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The Application of Intelligent Algorithms in the Animation Design of 3D Graphics Engines

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ABSTRACT

With the rapid improvement of computer hardware capabilities and the reduction of cost, the quality of game pictures has made a qualitative breakthrough, which has reached or exceeded the picture effect of many dedicated virtual reality engines. On the basis of the design and implementation of the virtual reality 3D engine, the rendering queue management method is proposed to improve the frame rate. Based on the object-oriented design method, emitter regulator particle rendering mode, and traditional bone skin animation technology, the key structure technology in skeletal animation is analyzed, and the animation controller used to control animation playback and key structure interpolation operation is designed, which achieves the ideal animation effect. Finally, a prototype system based on engine is implemented.

KEYWORDS

3D Graphics, Animation Design, Intelligent Algorithm

1. INTRODUCTION

Virtual reality is an integrated technology, which integrates the latest development of computer graphics, computer simulation, sensor technology and AI technology. It can also be said to be an analog system generated by computer technology (Sun F et al.2015). The 3D engine is the foundation of the virtual reality technology. Virtual reality contains a lot of technology of image processing, including light and shadow computing, animation processing, physical system, collision detection system and rendering system (Baken L et al.2015). At present, the three dimensional game technology maintains a good momentum of development in these aspects (Lau K W.2015). With the growing graphics function of the game engine and the ability

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of computer hardware, especially the rapid improvement of display capacity, the scene of the 3D game is rapidly developing toward a high sense of reality. So the game engine has been able to fully meet the requirements of the virtual reality in the picture quality (Qin Z et al.2016). Due to the rapid development of the game industry and the maturity of the game engine, the development speed of virtual reality can be greatly shortened and the development cost can be reduced better with the help of game engine (Liu K et al.2017). However, our country's current research on the game engine is relatively backward. If our country don't have a self-developed high-performance game engine, we can't catch up with the international level and resist the impact of a large number of foreign games fundamentally, nor can we drive the development of other industries (Park K B et al.2016). Therefore, independent research and development of solid and high-performance 3D game engine will be of great practical value for the development of our game and virtual reality application platform (Dorta T et al.2016).

2. RELATED WORK

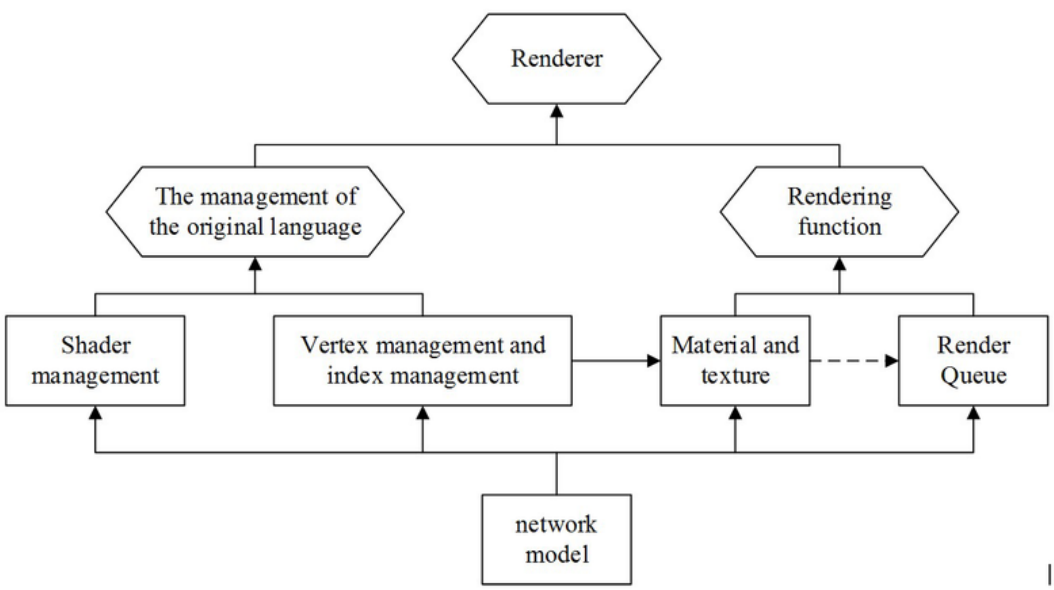
In the 90s of last century, NASA and the United States Department of defense organized a series of research on virtual reality technology and achieved remarkable results. NASA's lab engineered data gloves to made it a high availability product and simulated the operation of Johnson space station in real time, and simulated the test plan of virtual space exploration by Harbert space telescope (Mejía R I et al.2017). At present, NASA has established the aeronautical and satellite maintenance training system, the space station training system and the VR education system for the national use (Konrad R et al.2017). Fujitsu Laboratory Limited is studying the interaction of virtual organisms and the VR environment. They are still studying gesture recognition in virtual reality and have developed a set of neural network posture recognition systems that can identify postures (Diao J et al.2017). Virtual reality technology is a science and technology field with large investment and high difficulty. The research of virtual reality technology in China started relatively late, so there is a certain gap compared with some developed countries. With the rapid development of computer graphics and computer system engineering, virtual reality technology has aroused extensive interest and attention from our government departments and scientists. The 11th Five-Year plan, the National 863 plan, the 973 Plan, the National Natural Science Foundation and the national high technology research and development plan and so on have included the research of virtual reality technology in the scope of funding. China is keeping pace with the new international technology. At the same time, some domestic research institutions and key institutions have carried out virtual reality technology in military, engineering, sports, culture and education.

