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3D Animation and Human-Computer Interaction of Virtual Characters in Sustainable Ecosystem

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Keywords: 3D Animation Production, Human-computer Interaction, Artificial Intelligence Virtual Character, Artificial Intelligence Algorithm, Back Propagation Network Neural (BPNN)

Abstract: With the increasing popularity of artificial intelligence-related technologies, the emergence of various new technologies has brought people more convenient life and entertainment equipment. Nowadays, computer animation has penetrated into all aspects of people's lives. Computer animation has formed a huge industry, and there is a trend of further growth. The game industry has become an important pole of the computer animation industry, and its development has been in full swing over the years. However, the research on 3D animation production and human-computer interaction is only at the theoretical level. This paper conducts a scientific analysis and high-dimensional research on 3D animation production and human-computer interaction from the level of artificial intelligence virtual characters. The results of the study show that users can customize the path curves of artificially intelligent avatars, which aids in the connection of motion in 3D animation production. The average classification accuracy of imaginary EEG signals for gesture recognition and interaction based on EEG and EMG was 65.3%, which provided a basis for improving 3D animation production and human-computer interaction research.

1. Introduction

With the continuous improvement of computer hardware performance and the in-depth study of computer graphics, 3D games have become the mainstream of today's games including online games. Its typical features that attract more and more players have not only included highly realistic scenes, engaging plots, and multi-player cooperative support, but also increasingly reflected in the behavioral intelligence of virtual characters in the game. The behavioral intelligence of virtual characters in 3D games depends to a large extent on its interactivity, including the interaction between characters and the environment and between characters and players. Over the years, due to the increasing sophistication of artificial intelligence technology and motion control editing technology in games, game developers often have to spend a lot of money to achieve this kind of interaction. Therefore, by improving the efficiency of character interaction behavior development, the efficiency of game creation can be greatly improved. It is necessary to implement a virtual character interaction framework, which makes it possible to realize the visual editing of the character interaction behavior in the game based on this framework. This greatly improves the game development efficiency of developers, reduces development costs, and brings more benefits to developers while providing players with a better user experience, thereby promoting the faster development of the game industry and the national economy. At the same time, the framework can also provide a good platform for research in artificial intelligence, character animation, virtual reality and many other fields. In order to further understand and analyze 3D animation production and human-computer interaction, this paper analyzes 3D animation production and human-computer interaction based on artificial intelligence virtual characters.

In this paper, the research on 3D animation production and human-computer interaction is mainly analyzed from the perspective of artificial intelligence virtual characters, and it explores the composition and development of 3D animation production and human-computer interaction from a novel perspective, and explores its internal connection. In the aspect of artificial intelligence virtual characters, this paper studies the path algorithm. Experimental research on gesture recognition and interaction based on EEG and EMG. The result was an average classification accuracy of 65.3% for motor imagery EEG signals. The innovations of this paper are: (1) Different virtual character path planning algorithms are used. (2) Motion map technology is used to verify the possibility of seamless connection between motions.

2. Literature Review

3D animation production and human-computer interaction are constantly developing with the development of science and technology. In recent years, many scholars have conducted in-depth research on 3D animation production and human-computer interaction. Scholar Evangelidis K combined digital elevation models with high-quality raster graphics to provide a realistic three-dimensional representation of the Earth [1]. Sung-Dae analyzed the survey results based on the questionnaire survey participated by 3D animation producers, and discussed how to improve the cultivation of 3D animation creative talents in colleges and universities [2]. Abdrashitov R believed that the combination of computer animation and 3D printing had the potential to have a positive impact on traditional stop-motion animation [3]. Hibbeln M used human-computer interaction input devices to infer emotions [4]. Michalakis K believed that modern consumer electronic devices had developed to make the interaction between humans and machines more natural and effective [5]. The above research has carried out experiments and analysis on 3D animation production and human-computer interaction from various aspects, and continuously improved 3D animation production and human-computer interaction. However, the above research only stays in the field of education and life, and has not conducted in-depth and high-dimensional analysis of it, and it is difficult to find its essence. Therefore, it is necessary to study and analyze 3D animation production and human-computer interaction from other aspects.

In response to the above problems, this paper studied 3D animation production and human-computer interaction from the level of artificial intelligence virtual characters. This level had already been widely used in other fields. Scholar Jung expounded the role of virtual reality in postmodern education [6]. Hassabis D believed that a better understanding of the biological brain could play a crucial role in building intelligent machines [7]. Rongpeng tried to highlight one of the most fundamental features of the revolutionary technology in the 5G era. That is, initial intelligence emerges in almost every important aspect of cellular networks, including radio resource management, mobility management, service provisioning management, etc. [8]. Makridakis S believed that artificial intelligence had brought about widespread changes that also affected every aspect of society and life. Furthermore, its impact on businesses and employment was enormous [9].

Mancini M gave virtual characters a computational model for laughter synthesis [10]. The above research shows the application of artificial intelligence virtual characters in various fields. However, most of them are used in computer and life. And there is a lack of research and analysis on 3D animation production and human-computer interaction. Therefore, this paper analyzed 3D animation production and human-computer interaction based on artificial intelligence virtual characters, and provided a theoretical direction for its subsequent development and laid the foundation for future practical applications.

3. 3D Animation Production and Human-computer Interaction Method Based on Artificial Intelligence Virtual Characters

3.1 3D Animation Production

(1) Anima animation engine

Anima character animation engine is a physics-based character animation simulation development package developed by the Institute of Digital Media Technology, University of Electronic Science and Technology of China [11]. Before designing and developing the virtual character interaction framework, the architecture of the Anima character animation engine must be carefully analyzed. The Anima character animation engine adopts a plug-in architecture, which isolates each functional module, making the engine more extensible, reusable and replaceable. Figure 1 is a schematic diagram of the overall design of the system. It is based on the Anima core, uses Python as the scripting system, and adds the simulator module, geometry module, sensor module, actuator module, modifier module, simulation system module, etc. as plug-ins to the system.

