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The Fusion Method of Virtual Reality Technology and 3D Movie Animation Design

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***Abstract*—To further improve the design effect of 3D film and television animation, integrating virtual reality technology with 3D film and television animation design is studied. This method uses 3Ds Max software in virtual reality technology to build 3D film and television animation scenes by manual modeling. Based on the established 3D film and television animation scene, texture mapping is performed on it, and then the 3D film and television animation character model is established and simulated. After optimizing the established 3D scene and character model using the improved quadratic error measurement algorithm, the roaming interaction of 3D film and television animation scene is realized through Unity3D software, and the integration of virtual reality technology and 3D film and television animation design is realized. The experimental results indicate that the 3D film and television animation scene created using virtual reality technology is very realistic, which can effectively optimize the 3D film and television animation model. The number of path nodes is the least when the 3D film and television animation scene roams and interacts, which has a relatively significant application effect.**

Keywords—Virtual reality technology; 3D film and television; Animation design; model optimization; roaming interaction

I. INTRODUCTION

3D animation technology is also known as 3D animation technology. 3D animation technology has recently advanced functions such as animation character modeling, material design adjustment, scene environment building, etc. [1]–[3]. It can use various visual communication techniques to reconstruct and simulate more complex spatial scenes, logical thinking, character representation, and other external forms and realize the scheme on the 3D software platform [4]–[6]. At present, virtual reality technology can be applied more and more widely [7], especially in the direction of virtual simulation modeling in 3D space. VR and 3D animation technology can be integrated through 3D integrated model reconstruction and virtual scene creation [8], [9]. In the next stage of the development of 3D modeling technology [10], virtual reality technology is bound to bring innovations and breakthroughs to 3D animation production technology. Therefore, integrating virtual reality technology and 3D film and television animation design will encourage researchers to move towards more in-depth technology integration products [11] and then break through the outdated 3D animation-producing technology to make 3D animation more authentic through virtual scene reproduction.

Abas A et al. [12] suggested a multi-scale transformation multi-focus image fusion method, which fused virtual reality technology and 3D images through a meta-heuristic optimization algorithm to achieve the integration of virtual reality technology and 3D film and television animation design. Mila B et al. [13] proposed an experimental method for social aspects of game virtual reality, which applies virtual reality technology to establish game virtual scenes and characters and realizes the integration of virtual reality technology and 3D film and television animation design. Tastan H et al. [14] proposed the method of building modeling using the handheld user interface and direct operation in immersive virtual reality. This method combines holistic virtual reality technology, portable user interface, and direct operation modeling technology to obtain 3D film and television animation scenes, realizing the integration of virtual reality technology and 3D film and television animation design. Jo, H et al. [15] proposed different visual environment reproduction methods and used this method to integrate virtual reality technology with 3D film and television animation design to obtain urban soundscape and landscape. Karagiannis P. et al. [16] proposed a fusion method using simulation and virtual reality technology. This method utilizes virtual reality technology to build scene and character models and then uses the simulation technology of 3D film and television animation to integrate the scene and characters to integrate virtual reality technology and 3D film and television animation design.

Virtual reality technology is an important direction of simulation technology, which is a combination of simulation technology, computer graphics, human-machine interface technology, multimedia technology, sensing technology, network technology, and other technologies. It is a challenging interdisciplinary and research field with cutting-edge technologies. 3D animation, also known as 3D animation, is not limited by time, space, location, conditions, or objects. It uses various forms of expression to present complex and abstract program content, scientific principles, abstract concepts, etc. in a concentrated, simplified, vivid, and vivid form. Based on the above analysis, it can be concluded that the current research question is how to further improve the effectiveness of 3D film and television animation design, as well as how to integrate virtual reality technology with 3D film and television animation design. Therefore, this paper proposes a fusion method of virtual reality technology and 3D film and television animation design. Through manual modeling, texture mapping, character simulation, and optimization processing, achieve more realistic, interactive, and optimized 3D film and television animation scenes. In order to provide more efficient, realistic, and interactive solutions for 3D film and television animation design, promote the development of virtual reality technology, and bring more diverse and immersive virtual experiences to entertainment, education, cultural and artistic fields.

II. COMPARATIVE ANALYSIS

Compared with similar works mentioned in the introduction, this paper aims to further enhance the design effect of 3D film and television animation, and explore the integration method of virtual reality technology and 3D film and television animation design. Below, a fair comparison will be made between this work and similar previous works, highlighting the advantages of this work:

1) Method innovation: This paper uses 3D Max software from virtual reality technology to manually model 3D film and television animation scenes. Unlike the multi-scale transformation and multi focus image fusion method proposed by Abas et al. [12], this method applies virtual reality technology to the modeling process in a more direct way, thereby improving the realism and detail representation of the scene.

2) Texture mapping processing: In this work, texture mapping processing was applied to the established 3D film and television animation scene. This step makes the scene more realistic and visually appealing. In contrast, Mila et al. [13] did not extensively explore the application of texture mapping processing in the experimental methods of social aspects in game virtual reality.

3) Simulation processing: This paper establishes a 3D film and television animation character model and performs simulation processing on the model. By simulating the actions and behaviors of characters, the authenticity and realism of the characters are enhanced. In contrast, the method proposed by Karagiannis et al. [16] combines simulation and virtual reality technology to establish scene and character models, but does not explicitly mention the simulation processing of character models.

4) Improved optimization algorithm: This paper uses an improved quadratic error measurement algorithm to optimize the established 3D scene and character models. This algorithm helps to improve the accuracy of the scene and the appearance of the characters, thereby enhancing the quality of 3D film and television animation. In contrast, the method proposed by Tastan et al. [14] used handheld user interfaces and direct operations for building modeling, but did not provide a detailed description of the optimization algorithms used.

