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Interactive animation design based on the technology of virtual reality

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ABSTRACT

The so-called virtual reality, namely VR technology, originated in the 1980s, involving human intelligence, human-computer interaction technology, computer technology, sensor technology and other fields. The application of the technology of virtual reality in 3D animation has created a new form of animation, which makes 3D animation obtain more profound artistic experience and wider expressiveness, so as to improve the level of the technology of virtual reality. The audio-visual experience innovation of 3D animation makes the technology of virtual reality an important tool for the renewal of animation art in the future, and artificial intelligence is added to meet the needs of the public. The technology of virtual reality is widely used in the field of digital animation, which is an innovation in this field. It can better promote the integration of digital animation and information technology, and better eliminate the narrative limitation of the technology of virtual reality. The designer's careful design can be carried out with the current multi-element points of the image, which can achieve the mutual design of amorous festivals, and then show it in front of the viewer, so as to complete the mutual integration and interleaving between the audience and the virtual world, improve the viewing experience, the rapid development of modern science and technology, and the design of virtual reality animation technology has a very good effect, Game interaction can better promote the interactive design of virtual reality animation. Based on the technology of virtual reality and animation interactive design, this paper analyzes the animation fidelity, bone coin model creation, motion data capture and so on. In the three-dimensional animation, polygon polygon modeling and NURBS curve are used to complete the bone collateral animation modeling in the animation. The detailed features of the model are carved by bursh. Through the establishment of VRP platform, the fusion of bone movements, the refinement of materials, the design of collision environment and movement speed are realized.

Keywords: Three dimensional animation, virtual reality, perceptual experience, immersion, reality

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1. Introduction

The technology of virtual-reality, also known as VR technology, is a comprehensive and integrated technology type. It was first applied in the late 20th century, including artificial intelligence, human interaction technology, computer technology, sensing technology and other different technology types. The ultimate goal of applying the technology of virtual reality in 3D animation is to integrate computer technology, Internet technology and other design methods, and provide people with the opportunity to explore the world and understand the interesting space after building a virtual environment [1-5]. Therefore, the application value of the technology of virtual reality is high, which marks the modern science and technology's development tendency and has a key impact on 3D animation.

2016 is called "the beginning year of VR (virtual reality) by the scientific and technological circles and the media. It is a year of virtual reality blowout, which came into being with the very fast development of computer technology since the 1960s. The rapid advance and popularization of the technology of virtual reality has found out a new method of expression and totally new audience experience to animation, which makes the authors put lots of their effort to the impact of the new wave of the technology of virtual reality [6-8]. The nature of technology itself makes a choice for the art form. Undoubtedly, animation is the most closely combined discipline with technology in all art categories. Technology creates the expression form of animation in a way suitable for itself, and constantly gives birth to new feelings of animation experience. From the traditional hand-painted animation form to the combination of animation and computer technology, motion capture, we media, and mobile Internet, the development of animation has always been inseparable from the continuous addition of new technologies. The technology of virtual reality is getting more and more familiar in our daily life [9]. The science fiction Trilogy "three bodies" written by writer Liu Cixin has greatly improved our imagination of future science and technology. Of course, compared with today's the technology of virtual reality, there is still a gap. However, the idea of putting people in computers can also be helped by the technology of virtual reality in our real life. Just like the first steam engine invented by James Watt, the first car invented by Carl Benz and the first plane invented by Dieter brothers, virtual reality is changing human life in a new way [10]. The future prospect of virtual reality is so exciting.

Simply put, virtual reality is to use the power of technology to let people personally experience an environment which is not real, and the change of the technology of virtual reality for animation is also increasingly profoundly affecting the creation mode, presentation form, viewing experience and audience psychology of animation. After take the advantage of the high advance speed in the technology of information, animation technology revolution change is not only technical, but also to the animation art has brought very profound changes, especially digital technology into the animation, for animation creation, dissemination, watching huge influence, expand the form of animation makes it has infinite possibilities [11]. Since the technology of virtual reality has already gained great advance in a lot of different domains, a new virtual reality era is slowly unveiling its mysterious veil, which also enables the technology of virtual reality to be applied in animation.

If we can combine the technology of virtual reality and the technology of animation, we can make a great progress in many practical applications. Nowadays, the technology of virtual reality is widely used in tourism, medical care, education and other industries, but the current development of the technology of virtual reality is not mature, and the degree of public knowledge and technological development cannot load the needs of these fields. To promote the technology of virtual reality quickly, to get the rapid development of entertainment is the most suitable field [12-14]. In its own development process, the animation art can always be closely combined with the fast promote progress about the science and the information technology, so that the animation has obtained an unprecedented performance space and development pattern. Virtual reality for the form of

animation and the influence of experience is quietly happening around us, not only make animation in a new form in front of the audience, and enhance the audience experience of presence and interaction, emphasizes the dominance of the inner feeling, presents a broad development prospect.

2. Interactive design basis of virtual reality animation

2.1. Design interaction points based on light and shadow

In the design of virtual reality animation scene, reasonable lighting can better ensure the viewing effect of the film, make the audience have more viewing experience and higher attention. [15] Then, in the light and shadow interaction design, the audience can participate and improve the feeling of interaction. For example, the effect of virtual reality animation has been improved through the rational application of spotlights in stage plays. Panoramic video can let the audience get more information. Through the application of spotlight, a large number of situations can be improved.

2.2. Design interaction points based on sound

Through the technology of virtual reality and animation, it can be better immersed in the environment set by the film, and at this time, sound is particularly critical [16]. If there is no sound in the picture, it cannot produce a very good sense of distance and space, and the viewing experience will be reduced.

