Research Article

Animation Image Art Design Mode Using 3D Modeling Technology

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This paper starts with the external visual performance of animation characters, discusses the design style of three-dimensional animation characters, and integrates with traditional art, and makes a new research and attempt from the combination of art and technology, so that nonprofessionals can easily design three-dimensional animation characters. Aiming at the problem of low recognition level of behavior control data points in traditional 3D virtual animation model method, a method of role modeling and behavior control in 3D virtual animation design is designed. Based on the physical engine, a dynamic model of the character skeleton is established, and the joint motion trajectory is simulated to complete the real-time rendering of the effect. Combined with the case analysis, it is discussed from the aspects of animation character modeling, user experience, and so on. Experimental results show that, compared with traditional methods, the data points collected by the proposed method in the process of character behavior control are more dense, the animation effect is more realistic, and it is highly effective and superior.

1. Introduction

With the popularization of computer technology and digital information technology, computer animation technology has been developed and widely used and has become one of the most popular forms of multimedia expression [1]. In computer animation technology, animation character painting and modeling are particularly important. In order to better present animated characters and improve the animation effect, the design of animated characters is becoming more and more complex [2]. Therefore, finding an excellent animation character painting and modeling method has become the main research direction of animation designers and academic researchers. With the growth of people’s demand for animation appreciation, the 3D virtual animation design industry has attracted more and more attention [3]. People’s demand for animation is not only image effect but also three-dimensional and realistic image experience. As a design industry, three-dimensional virtual animation has attracted a lot of attention [4]. With the development and progress of 3D virtual animation technology, a variety of excellent animation production software have gradually emerged in recent years, which has significantly improved the production level and production efficiency of 3D virtual animation [5]. However, the animation character painting and modeling methods commonly used in the past apply 3D design software such as 3Dmax and ZBrush to build a three-dimensional digital animation character model, but the authenticity, flexibility, and experience of animation presentation effect cannot meet the needs of current animation design.

As an important branch of computer animation, 3D virtual animation technology mainly uses computer graphics related processing technology to simulate real personnel and objects and design virtual and abstract content without being affected by space conditions [6]. It is widely used in education, military, medicine, entertainment, and other fields [7]. Character modeling is the basis of 3D virtual animation design. The corresponding 3D virtual character model is established by integrating the three-dimensional concept with the plane animation and combining the character characteristics of the 2D model [8]. However, the 3D virtual
structure cannot be easily generated by one or more graphics. It needs to match the 2D animation to combine into a complete 3D virtual character model [9]. This paper combines 3D design with virtual reality technology, applies it to animation image art design, and puts forward the method of character painting and modeling in 3D virtual animation design.

Three-dimensional virtual animation mainly uses computer technology to simulate and design characters and things to achieve realistic effects [10]. It is an important branch of computer animation and computer graphics. It designs both virtual and abstract three-dimensional animation effects through the provision of real character materials and computer technology [11]. In 3D animation, the essential part is 3D animation character model. Although there are many modeling software systems on the market, which can meet different modeling requirements, these systems are complex to operate, difficult to master, and difficult for nonprofessionals to use [12]. The establishment of three-dimensional virtual character model is to calculate its matrix and vector from the perspective of mathematics and use the curve sequence formed by each sampling point in the character contour to form a three-dimensional network [13]. The behavior control of virtual characters is mainly completed through joint and bone animation. Neural network is used to control the movement and response of the character model to ensure that the three-dimensional virtual characters maintain regular movement in a certain range. After research, through animation image art design and modeling, the three-dimensional sense and rendering effect of characters can be improved, and the animated characters can be presented to the viewer richly and vividly. This paper discusses the design style of three-dimensional animation characters and the integration with traditional art. The method of character painting and modeling in 3D virtual animation design is proposed, and the 3D virtual animation character painting and modeling system is constructed.