In summary, compared with previous similar works, this work has innovation in exploring the integration process of virtual reality technology and 3D film and television animation design. By using 3Ds Max software for modeling, texture mapping, simulation, and improved optimization algorithms, this work successfully enhances the realism and visual effects of 3D film and television animation, bringing new possibilities for the integration of virtual reality technology and 3D film and television animation design.

III. INTEGRATION DESIGN OF 3D FILM, TELEVISION, AND ANIMATION

A. Integrated Technical Architecture

The realization of virtual reality technology is a foundation for 3D film and television animation designs [17]. The essence of 3D animation is a sense of stereo vision generated by the continuous projection of graphics and images. Experiments can transform the imagination in their minds into 3D animation models and realize model creation and visual optimization through the 3D modeling software platform. Virtual reality technology is gradually extended and developed based on three-dimensional animation technology. Its advanced scene reconstruction ability initially needs three-dimensional models to build. The prerequisite for the final realization of virtual reality space scenes is the adaptive transformation ability of three-dimensional images. Experiments can conduct interactive feedback of virtual reality scenes by upgrading 3D animation technology. Therefore, virtual reality technology and 3D animation technology come from a school of thought design [18]. After the development of 3D animation technology, it is called virtual reality technology. However, the interactivity of 3D animation technology stays in the passive information acceptance of the experimenter. The interactivity of virtual reality technology can make the system cooperate and deepen the scene according to the behavior logic of the experimenter and convey the space scene simulated by computer data artistically. 3D animation technology is the fundament of producing virtual reality technology data. Here, the technical architecture for integrating virtual reality technology and 3D film animation has been designed and shown in Fig. 1.

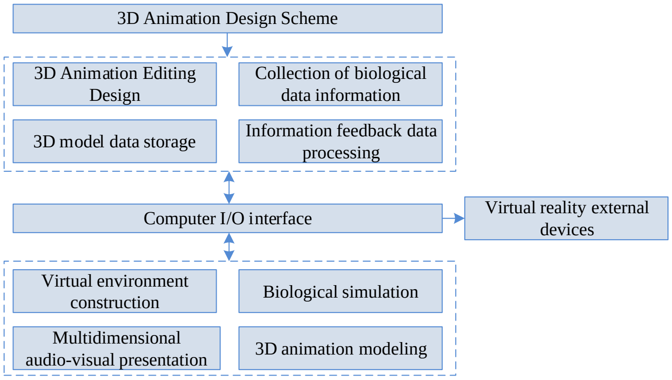


Fig. 1. Architecture of virtual reality technology and 3d film and television animation design integration technology.

The integration technology of virtual reality technology and 3D film and television animation design gets 3D animation pictures of virtual reality through virtual environment construction, multi-dimensional audio-visual presentation, biological simulation, and 3D animation modeling, and then connects 3D animation editing design, biological data information collection, 3D model data storage and information data feedback processing through computer I/O interface, realize the integration of virtual reality technology and 3D film and television animation according to 3D animation design scheme and virtual reality external equipment.

B. Manual Modeling Method of Animation Scene Based on 3Ds Max

The first step of basic 3D animation production is 3D scene modeling, and a 3D model scene is the golden key to open animation production. As a model designer, it is necessary to determine various modeling data of 3D scenes. For some indoor scenes with small space areas, it is relatively easy to obtain basic measurement data. Obtaining more reliable scene data is impossible for virtual scenes with large space and unlimited space. Now, it is essential to collect virtualization information data according to the previously simulated spatial scene data samples [19], reconstruct the scene model with the help of powerful computer data model processing ability, and complete this spatial scene modeling work with the highest efficiency through this virtual scene simulation method. This method enlarges and outputs the scene information through virtual reality, efficiently completes the reconstruction of a 3D model scene, and improves the accuracy of scene model data through virtual reality assistance to create a more realistic virtual world.

1) Construction of 3D film and television animation scene model: This section will introduce the processes of producing complex 3D film and television animation scene models in 3Ds Max [20] and final 3D film and television animation scene models. The technical process of 3D animation 3D Max model construction is illustrated in Fig. 2.

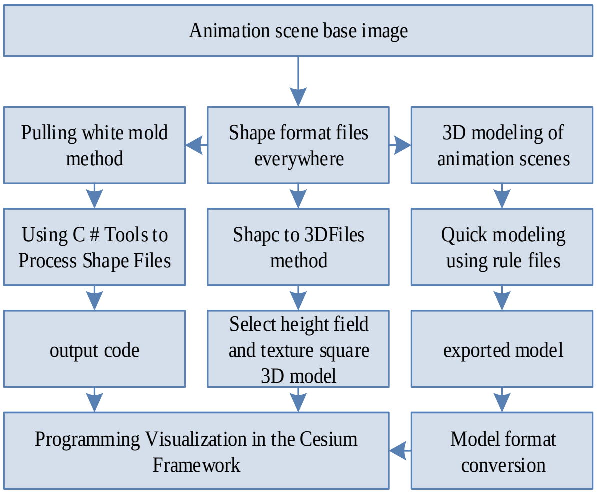


Fig. 2. 3D animation 3D max model construction technology process.

The production of 3D film and television animation scenes is the most difficult part of 3D software. The concept of time dimension is added in the production process, and almost any object or parameter can be animated in 3Ds Max [21]. Import the designed virtual scene base map or real image scene base map into the 3Ds Max software, and export the shape format file through 3Ds Max. Based on the cut file, you can quickly create 3D film and television animation scenes using rule files, export 3D film and television animation scenes and convert the model format, convert the shape format file into 3D Tiles method, select the elevation to generate 3D film and television animation scene, use the pull white mold method, process the shape format file through C # tool and output the code, and then program the code, animation scene model and format converted animation scene model in the Cesium framework to achieve 3D animation 3Ds Max model construction.

