but also is difficult to ensure the quality and consistency of modeling. Li [3] analyzed the application of cubic B-spline curves in computer-aided animation design. In character animation, cubic B-spline curves are widely used to create smooth and continuous actions. Animators can use this curve to accurately control the speed and rhythm of characters in their actions, achieving more realistic and vivid effects. In computer animation, it is often necessary to gradually transform one shape or object into another. Cubic B-spline curves can be used for this type of deformation animation because they can create smooth and continuous shape transformations. Cubic B-spline curves are also used to simulate natural phenomena such as the motion of waves, flames, or clouds. By using this curve to control the motion of simulated objects, very realistic animation effects can be created. In many animations, objects or characters need to move on the screen. Creating these paths using cubic B-spline curves can make the movement appear more natural and smoother. In the animation of virtual characters or emoticons, cubic B-spline curves can be used to control the movement of facial muscles to achieve more complex facial expression changes. Cubic B-spline curves can also be used for interpolation and prediction in animation. For example, a spline curve can be created based on several keyframes, and then used to predict the position and shape of objects in other frames. With the growth of computer graphics and 3D modeling technology, automatic modeling technology has gradually become a research hotspot. However, there are still some problems in the existing automatic modeling methods, such as low modeling efficiency and unstable model quality.

Li et al. [4] analyzed the 3D model design of multi visual animated characters based on virtual reality technology. When creating 3D models of animated characters, it is necessary to use 3D modeling software such as 3ds Max or Maya. This process requires designers to possess in-depth 3D modeling skills, including modeling the shape, details, texture, and color of objects. At the same time, in order for the model to appear realistic in a virtual environment, designers also need to understand texture mapping techniques. He also learned how to use a virtual bone system to add animation to the model. This process involves mapping the virtual bone system to the joints of the model and setting keyframes for animation. Designers need to be familiar with animation principles and techniques in order to create realistic and physical rules compliant animations. To provide the best experience, designers need to create models from multiple perspectives, including first person and third person perspectives. In addition, designers also need to consider how to manage these perspectives in order to smoothly switch perspectives when users move. In addition, designers also need to consider how to simulate physical characteristics such as gravity, collisions, etc. to provide a more realistic experience. Animation Space Time Machine "is a creative and imaginative concept that integrates gamified elements into 3D urban modeling, 4D networks, and cross media stories to reconstruct history. This is a comprehensive solution aimed at providing an immersive historical experience, allowing users to have a deeper understanding and experience of history. Matthys et al. [5] reconstructed a virtual model of a historical city using 3D technology, detailing various details such as buildings, streets, and vegetation. This technology can make users feel like they are in the historical environment of the past and feel the atmosphere of life at that time. This is a dynamic and interactive spatiotemporal model that not only contains 3D spatial information, but also incorporates temporal dimensions. Users can observe the development process of historical events in this network, and even change certain historical conditions to observe possible branches of history. Create rich and in-depth historical stories through different media forms (such as text, images, audio, video, etc.), combined with historical literature and archaeological materials. These stories can further enrich the historical background and provide users with more historical details.

The most important thing in virtual simulation technology is the interaction between people and environment. Virtual environment is designed by designers, so designers can adjust or change a scene or a role in the virtual environment at will according to actual needs. 3D character model and animation automatic generation technology is a relatively huge research topic, which involves a lot of knowledge and complicated process, such as 3D model construction, skeleton extraction, bone animation and so on. As an important branch of AI, DL has made remarkable achievements in the fields of image recognition and natural language processing. In recent years, DL has also made some progress in the field of 3D modeling. For example, some researchers used DL algorithm to classify, segment and reconstruct 3D models, and achieved good results. In addition, some automatic modeling methods based on DL are also proposed, which can automatically generate complex 3D models. These studies provide theoretical and technical support for the DL-based animation design instructional system proposed in this article. This article introduces an animation design instructional system based on DL, which involves the technology of animation role CAD modeling. The system can use DL algorithm to model automatically, which provides a convenient and efficient animation role modeling platform for learners.

Because the teaching time of animation design course is relatively long, only teachers can demonstrate a little and students can do a little, so it is difficult to grasp the overall stage of 3D modeling. Therefore, there is an urgent need for a complete and concise demonstration of modeling teaching process, so that students can grasp the overall effect before creating 3D, stimulate the interest with the senses, achieve twice the result with half the effort, and improve the enthusiasm and initiative of students. This article presents an animation design instructional system based on DL, which involves the CAD modeling technology of animation roles. Its possible innovations and contributions are as follows:

(1) In this article, an animation character modeling method based on DL is proposed. By learning a large quantity of 3D animation character models, an automatic encoder model is obtained, which can transform the input 2D images into 3D models.