2. Related Work

In terms of three-dimensional modeling, literature [14] facilitates users’ modeling, while browsing develops browsing modeling technology based on their needs in the design space. Literature [15] constructed an animation image innovation design model based on evolutionary computation, according to the process of computer-aided animation image innovation design. Component reconstruction, evolutionary design, component management, and automatic assembly are the main features of the system. It allows for the automatic generation and assembly of components in a visual environment, as well as manual model modification. According to the literature [16], the 3D model simplification method based on symmetrical feature detection can improve model simplification efficiency in a limited range. On the basis of retaining features, the three-dimensional model with feature preservation can solve the distortion caused by simplification to some extent and make the model not take up a lot of memory space. Its application importance is more prominent, especially in simulation experiments with a large number of models. Literature [17] analyzes the problems that exist in 3dsmax expression design under the current technology and designs the concept of a character facial expression animation system based on 3dsmax on the basis of studying the principles and methods of 3D virtual character expression generation. A 3D model simplification method based on symmetrical feature detection is described in the literature [18, 19]. It will study the simplification of 3D model in simulation application from three aspects: diversity modeling of 3D model, degree simplification, and symmetrical feature detection to improve simplification efficiency. Literature [20] created an animation character database through the analysis of characters. User screening and refining make the character modeling more infectious. Literature [21] makes use of the idea of computer-aided design and the method of biological genetic evolution, so that designers can break the inertia thinking. According to the general function of facial expression muscles, literature [22] designed a solution to realize the real facial expression animation system by using 3dsmax. Literature [23] focuses on the research close to humanoid creatures to adapt to the goal of the subject. Through classification and analysis, each part is reasonably cut and can be applied to other roles. Literature [24] points out that computer animation creation software is a complex system, which requires the knowledge integration of computer experts, artists, and other producers with completely different knowledge structures. Literature [25] applied evolutionary computing technology to the innovative design of animation image, proposed a new method of computer-aided generation of three-dimensional animation character image, and established an intelligent animation character image design CAD system based on NURBS. In this paper, the art design and modeling method of animation image based on 3D modeling technology is proposed. The simulation results show that this method has better quality and lower energy consumption than the comparison method. Compared with traditional methods, it provides support for designers to develop innovative ideas to a certain extent. It has a high popularization value.

3. Methodology

3.1. Animation Image Art Design. With the development of animation industry, the improvement of aesthetic requirements of 3D animation characters, and the increasing audience, it has gradually developed into an industry. Computer virtual 3D character is a new digital art content with authenticity, virtuality, technology, and dynamic attributes, which can be widely used in many fields such as film and television animation and computer games [26]. In the process of animation character design and production, it can greatly reduce the time cost and other investment to produce a qualified animation character quickly and effectively [27]. Combining 3D animation design technology with virtual reality technology and applying it to character painting and modeling in 3D virtual animation design can improve the level of animation character painting and modeling and increase the vividness and stereoscopicity of animation.
characters. The structure of the virtual animation character drawing and modeling system is shown in Figure 1.

It can be seen from Figure 1 that action capture, virtual animation character painting, and 3D model design are the three main links of character painting and modeling in animation design, and virtual reality technology and 3D design technology complement each other. The system integrates animation technology, VR virtual technology, 3D design technology, and network technology, etc. Through the unified combination of VR virtual technology and 3D design, viewers can watch various real and vivid animation characters and feel involved and enhance authenticity.

I must master anatomical knowledge in order to create virtual characters, which is similar to learning traditional painting. We can only grasp the details accurately and completely if we clearly understand the internal structural relations of objects in order to avoid letting the representation of objects affect our cognition of things. The relationship between facial muscles and facial expressions, as well as the law of facial expression movement, can only be understood in this way [28]. To achieve the wiring rationality of the 3D virtual model, the physical engine must be used as the foundation, and the dynamics method must be used to realize each pose of the 3D virtual character animation [29]. Character animation, unlike other fluid or deformation animation, is usually divided into two parts: the establishment of the bone model and the establishment of the outer skin. Because the outer skin is usually attached to the bone model and moves with the bone, the bone model is the most important. Starting with the root bone at the highest level, we should realize the connection between bones using the degree of freedom of rotation and then adjust the records of the parent bone and the root bone using the designed bone model. For this reason, Maya software system is used to create bone model, and IK/FK conversion system is established to control arm conversion. And it can be used in any three-dimensional simulated character model. The process of creating bone model with Maya is shown in Figure 2.

Role modeling is the most critical link in the process of 3D virtual animation design [30]. Three-dimensional virtual animation structure needs to match multiple animation graphics in two-dimensional mode to establish a complete three-dimensional virtual animation character, and the role establishment of three-dimensional virtual animation is based on the angle of mathematical matrix and vector, and through the establishment of corresponding sampling points on the outline of character material characters, the corresponding sampling curve sequence is drawn, thus forming a preliminary three-dimensional network model. The essence of 3D virtual animation is the joints and joints of 3D characters. At this time, it is necessary to use artificial neural network to capture the movements and control the movements of 3D characters, so that 3D characters can realize regular and barrier-free movements under certain conditions.