2) Realization of 3D film and television animation scene; After the 3Ds Max model is established, 3D Exploration, Wcvt2pov, and other software can convert the 3Ds Max model into the corresponding OpenGL C C++ format file, or the program can directly load the 3Ds Max model. The software format conversion method can preserve the model's color, texture, and other information [22]. However, some limitations are that software support and manual interaction are required for model transformation, and only one model can be transformed at a time. Therefore, the efficiency could be higher. The method of program direct loading can freely control the model to be loaded and promote the efficacy of program operation. After the 3DS model is loaded into the OpenGL program, the corresponding scaling, rotation, movement, and other controls are also required. The detailed process is as follows:

a) Read 3Ds Max models. 3Ds Max files are organized in a block structure, and there is a nesting relationship between blocks. Therefore, the 3D model data in the 3Ds Max file is read from a block in the model file, and the functional information of the block is judged according to the block ID, and then the corresponding processing is performed according to the block ID. A sub-block is read in the block processing process, such as the main editing block; block information is judged, and the corresponding data is extracted and stored.

b) Build model display list. When writing OpenGL programs, if you encounter repeated work, you can create a display list, load the repeated work, and call the display list where necessary. There are generally four steps to using the display list: assigning the display list number, creating the display list, calling the display list, and destroying the display list.

c) Minimum and maximum according to 3Ds Max model x, y the coordinates and the actual required width and height of the 3D scene are used to calculate their scaling ratio and scale the model. The functions used are: $glScalef(GLfloat\ x, GLfloat\ y, GLfloat\ z)$. Multiply the current matrix by a matrix indicating the scaled object. x, y and z refer to the scaling in corresponding directions, respectively.

d) Rotate the model according to the direction angle of the model in the 3D film and television animation scene. The functions used are: $glRotatef(GLfloat\ x, GLfloat\ y, GLfloat\ z)$. Multiply the current matrix by a matrix indicating a rotating object. The object will reach around $(0,0,0)$ reach (x, y, z) the line of rotates counterclockwise, parameter $angle$ represents the rotation angle.

e) Calculate the model according to the position of the 3D movie animation scene model in the 3D scene x, y, and z

translate the 3D movie animation scene model. The functions used are:

$glTranslatef(GLfloat\ \ x, GLfloat\ \ y, GLfloat\ \ z)$ Multiply the current matrix and a matrix indicating moving objects. These three parameters indicate the displacement values in three coordinates, respectively.

f) Realize the placement of 3Ds Max models in the 3D scene according to the corresponding size, direction, and position, call the display list, and complete the drawing of 3D movie animation scene models.

C. Texture Mapping Processing

After the establishment of 3D film and television animation scene models, to make the scene more realistic, it is necessary to conduct texture mapping processing on it. Before texture mapping, select the contour of a 3D film and television animation scene [23]. Here, a cubic uniform B-spline curve extracts the contour of 3D film and television animation scenes. The expression formula of the curve parameter equation is as follows:

$$C(u,v) = [x(u), y(u), z(u)] \tag{1}$$

In the above formula, $C(u,v)$ represent cubic uniform B-spline curve equation; u and v are parameters; $x(u)$, $y(u)$, $z(u)$ all are cubic B-spline basis functions.

The cubic uniform B-spline curve and expression formula are as follows:

$$r_i(u) = C(u,v)\sum_{j=0}^{3} N_{j,3}(u) \tag{2}$$

In Eq. (2), $r_i(u)$ represents the i th sum of three cubic uniform B-spline curves; $N_{j,3}$ represents the total number of cubic uniform B-spline curves.

After the contour line is drawn, rotate the selected rotational axis to build the model [24]. The right-hand coordinate system is used in texture mapping, x the positive direction of the shaft is to the right and y the positive direction of the axis is upward, so the rotation axis is selected as y shaft. Therefore, the parametric equation of the surface after rotation is:

$$\begin{cases} x = x(u) * sin(v) \\ y = y(u) \\ z = x(u) * cos(v) \end{cases} \tag{3}$$

For the gridding of 3D film and television animation scene models, the unit length of the grid will be intercepted according to the curvature of each point of the drawn contour line, and the grid will be further subdivided where the curvature is large. The curvature solution formula is as follows:

$$k = \frac{r_i(u)|\ddot{r}(s)|}{x^2+y^2+z^2} \tag{4}$$

In the above formula s indicates the arc length parameter; t represents a non-arc length parameter; $\ddot{r}(s)$ means right $r(s)$ perform a second derivative.

After the above steps, the mesh of the 3D movie and television animation scene model is more reasonable, and the resulting mesh quadrilateral tends to be the non-planar area of the original model, which is more conducive to rendering in the texture mapping phase.

Texture mapping technology can simulate the fine and irregular color texture on the surface of people (objects). The texture mapping technology can cover any planar figure (image) on the 3D animation model's surface [25] so that the model surface can produce a more realistic color texture, enhance the authenticity of 3D animation, and facilitate the modeling processes. There are two steps in texture mapping technology. The first step is to determine the texture attribute, determining which part of the person (object) surface parameters must be set as the texture shape. The second step is to create a mapping relation between the texture space and the person (object) space and a mapping relation between the person (object) space and the screen space. Fig. 3 shows the mapping definition.

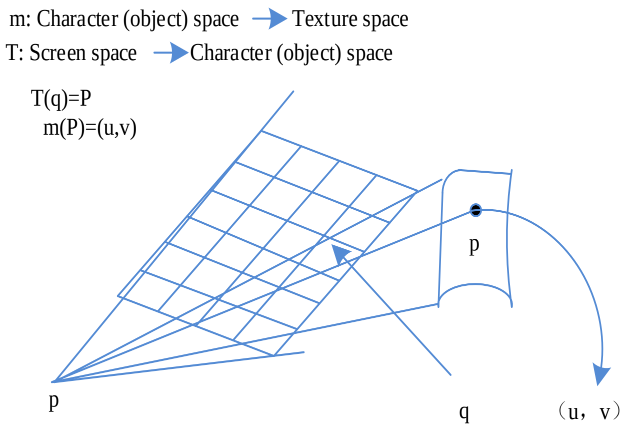


Fig. 3. Mapping definition.