2.3. Interaction design based on audience and role eyes

Modern the technology of virtual reality can not accurately grasp the audience's eye movement. On the one hand, it cannot use the role to make eye contact with the audience, so the communication effect is relatively poor. Through this technology, the head tracking simulation can be realized, and then the head detection can be realized to understand the law of its movement, which can meet the data transformation and application

2.4. Interactive design method of virtual reality animation

With the help of the fast-promoting speed of the computer graphics technology, the level of the technology of virtual reality and animation technology has also been greatly improved [17]. Nowadays, many software and hardware manufacturers located in or out of our country begin to develop products with strong functionality and higher effect. After in-depth research, the functional improvement can be realized, which can be applied from the following aspects.

2.5. Motion capture system

Using manual animation will lead to a long time. If mass production is realized, it will pay a high cost, require a large number of animation designers, and the cycle will be relatively long. It is very difficult to adjust animation. However, the combination of capture systems in virtual reality animation can better reduce the cost and quickly produce high-quality animation quality.

2.6. 3D modeling system

In the process of model creation, there are usually high complexity and realistic expectations of the model. Various methods can be applied to build the model. For different simulation objects, the modeling methods can be divided into physical, landscape appearance, virtual real integration and other technologies. In the three-dimensional animation simulation stage, the three-dimensional scanner can be used to complete various physical simulations and determine the best data information at the same time [18-19]. The construction speed of this three-dimensional model is very high, and the accuracy of data is also very good.

Use VRP virtual reality interactive platform, the application of the fine arts professional's application of 3 d graphic virtual interactive platform, its practicability is high, also can satisfy the visual standard, the technical level is very high. In the operation of the platform, go in 3 d scene model import, can use the design of interactive events to multi-angle anime determination of lens.

In addition, through this platform can achieve efficient rendering engine to obtain the best animation image, hardware can realize compatible, interactivity and has a high influence, also can achieve seamless virtual platform, to meet the standard of interaction design.

Virtual reality in design, should consider the scene construction and aspects and so on, the early stage of the animation creation, then to 3d model platform construction [20]. Virtual reality interactive platform to implement the program repeated design, can satisfy the standard of design, and can realize the scene simulation, judgment, to determine the logical relation of them. Both have obvious differences, but these are able to determine the standard of the virtual reality interactive action realistic animation simulation model. Virtual reality animation can be achieved better animation form, and then through the 3d model platform characteristic analysis, finally can realize the simulation application. Different three-dimensional simulation scene elements have obvious difference, want to combine the actual situation to determine different characteristics.

1) Creation of standard model library. Be able to set up animation environment settings and community construction according to needs, and then analyze the diversity of virtual models, and finally determine the model that meets the needs of designers.

2) Create a standard material library. Adjust the precision texture of each object as needed, and then determine the mapping direction according to different model requirements, so as to clarify the specific coordinate mapping method.

3) Modeling according to the size standard, but also comprehensively analyze the historical data, and then be able to reflect the specific model space size.

4) Write the name of the model. In the interactive design process, the model and users should ensure that the naming and objects meet the requirements of accuracy, so as to meet the final interactive design standard.

A common way of image modeling is to collect image information comprehensively, then splice it through computer software, and then form a panorama. Adjust the data according to the requirements, and a realistic scene will be formed. In practical application, the number of model faces is very low. If you can set the mask picture model, you can determine the picture with high quality [21]. For example, in the process of making tree model, the material of trees should be given through three-dimensional simulation model rendering technology, so that they can be more clearly understood. Then, the leaves and branches are processed by PS and other image software, and transformed into TGA files by using three-dimensional model platform. Finally, the model creation is realized through this material. In the specific production process, we should prevent the application of more tree models, such as a large number of overlay surfaces, and the redundant parts can be deleted directly in the system. When making leaf material with PS software, it should be variegated and sharpened, which can improve the image resolution and enhance the simulation effect.

For the development progress and the design process of the interactive system equipped with the technology of virtual reality, the creation of three-dimensional model has high complexity. Since we want to improve the visualization, the running speed of the computer can be improved, the model can be simplified, the redundant part can be removed, and then the resource utilization can be improved. In the modeling, three-dimensional modeling is used to achieve trade-off processing and improve the running speed. If there are many internal surfaces of the model, the processing speed will be reduced and the amount of file data will be large, so the system operation effect will be poor. In network publishing, the download speed and time should be controlled to realize the optimal configuration of the model.

Users and virtual reality can achieve interactive effect in scene simulation, and then conduct scene processing to obtain corresponding information, which can finally promote the improvement of immersion [22].

Users can find objects in the virtual environment and display the physical environment through simulation design. For example, in the virtual environment, characters can go upstairs automatically, and collision inspection should be carried out at any time, so it is necessary to determine whether they meet the requirements by applying character gravity and collision inspection. Therefore, in the process of design, collision detection should be carried out to reasonably determine the specific collision type. If the model with very small size is selected, it will directly affect the speed. Therefore, in the process of design, the form of rectangular model should be selected for the determination of collision attributes, which can directly replace too many small models and ensure that some replacement models can be hidden, the solution of multiple problems can also effectively prevent scene failure collision. It can realize the reasonable calculation of internal data, adjust the way of collision, clear the specific scene clearly, and then adjust the material of the object, so that the environment simulation can be more accurate.