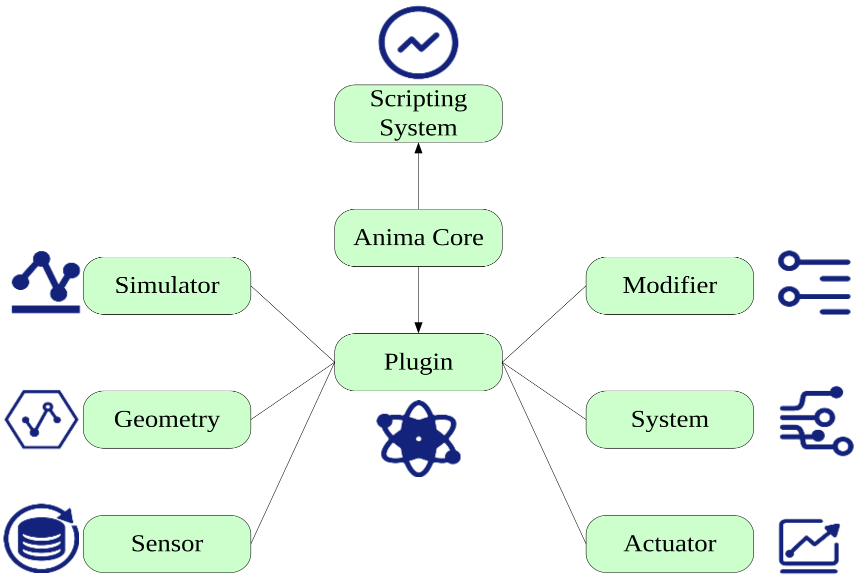


Figure 1. Schematic diagram of the overall structure of the Anima character animation engine

(2) Finite state machine

Finite State Machine (FSM) is an abstract concept in computer science and mathematics. It is the behavioral pattern of a system or complex object that contains a finite number of defined states, and transitions between states that exist in response to changes in the environment. It has been widely used in various aspects over the years [12].

Assuming that $p(t)$, $q(t)$ and $y(t)$ represent the input, state and output of an FSM, respectively, then its schematic diagram is shown in Figure 2.

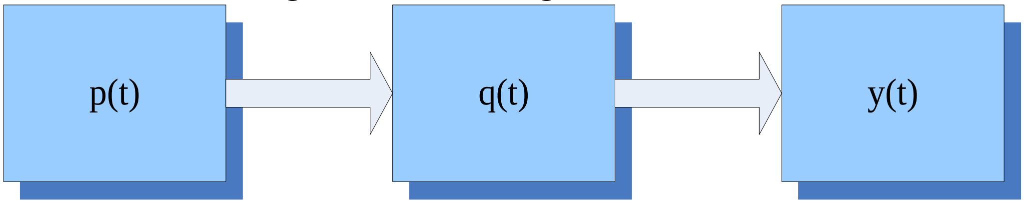


Figure 2. Schematic diagram of the working of the finite state machine

(3) Animated film innovations brought about by 3D technology

An animated film created by combining the theme of Chinese folk love myths with 3D technology is an efficient path to organically integrate technology and art by taking advantage of traditional Chinese culture. For example, the 3D animation film "White Snake: The Origin" is a Sino-US joint venture animation film. In terms of production technology, it uses advanced technology from Europe and the United States and has a very high technical content. In the process of production, they have absorbed foreign advanced technical experience and provided the audience with a visual feast. In terms of content, it breaks the previous imitation of the storytelling methods of European and American countries, and establishes the framework of the story on the traditional Chinese folk love myth and legend "The Legend of the White Snake". Using the big IP hotspot "The Legend of the White Snake" can attract different audiences, and using the attraction and influence of traditional Chinese folk art can achieve the integration of tradition and technology. Technology and content are important reasons for the success of "White Snake: The Origin". As a technical skill, 3D technology is very different from the production of traditional animation films. Its own characteristics have created its powerful advantages. It can not only use the advantages of convenient lens switching to present rich picture effects, but also make the effect experience of the film more realistic. The production and performance of grand scenes can also meet the visual requirements. In "White Snake: The Origin", Xiaobai and Axuan jump down from the cliff and use the conversion of the fighting scene. The application of 3D technology makes the production difficult. At the same time, the visual effect is more intense.

3D animation films have sprung up in Europe and the United States, opening a new era of 3D animation films. In recent years, works with strong Chinese style have emerged one after another, and Chinese style has been increasingly sought after by many audience groups. The success of the 3D animated film "White Snake: The Origin" is based on this, and there is its contingency and inevitability. Compared with other art forms, 3D animated film works are more commercialized. And compared with traditional hand-painted animation, the immersive visual impact of 3D animated films is an important feature for them to gain a strong audience. Since 2006, Chinese 3D animation films have shown explosive growth, which also shows the audience's recognition of this animation form from another aspect. However, since 3D animation entered the Chinese market, the visual effect has not been able to meet its requirements with the change of audience psychology. Therefore, on the basis of improving technology, we should seek other breakthroughs, start from the audience's cultural psychology, find new breakthroughs, break through the previous imitation of European and American countries, and use traditional culture to tap our own advantages. In the face of the high pressure of cultural input of foreign works seeking to show, we should form works with our own values and aesthetics, form our own audience groups, make use of the charm of Chinese traditional culture and international influence, and take the strong cultural heritage of Chinese folk art as the support to realize the optimization of the audience groups.

3.2 Sustainable ecosystem under human-computer interaction

In the future political, economic and social development, human and environmental crises and responsibilities should become the focus of attention. Great changes have taken place in human society, human behavior and the relationship between human and nature. On this basis, it is necessary to carry out "top-down" top-level design with the help of institutional and organizational forces, such as the state, local governments, enterprises, etc., and more importantly, it is necessary to promote the transformation of people's life and production patterns from a "bottom-up" human perspective.