Physical dynamics method is used to capture the character’s trajectory, which makes the character’s behavior more vivid. In order to make the character complete the action according to the actual demand, the proportional-differential controller is used to control the character, change the driving force of the character state, exert pressure on the joints of the character, and allow the user to adjust and customize the controller according to this mechanism. Structural feature analysis is the basis of animation character modeling. The structural features of animation characters are usually divided into two types: regular structure and irregular structure. The regular animation character modeling is relatively simple, while the irregular animation character modeling is relatively demanding.

3.2. Establishment of Three-Dimensional Animation Character Model. As the soul of the three-dimensional virtual character, the adjustment and control of bone joints become very important. After the general behavior control, we should also consider the control of behavior branches. First of all, interactive control, interactive control between three-dimensional virtual characters, interactive control between users and three-dimensional virtual characters, search for the most suitable control points of interactive control, and set up operations that are suitable for users in various environmental angles. It is also necessary to adjust the interactive interface in time, observe the three-dimensional virtual character image from different perspectives, and combine the observation points with each data collection point to make the three-dimensional virtual character image more realistic.

Capture the movements of the characters’ materials and copy the tracks using the physics method, so that the 3D virtual animation characters can move and adjust in proportion to the real characters, achieving fidelity. A successful animation character design necessitates the designer iterating on the prototype, which slows down the creation of 3D animation. As a result, by modifying existing models, we can generate a large number of animation images, stimulating the designer’s creativity and improving design speed and quality.

Starting with detail modeling, the stacking modeling method is a modeling method that combines multiple detail models into a single model. This modeling method’s modeling process is similar to that of construction, in that it involves constructing parts of the entire structure based on foundation construction and then unifying each part to create the entire structure. Before the animation ontology model is established, it is necessary to classify and describe the objective animation character structure. If there are 6 elements in the animation character, describe it as follows:

\[
P = [X, T, J^r, \text{Rel}, S^o, T_{\text{in}}].\tag{1}
\]

In the formula, \(X\) and \(T\), respectively, represent different elements in the virtual environment and the relational operators between different elements. \(J^r\) and \(\text{Rel}\), respectively, represent the conceptual hierarchy and nonclustering relationship between different elements. \(S^o\) and \(T_{\text{in}}\) respectively, represent the existing ontology prototype and the intrinsic correlation of the elements. Among them, \(X_1, X_2, \ldots, X_n \in X\) describes all the elements in the
animation character structure. The relational operator described by $T$ can be expressed as
\[
\begin{cases}
\text{attribute_of} & (X_1, X_2), \\
\text{compose_of} & (X_1, X_2), \\
\text{effect_of} & (X_1, X_2).
\end{cases}
\] (2)

The formula, respectively, describes the correlation between $X_1$ and $X_2$. In the process of transferring animated characters in the form of pictures to the 3D modeling software, the number of strobe frames of different videos shows the waiting phenomenon of Poisson distribution sorting. In order to highlight the difference between ontology features, the 3Dmax software operating system uses ontology element features and operating behavior as the sensitivity index to improve modeling efficiency. For the sensitivity index, the characteristic elements in formula (2) can be described by formula (3):

\[
\text{Sensitive}_{tune} = \{\text{attribute_of} (X_1, X_2), \text{compose_of} (X_1, X_2), \text{effect_of} (X_1, X_2)\}. \] (3)
According to the maximum mean square error, the threshold of the sensitivity index can be determined. The formula is described as

\[
\text{Threshold}_{\text{Sensitivity time}} = \frac{1}{3E} \left[ \int_{t=0}^{E} \text{attribute of } (X_1(e), X_n(e)) \partial(e) \right],
\]

where \( E \) represents the playing time of video animation.

Through systematic feedback, the control parameters suitable for 3D-simulated character animation joints are set to realize the proportional combination of external information and 3D virtual animation, to avoid external interference as much as possible to realize the conversion of relative data, to increase the similarity between the character image and the real image, to bear the force scientifically with the bone joints, and to meet the constraint control conditions for 3D virtual animation.

To build 3D simulation objects in the dynamic world, the steps of 3D character animation must be strictly followed, and data exchange must be completed on time. The required characters’ speed and the strength that the characters must bear are set according to the requirements, and the 3D simulation characters are copied correspondingly to realize the interaction in the simulator. The characters are filled with colors during the painting process to enrich the structure of animated characters and increase the saturation of animated characters. Color design of animated character costumes is possible in addition to color painting of the basic shapes of animated characters. Simultaneously, it is necessary to control the correlation between the overall color of animated characters and key characters during the color design process of animated characters. That is, color judgment and allocation are completed, and color structure coordination is realized, using three-dimensional images of animated characters.