Just basic contour characteristics, i.e., lack of surface texture details, can decrease the realism. It needs to map each module's texture to raise the model's realism.

The general direction of the surface patch specifies which space plane the surface patch projects to and projects to the plane with the smallest angle between the whole direction of the surface patch and the plane. As some parts of the person (object) surface are curved, it is necessary to calculate the overall direction of the curved surface. The computation method can be summarized as follows:

Assume that v_1, v_2, v_3 are three vertices of a triangular patch and cross product $[v_1 - v_2] * [v_2 - v_3]$ is perpendicular to the patch and normalized to get the normal vector of the triangular patch V the average vector sum of the module can be obtained by averaging the sum of all patch normal vectors, and then the general direction of the module can be obtained. The equation is as follows:

$$C = \sum_{i=1}^{PolyNum} \frac{v_i k}{PolyNum} \tag{5}$$

Where, $PolyNum$ indicates the total number of vertices.

To study the mapping relation between the surface patch and its related texture coordinates, the texture coordinates of the grid points is computed through the perspective projection transformation, and the formula is as follows:

$$V = kX' = CHX \tag{6}$$

In which h_1, h_2, h_3, h_4, h_5 belongs to an unknown parameter, and (u, v) is the texture coordinate, the corresponding homogeneous texture coordinate is X', grid point space homogeneous coordinate is X, the perspective projection matrix of $3 * 4$ is H and the constant coefficient is k. Based on the Eq. (5) and Eq. (6), two independent linear equations exist for each group of corresponding mesh and texture vertices. To transform the matrix H, selecting three sets of feature points is necessary.

Analyzing all texture mapping processes, and setting the texture image size to $m * n$ simplify Eq. (7), and the process is as follows:

$$H = \begin{bmatrix} h_1 & 0 & 0 & h_4 \\ 0 & h_2 & 0 & h_5 \\ 0 & 0 & h_3 & 1 \end{bmatrix} \tag{7}$$

where, s and t is an unknown parameter, (x, y, z) is the surface vertex coordinate.

For Eq. (8), only a set of characteristic points can be used to calculate the unknown parameters. When extracting textures, all textures are made into the smallest bounding box. There are many tangent points at the edge of the image [26], which is very easy to get a group of feature points. Set texture coordinates(u', v') and surface vertex coordinates$(x', y', z')$is a group of characteristic points, which can be obtained by substituting into Eq. (8):

$$H' = \begin{bmatrix} 1/m & 0 & 0 \\ 0 & 1/n & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & s \\ 0 & 1 & 0 & t \\ 0 & 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} x & y & z \end{bmatrix}^T \tag{8}$$

$$F = H'V \tag{9}$$

After the above steps, the texture mapping of the 3D movie animation scene model is completed.

D. Character Modeling of 3D Film and Television Animation

According to the 3D animation character model and action library, users should just choose their required role prototype, modify the parameters like the height and body proportion of the role prototype, and get the 3D animation target character. The 3D animation target character matches the prototype 3D animation character's skeleton, mask, controller, and original actions in the action library. Fig. 4 is the composition diagram of the 3D animation character.

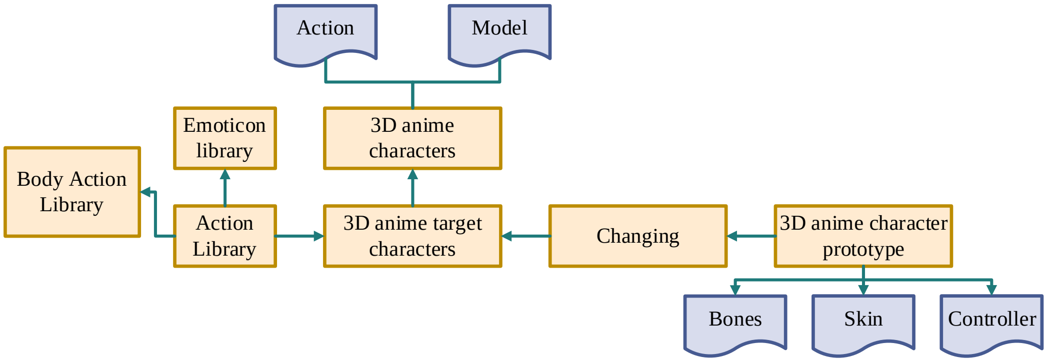


Fig. 4. Composition of 3D anime characters.

Components of a 3D animation character template include a virtual skeleton, skin, and controller, and it is a prototype for 3D animation. A set of basic actions allocated for 3D animation character prototypes is the 3D animation character action library. Users can freely modify the proportions and shapes of 3D animation characters based on the graphical interface, design the 3D animation character they want, or create new 3D animation characters.

E. 3D Animation Character Simulation

Motion capture technology is used to store many motion instances of character motion in the concerned motion library. The attained motion instances are represented in 3D form through virtual artificial synthesis software so that the 3D animation system is visual and convenient to change the action of the character model. The Newtonian Euler motion model is used to verify whether the new action studied is reasonable.

The character action is set as motion (t) by the 3D animation system, and the character's original pose (ti) is changed to gain a new character pose (ti). These operations lead to visual interactive action design. The user window is $O \times G$ in size. By moving the character model with the mouse, the variation in direction f will be Δf and the change in direction g will be Δg. According to Euler's theorem, for $< \alpha, \beta, \gamma > as$ representatives of d, f and g, the relationship of direction rotation after reasoning is as follows:

$$\begin{gathered} \sin\alpha = aF\Delta f/[O(1-a)\Delta g/G] \\ \sin\beta = bF\Delta f/[O(1-b)\Delta g/G] \\ \sin\gamma = cF\Delta f/[O(1-c)\Delta g/G] \end{gathered} \tag{10}$$

In Eq. (10), the influencing factors are a, b and c representing d, f, g in three directions. Δf and Δg are opposite Euler angles and $< \alpha, \beta \ and \ \gamma >$ are the degree of influence. Calculations achieve the newly pose of the character model, and the 3D animation character model is simulated.