Human beings are not just a "need to be satisfied" creature. They can also use their subjective initiative to guide their actions, so as to achieve a common value. However, due to the following reasons, human subjective initiative cannot be effectively stimulated, nor can it produce the expected effect: the existence of human crisis. This is probably because the signs of human crisis are too weak, or because the process is too slow, or because of the lack of an intuitive and persuasive method, people can not feel the environmental crisis.

There is the inertia of life. More and more people are aware of the impact of human activities on the environment, but are unwilling to reduce the existing "quality" in order to change, so we must consider how to stimulate people's motivation to change their lives. I have tried to change my life habits, but it is difficult to make people believe and stick to my behavior because I am not sure whether it can solve the problem, that is, lack of positive feedback, or get appropriate rewards. We have tried to carry out reform, but there is no effective organization to promote the change of social scale, so as to achieve a new balance in sufficient quantity.

Coordination among the four NHCA systems is the key to sustainable design. Sustainable interaction design refers to the use of interaction design ideas, methods and tools to design and manage a sustainable design system, thus promoting and maintaining the benign interaction within the system. This is an interactive design that links human activities with the outside world. Its purpose is to make human behavior change, so that the whole system can be adjusted and achieve the goal of sustainable development.

(1) Overall framework of human-computer interaction system

The human-computer interaction system constructed in this paper includes multiple subsystems of brain-computer interface system, surface electromyography system and virtual reality system. Among them, the brain-computer interface system and the surface electromyography system serve as the bridge between the user and the interactive device. The interaction between people and external devices is realized by detecting and recognizing EEG and EMG signals. The virtual reality system is mainly responsible for providing real visual effects, such as virtual reality-based visual guidance and virtual reality visual feedback. The overall framework of the human-computer interaction system based on EEG and virtual reality is shown in Figure 3.

(2) Brain-computer interface system

Generally speaking, a complete brain-computer interface system mainly includes: signal acquisition, signal processing, control system and external equipment. The acquisition of EEG signals requires the use of an EEG cap or an EEG [13]. There are two types of EEG caps for measuring EEG (Electroencephalogram, EEG), one is dry electrode and the other is wet electrode.

EEG signals can be divided into five types: Gamma, Beta, Alpha, Theta, and Delta according to different frequency segments. The state corresponding to each EEG is shown in Table 1. Different EEG signal frequency bands correspond to different states. According to this correlation, the relationship between human brain state and EEG energy in different frequency bands can be studied.

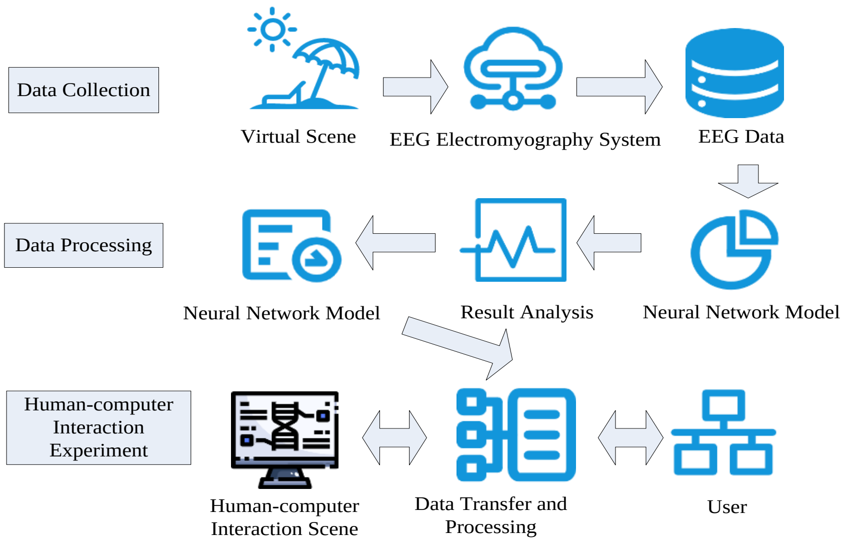


Figure 3. Overall framework of human-computer interaction system

Table 1. Brain wave types and corresponding states

Gamma	30-100Hz	Enhance perception,Peak mental state
Beta	10-30Hz	Alert,Active,Thinking, Focused
Alpha	10-15Hz	Relax, Close your eyes
Theta	5-10Hz	Sleep, Dream, Meditate
Delta	1-5Hz	Deep sleep, Decreased consciousness

The brain-computer interface virtual reality human-computer interaction platform built in this paper is based on the motor imagery brain-computer interface. Motor imagination does not require external stimulation, and can interact with external devices only through imagination, which is more humanized and intelligent.

(3) Surface electromyography system

Electromyogram (EMG) refers to muscle bioelectrical signals recorded by electromyography acquisition equipment. Human EMG can be divided into surface EMG (sEMG) and indwelling EMG (iEMG) according to different collection methods [14]. Needle EMG uses tiny needle electrodes inserted into the muscles, which causes certain trauma to the user, but the collected EMG signals are reliable and have a high signal-to-noise ratio. Surface EMG electrodes are placed on the surface of the skin, which is a more convenient and widely used EMG acquisition method without trauma to the human body.

Human motion intention comes from the brain. When a person makes a certain gesture, bioelectrical signals are first sent from the brain, and then travelled through neurons to the skeletal muscle to cause the muscle to contract or stretch to act accordingly. During the conduction of bioelectrical signals between neurons, the concentration of charged ions in human cell membranes changes to generate motor unit action potentials (MUAP) [15].

(4) Virtual reality visual system

Virtual reality technology is an emerging and more mature technology in the 21st century. Virtual reality can be applied to all walks of life. Whether it is game entertainment or education and training, virtual reality has a lot of room for development and market value. With the rapid development of 5G technology, 5G is expected to realize low-latency and high-speed transmission of large amounts of data in virtual reality systems. This undoubtedly pushes virtual reality technology to a higher degree of popularity.