3. METHODOLOGY

3.1 Grid Model of xVR Engine Renderer

The rendering system designed in this paper consists of three parts and five modules. The first part is the rendering of the primitives management module. The rendering primitives management module is mainly used to manage the rendering primitives, which allows the programmer to use the rendering system efficiently. This part includes two modules: the management of the vertex and the shader, and index management module. These two modules are independent and complementary to each other, but they need to work together. The second part is the part of realizing the rendering function. This section consists of two modules: the material and texture modules and the rendering queue. The material and texture modules are used to manage material and texture, and prevent the renderer from reading the same material and texture repeatedly. The rendering queue mainly plays two roles: one is to ensure the correct drawing order. For example, the sky box is drawn first, then the general object is drawn, and the final drawing interface is made. Two is to improve the efficiency of the rendering. The objects that conform to certain conditions are drawn together to reduce the switching of the rendering state as much as possible. The third part is the grid model, which uses the first two modules to render the model. The system structure diagram is shown in Figure 1. Among them, the original language management module and rendering function module are not specific modules, they are a conceptual module which is abstracted from specific modules according to functions.

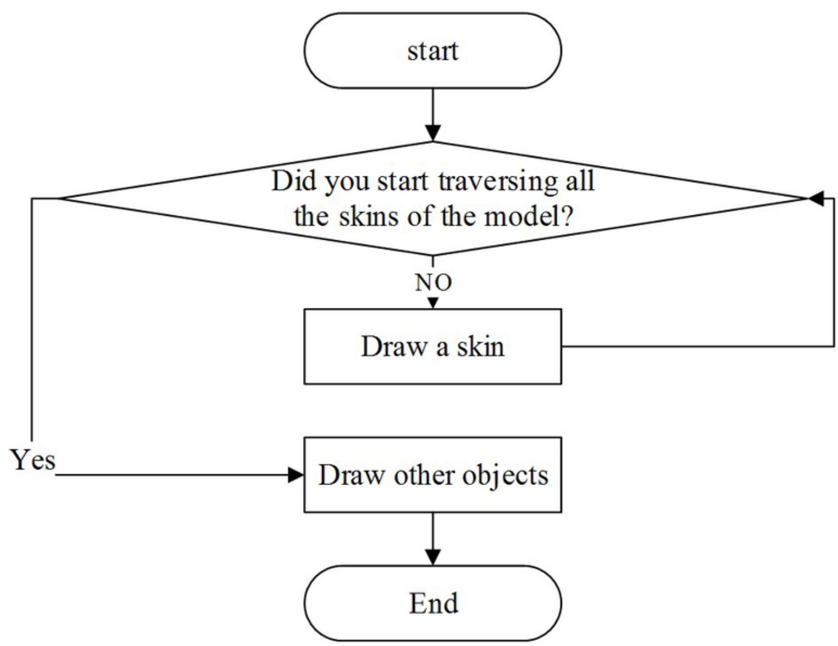
Figure 1. Renderer overall structure diagram



The grid model is one of the most important parts of a game. A game is sure to have a lot of models, such as characters, buildings, plants, etc. Moreover, the mesh model is made up of points set with rendering information through mutual connection. Therefore, programmers are not very realistic in designing a model by constructing their own vertex. Basically all the models in the game are obtained from the model script, so the model must be scripted. In general, the design and modeling of the model are done by modeling software, such as 3dsMax and Maya. The grid files of these modeling software have already scripted the model, so we only need to use the export plug-in to export it into the model format we need. In addition, the fbx file can be used too. The fbx is a relatively new format, which is a free cross platform content exchange format for Autodesk. Both 3dsMax and Maya support export in FBX format, and there are many other 3D content making programs that also support import and export of the format. This format is especially suitable for animated models, bones and skin in XNA. XNA provides two class processing models and grids: Model and ModelMesh. We can manipulate the models created in 3dsMax and Maya with these two classes. The basic flow of the grid model in XNA is shown in Figure 2.