(2) The animation role modeling method based on DL proposed in this article can not only improve the efficiency of animation production and reduce the cost, but also provide valuable technical support and instructional tools for the education field.

(3) This method combines the advantages of DL and computer graphics, and can provide a convenient and efficient animation role modeling platform for learners.

This article introduces the significance of animation role CAD modeling technology in animation design instructional system; In the related work part, the research work of scholars in this field is summarized, and the research ideas of this article are put forward. In the method part, the modeling method of animated character model based on DL is introduced. Finally, the performance of the proposed animation role CAD modeling method is verified.

## 2 RELATED WORKS

Močnik et al. [6] used an optimized Kaneda Lucas Tomasi tracker and a kinematic model based on Denavit Hartenberg to capture the session gestures of specific session agents. In human-computer interaction, capturing the conversational gestures of specific session agents is crucial for improving user experience and natural interaction. To achieve this goal, we can use an optimized Kaneda Lucas Tomasi tracker and a kinematic model based on Denavit Hartenberg. The Kaneda Lucas Tomasi (KLT) tracker is an optical flow-based method used to track objects in videos. It estimates the position and velocity of objects by calculating the pixel motion between adjacent frames. In order to optimize the KLT tracker, we can adopt some techniques such as feature pyramid, dynamic threshold, and motion estimation. These technologies can improve the accuracy and robustness of the tracker, enabling it to better handle the gestures of the session agent. Oshita [7] used deep learning and Agent spatial heatmap for agent navigation in crowd simulation. The use of deep learning and Agent spatial heatmap for crowd simulation in Agent navigation is one of the important technologies in computer animation and virtual worlds. In crowd simulation, Agent navigation is particularly important because it can affect the behavior and mobility of the crowd. Deep learning can be used to solve agent navigation problems. One method is to use convolutional neural networks (CNN) to predict the heat map of the environment around the agent. A heatmap can display the density and movement direction of the crowd around the agent, thereby helping the agent determine the optimal movement path. In reinforcement learning, agents learn how to act by interacting with the environment to achieve a given goal. Agents can use algorithms such as Q-learning to learn how to choose the best action to achieve efficient navigation in crowd simulations. Computer animation and crowd simulation in virtual worlds can also use other technologies, such as cellular automata, physical simulations, and social force models. These technologies can be combined with deep learning and Agent spatial heat maps to achieve more realistic and realistic crowd simulations. Park et al. [8] analyzed intelligent manufacturing systems with interoperable data patterns. It adopts digital twin technology to achieve intelligent and digital manufacturing processes through cloud data storage and computing capabilities. The system adopts an interoperable data model, enabling seamless exchange and sharing of data from different sources and formats. At the same time, cloud-based architecture enables dynamic expansion of data storage and computing resources, which can meet the needs of large-scale and high concurrency scenarios. During the production execution phase, the automation and intelligence of the production process can be achieved through linkage with actual production equipment. In the product service stage, by analyzing and predicting product operation data, more accurate and personalized services can be provided. In short, intelligent manufacturing based on interoperable data patterns. The cloud based digital twin manufacturing system is a new type of manufacturing system with high intelligence, digitization, and scalability, which can bring higher production efficiency and better product services to manufacturing enterprises. Torres et al. [9] conducted visual activity analysis from 3D asset synthesis pose sequences. The synthesis and analysis of 3D pose sequences are of great value for many applications, including motion analysis, health technology, game design, virtual reality, and film production. Visual based activity analysis is the use of computer vision technology to identify and understand actions and behaviors in a scene. Firstly, 3D pose data needs to be collected. This can be achieved in various ways, including using depth cameras, motion capture systems, or manually annotated datasets. Then, use this data to create a 3D pose model. Once you have a 3D pose model, you can create pose sequences.

This can be achieved by interpolating or fitting the pose of the model at different time points. Then, VAR based techniques can be used to identify and analyze these pose sequences. This may include using machine learning classifiers, such as Support Vector Machines (SVM), Random Forests, or deep learning models, such as Long Short-Term Memory Networks (LSTM) or 3D Convolutional Neural Networks (3D-CNN). In order to train and validate the VAR system, it is necessary to create an activity dataset containing annotations. This requires a lot of manual work, as each pose needs to be accurately labeled.