Applying the feedback control theory, its controller represents the feedback controller, inputs relevant control parameters, and outputs the rotation data information of the character joints through the controlled system of the virtual character. Because the feedback control system can receive information data from outside, it may also be interfered by external forces. Since each behavior posture is composed of the spatial form of the bone structure and the spatial translation of the root joint, the unit quaternion and the rotation matrix are converted to each other, and the rotation matrix corresponding to a unit quaternion \( q = [w, (x, y, z)] \) is as follows:

\[
M = \begin{bmatrix}
1 - 2y^2 - 2z^2, 2xy - 2wz, 2xz + 2wy \\
2xy + 2wz, 1 - 2x^2 - 2z^2, 2yz - 2wx \\
2xz - 2wy, 2yz + 2wx, 1 - 2x^2 - 2y^2
\end{bmatrix}.
\]

In the formula, the spatial translation of the root joint is \( P = (x, y, z) \). Spherical linear interpolation is performed on the two unit quaternions of formulas (6)–(8) is obtained.

\[
q_1 = [w_1, (x_1, y_1, z_1)],
\]

\[
q_2 = [w_2, (x_2, y_2, z_2)],
\]

\[
\text{slerp}(q_1, q_2, \mu) = \frac{\sin(1 - \mu)\theta}{\sin\theta} q_1 + \frac{\sin\mu\theta}{\sin\theta} q_2,
\]

where \( \theta = \arccos(w_1w_2 + x_1x_2 + y_1y_2 + z_1z_2) \) is the angle from \( q_1 \) to \( q_2 \). \( \mu \in [0, 1] \) is the interpolation parameter. When \( q_1, q_1^{-1} = [w, x, y, z] \), the distance between \( q_1 \) and \( q_2 \) is

\[
d(q_1, q_2) = \arccos \omega.
\]

For a three-dimensional virtual animation character with \( n \) joints, it has two different behaviors and poses: (10) and (11).

\[
m_a = (P_{a1}, q_{a1}, q_{a2}, \ldots, q_{an}),
\]

\[
m_b = (P_{b1}, q_{b1}, q_{b2}, \ldots, q_{bn}).
\]

The similarity of behavior and posture between \( m_a \) and \( m_b \) is

\[
\text{sim}(m_a, m_b) = 1 - \frac{1}{n\sum_{i=1}^{n} \omega_i d(q_{ai}, q_{bi})},
\]

where \( q_{ai} \) and \( q_{bi} (i = 1, 2, \ldots, n) \) are the unit quaternary rotations of the \( i \)th bone joint on the behavioral poses \( m_a \) and \( m_b \) of the three-dimensional virtual animation character. \( \omega_i \) is the calculation weight of the \( i \)th bone joint. The value range of \( \text{sim}(m_a, m_b) \) is \([0, 1]\) and \( \sum_{i=1}^{n} \omega_i = 1 \).

While endowing evolutionary computation with the characteristics of self-organization, self-learning, and self-adaptation, the survival of the fittest, natural selection, and simple genetic operation make evolutionary computation free from the constraints of search space and without other auxiliary information.

4. Results Analysis and Discussion

Using the algorithm in this paper, various components that can be assembled into products are generated, and then the generated components and manually designed components are assembled together by using the management and assembly technology of soft components to demonstrate cartoon modeling in three dimensions. Because each component is derived by mathematical model and genetic algorithm, instead of being conceived manually and then reproduced by computer tools, some novel appearance shapes can be produced, and some original designs can still be reused. Because of its novel appearance and high
efficiency, it can greatly improve the efficiency and level of animation production by designers and improve the market competitiveness.

After the design of 3D virtual characters is completed, simulation experiments should be conducted to verify the rationality of the design and the effectiveness of the control, and the collection points of the characters in the design process should be verified and recollected, and the corresponding data should be compared with traditional methods to adjust the 3D virtual characters to some extent, so as to realize the 3D-simulated characters experiment in all scenarios. First, the algorithm in this paper is compared with the traditional neural network algorithm, and the experimental results are shown in Figure 3.