Virtual reality technology (Virtual Reality, VR) can create a virtual environment in which users can immerse themselves. At present, VR technology realizes the interaction between users and the virtual world, and various operation behaviors of users can be mapped to the virtual world. And VR's graphic reality and three-dimensional reconstruction technologies give users realistic visual feedback. After entering the 21st century, VR technology has become more and more mature. The application scenarios of VR are very broad, including games, education, medical care, military and other fields.

The main function of the virtual reality visual system is to use its high-performance graphics processing engine to provide users with real interactive scenes and realistic visual images, with 360° all-round visual effects, approximating the perception of the real three-dimensional world. The work that needs to be done to build a VR visual system mainly includes 3D modeling, graphics rendering processing and VR display.

The most commonly used image processing engines are Unity3D and Unreal Engine 4 (UE4). Unity3D provides many API interfaces that allow users to make and use functional plug-ins and seamlessly integrate them into various systems. Not only that, Unity3D is easy to use and get started with. It is a game development tool that allows users to easily realize rich content such as 2D or 3D game development, 3D animation production, and driving simulation testing. It is a professional game engine with good comprehensive capabilities. Compared with Unity3D, UE4 has more powerful image rendering capabilities, but its system scalability is not as good as Unity3D.

At present, there are relatively few studies on the combination of brain-computer interface and virtual reality, mainly focusing on rehabilitation training, EEG-controlled VR games, and VR virtual driving based on brain-computer interface. The VR environment can provide users with realistic virtual visual feedback. The brain-computer interface provides a better way of interaction, which does not require hands-on interaction between people and virtual three-dimensional models only by means of "ideas".

Brain-computer interface and virtual reality are relatively new technologies, and the combination of the two will surely create different sparks. The combination of brain-computer interface technology and virtual reality can create a rehabilitation training system for stroke patients. The realistic visual feedback of virtual reality can better stimulate the nervous system and allow stroke patients to recover quickly. The combination of brain-computer interface and VR can also control virtual human models through EEG. In addition, people can roam in VR virtual cities through imagination, which are very good VR experiences. Neurable's products combine brain-computer interface and virtual reality, allowing users to play VR games only through imagination, which is a brand-new interactive experience. Brain-computer interface-virtual reality technology is expected to become the new favorite of game entertainment and medical education industry.

By combining brain-computer interface and virtual reality, it can provide more realistic visual feedback and new interaction methods for human-computer interaction system. Not only that, the VR system can guide the subjects' motor imagery through virtual images during data collection, thereby improving the quality of motor imagery EEG signals. The combination of brain-computer interface and virtual reality technology still has much to study and explore.

3.3 AI Virtual Characters

Artificial intelligence is an important product of the development of computer science. It covers many areas of computer science, including neural networks, genetic algorithms, machine learning, intelligent recognition, computer vision, and more. At present, the research of artificial intelligence has achieved fruitful results, forming a relatively complete theory and technology, and has produced many high-tech products in many fields, which has greatly expanded people's "wisdom".

AI virtual characters can be divided into the following five levels, as shown in Figure 4.

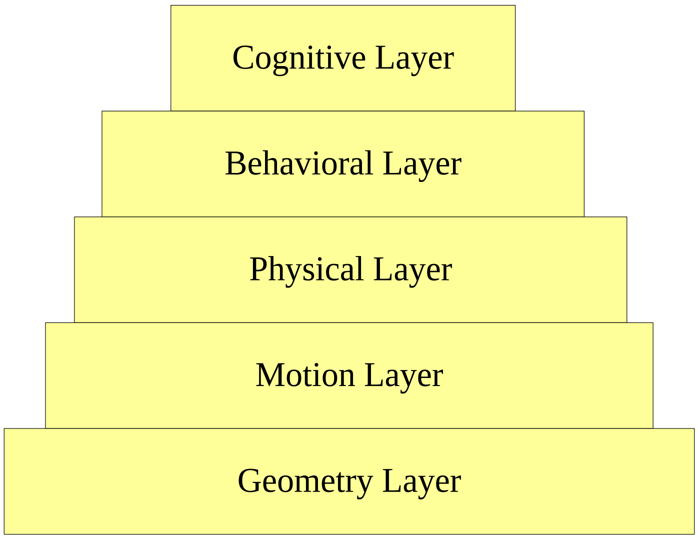


Figure 4. Model hierarchy for smart actors

The update and development of 3D image graphics software and hardware equipment has also enabled the original 2D scene to be updated and developed into a 3D scene, and the 2D map has been upgraded to a 3D map. The previous two-dimensional scenes and maps had small spaces, blurred pictures, and low definition, making it difficult for people to watch and control them. Now it is upgraded to 3D scenes and maps, the space has become larger, the picture has become more realistic, and the clarity has become high-definition or ultra-high-definition. These significant changes make path planning for avatars in the scene map a lot easier and easier.

Using the method of modularization [16], the interaction between virtual characters and game scenes can be abstracted into a framework as shown in Figure 5.

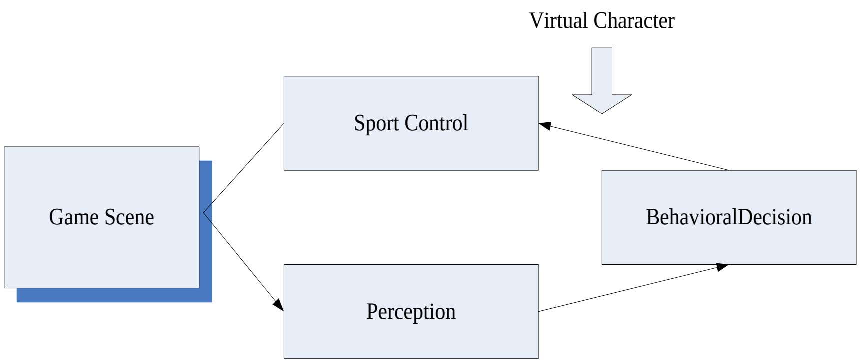


Figure 5. The interaction framework between the virtual character and the game scene

Compared with the previous two-dimensional scene map, the advantages of doing the path planning of the virtual character in the three-dimensional scene map are self-evident. The virtual character can apply the pathfinding algorithm in the scene map, find the path independently, and complete the path planning.