Wang and Shi [10] analyzed deep learning based facial expression dynamic capture and 3D animation generation. It requires collecting video or image data containing facial expression changes. The dataset should include samples of various facial expressions (such as happiness, sadness, anger, etc.) under different angles and lighting conditions. Preprocess the data, including image enhancement, alignment, and standardization to improve the performance of the model. Extract features from preprocessed images using deep learning models such as CNN or RNN. These features can be local facial features (such as eyes, mouth, etc.) or global features (such as the overall shape of the face). Input the extracted features into another deep learning model (such as fully connected layers or recurrent neural networks) for classification. The goal of this model is to map the input features to predefined facial expression categories (such as happiness, sadness, etc.). If it is necessary to capture the dynamic changes of facial expressions, time series models (such as recurrent neural networks) can be used to process continuous video frames. In this way, the model can learn the pattern of facial expression changes over time, thereby predicting the facial expression for the next frame. Wang et al. [11] analyzed the 3D computer-aided design modeling and printing of precise transplantation of toes and hands. The advantage of transplanting 3D computer-aided design modeling and printing technology is that it can personalized design according to the actual needs and physical conditions of patients, while also reducing surgical time and postoperative recovery time, improving the success rate of surgery and patient satisfaction. However, there are also some challenges and limitations to this technology. For example, 3D printed materials for hand organs need to meet human biocompatibility requirements and have sufficient strength and stability. In addition, the cost of this technology is relatively high, and it is currently not widely available to all patients who require hand transplantation. Xu [12] analyzed the possibility of virtual reality technology in animation scene design, with immersive animation scene design being one of its important applications. In immersive animation scene design, SN application is an effective way to help users better understand and immerse themselves in animation scenes. It aims to create an immersive animation scene through virtual reality technology, allowing users to experience animation stories firsthand. SN applications enable users to interact with the environment through various interactive methods by constructing a realistic virtual environment, thereby allowing users to experience the depth and breadth of animation stories. In SN applications, animation scene design is crucial as it determines the immersion and realism of the entire application. Xu and Xu [13] analyzed the research on smartphone user interface animation design. When users operate on the smartphone interface, animation design should be able to provide timely feedback and response. For example, when a user swipes or clicks on the screen, the interface should display the successful completion of these operations through animation effects. This interactive feedback animation design can improve the user's interaction experience, while also enhancing their understanding and memory of operations. For new users, they may feel confused and confused when using the smartphone interface for the first time. Therefore, animation design can also be used as a guide and tutorial to help users quickly understand the usage methods of applications. For example, on the launch page of certain applications, animation effects can be used to showcase the main functions and usage methods of the application.

Zhang and Chen [14] analyzed the application of computer-aided animation technology in hematology medicine teaching. Through computer-aided animation technology, the process of blood circulation, including the flow of blood in the heart, blood vessels, and lungs, can be vividly displayed. This type of animation can help students better understand blood physiology and diseases, making abstract theories intuitive and easy to understand. Animation technology can be used to display the structure and function of cells, including organelles, cell membranes, chromosomes, etc. This technology helps students better understand the complexity and function of cells, and deepen their understanding of the pathogenesis of blood diseases. Through computer-aided animation technology, it is possible to simulate the onset process of blood diseases, such as anemia, leukemia, platelet abnormalities, etc. This animation can help students better understand the pathogenesis of diseases, understand the treatment methods and effects of diseases. Zhao and Zhao [15] conducted computer-aided graphic design for 3D animation scenes in virtual reality. Through virtual reality technology, students can simulate experimental operations in computer simulations, thereby improving their experimental skills and knowledge level. In addition, animation can help students better understand abstract concepts and processes, improve their learning efficiency and grades. Virtual reality and animation can help sixth grade students improve their cognitive level. Through virtual reality technology, students can simulate various situations in the real world in computer simulations, thereby improving their cognitive abilities and problem-solving abilities. In addition, animation can help students maintain focus and concentration during the learning process, thereby improving their cognitive level and learning effectiveness. The impact of virtual reality and animation on the circulatory system load of sixth grade students is relatively small. However, students should pay attention to maintaining appropriate body posture and rest time during the learning process to avoid fatigue and other health problems caused by prolonged learning. Zhao [16] analyzed the design of a multimedia personalized medical museum exhibition system driven by VR and deep learning. It aims to create an interactive and experiential medical exhibition environment. This system will utilize the latest virtual reality (VR) technology, deep learning algorithms, and multimedia sensing devices to provide personalized visiting experiences and learning environments. Create an immersive medical museum experience for visitors through VR technology. Visitors can explore and interactively learn medical knowledge in a virtual environment, such as through virtual surgery or disease simulation. Using deep learning algorithms, recommend the best visiting path and key exhibits for visitors based on their personal characteristics and visiting behavior. This can be achieved by analyzing past visit data and medical literature. The existing DL models often lack visual tools, which makes it difficult for animation designers to understand and modify the models intuitively. This article introduces an animation design instructional system based on DL, which involves the technology of animation role CAD modeling. The system uses DL algorithm to realize automatic modeling, which provides a convenient and efficient animation role modeling platform for learners. In this article, the implementation stage of the algorithm is introduced in detail. The animation design instructional system can provide valuable technical support and instructional tools for animation production industry and education field.