It can be seen that this algorithm is superior to the traditional algorithm, which further demonstrates the superiority of this algorithm. Set the original data in the computer, use the comprehensive application platform of role behavior automatic control to create the logic of role behavior in 3D virtual animation, and upload the obtained data. The traditional collection method is used to collect and detect the data of 3D virtual animation, and upload the obtained data. The data are integrated and classified in time, and the same differences between traditional and current data points are analyzed. The most suitable data are selected for input to ensure the rigor and comprehensiveness of 3D virtual characters before the experiment. The specific comparison results of the collected data points are shown in Figure 4.

As can be seen from Figure 4, the collected data are combined for comparison, and the data points collected by this method are denser, because the control points are clearly identified, and the accuracy is obviously improved. The method mentioned in this paper has high integrity, dense data, and high verifiability, which meets the rigorous and scientific requirements of the experiment. In order to ensure the rigor of the experimental results, many simulation experiments of behavior control were conducted. After many times of verification, it conforms to the unique efficiency and effectiveness of the times.

In order to verify the effect of this method in 3D virtual character modeling, this method is compared with OpenGL-based 3D modeling method and SketchUp-based 3D modeling method. Compare the frame rate and texture number of the three modeling methods in building the 3D model of the above animated characters, and the results are shown in Figures 5 and 6.

According to the analysis of Figure 5, in the process of building 3D model of animated characters, compared with the other two comparison methods, the running frame rate of the model built by this method is higher, and compared with the other two methods, the improvement range is larger. This shows that the image quality of the model established by this method is better after the behavior control, and the behavior connection of animated characters is smoother. From the analysis of Figure 6, it can be seen that in the process of building 3D models of animated characters, compared with the other two comparison methods, the number of textures in the model built by this method is the
highest. Compared with the other two methods, the improvement range is larger. This shows that the 3D model built by this method has higher definition. Based on the comparison results of Figures 5 and 6, it can be seen that the quality of the model established by this method is better than the other two comparison methods. When the 3D virtual simulation experiment is finished, it is necessary to analyze its various functions, various terminal operations, and various scenarios. The simulation comparison of reliability optimization of image segmentation topology is shown in Figure 7.

Select a computer with suitable memory to set the original data of 3D-simulated characters, and then connect the computer with the integrated platform, and make full use of the integrated platform of 3D virtual characters’ actions and behaviors to control its automatic control. In order to verify the energy consumption advantage of this method in the process of animation image design and modeling, compare the energy consumption of three modeling methods in the process of building the 3D model of animation characters in the experiment, and the results are shown in Figure 8.

It can be seen from Figure 8 that the fluctuation of energy consumption in the process of painting and 3D model building for different actions in this method is significantly lower than that of the other two comparison methods. Therefore, this method has low energy consumption in the process of drawing and modeling 3D virtual characters.

Select the corresponding modeling method to make 3D virtual model of animated characters. The animation model includes three aspects: light, material, and rendering. Different types of light and shadow are used to simulate the light and shadow effect of light, and the authenticity of the animation model is enhanced by material. The characteristics described by light and material can be realized by rendering.

After comparing and integrating the data, it is time to provide a scientific foundation for 3D virtual character behavior control and modeling methods, as well as integrate and analyze the experimental data. The experiment’s conclusion does not mark the end of the process; rather, it marks the start of the next successful experiment. Not only will meticulously recording the experimental data makes it easier to use adjustment and correction, but it will also provide experimental data for future generations. Finally, image determination defines the design method for 3D virtual character images as well as the standard for 3D character images. This method is highly effective and superior, according to repeated experiments.

5. Conclusions

People’s requirements for the effect of animation character construction are constantly improving as China’s animation industry grows, and the original character modeling technology can no longer meet people’s aesthetic requirements. This paper proposes an art design and modeling method for
animation images based on 3D modeling technology, as well as an updated and designed method of character modeling in 3D virtual animation, which improves the fineness of character images, enriches colors, and makes the character effect more realistic. The experimental results show that this method produces better quality and uses less energy than the comparison method. In comparison to traditional methods, it helps designers develop innovative ideas to a degree. It has a high level of popularity. However, because animation image design is a complex and free task, the method described in this paper has not yet reached the level of designing animation character images at will. To improve the function and efficiency, more research into the artistic features of animation characters is required, as well as learning from the design structure and features of some commercial or open source software specialized in animation creation.

Data Availability
The data used to support the findings of this study are included within the article.

Conflicts of Interest
The author does not have any possible conflicts of interest.

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References