The most obvious feature of the design progress about the virtual character animation is to realize virtual interaction. In the initial design, the virtual model can show bone animation, modify and adjust the polygon model, deal with the details, and create multiple model libraries according to the needs of design [23]. There is a lot of information in the model library, such as the display of character conversation, running, walking and so on, which can promote the improvement of simulation performance. Then we can integrate the producer into the virtual environment, determine the character's gravity parameters, make collision detection, set the character's walking speed as needed, determine the most reasonable path scheme, and add some operation space in combination with the design needs.

In the 3D simulation modeling platform, the figure shape, such as head and spine, can be reasonably determined through modeling, and then the material can be reasonably determined. Through the bone binding technology to determine the character walking animation, and then we can realize the design and determination of the action library. Input the originally determined characters directly into the VRP character library, which can be applied at any time to improve the design level. The setting of virtual environment can be realized by using the scene layout after the completion of character production and determining the gravity parameters. Then, in the path design, the bone motion fusion can be determined, and the character motion can be effectively reflected, which can meet the design requirements of the system in terms of speed design, collision detection, camera application and so on [24].

The camera group in the motion capture system should be reasonably set at the top of the building, and then it should ensure that the stereo projection system is installed in the center of the room top, and the three-dimensional model system can be set. From the design requirements of this paper, we can better realize sports display and interpersonal interaction, and improve the animation experience.

3. Analysis of Animation Interactive Design based on the technology of virtual reality

3.1. Technical architecture of the technology of virtual reality

3.1.1. VR interactive process. There usually are three different parts in the interaction application of VR technology, they are as follows: the first one is user operation, the second one sensor equipment and the final one is the virtual model. The user carries out operation interact with each other in a three-dimensional virtual scene model created by the system, and finds and feeds back the

distinguishments between the virtual environment and the real environment in real time, as shown in Figure 1.

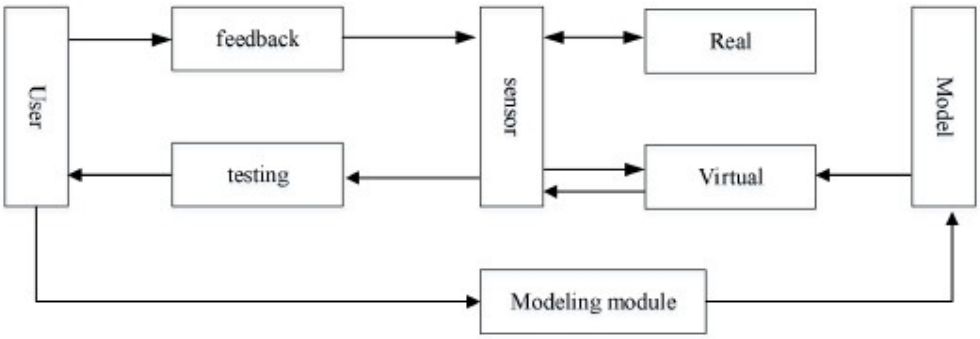

Fig. 1. Virtual reality system interaction process

3.1.2. Technical architecture. Semantic object is the fundamental device commonly used in the interaction, including behavior parts, interaction parts, graphics parts, application parts and so on. The feedback information offered as the response to user perceivable objects through fixed rules, and finish the specific interaction tasks. We show the process of interaction between semantic objects in Figure 2. There is important communication between any two different components, and they also include command and response. The command mainly implements the function of call and rule query, and the response can be seen as the information about feedback for object rules and behavior states.

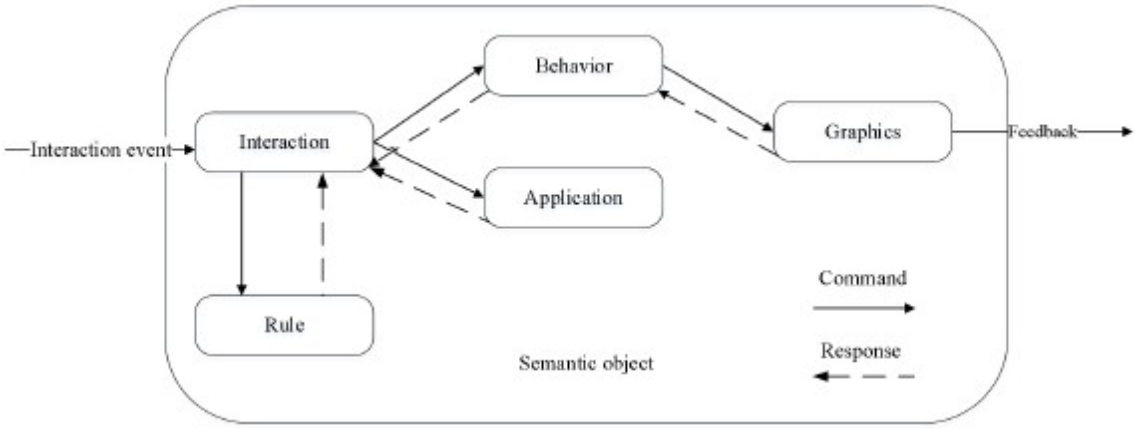

Fig. 2. Parsing process of semantic object interaction events

3.1.3. Hardware architecture. Hardware equipment is an important support to realize interactive technology and user experience. The application of VR technology mainly includes input equipment, output equipment and position tracking equipment. The input equipment includes not only the traditional computer, mouse and keyboard, but also various sensors, three-dimensional tracking ball, etc. Output equipment includes various display screens, cave display system, etc. Manipulation and tracking equipment includes data gloves, position detectors, etc [25].