## 3 METHODOLOGY

### 3.1 Feature Detection Based on DL

With the continuous growth of computer graphics and DL technology, the feature detection of animation characters has become a research hotspot in the field of computer vision and animation design. Feature detection of animated characters refers to extracting the feature information of characters such as shape, posture and expression from the animated character model, so as to carry out subsequent operations such as character recognition, classification and synthesis. Traditional feature detection methods of animated characters mainly rely on hand-designed feature extractors. However, these feature extractors are difficult to adapt to the complex and changeable animated character model, and the effect of extracted features is limited.

Convolutional neural network CNN in DL technology is a widely used feature extractor, which can automatically learn the feature expression in images. In the feature detection of animated characters, CNN can be used to automatically extract the features of animated character models. Specifically, the animated character model can be transformed into an image representation, and the triangular mesh on the surface of the model can be transformed into a two-dimensional image.

Each pixel value represents information such as the normal vector or texture coordinates of the point. Then, the image is convolved by CNN, and the feature map in the image is extracted. The size of the feature map is the same as that of the input image, and each pixel represents the feature expression of the position. Through multiple convolution operations, more and more abstract feature expressions can be obtained, and finally the feature vectors describing the whole animated character model can be obtained.

This article proposes an animation role modeling method based on DL. Firstly, a large quantity of 3D animation character models is collected as training data and preprocessed, including data cleaning and feature detection. Then, using CNN to learn the training data, an automatic encoder model is obtained. The model can transform the input two-dimensional image into a 3D model, thus realizing automatic modeling. The DL architecture for feature detection of animated characters is shown in Figure 1.

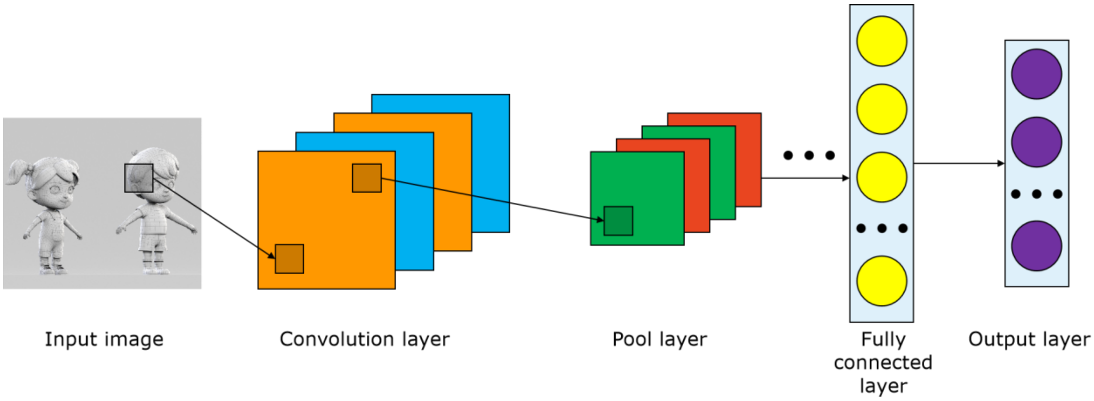


**Figure 1**: DL architecture of animation character feature detection.

Firstly, a series of feature vectors are obtained by preprocessing the training data. Then, CNN is trained by these feature vectors, and an automatic encoder model is obtained. In the training process, random gradient descent is used as the optimizer, and appropriate learning rate and iteration times are set. After training, the model can transform the input two-dimensional image into 3D model.