In the naked-eye 3D display system, intelligent virtual characters can perceive changes in the external environment. It can identify different terrains, identify land and sea, avoid obstacles such as boulders, houses, trees, climb up hills, plan a walking route to a destination, and more. All of these benefit from the in-depth research of artificial intelligence and the application of artificial intelligence in the field of virtual character path planning.

(1) Dijkstra's algorithm

Dijkstra's algorithm can be specifically described as: in a graph, the shortest path from a source point to other vertices is found. Assuming that there is a weighted graph N, a source point w is arbitrarily selected in the graph, and the shortest path from the source point w to each vertex in the graph N is found [17]. For example, in the weighted directed graph N shown in Figure 6, the shortest path from w_0 to each of the remaining vertices is found. The distances from the source point w_0 to the remaining vertices are shown in Table 2.

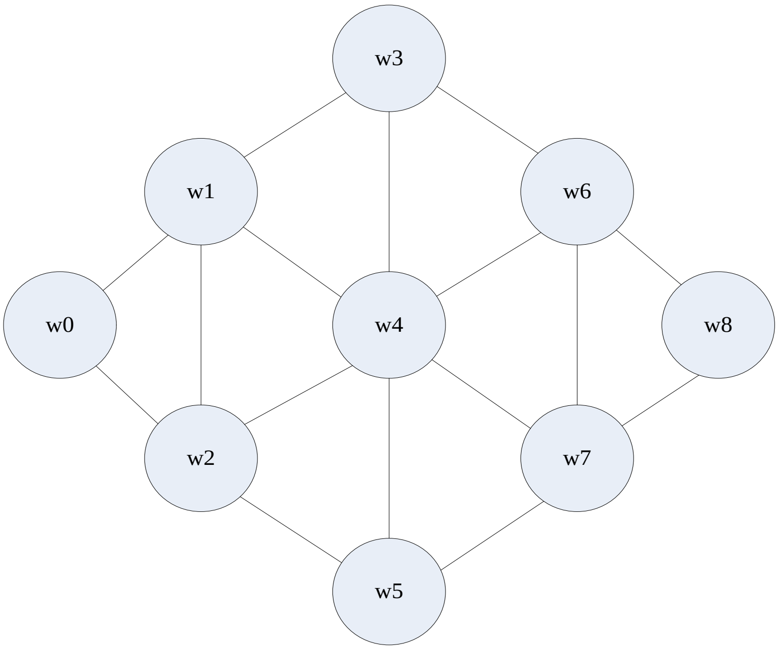


Figure 6. Weighted graph N

The following is the stored adjacency matrix table of the weighted graph N.

Table 2. Stored adjacency matrix for weighted graph N

Vertex	w_0	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8
w_0	0	2	6	∞	∞	∞	∞	∞	∞
w_1	2	1	4	8	6	∞	∞	∞	∞
w_2	6	4	1	∞	2	8	∞	∞	∞
w_3	∞	8	∞	1	3	4	∞	∞	∞
w_4	∞	4	2	3	2	1	4	8	∞
w_5	∞	∞	9	∞	3	∞	5	4	∞
w_6	∞	∞	∞	5	7	∞	∞	2	7
w_7	∞	∞	∞	∞	9	6	1	5	4
w_8	∞	∞	∞	∞	∞	∞	7	5	0

In order to better explain Dijkstra's principle of finding the shortest path, an auxiliary vector M is introduced. For each component $M[i]$ of the auxiliary vector, it can be expressed as the longest length from the starting point w_0 to each end point w_i, and this length is the distance of the shortest path currently found. The starting state can be obtained from the graph N. If there is an edge from w_0 to w_i, then denote the length on the $M[i]$ edge; if there is no edge, then denote $M[i]$ as infinity.

$$M[k]=Min\{M[i] \quad w_i \quad \in W\} \ (1)$$

Obviously, the route with the length of Formula (1) is the one with the smallest distance from w_0. The next shortest path length is Formula (2).

$$M[k]=Min\{M[i] \quad w_i \quad \in W-B\} \ (2)$$

Then in the weighted graph N, the shortest path from the source point w_0 to the remaining vertices w_i, its length value can be expressed as Formula (3):

$$M[i]=arcs[Locate \quad Vex(N,w)[i] \quad w_i \in W] \ (3)$$

w_k is selected such that:

$$M[k]=Min\{M[i] \quad w_i \in \quad W-B\} \ (4)$$

w_k is the end point of the shortest path from source point w_0 to w_k found now.

$$B=B\cup\{k\} \ (5)$$

The shortest path length is reassigned from source point w_0 to any vertex w_k on set B.

If:

$$M[k]+arc[k][j] \pi M[j] \ (6)$$

Then, $M[j]$ is modified to:

$$M[j]=arcs[k][j]+M[k] \ (7)$$

By repeating the operation a total of $n-1$ times, the shortest path from the source point 2 to the remaining vertices on the graph can be calculated. These shortest paths are arranged in order of increasing length.

For example, the shortest distance from w_0 to w_8 in the weighted graph N is found. Stepping through the program gives detailed results for finding the shortest path, as shown in Table 3.

Table 3. Results of each step

$D[w]$	$P[w]$	$Final[w]$
0	0	1
2	1	1
5	1	1
8	6	1
4	2	1
9	4	1
11	5	1
15	6	1
18	8	1

(2) A^* algorithm

At the start of pathfinding, a "storage table J" is created. The starting point P is put into the storage table J, and other nodes will be put into the storage table J in the future. The starting point P is the first node to be processed, and then the other squares in the table J are processed in turn. The nodes in the storage table J may or may not constitute the final path [18]. Storage table J is a list of nodes to be processed.