3.2. Analysis of key technologies of VR animation

3.2.1. Interactive node design of VR animation. Assume (u,v) and (X_w,Y_w,Z_w) are the coordinates of point P_t measured in the space of sub-pixel in the scene image and the corresponding real-world three-dimensional coordinates. The normalized coordinates of the camera coordinates in the radial

and tangential distortion can be computed by using the subpixel coordinates in the animated scene by Equation (1).

$$\begin{bmatrix} x_d(1) \\ x_d(2) \\ 1 \end{bmatrix} = \begin{bmatrix} a_x & 0 & u_0 \\ 0 & a_y & v_0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} \tag{1}$$

where, a_x and a_y are the scale factors used in the animation scene image coordinate system on the X -axis and Y-axis; $x_d(1)$ and $x_d(2)$ are the left point of the X and Y axes of the normalized animation scene; u_0, v_0 are the central pixel coordinate of the animation scene. When the initial estimated value corresponding to x_n is x_d, x_n is denoted by $x_n = \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} x_{d(1)} \\ x_{d(2)} \end{bmatrix}$, and the x_n, which is a normalized dynamic coordinate, is computed by joint solution of equation (1), the equation can be expressed as follows:

$$x_n = \begin{bmatrix} x \\ y \end{bmatrix} \begin{bmatrix} \dfrac{\left(x_{d(1)} - \delta_{(1)}\right)}{k_{radial}} \\ \dfrac{\left(x_{d(2)} - \delta_{(2)}\right)}{k_{radial}} \end{bmatrix} \tag{2}$$

In equation (2), $\delta_{(1)}$ and $\delta_{(2)}$ are the values of tangent. When x_n is getting convergence as n becoming larger and larger, its value can be calculated through multiple iterations of x_n, k_{radial} and δ. Since x_n is the coordinate of the coordinate system of the camera in the normalized linear model, when the camera field coordinate is $\left(X_c, Y_c, Z_c\right)$, the transformation of the world coordinate system and the camera coordinate system is realized through the formula:

$$Z_c \begin{bmatrix} X_1 \\ y \\ 1 \end{bmatrix} = Z_c \begin{bmatrix} \dfrac{X_c}{Z_c} \\ \dfrac{Y_c}{Z_c} \\ 1 \\ \end{bmatrix} = R \begin{bmatrix} X_w \\ Y_w \\ Z_w \end{bmatrix} + t \tag{3}$$

where, r and R are the translation vector used for compute the transfer information for the real object and the rotation matrix used for find the rotation relationship between the real object and the image of that object respectively.

3.2.2. 3D animation motion capture. Usually, get a great simulation oftask action in the 3D scene is the most important step ofthe created manikin. Figure 3 shows the motion capture system module, that is, tracking and obtaining the key point motion of each individual firmware on a continuous event to describe the three-dimensional motion process. By the way of motion capture technology to track, and refine the procedure of movement data, and load the movement to Character Studio, adjust the unreasonable movement posture, create three-dimensional character animation source files.

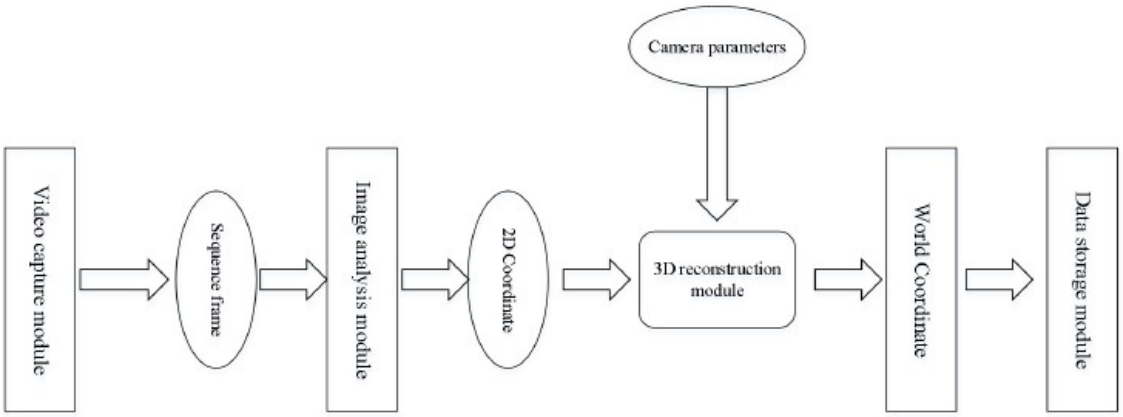

Fig. 3. Motion capture module

After the motion capture system is established, the design of animation model touch detector needs to be realized. The user's operation perception, such as movement and flight, is realized through touch detection to meet the viewer's dimensional object interaction in the not-real world. This includes the touch sensor node, the sphere Ensor node, and the cylinder sensor node.

Touch sensor sensor to create user actions on the user side and convert them into output trigger signals. Def can define the unique ID and name of the node and realize the specification of the file. Use implements the ID reference of def definition node, and improves the coding efficiency by referring to the node object instead of simply copying the node.

Time sensor time sensor can control the time according to a certain law to complete the change control of animated character modeling. Through the time sensor I time sensor node, the creation of virtual time is realized, the change process time of animated dynamic objects is controlled, and the deformation and displacement of space object modeling are realized at the same time. The time sensor time sensor does not produce any visual effect, but more produces node demand animation effect for the interpolator output time.

3.3. Matching of motion data and model

After we get the data by the way of animation capture technology, the data is processed by motion orientation, and we added the data about some three dimensional of the known skeleton structure to the 3D task model topologically. We use the function of motion redirection in the Maya software to generate and load BiP format actions to guide the actions of 3D task models with different scale structures, the overall flowchart is displayed in Figure 4.