Let $X_i^k$ represent the sum of inputs of $k$ layer neurons $i$, $Y_i^k$ is the output, and the weights of $k-1$ layer neurons $j$ to $k$ layer neurons $i$ are $W_{ij}$, then there is the following functional relationship:

$$Y_i^k = f\left(X_i^k\right) \tag{1}$$

$$X_i^k = \sum_{j=1}^{n+1} W_{ij} Y_j^{k-1} \tag{2}$$

Generally, $f$ A is an asymmetric Sigmoid function:

$$f\left(x_i^k\right) = \frac{1}{1+\exp\left(-X_i^k\right)} \tag{3}$$

Let the corresponding human body signal be $Y_i$, and define the error function $e$ as:

$$e = \frac{1}{2}\sum_{i}\left(Y_i^m - Y_i\right)^2 \quad (4)$$

When analyzing, processing and processing human motion data, the first problem to be solved is how to extract motion information from the captured data and establish a mathematical model. If human motion is regarded as multi-particle motion, it is needed to fit the trajectory of particles and study the motion characteristics of different parts of human body in different motions. If the interaction of multiple particles is considered, it is needed to study and select a reference point, and then analyze the relative motion of particles relative to the reference point.

### 3.2 Virtual Character Model Construction

In the stage of human motion analysis, researchers pay more attention to human motion posture. Usually, the joint angle is used to represent the human posture during the movement. For animated character models with dynamic changes, automatic encoders or cyclic neural networks can be used for feature detection. Firstly, a large quantity of animated character model data are collected, preprocessed and labeled; Then, the DL algorithm is used to train the animation character data, and the animation character feature representation and modeling rules are learned. Then, according to the trained feature representation and modeling rules, the automatic modeling program is realized.

Geometric model expresses the shape and appearance of computer characters, and skeleton model can realize the animation of computer characters. The movement of each character in the 3D scene refers to its displacement in the world coordinate system, while the rotation of each character refers to its transformation relative to its own coordinates. The displacement of the object can be expressed by coordinate transformation, and the rotation of the object can be expressed by skeletal animation. The 3D scene can't be a static world, it is a moving world, and many objects in it have their relative world and their own movements. The relative world movement needs coordinate transformation, while the relative self-movement needs skeletal animation technology.

The human skeleton structure is very complex, with more than 200 degrees of freedom. As shown in Figure 2, the skeleton model designed in this article has 30 joint points.

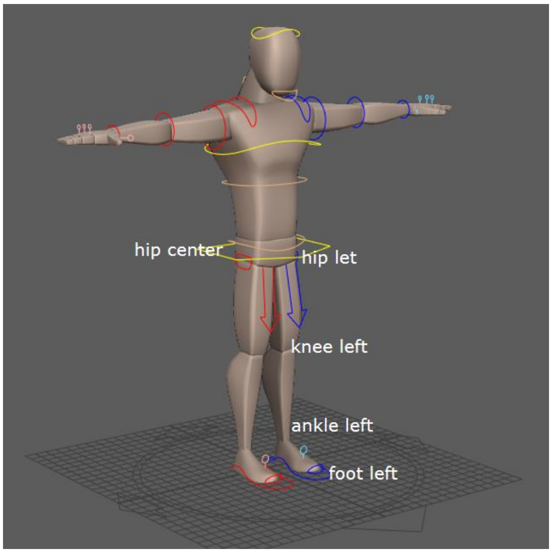


**Figure 2**: Character skeleton model.

Space-time curve and joint angle directly model the original acquisition signal. The multi-rigid-body inverse kinematics method is usually used to convert the particle trajectory to the joint angle of human motion. The 3D coordinates of human joint points can be expressed as the cascade transformation of vectors in multiple local coordinate systems, and the second matrix form is:

$$[x, y, z]^T = T^0 T^1, \cdots, T^n [x', y', z']^T \tag{5}$$

Where $[x, y, z]^T$ is the coordinate of the joint point in the world coordinate system, $[x', y', z']^T$ is the coordinate of the joint point in the $n$ th local coordinate system, and $[x', y', z']^T$ can calculate the rotation angle and limb length in the $n$ th local coordinate system.

In the field of skeletal animation, we abstract people as a combination of skin and skeleton. The principle of linear mixed skin algorithm is to calculate the positions of skin vertices under the influence of a single related joint, then make a simple weighted connection, and finally get the position information of skin vertices:

$$T' = \sum_{i=1}^{n} w_i H_i T \tag{6}$$

Where $T$ is the position of the current vertex (skin mesh vertex) in the world coordinate system, $T'$ is the position of the transformed vertex in the world coordinate system, $H_i$ represents the transformation matrix of all joints associated with the current vertex to the world coordinate system in the initial posture, the quantity of previous nodes is $n$, and $w_i$ is the influence weight factor of the $i$ th joint on the current vertex.