F. 3D Animation Model Optimization Method based on Improved Quadratic Error Measure Algorithm

The edge collapse algorithm, also known as the Quadric Error Metric (QEM) algorithm, is not only fast in running speed, low in memory consumption, and simple in calculation but also has a very high overall similarity between the simplified mesh and the model. This paper improves the original quadratic error measure algorithm (QEM) and uses the improved QEM algorithm to optimize the scene modeling.

The specific steps are as follows:

1) Read in the original mesh data, which contains the vertex coordinates in the mesh and the vertex, sequence and other data information of the connected triangular patch.

2) Find the discrete curvature of each vertex in the mesh $K(h)$ the area of the local area is obtained from the formula $LRA(h)$, and compare the two weighting factors with the matrix $Q(h)$ weighting to obtain the quadratic error matrix of each vertex in the network $Q'(h)$:

$$Q'(h) = \frac{K(L_h)K_H}{\sin\alpha \sin\beta \sin\gamma} \tag{11}$$

where, $K(L_h)$ include vertices for Gaussian curvature of the edge of h,$K_H$is Gaussian curvature of a vertex h.

The expression of K_H is:

$$K_H = 2\pi - \frac{\sum_n \theta_h}{S_{\sum}(h)} \tag{12}$$

where, θ_h is an adjacency angle of vertex v;n is the number of triangles associated with vertex h; $S_{\sum}(h)$ is a vertex h the sum of adjacent triangular mesh areas, that is the local area.

3) The appropriate threshold through which the input is low $w = 0.9$, determines whether it is a boundary. If it is a boundary, set $\Delta(h) = inf$.

4) Get the quadratic error matrix of each vertex according to step $2Q'(h)$. To calculate the shrinkage cost of each edge ζ, if $(h_1, h_2) \rightarrow \tilde{h}$ the shrink cost is put on the stack, the higher the value of ζ, the more backward it is in the stack, and on the contrary, the more forward it is.

5) Take the edge with the lowest shrink cost from the stack to perform the shrink operation, that is, the top of the stack. Simultaneously, update the data structure of the network, calculate the new edge collapse cost, and update the stack sequence.

6) If the ideal simplification requirements are met, the algorithm ends; otherwise, the above process continues until the simplification requirements are met.

After the above steps, the optimization of the 3D animation model is realized, and the resulting film and television animation screen is more fluent, and the structure is more reasonable.

G. Interaction Mode of 3D Film and Television Animation Scene based on Unity3D

Unity3D software is designed with the interaction mode of 3D film and television animation scenes based on the improved A * algorithm. The improved A * algorithm is used to plan the interaction path in the 3D film and television animation walkthrough, obtain the optimal interaction path, and avoid collision in the interactive display process of the 3D film and television animation walkthrough.

The key part of the A * algorithm is the evaluation function $f'(n')$, that is, the source point in the 3D movie animation model p_0 to end p_{end} passing through nodes n' the total cost of $B(n')$ and estimated cost $h'(n')$ add to get.

The collective steps of the A * algorithm to search for the best path in the 3D movie animation model are summarized as follows:

Step 1: Initialize the 3D movie animation model data and add it to the open table of the open list p_0, select in open table $f'$the node with the lowest value is regarded as the current node p_1, if none p_1, then the 3D movie animation model interactive display path search fails, and the path search ends; if $p_1$is p_{end}, then the 3D film and television animation model interactive shows that the path search is successful, and the path search ends; With p_1 by p_{end} the path from the source node to the destination in the interactive presentation process of 3D film and television animation model is the search path.

Step 2: In the closed table, add p_1, traversal p_1 all adjacent nodes of p', if close-table exists p', no processing is required; If the close-table does not exist p', you need to solve again the value of $B(n')$, $h'(n')$, set $O_1$by $p'$and add it in the open-table p'; if p'in open-table, comparative analysis p_1 to p' of $B(n')$ is the value below p' of $B(n')$ value, if lower than p' of $B(n')$ value, then no processing is required. If the value exceeds p' of $B(n')$ value, then p_1 to p' of $B(n')$ value is changed to p' of $B(n')$ value with the predecessor node of p_1 by p'.

Step 3: Repeat step 2 to process the remaining adjacent nodes in order until the open table is empty.

To speed up the search efficiency of the interactive display path of 3D film and television animation roaming, a hierarchical strategy is introduced into the A * algorithm, and the 3D film and television animation model is regarded as a complete map divided into several areas of consistent size. For the obstacles within the boundary line, it is necessary to remove the obstacles first, then solve the scale of the obstacles within the boundary line, add the obstacles within the boundary line in the area with the highest scale, and complete the area division of 3D movie and television animation model in this way.

By setting parameters E and R, and designing fixed rules, the search algorithm is obtained and used in each area, and the proportion of obstacles in the 3D film and television animation model, is E which is the ratio of the total number of nodes occupied by obstacles in the current area to the total number of nodes in the area, and the threshold coefficient is R.

Adopt E determine that a certain search algorithm needs to be used in this area and determine that further subdivision is required; The value R has a negative correlation with the area division size, a positive correlation with the number of expansion nodes, and a positive correlation with the path search time. According to the relationship between E and R to establish the following rules:

1) On $E = 0$, it represents no obstacle in the area, and the shortest optimal path can be obtained directly according to the straight line between two points. If $p_0$and p_{end}both are in this area, then this path is the optimal path; if $p_0$and p_{end} are not in the same area, search for the middle point between the optimal path and the boundary line of the area in the area and regard the middle point as that of the next area p_0.

2) On $E < R$, means there are fewer obstacles in the area, and the hierarchical strategy is still adopted to subdivide the area further.