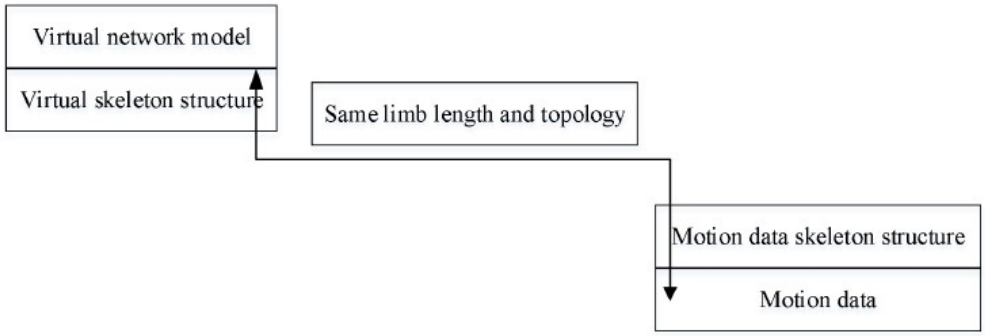

Fig. 4. Virtual model motion and data matching framework

4. Design and Application of VR Technology and Animation

In terms of the production process of animation design cases, it is divided into pre-production, mid production and post production. The preliminary production includes theme content, role scene, mirror composition and modeling design. The medium-term production includes animation performance, material rendering and dynamic interaction in virtual interactive software. Post production is mainly the synthesis of audio-visual elements and dynamic interactive output. The main applied technologies include modeling technology, rendering technology and animation technology. In this paper, according to the design case and technical production process, Autodesk Maya, ZBrush and Virtools software are selected for interactive animation design and production.

4.1. Overall design of interactive nodes

Interaction node is the first step for providing timely interaction for viewers in the process of playing virtual interactive animation. For virtual interactive animation, interactive contact points should be suggestive, reasonable and bow guiding. According to the story content structure and appreciation of the animation display, it is necessary to guide the development of the animation story through the interactive node, which is the intersection and penetration of the story plot, that is, the film will help every story plot to interact with each other. Figure 5 gives the detail framework and structure for this phenomena on the basis of a domestic ink animation.

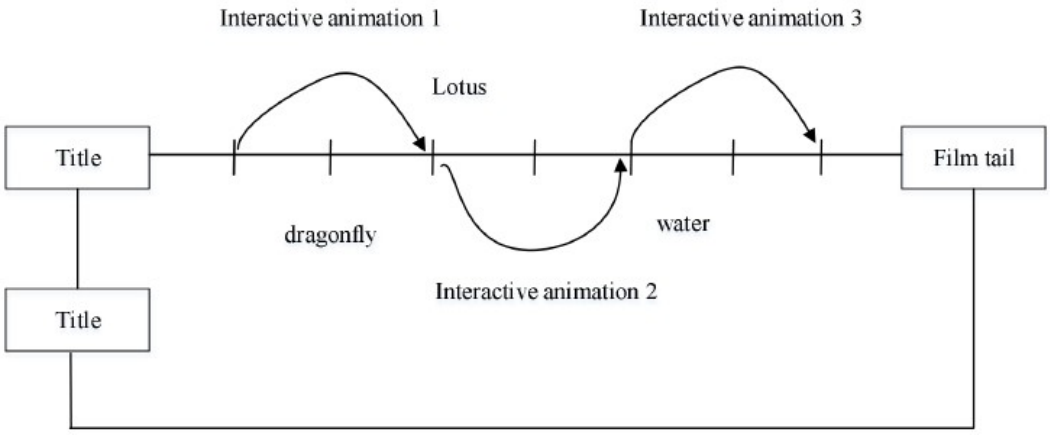

Fig. 5. Framework of virtual interactive nodes

4.2. Animation production of VR technology

The model making process includes modeling, material and animation. This section integrates the next generation game author technology on the basis of Maya 3D animation software to improve the authenticity and vividness of animation modeling. Before modeling, polygon modeling is mainly used. If we want to model the animation for the bones, we can use the NURBS curve to meet these requirements and the NURBS model only needs to be transformed into Polygon model before outputting ". NMO" format. At the same time, secondary modeling can be used for some original models to avoid the unreasonable wiring of model faces which may occurs with a huge number of chances.

4.3. Animation of model bones

Static models and dynamic models are included in the animation production. The mainly elements exist in a static model usually includes the plants, the soil, the structure of in the design procedure of animation, etc., this kind of animation action range is small and usually full of strong randomness. The dynamic model is usually an animal body, and such animation has the characteristics of

controllability and a large range of activity. In the animation process, the software of Maya is usually used to establish the bones of the required model.

4.4. Design of virtual reality interactive platform based on VRML

Virtual Reality Modeling Language (VRML) is the most commonly used three-dimensional virtual environment programming language for virtual reality researchers. The language takes the Internet as the basic application framework. The programming can not only realize the reproduction of 3D virtual scene and scene animation simulation, but also provide a man-machine interaction platform. On the one hand, VRML programs contain a large number of nodes used to create virtual scenes, such as shape nodes, appearance nodes and so on. The creation programs of these nodes can be written by VRML, or imported into VRML files after being created by other computer graphics software. On the other hand, VRML provides a variety of sensor nodes and external embedded script nodes. Users can customize the interaction events in the virtual scene to achieve the purpose of human-computer interaction.

In the VRML file, all the shapes in the virtual scene are composed of nodes, which describe the shapes in the virtual scene visually and interactively. For example, model nodes and texture nodes describe the shape and appearance of virtual modeling, and sensor nodes describe the interaction between modeling. VRML program files provide a total of 54 node types, which can generally be divided into 7 categories. Here, seven types of nodes are summarized and described in Table 1.