If a translation component is represented by a matrix, it is used to describe the translation of joint point $i$ from the current local coordinate system to the coordinate system where its parent node is located at moment $j$. Matrix $R_i^j$ is used to represent a rotation component, which is used to describe the rotation amount of the $i$-th joint point around its parent node at time $j$. Where $1 \le i \le N$.

$$P_{root}^t(x, y, z) = M_{root}^t R_{root}^t P_{root}^{t-1}(x, y, z) \tag{7}$$

$$P_i^t(x, y, z) = M_{root}^t R_{root}^t M_1^t R_1^t, \cdots, M_1^t R_1^t P_0^t(x, y, z) \tag{8}$$

Where $i = 1, 2, \cdots, N$ in the above formula. When $i = root$ indicates that the node is the root node, $i = 0$ indicates that the joint point is in the initial position.

### 3.3 Automatic Generation of Character Animation

3D animation is to use it to simulate the upcoming scene in the future, and find out the possibility of future occurrence, and how to take corresponding measures to deal with it. Virtual simulation technology is a form of 3D animation, which has a good 3D sense and aesthetic value, and can display the spatial structure of buildings completely and vividly. Because the size ratio of the virtual character may not be completely consistent with the proportion of the captured entity, or even the skeleton results are different, the action may lose its original characteristics. At this time, motion redirection can redirect the motion data to the virtual character model through a series of operations to keep the original characteristics of the action.

The input is the angular vector data stream of a joint and the position of the end effector corresponding to the original model in discrete time, and the output is the angular vector data stream corresponding to the joint at discrete time, where the output data is calculated by the current joint data and the input at the previous moment. The biggest advantage of this algorithm is that the rotation and translation information of joint points is more stable compared with the data redirected by motion capture, and the error data generated during capture is reduced.

If we know the translation and rotation components of the root node in the global coordinate system, we can calculate the spatial coordinate position of the root node. Several animation frames are combined to form a motion sequence, and some animation sequences are connected to form a 3D character's skeletal animation. Calculate the aspect value $Aspect$ one by one:

$$Aspect = a\tan 2\left(-Slope_{we}, Slope_{sn}\right)\times 180 \div \pi \tag{9}$$

The mapping set $M$ of 3D model instance and "skeleton" hierarchy is defined as:

$$M = \left(T, D, P\right) \tag{10}$$

$T$ is the "skeleton" set of 3D model, $D$ is the corresponding 3D model instance set, and $P$ is the corresponding attribute relation set between 3D model structures. Example $d_i \in D$ corresponds to structure connected graph $F_i$ .

The normal vector of a surface $S$ at point $p(x,y)$ is defined as $n(x,y) = n/|n|$, where:

$$N = \frac{\partial \overline{p}(x,y)}{\partial_x} \times \frac{\partial \overline{p}(x,y)}{\partial_y} \tag{11}$$

A covariance matrix is established, which is composed of the position relationship of data point $p_i$ and its neighboring points.

In order to ensure the real-time rendering of the system, it is needed to minimize the quantity of intersection tests. Therefore, the principle of line-plane intersection test is used to detect the collision between animated characters and static objects on the platform. The current position of animated characters is connected with the next position by a straight line. If the line segment intersects with static obstacles, the intersection position is calculated. When the animated characters move to the intersection point, they move along the edge of the obstacles until they move to the next intersection point, and then move along the original straight-line path again.

## 4 RESULT ANALYSIS AND DISCUSSION

Character animation technology mainly includes two parts of information: skin and skeleton movements. In this article, BVH data files under different movements are selected for animation-driven test. According to the hierarchical structure of skeleton tree of human body standard posture defined in the file, the local coordinate system of each bone is obtained hierarchically, and then its transformation matrix is calculated, and then its transformation matrix is applied to its next-level bones at the same time, so as to realize the alignment of all bones. Firstly, some cartoon characters are collected from the Internet as input data. Then, the trained automatic encoder model is used to model the input data, and the corresponding 3D model is obtained. Compared with the real model, it is found that the algorithm can restore the shape and details of animated characters well, and has high precision and robustness.

Complete the advanced control of animation character movement in OSG, and use the message passing mechanism to update the animation at the frame rate of 30 frames per second. By changing the translation and rotation components, the position and posture of the animated characters in 3D space can be transformed to form a continuous animated picture. Figure 3 below shows the generation effect of animated characters.

**Figure 3**: Animation role generation effect.

In this article, the motion of the animated character is controlled at the turning point of the path, and only the degree is rotated at a time. When the displacement of the animated character is updated, the rotation angle is also updated until it turns to the correct motion direction, thus forming a continuous and smooth motion effect. Figure 4 is a skeleton animation effect diagram of a character model driven by a motion data file.