3) On $E \geq R$, the number of representative obstacles is consistent with the threshold, or even exceeds the threshold. In this case, the A * algorithm is directly used to search the path.

According to the above rules, searching the path in the interactive display process of 3D film and television animation roaming can effectively divide the big map into small maps, which is conducive to processing, selecting the optimal path search method for small maps, speeding up the path search efficiency, and effectively avoiding collision events in the interactive display process of 3D film and television animation roaming.

IV. EXPERIMENTAL ANALYSES

Taking an animation design scheme as the experimental object, the method in this paper is used to integrate virtual reality technology and 3D film and television animation and present the animation design scheme to validate the practical application impact of the method proposed in the present paper.

Take a scene of the animation design scheme as the experimental object, and present the scene using the method in the current investigation. The results are illustrated in Fig. 5.

It is clear from the analysis of Fig. 5 that the application of the method used in the present paper can effectively establish the 3D film and television animation virtual scene. From the 3D film and television animation virtual scene established in this paper, it can be seen that the color of trees, grass, and flowers is real, and the three-dimensional effect is good. The water body can not only map the scene in the sky but also show a clear effect, and the river bottom can be seen through the water body. These results indicate that the 3D film and television animation virtual scene built by this method has good stereoscopic and real effects.

The texture coordinate calculation results are used to measure the texture mapping effect of this method on 3D film and television animation scenes. With 15 texture coordinate points as experimental objects, this method calculates the texture coordinates. The results are presented in Table I.

Fig. 5. Virtual scene of 3D film and television animation.

TABLE I. TEXTURE COORDINATES OF 3D FILM AND TELEVISION ANIMATION SCENE (CM)

Texture coordinate encoding	**Calculated value**		**Actual value**	
	X-direction	***Y-direction***	***X-direction***	***Y-direction***
1	3.24	8.54	3.24	8.54
2	4.06	10.34	4.06	10.35
3	1.58	2.88	1.58	2.88
4	2.79	9.17	2.79	9.17
5	11.07	5.97	11.07	5.97
6	25.13	14.96	25.13	14.96
7	10.25	11.85	10.25	11.85
8	6.98	8.97	6.98	8.97
9	8.94	16.34	8.94	16.34
10	15.27	16.85	15.28	16.85
11	30.17	22.13	30.17	22.13
12	2.89	6.84	2.89	6.84
13	16.63	20.57	16.63	20.57
14	13.79	19.82	13.79	19.82
15	21.11	18.84	21.11	18.84

From the analysis of Table I, it can be seen that the texture coordinates of 3D film and television animation scene texture mapping are calculated using the method in the present research. In the calculation results, only the texture coordinates coded as 10 and 2 have deviations from the actual results in the X and Y directions, but the deviation value is only 0.01cm, which is small. Other texture coordinate values calculated are identical to the actual coordinate values. These results imply that the texture coordinates of 3D film and television animation scene texture mapping calculated by the method in this paper are more accurate, and it has a strong ability for 3D film and television animation scene texture mapping.

To further verify the texture mapping capability of this method, take a 3D movie animation scene as the experimental object and use this method to conduct texture mapping processing. The texture mapping results are shown in Fig. 6.

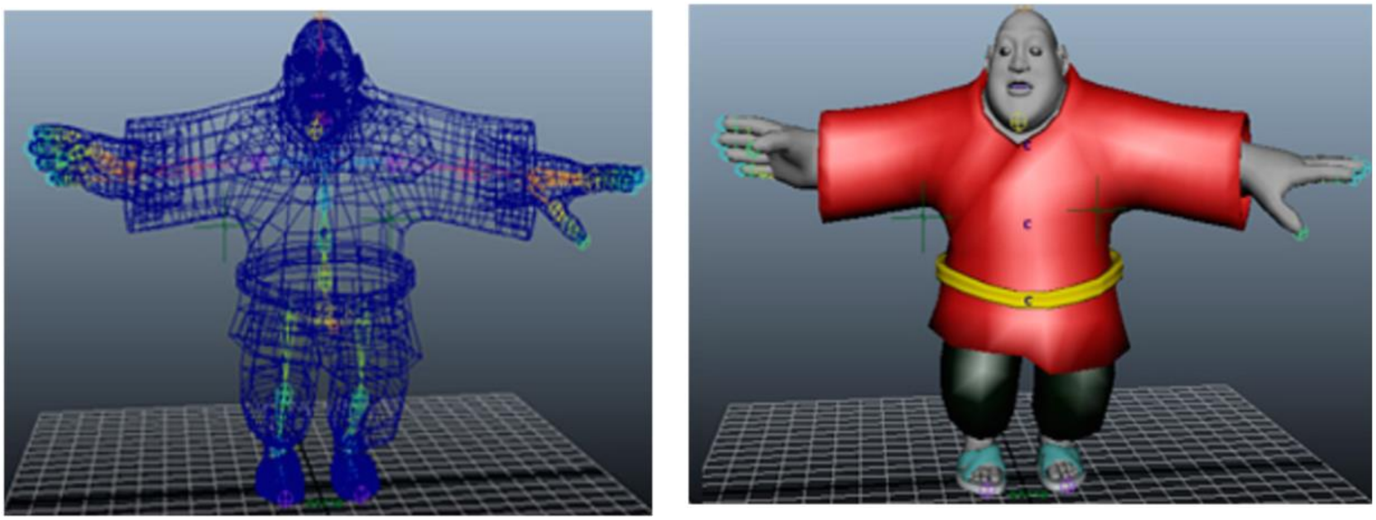
(a) Before mapping

(b) After mapping

Fig. 6. Texture mapping effect in 3D film and television animation scenes.

According to the analysis of Fig. 6, after applying the method in this paper to texture map the 3D film and television animation scene, the entire 3D film and television animation scene has bright colors, and the texture map position is not prominent or concave, indicating that the method of the current paper has better texture mapping effect on 3D film and television animation scene.