All squares adjacent to the starting point P are found, and if the adjacent squares include an obstacle square, it is discarded. All non-obstruction squares are put into storage table J, and these all non-obstruction squares are the "parent nodes" of the starting point P. The concept of a parent node is introduced, which facilitates the formulation of the final path. A storage table K is created, the starting point P is deleted in storage table J, and it is put into storage table K. Stored in the table K are the discarded nodes that are not considered to form the path. The starting point P is placed in the storage table K, and the squares representing it are colored light green. All non-obstacle squares in storage table J are painted black. In each black square, there is a circle and a connecting line, the circle indicates the direction of movement, and the connecting line points to the position of the parent node of each black square, that is, to the starting point P.

In the above manner, the other non-obstacle squares in the re-storage table J are selected. In table J, how to select the second square to move to can be done with the help of Formula (8). In Formula (8), the square with the smallest value of Q is the square to be moved to the second one.

$$Q(n)=W(n)+Y(n) \quad (8)$$

The quality of evaluation function $Y(n)$ is determined by the estimated distance [19]. The closer the distance estimate is to the true value, the more efficient the evaluation function is. In practical scenarios, the Manhattan method is used to estimate the remaining distance, as Formula (9).

$$Q(n)=W(n)+(abs(dx-nx)+abs(dy-ny)) \quad (9)$$

The flow chart of the character pathfinding based on the A^* algorithm is shown in Figure 7.

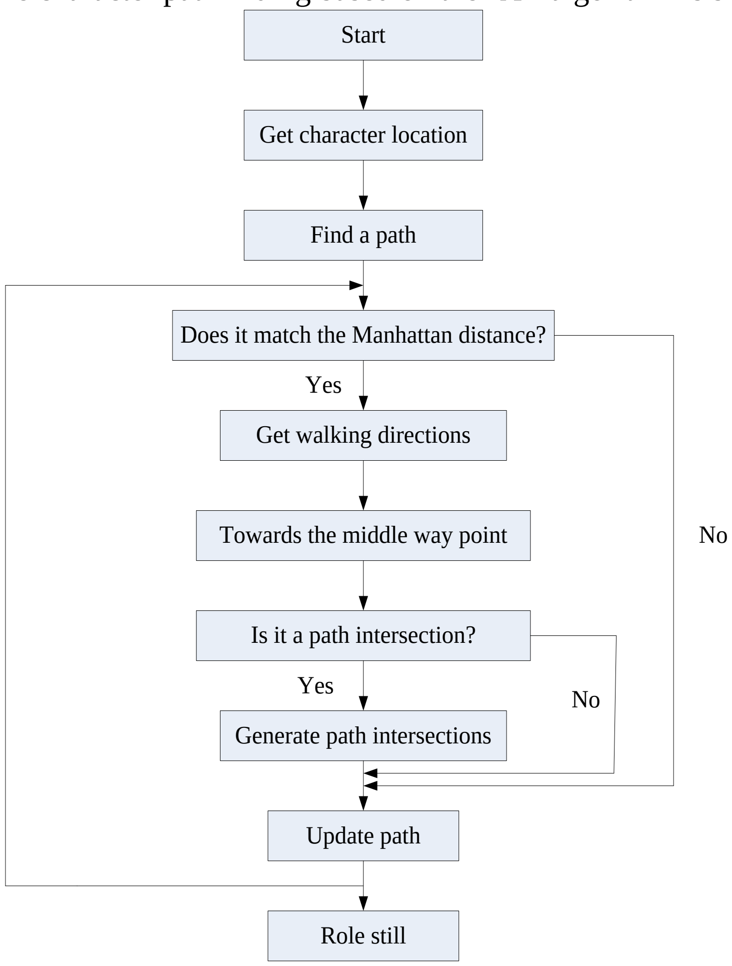


Figure 7. Character pathfinding flowchart

(3) BP neural network algorithm

BP neural network is a neural network learning algorithm, the full name of artificial neural network based on error back propagation algorithm [20]. A single-layer neural network can only solve linearly separable problems. To solve nonlinear problems, a multi-layer neural network with hidden layers must be used. The neural network proposed an effective algorithm for the connection weight adjustment problem of the hidden layer, which successfully solved the weight adjustment problem of the multi-layer feedforward neural network for solving nonlinear continuous functions.

It is supposed that the input and output of the q-th node of the hidden layer are:

$$I_q = \sum_{p=1}^{N} w_{pq} \cdot O_p \quad (10)$$

$$O_q = f(I_q) \quad (11)$$

Among them, $f(I_q)$ is the excitation function.

$$f(I_q) = \frac{1}{1+e^{-I_q}} \quad (12)$$

Since the output of the hidden layer is the input of the output layer, the total input and output of the k- th node of the output layer are:

$$I_k = \sum_{q=1}^{H} w_{qk} \cdot O_q \quad (13)$$

$$x_k = O_k = f(I_k) \quad (14)$$

If there is an error between the network output and the actual output, the error signal is propagated back, and the weights are continuously corrected until the error meets the requirements.

(4) Realization of Human Body Model Control in Unity3D

In the EEG data acquisition experiment based on virtual reality, the envoy is given visual guidance through the built virtual human model. The construction of the human body model requires the use of professional 3D modeling software such as 3Ds Max or Maya. In order to be able to use C# script to control the human body model in Unity3D, its human body model also contains human bones. After exporting the created human body model to FBX format in 3Ds Max, it can be imported into Unity3D for use.

After successfully importing the human model, the human skeleton needs to be configured. In the Unity3D main interface, the human body model is clicked, and the Animation Type option is set in the Inspector. Humanoid only supports human-type models, other animation types such as Generic also support non-human-type models. Since the human model needs to be controlled later, the Humanoid animation type is set.