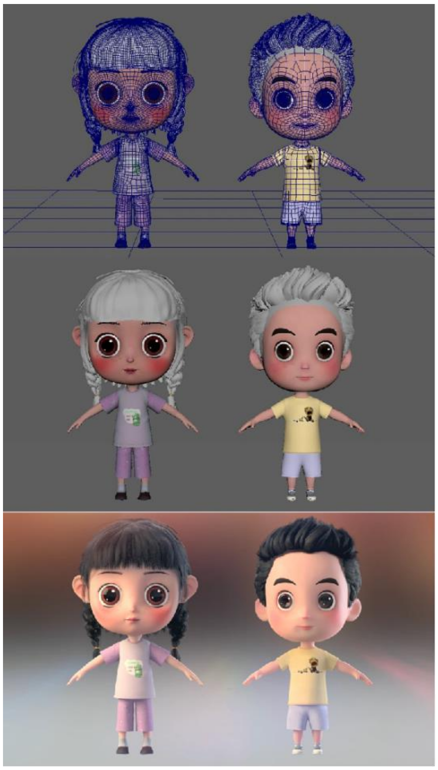

**Figure 4**: Skeleton animation generation.

The generation effect of skeleton animation is still good, and some basic actions have been completed. The improvement of this place in the future is to add AI elements, which makes the animation generation more natural and real.

The virtual human action simulation based on skeletal animation algorithm may completely replace the traditional human action simulation method, and this new interactive mode is more convenient to operate. The most important thing is that the motion data of human joints can be obtained quickly and conveniently at a lower cost.

In this article, a few variables are used to replace the original data set. In the experiment, the modeling error simulation of SVM algorithm, GAN algorithm and this algorithm is compared, as shown in Figure 5. The modeling precision simulation of this algorithm is shown in Figure 6. Modeling error test mainly measures the difference between the role model generated by the algorithm and the original role model. The modeling precision test mainly evaluates the quality of the role model generated by the algorithm and the degree of conformity with the original role characteristics. By comparing the differences in shape, texture and details between the character model generated by the algorithm and the original model, the modeling precision of the algorithm is evaluated.

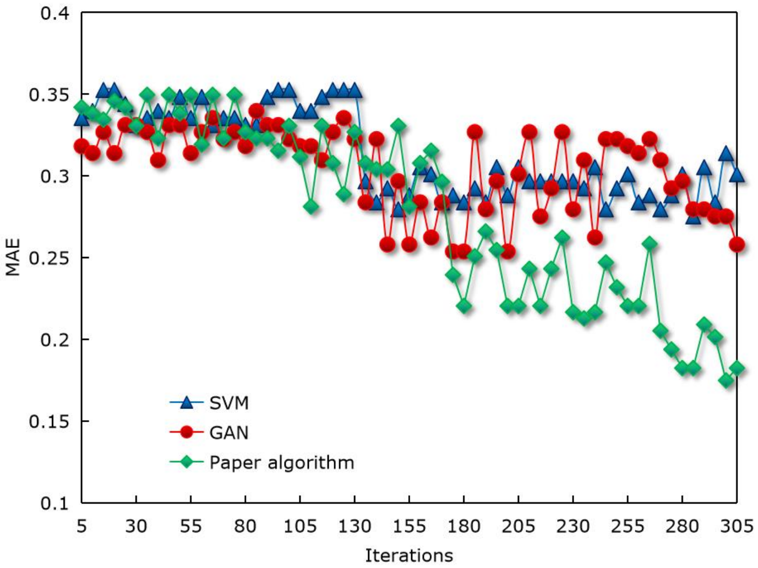


**Figure 5**: Modeling error of algorithm.

The results are shown in Figure 5 and Figure 6. The error is reduced by more than 25%, and the highest precision can reach 97.66%. The test results may be influenced by some factors, such as the quality of data set, the complexity of model, the parameter setting of the algorithm, etc. Therefore, when testing the performance of the algorithm, it is needed to comprehensively consider these factors and make a reasonable analysis and explanation.

DL-based animation character feature detection algorithm has high performance in response speed, which can provide faster and more efficient support for animation design and production. The comparison result of response speed is shown in Figure 7, which shows the response speed of SVM algorithm, GAN algorithm and this algorithm.

The results show that the response speed of this method is faster. DL-based animation character feature detection algorithm has high performance in response speed. Compared with traditional feature detection methods, DL algorithm can automatically learn and optimize the feature detection process, thus greatly improving the response speed. By using the kernel generated by orthogonal Chebyshev polynomials, the correlation and data redundancy between data are effectively reduced, thus improving the efficiency and precision of the algorithm.