Take an animated character in the animation design scheme as the experimental object, use the method in this paper to establish its virtual character model, and the establishment results are shown in Fig. 7.



(a) Design base drawings

(b) Achievement

Fig. 7. Animated character virtual character model.

It is clear from the analysis of Fig. 7 that this method can effectively establish the 3D model of the animated character virtual character based on the base map of the animated character virtual character. The 3D model of the animated character virtual character established has a good three-dimensional effect, and the character's facial expression is more real. To sum up, the method in this paper can better build virtual character models of animated characters.

Taking a 3D movie animation scene as the experimental object, the method in this paper is used to optimize the 3D movie animation scene, and the optimization results are illustrated in Fig. 8.

It is evident from the analysis of Fig. 8 that after the optimization of 3D film and television animation scenes using the method in this paper, the contrast of 3D film and television animation scenes has been improved, and the clarity of the entire 3D film and television animation scenes has also been effectively improved, making the visual effect of 3D film and television animation scenes better. In conclusion, the present research method can effectively optimize 3D film and television animation scenes and has a relatively significant application effect.

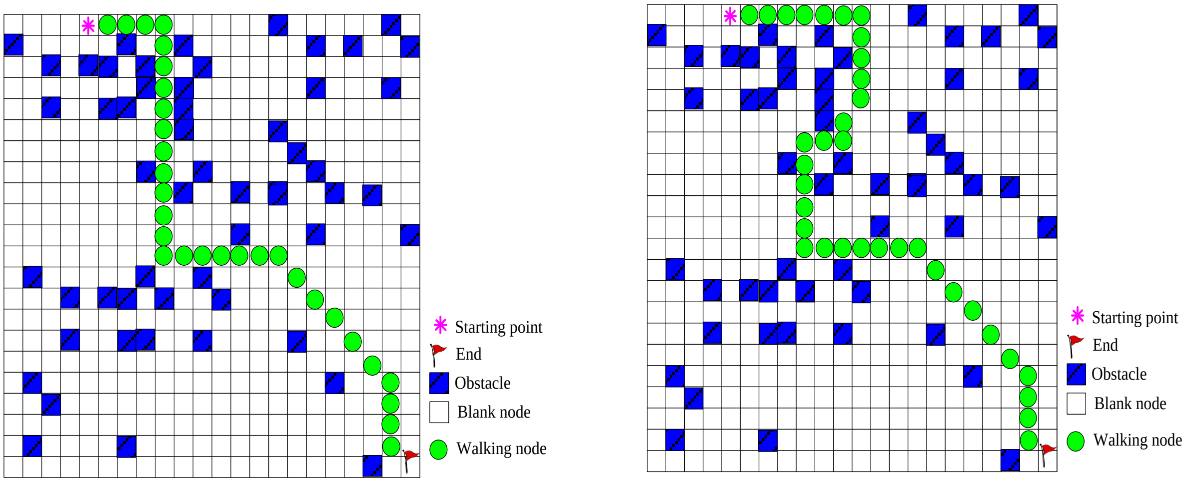
Verify the roaming ability of the 3D film and television animation scene established by this method, and test the roaming ability of the 3D film and television animation scene established by this method with the roaming path as the measurement index. To make the experimental results more sufficient, the methods utilized in the references [12]- [16] are used to experiment. The experimental results are illustrated in Fig. 9.

It is obvious from the comprehensive analysis of Fig. 9 that when the method in this paper is used to roam and interact with 3D film and television animation scenes, the shortest roaming path selected in this method is only 30 nodes, while the path nodes selected in other reference methods when roaming and interacting with 3D film and television animation scenes are higher than those of the method proposed in the current study. The results show that the method in this paper can effectively combine virtual reality technology with 3D film and television animation design and select the shortest path when roaming 3D film and television animation scenes, which has a strong application effect.

(a) Before optimization

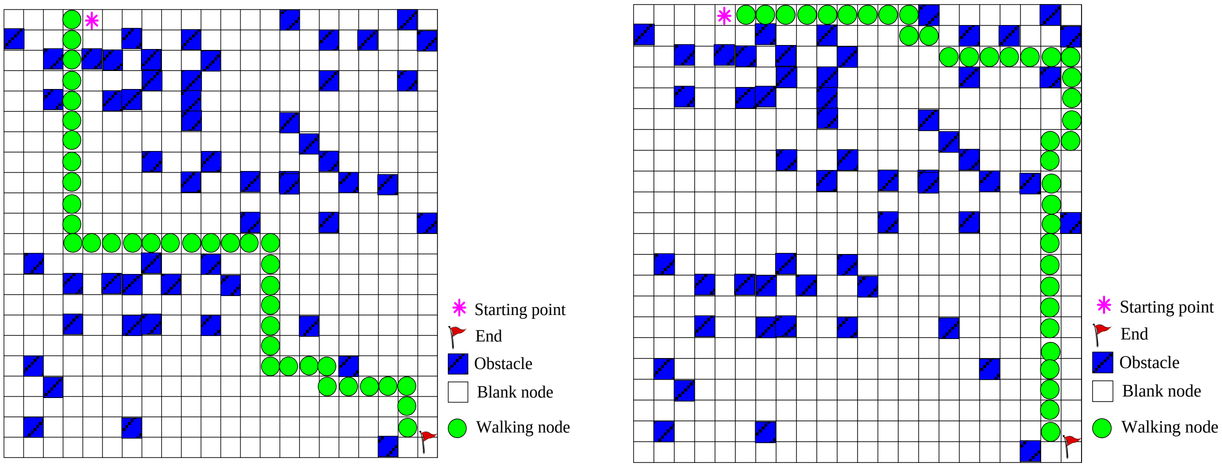
(b) After optimization

Fig. 8. Optimization results of 3d film and television animation scenes.