Table 1. Classification ofVRMLnodes

Node type	Function description	Node example
1. Geometric node	Defining virtual scene object shapes	Box Node (Box), Text Node (Text)
2. Appearance node	Defines a virtual styling material to add an image or image map to the styling appearance	Image map section (Image texture), image map section (Movie texture)
3. Group nodes	Combine some nodes into a whole	Group node (Group), coordinate transformation node (Transform)
4. Environment, video, video and view navigation effect nodes	Design of virtual environment background, light source, point of view, such as navigation, watch the effect	Background node (Background), viewpoint node Viewpoint
5. Standardize the interface nodes	Provide standards for add - in scripts of programs	World info scene information node, script node (Script)
6. The sensor nodes	Realize human - computer interaction	Time Sensor (Times sensor), touch sensor (Touch sensor)
7. Extending VRML nodes	Create a new user - defined node	Prototype nodes (PROTO), user - defined section (EXTERNPROTO)

Although there are many types of nodes, in VRML syntax definition, each node is composed of single or multiple fields / events. Domain / event contains domain name / event name and domain value / event value describing node attributes, which are equivalent to variables, arrays or fields in database in other programming languages. The field value is used to define the parameter value of the current state of the node, and the event value is used to describe the parameter value required by the node to obtain or generate some interactive functions. Similarly, VRML files divide the of domains and events into 20 basic types. It is still described here in the form of table (Table 2). In the table, the domain name / event name starting with SF represents single domain value / single event, and the domain name / event name starting with MF represents multi value domain / multi event value.

Table 2. Classification of field and event in VRML

Domain/replica	Function description
SFBool	The Boolean single domain values, TRUE, FALSE to determine whether a feature is activated, the initial value is FALSE
SFColor	RGB color triples, with an initial value (000), and all three values are between 0.0 and 1.0
MFColor	Multiple RGB color triad, value between 0.0 to 1.0, the initial value of []
SFFloat	Specify a single precision floating point number, the initial value (000).
MFFloat	Specify multiple single - precision floating points with an initial value of []
SFImage	A single non - compressed 2 - dimensional image, with an initial value (000), represents the width, height, and group score integer values
SFInt32	Specifies a 32 - bit integer, which can be hexadecimal or decimal, and the initial value of the outgoing event is 0
MFInt32	Specifies zero or more VRML nodes, and the outgoing event initial value is [].
SFNode	Specify any rotation, the event initial value (0010), the first three values represent the rotation axis vector, the value range 0.0~1.0, the fourth value indicates the rotation amount, the direction meets the right - hand rule, in radian
MFInt32	Specify zero or more any rotations, and the outgoing event initial value is []
SFNode	Single string arranged by the utf8 universal character set with an initial value of "(null value)"
MFRotation	Zero or more string, the initial value of []
SFString	Specifies a time value, whose value is represented by a double - precision floating - point number, with an initial value of - 1.
MFString	Specify zero or more - time value, the initial value of [].
SFTime	Specifies a two - dimensional vector containing two floating - point values to determine the two - dimensional position of the virtual shape, with an initial value of (00).
MFTime	Specifies zero or more 2D vectors with an initial value of []
SFVer2f	Specifies a 3D loss, and the vector contains three floating - point values to determine the 3D position of the virtual shape, with an initial value of (000).
MFVec2f	Specifies zero or more three - dimensional vectors with an initial value of []

In VRML, nodes define the existing form of virtual modeling, and domain values and event values define the functional characteristics of virtual modeling. On the one hand, the node constructs the virtual scene environment. On the other hand, the domain value / event value of the node can be changed through routing or external script files, so as to realize the perception and interaction of the virtual scene.

4.5. VRML interactive event design

In order to realize the interaction function of virtual environment more truly, VRML provides sensor (also known as detector, which is collectively referred to as sensor) node, event interface, routing path and script interface. Among them, the sensor node is used to detect and transmit user behavior, the event is used to describe the response behavior, the routing is responsible for transmitting events in the node, and the script allows users to customize the sensor and response events. The design of these nodes and interfaces provides conditions for the implementation of VRML interaction behavior. The VRML interaction principle based on these devices is shown in Figure 6.

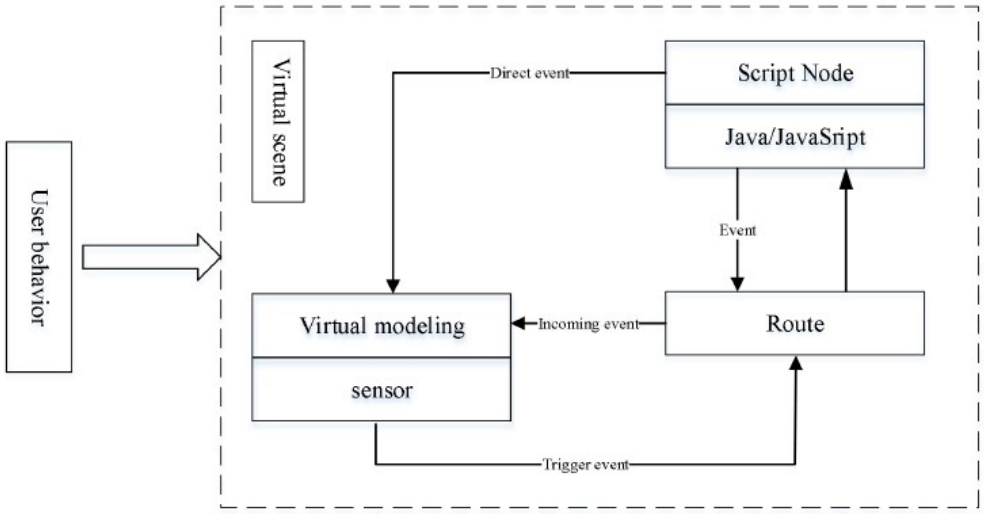

Fig. 6. Schematic diagram for VRML interaction

As can be seen from the Figure 6, the implementation of VRML interactive function is event driven. The virtual scene can receive two kinds of event drivers, one is the incoming event transmitted by the route, and the other is the direct event transmitted by the external program interface. The working principles of the two-event driven are as follows:

1) Incoming event movement (routing f sensor node f routing f virtual modeling): the routing statement defines the transmission path of all events in the virtual scene, and describes the incoming event domain and outgoing event domain of the corresponding node. The sensors in the virtual scene are used to activate and trigger events. The trigger events are sent to the input event domain of the corresponding nodes in the scene through routing, and the key value interpolation is generated through the interpolator node, so as to produce the dynamic change effects such as the change of the position and shape of the model nodes in the virtual scene.

2) Direct event driven (external program interface → sensor node → routing → externalprogram interface → routing → virtual modeling): the external program interface includes Javaprograms and script nodes. The Java program can be a script program written in JavaScriptlanguage or a java program introduced through UL domain. It is a description of the event. Scriptnode is a control sensor and interpolator node, which is used to define and change the appearanceand behavior of model nodes in virtual scene. The external program directly transmits the editedevent to the virtual scene. Similarly, the trigger event is triggered by the sensor node in the virtualscene and routed to the external program interface. The external program interface calculates andprocesses through the script node to generate key value interpolation, and then reversely transmitsit to the virtual scene through routing, so as to make the model node in the virtual scene respond toevents.

The function of VRML sensor is to detect the user's interaction with the virtual environment, and output the corresponding trigger signal to the time sensor. After receiving the trigger signal, the time sensor sends a signal to other sensors at that time to drive the dynamic change process related to time. According to the different interaction behavior, VRML also defines two types of sensors in addition to time sensors. The first type of sensor is mainly used to detect the interaction between external equipment and virtual environment. For example, the contact sensor changes the virtual modeling state by clicking the mouse to touch the virtual modeling. The second type of sensor is mainly used to detect the position and direction of the virtual avatar in the environment. For example, the proximity sensor is used to detect whether the virtual avatar is close to a certain area, and the collision sensor is used to detect whether the virtual avatar collides with the virtual shape.

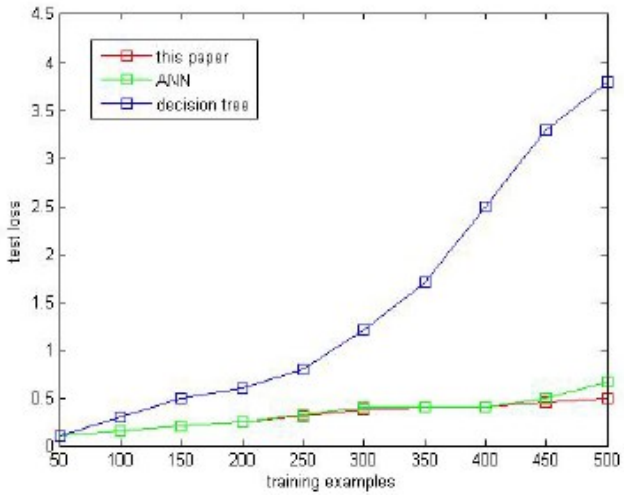

Fig. 7. The test loss when using different number of training examples

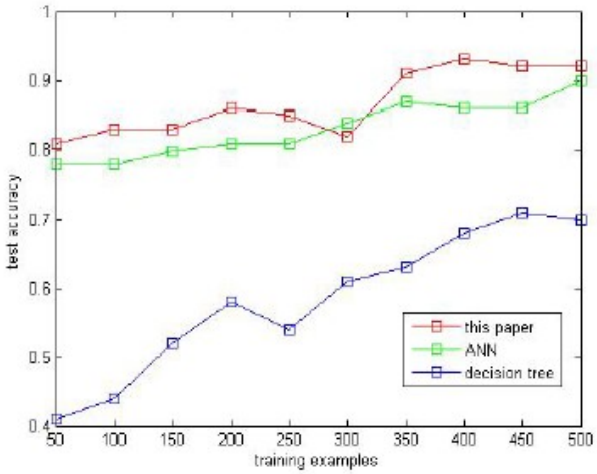

Fig. 8. The Comparison for the test accuracy obtained by different methods

As we can see in Figure 7 and Figure 8, it is illustrated that the proposed method proposed has the highest test accuracy and the lowest test loss when we using the same number of examples to train the model. Hence, we can get the conclude that our method is very suitable for the situation in which we have limited number of training examples.

5. Conclusion

As we can see in this paper, it is an important innovation about the traditional creation of animation if we introduce the technology of vertical reality in this domain, it can help us promote the development progress and the integration procedure for the digital animation and information technology effectively, and help us to solve the difficulty of narrative limitation of virtual reality animation technology. The main work of this paper is that we proposed a framework for the three-dimensional animation, using polygon modeling and NURBS curve, complete skeleton animation modeling.to highlight the model, the truth of concave and convex characteristics brush tools provides standards and used for carving movement function of the model. Movement through the establishment of platform, bone fusion, improve the movement of materials, solid collision environment and design.