The Avatar Definition is set to Create From This Model. After clicking Configure, the human skeleton setting interface will appear. The bones in Unity3D include Body, Left Arm, Right Arm, Left Leg, and Right Leg. The Hierarchy window on the far left shows the skeleton model hierarchy and name. The middle Scene window shows the bone's representation in the 3D model. The Inspector window on the right shows the position of the skeleton model's joint points in the human body model. The EEG data acquisition experiment needs to use the left and right hands of the human body model, that is, the joint point information in the Left Arm and Right Arm needs to be used. Left Arm and Right Arm include Shoulder, Upper Arm, Lower Arm, Hand and other joints.

After the Unity3D bones are configured, C# scripts can be written to control human motion. In Unity3D, the script is added to the scene object by adding the script to the Add Component, so as to realize the control of the object. By writing a C# script, the left and right hands of the mannequin can be controlled, and the left and right hands of the mannequin can be lifted and lowered by clicking the button. Scripts in Unity3D generally contain "*Start*( )" functions and "*Update*( )" functions. When the game is running, the "*Start*( )" function is executed only once, and the "*Update*( )" function is executed repeatedly with the video frame as a cycle. The control logic of the virtual human body model is shown in Figure 8.

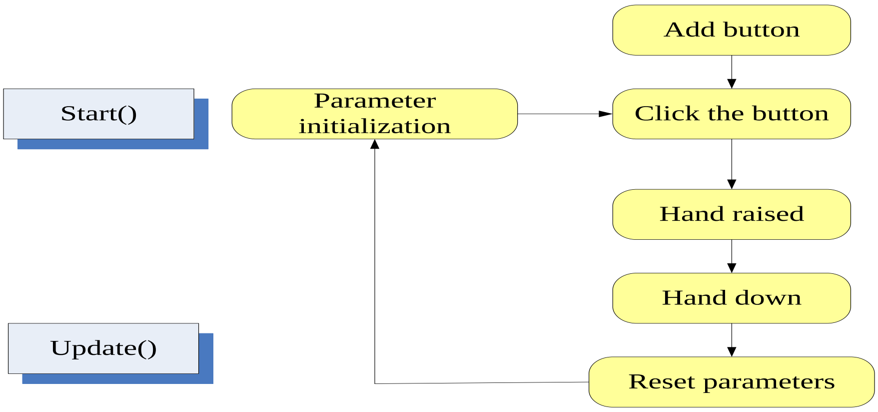


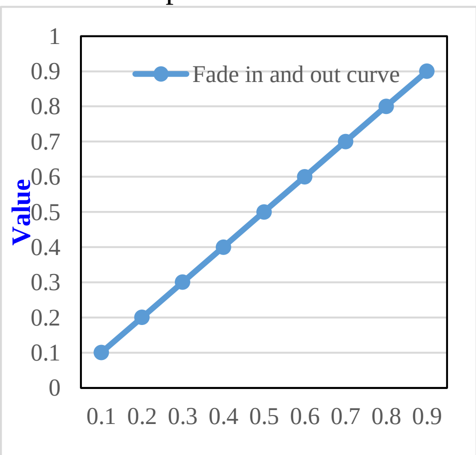
Figure 8. Virtual human hand control logic

4. 3D Animation Production and Human-computer Interaction Experiment Based on Artificial Intelligence Virtual Characters

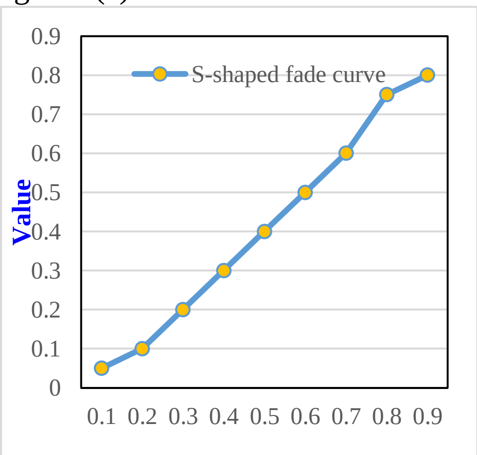
4.1 Experiments and Results of 3D Animation Production

Experiments use motion map technology to verify how to achieve seamless connection between motions and achieve smooth transition animation. The most intuitive fading function is $g(f)=f$, and its corresponding fading curve is shown in Figure 9(a), which is called a linear fading curve. The feature of this fading method is that the proportion of Motion1 (Motion2) in the transition animation rises (falls) evenly. The curve is simple and works just fine when used. But people's eyes have a characteristic, that is, they are more sensitive to high-frequency information. To illustrate this problem, take the mixing weight W2 of Motion2 as an example. W2 is always 0 until the crossfade starts. And at the beginning of the crossfade, W2 suddenly has a positive increment (slope knee), which means that the avatar may appear unnaturally jerk due to the sudden introduction of Motion2 in Motion1.

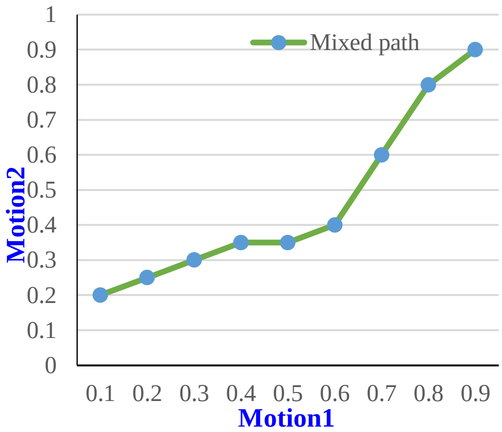
In order to improve the situation, the sudden change in the blend weights had to be overcome to make Motion2 fade in more gently (and at the same time, make Motion1 fade out more gently). A possible solution is to let 1. This is the famous S-curve (S-Curve). The S-shaped fade curve is shown in Figure 9(b). In the frame, in order to obtain the motion connection from Motion1 to Motion2, the time in Motion1 is taken as the horizontal axis, and the time in Motion2 is taken as the vertical axis, and the mixed path curve as shown in Figure 9(c) can be formed.