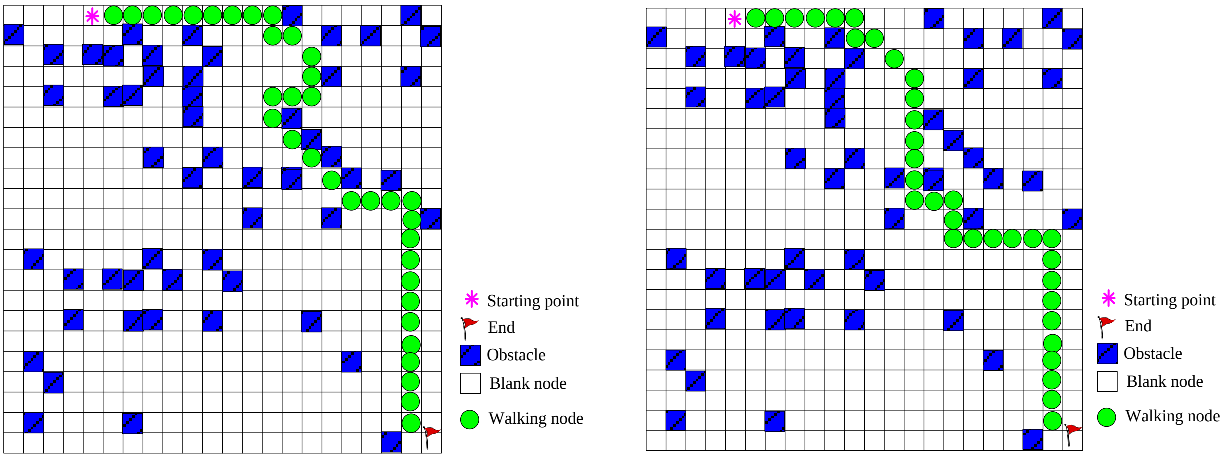
(a) Proposed method

(b) Reference [12] method



(c) Reference [13] method

(d) Reference [14] method



(e) Reference [15] method

(f) Reference [16] method

Fig. 9. Interactive performance test results of 3d film and television animation scene roaming.

V. DISCUSSION

This paper successfully establishes a realistic and interactive 3D film and television animation virtual scene by studying the integration method of virtual reality technology and 3D film and television animation design. According to the above theories and experiments, it can be concluded that:

By analyzing Fig. 5, it can be seen that the 3D film and television animation scene established in this paper exhibits more realistic colors and three-dimensional effects in areas such as trees, grasslands, and flowers. In addition, water bodies not only reflect scenes in the sky, but also present a clear effect, through which the riverbed can be seen. These results indicate that the 3D film and television animation virtual scene successfully established by the method proposed in this paper has good stereoscopic and realistic effects.

The method used in this paper has high accuracy in calculating texture maps for 3D film and television animation scenes. Most texture coordinates are exactly the same as the actual coordinates, while only a few texture coordinates have slight deviations in the X and Y directions. However, these deviations are only 0.01cm and belong to smaller values. Therefore, the method proposed in this paper demonstrates high accuracy and capability in calculating texture maps for 3D film and television animation scenes.

After applying the method described in this paper to texture map 3D film and television animation scenes, the entire scene presents bright colors and uniform texture map positions, without any protrusions or depressions. This indicates that the method proposed in this paper has shown good performance in texture mapping of 3D film and television animation scenes. Further analysis of Fig. 7 reveals that based on the virtual character base map of animated characters, our method has successfully established a three-dimensional model with good stereoscopic effects and real facial expressions. This indicates that the method presented in this paper demonstrates excellent ability in establishing virtual character models for animated characters.

After optimizing the 3D film and television animation scene using the method described in this paper, the contrast of the scene is improved, and the clarity of the entire scene is also significantly improved. This makes the visual effects of 3D film and television animation scenes more outstanding. In summary, the method proposed in this paper has significant application effects in optimizing 3D film and television animation scenes. For the roaming interaction of 3D film and television animation scenes, the method selected in this paper has the least number of roaming path nodes, only 30 nodes, which is significantly less than the number of path nodes selected by other literature methods. This indicates that the method proposed in this paper has shown significant advantages in integrating virtual reality technology and 3D film and television animation design, and has chosen the shortest path in the roaming of 3D film and television animation scenes, demonstrating strong application effects.

In summary, through the analysis of various experimental results, it can be concluded that the fusion method of virtual reality technology and 3D film and television animation design proposed in this paper demonstrates excellent capabilities and effects in the establishment of 3D film and television animation virtual scenes, texture mapping, character simulation, optimization processing, and roaming interaction. This is of great significance for promoting the development of 3D film and television animation design, improving user experience, and expanding the application fields of virtual reality technology. Future research can further optimize and expand this method to provide a more satisfactory virtual reality experience.

VI. CONCLUSION

The continuous integration and complementation of 3D animation technology and virtual reality technology can bring new breakthroughs to the two technical fields and make this virtual 3D animation system exert the best guiding force. The integration of virtual reality and 3D animation technologies makes the expression of 3D animation more diversified. Through the technical support of virtual reality technology, 3D animation can bring more real resonance of literary and artistic ideas to the experience. Therefore, integrating virtual reality technology with 3D animation technology is an inevitable trend, which can bring more opportunities for the future development of both technologies.

Considering that real-time rendering is crucial in virtual reality technology. How to improve rendering speed and efficiency while maintaining high-quality rendering, and ensure smooth operation on virtual reality devices, is an unresolved issue. Therefore, in the future, new real-time rendering algorithms and hardware acceleration technologies will be explored to achieve higher quality graphics rendering and faster rendering speed, providing users with a smoother virtual reality experience.

DATA AVAILABILITY

On Request

COMPETING OF INTERESTS

The authors declare no competing of interests.

AUTHORSHIP CONTRIBUTION STATEMENT

He Huixuan: Writing-Original draft preparation, Conceptualization, Supervision, Project administration.

Xiang Yuan: Methodology, Software, Validation

DECLARATIONS

Not applicable

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