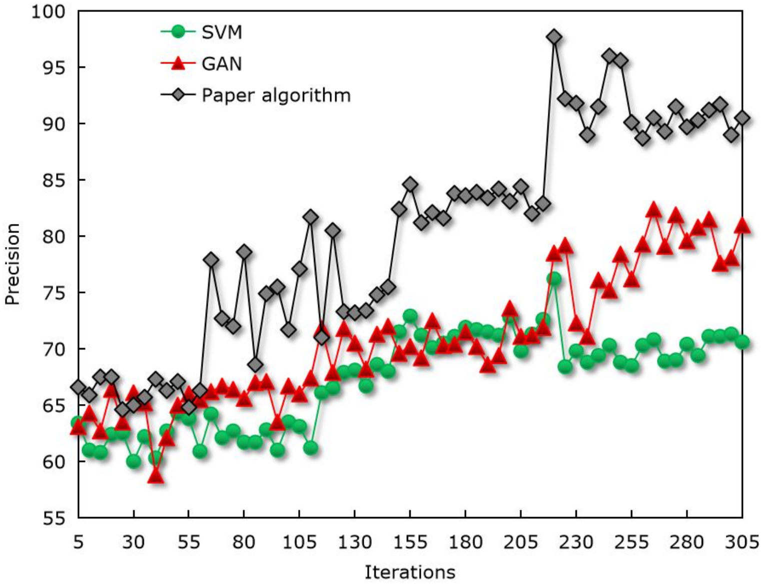


**Figure 6**: Modeling precision of algorithm.

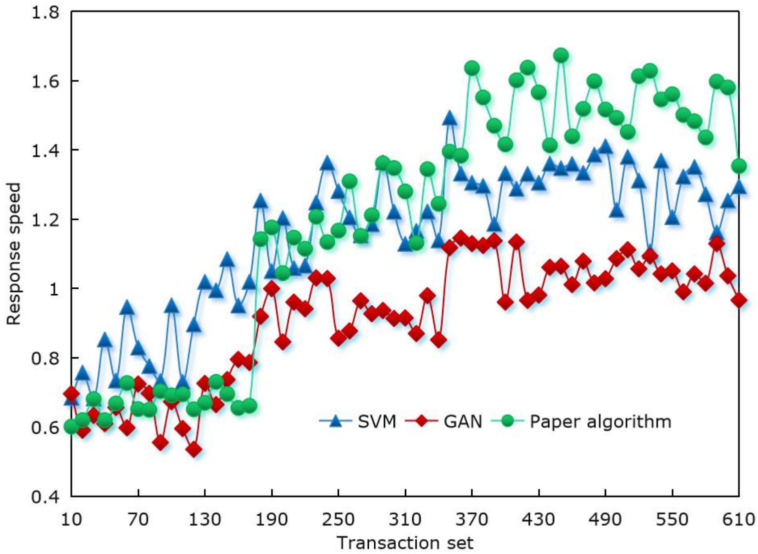


**Figure 7**: Response speed of algorithm.

## 5 CONCLUSIONS

With the growth of computer technology and multimedia technology, animation has also entered a new digital era from the film era. The animation design instructional system puts the overall design stage of 3D animation, teaching resources and excellent animation short clips on the network, and uses computer network means to strengthen teaching efforts and enhance the role of each link in the teaching process, thus deepening teaching reform and improving teaching quality. This article introduces an animation design instructional system based on DL, which uses DL algorithm to automatically model and provides a convenient and efficient animation role modeling platform for learners. This article introduces the implementation stage of the algorithm in detail, and verifies the effectiveness and feasibility of the algorithm through simulation experiments. The simulation results show that the precision is up to 97.66% and the error is reduced by more than 25%. The implementation of this algorithm provides a new and effective solution for animation role modeling. The animation design instructional system can automatically model, which greatly improves the efficiency and precision of modeling, reduces the difficulty of modeling, and enables more learners to easily model animation roles. Moreover, the system also has good generalization performance, can adapt to different role types and forms, and has strong universality and expansibility.

This article puts forward an animation role modeling method based on DL, which provides a valuable technical support and instructional tool for animation industry and education. The algorithm implementation and simulation experiments verify the effectiveness and feasibility of the algorithm. In the future, we can further explore the application of this method in other fields, such as game development and virtual reality.

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*Gang Hao*, https://orcid.org/0000-0002-1114-5462
*Ling Cao*, https://orcid.org/0009-0002-7431-470X
*Zhenghong Xiao*, https://orcid.org/0009-0004-4711-8011

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