References

[1] Meryl Paquay RN, CCRN, MSc, PhD a b, Jgrc B, Scrc B, et al. Relationships Between Internal Factors, Social Factors and the Sense of Presence in Virtual Reality-Based Simulations[J]. 2022.

[2] Werbos P J Automatic Differentiation: Applications, Theory and Implementaations, Lecture Notes in Computational Science and Engineering, ch. Backwards Differentiation in AD and Neural Nets Past Links and New Opportunities M. Springer: Springer-verlag, 2005. 50: 15-34.

[3] Werbos P J. No Matter. Never Mind: Proceedings of Toward a Science of Consciousness Fundamental approaches, ch. What Do Neural Nets and Quantum Theory Tell us About Mind and Reality[M]. Philadelphia: John Benjamins, 2002: 63-87.

[4] Marijke van der Linde-van den Bor a, A F R, B F S, et al. Patients' voices in the development of pre-surgical patient education using virtual reality: a qualitative study. 2022.

[5] He H. Self-adaptive System for Machine Intelligence. Piscataway[M]. Hoboken: Wiley, 2011 1-24.

[6] He H, Ni Z, Zhao D. Reinforcement Leaming and Approximate Dynamic Programming for Feedback Control, ch. Leaming and Optimization in Hierarchical Adaptive Critic Designm Piscataway: WILEY-IEEE, 2012: 78-97.

[7] Kim, G., B. Jin, and D. C. Shin. "Virtual reality as a promotion tool for small independent stores." Journal of Retailing and Consumer Services 64(2022).

[8] Werbos P J. Advanced Forecasting Methods for Global Crisis Waming and Models of Intelligence]. General Systems, 1977, 22: 25-38.

[9] PvaB, PecA, Bh C, et al. Application of virtual reality in neurosurgery: Patient missing. A systematic review. 2022.

[10] Werbos P J. Handbook of Intelligent Control: Neural, Fuzzy, and Adaptive Approaches, ch Approximate Dynamic Programming for Real-time Control and Neural Modeling[M]. New York Van Nostrand 1992: 493-525.

[11] Bertsekas D P, Tsitsiklis J N. Neuro-dynamic Programming[M]. Belmont: Athena Scientific, 1996.

[12] Prokhorove D, Wunsch D. Adaptive Citic Designs]. IEEE Transactions on Neural Networks 1997,8(5):997-1007.

[13] He H, Ni Z, Fu J. AThree-networkArchitecture for On-line Learning and Optimization based on Adaptive Dynamic Programming J. Neurocomputing, 2012, 78(1): 3-13.

[14] Prabhu V G, Stanley L, Morgan R, et al. Comparing the Efficacy of a Video and Virtual Reality Intervention to Mitigate Surgical Pain and Anxiety[M]. 2022.

[15] Faraj M M, Lipanski N M, Austin M, et al. A Virtual Reality Meditative Intervention Modulates Pain and the Pain Neuromatrix in Patients with Opioid Use Disorder[J]. Pain Medicine, 2021(11):11.

[16] Cooper N, Millela F, Cant I, et al. Transfer of training—Virtual reality training with augmented multisensory cues improves user experience during training and task performance in the real world[J]. PLoSONE,2021,16(3):e0248225.

[17] Ryan C, O'Malley E, Sheppard D. O74: ASSESSING THE USEFULNESS OF THREE- DIMENSIONAL IMAGING AND VIRTUAL REALITY IN SURGICAL PLANNING: A MEDICAL STUDENT LED PILOT STUDY[J]. British Journal of Surgery, 2021(Supplement_1): Supplement_1.

[18] Esposito D, Bollini A, Gori M. Virtual Reality Archery to quantify the development of Head-Trunk Coordination, Visuomotor transformation And Egocentric Spatial Representation[C]// 2021 IEEE International Symposium on Medical Measurements and Applications (MeMeA). IEEE, 2021.

[19] Nameth K, Brown T, Bullock K, et al. Translating Virtual Reality Cue Exposure Therapy for Binge Eating into a Real-World Setting: An Uncontrolled Pilot Study[J]. Journal of Clinical Medicine, 2021, 10.

[20] Dimitrios C, Marios S, George N, et al. Letter: Immersive 3-Dimensional Virtual Reality Modeling for Case-Specific Presurgical Discussions in Cerebrovascular Neurosurgery[J]. Operative Neurosurgery, 2021.

[21] Dimitrios C, Marios S, George N, et al. Letter: Immersive 3-Dimensional Virtual Reality Modeling for Case-Specific Presurgical Discussions in Cerebrovascular Neurosurgery[J]. Operative Neurosurgery, 2021.

[22] Lasaponara S, Marson F, Doricchi F, et al. A Scoping Review of Cognitive Training in Neurodegenerative Diseases via Computerized and Virtual Reality Tools: What We Know So Far[J]. Brain Sciences, 2021, 11(528):528.

[23] Rutkowski S, Szczegielniak J, J Szczepanska-Gieracha. Evaluation of The Efficacy of Immersive Virtual Reality Therapy as a Method Supporting Pulmonary Rehabilitation: A Randomized Controlled Trial[J]. Journal ofClinical Medicine, 2021, 10(2):352.

[24] Kim E B, Kim S, Lee O. Upper Limb Rehabilitation Tools in Virtual Reality Based on Haptic and 3D Spatial Recognition Analysis: A Pilot Study[J]. Sensors, 2021, 21.

[25] Zhang L. 3D Interactive Model Design Based on Multimedia Animation Technology[C]// CONF-CDS 2021: The 2nd International Conference on Computing and Data Science. 2021.