a. Linear fade curve 1



b. S-shaped fade curve 2



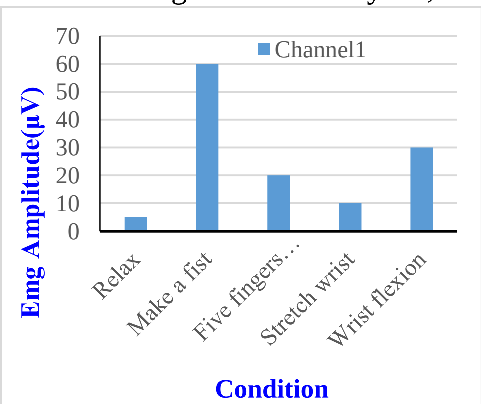
c. Blending path curves

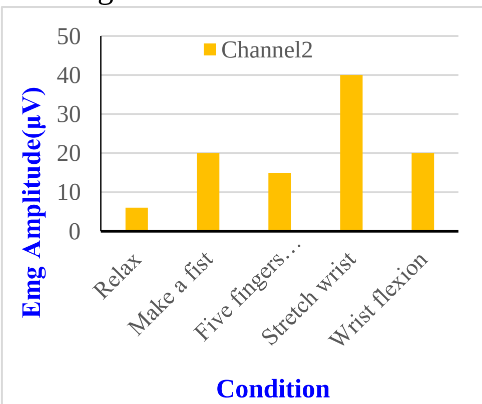
Figure 9. Linear and S-fade curves and blend path curves

If such a blend path curve can be customized by the user (such as interactively), it brings great creative freedom to the motion link. In particular, the mixed path curve corresponding to the multi-level time synchronization is a continuous polyline segment.

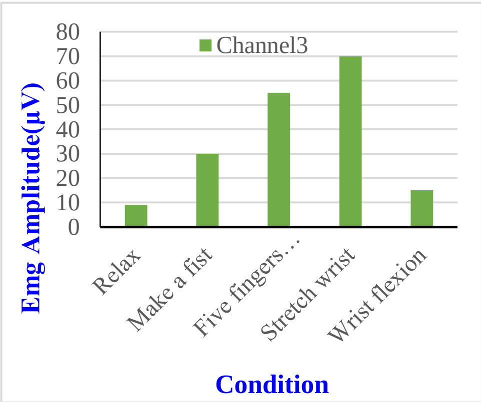
4.2 Human-computer Interaction Results Based on Artificial Intelligence Virtual Characters

The experiment uses a new interaction method: based on EEG and EMG, gesture recognition and interaction are realized, and the virtual cockpit system is used as an interactive platform to explore the application scenarios of smart cockpit based on EMG and EEG. EMG is a relatively stable bioelectrical signal, which can be used as the input signal of human-computer interaction system. In order to further identify the input EMG signal and realize the gesture interaction function based on EMG, the EMG of five gestures is analyzed, as shown in Figure 10.

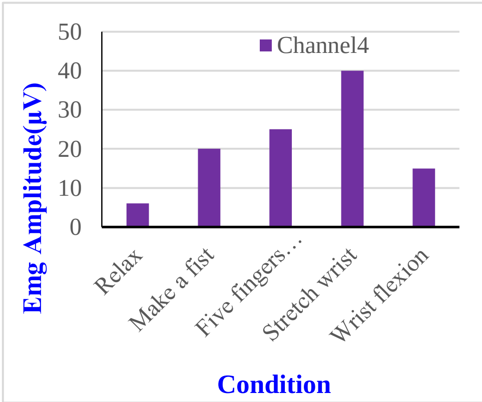




d. EMG amplitude characteristics of channel 1 e. EMG amplitude characteristics of channel 2



f. EMG amplitude characteristics of channel 3



g. EMG amplitude characteristics of channel 4

Figure 10. EMG amplitude characteristics of five gestures

Figure 10 shows the EMG amplitude characteristics of five gestures. From its amplitude feature map, it can be seen that the degree of discrimination between gestures is high, and the gesture type can be judged according to the values of the four channels. The amplitude characteristics of EMG are directly related to the degree of muscle relaxation of each channel. When making related actions and gestures, it is necessary to avoid misidentification caused by excessive force.

According to the above analysis, it is completely feasible for EMG-based gesture recognition to be used in human-computer interaction systems. Whether it is a deep learning-based method or a general recognition method, the EMG of five gestures can be recognized.

The EEG signal is relatively unstable, and the motor imagery EEG signal has a fixed paradigm, but it needs a long period of training to achieve better results. In general, the characteristics of motor imagery EEG signals cannot be directly seen from their EEG time-domain or frequency-domain maps. Therefore, the effect of EEG interaction is evaluated by counting the number of correct classifications and the correct rate of online experiments. By loading the one-dimensional convolutional neural network model for EEG classification, and statistically analyzing the classification effects of the three types of motor imagery EEG signals for 120 seconds, the results in Table 4 are obtained. Its average classification accuracy is 65.3%.

Table 4. Classification results of motor imagery EEG signals

Types of Motor Imagery EEG	Classification Accuracy
No Motor Imagery	70%
Imagine Left Hand Movement	60%
Imagining Right Hand Movement	66%
Average Value	65.3%

5. Conclusions

This paper studies 3D animation production and human-computer interaction based on artificial intelligence virtual characters, which can provide a better foundation and method for the improvement and development of 3D animation production and human-computer interaction. In recent years, with the improvement of people's living standards and the popularization of the Internet, the demand for cultural products has become more and more strong, which has brought about changes in the animation industry. From the original 2D animation to the current popular 3D animation, it not only brings an upgrade of animation effects, but also increases the development cost accordingly. Especially with the increasing demand for 3D animation products, the industrialization of 3D animation industry has not kept pace with the development of technology, and the production of 3D animation products has become more and more difficult. Therefore, a new collaborative management system that fits the animation production process is urgently needed to meet the needs of industrial development. This paper analyzes 3D animation production and human-computer interaction from a novel perspective. Through technological and higher-dimensional analysis methods, 3D animation production and human-computer interaction can continue to develop by leaps and bounds.

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