A grid model is a set of vertices with a certain order. For the game engine, efficiency and extendibility are very important. So, it needs to be managed in a different grid in the xVR engine. That is according to different grid material into a plurality of grid data fragments, each fragment of grid data using the same

Figure 2. Network model drawing flow chart



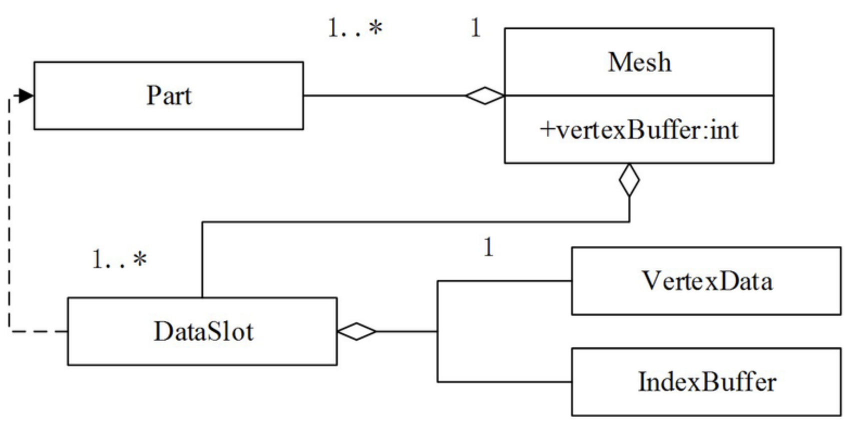
material, all grid data shared vertex buffer fragments of a grid, and a unified starting index buffer counter, each grid data segment has a vertex buffer between them, as shown in Figure 3 shown.

As you can see in Figure 3, the Mesh class has a common vertex buffer that can be shared with a grid data fragment. Each grid data fragment is composed of the instance segment Part and the data fragment DataSlot. Among them, the Part class is responsible for managing the specific instances of the grid and creating and managing the geometric map data. The DataSlot class is mainly responsible for the management of common vertex buffers, vertex data and index buffers, as well as the geometric metafile data for each grid. Each grid data fragment has its own material or texture. For example, you can wear clothes and pants for a human body model and he can change his clothes and pants in the game. In this example, the human model can be placed in the vertex buffer of the grid, and the upper and lower bodies are stored in different Part, respectively. These Part can create different materials or textures, and each Part has a DataSlot that corresponds to the management of vertex data and index buffers. In this way, when you need to change the character's clothes or pants, you only need to change the material or texture of the corresponding half.

3.2 3D Animation Construction Algorithm Based on Skeleton Static Model

The three-dimensional human body model can be regarded as a set of bones connected by a series of connections, for example, the upper limbs are connected by the upper and lower arms and the elbow joints, while the upper arms and trunk are connected by shoulder joints. The skeleton structure is a series of connected bones that form a hierarchical relationship. In these bone sets, there is the only bone called the root bone, which is the center of the entire skeleton structure. Other bones are attached to the root skeleton as a descendant. When the skeleton is retrieved, it is usually carried out according to the hierarchical relationship. It is

Figure 3. Grid model and its data fragment class diagram



first to find the skeleton (pelvis) that forms the skeleton, and then the root bones begin to be retrieved until the needed bones are found. The skeleton is organized into a tree structure according to the hierarchical structure of the father and son. Like a tree structure, all bones in the skeleton structure are connected to the upper bones and eventually connected to the root bones. For the calculation of key structure similarity, the key structure information includes two kinds, one is the coordinate information of touch point and the other is the coordinate information of the touch-controlled component. The video recording of this platform is based on the coordinate information of touch points and driven by events. Therefore, in order to improve the accuracy of adaptive matching, touch point coordinate information needs to be calculated by key structural similarity to determine the key structure of the splicing point. The calculation of similarity is introduced into the distance formula of two points in Euclidean space. It is assumed that x, y is the two point of n-dimensional space, and the Euler distance between them is:

$$dist(X,Y) = \sqrt{\sum_{i=0}^{n}(x_i - y_i)^2} \quad (1)$$

when n=2, the Euclidean distance is the distance between the two points on the plane. When Euclidean distance is used to express similarity, the following formula is generally used: the smaller the distance, the greater the similarity:

$$sim(x,y) = \frac{1}{1+d(x,y)} \quad (2)$$

So the similarity between the key structure Gi and the Gj (distance difference) Sim C Gi, Gj) is calculated as follows:

$$Sim(G_i,G_j) = \frac{1}{1+D(G_i,G_j)} = \frac{1}{1+\sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}} \quad (3)$$

In the setting of the threshold, the setting of the threshold can be derived according to the similarity calculation formula. In the described scene, the stitching condition that the locus of the touch point can accept is related to the pixel information of the coordinate points. After a lot of data experiments, the acceptable maximum pixel is 2, and the threshold value is calculated and deduced. The values are as follows:

$$\begin{aligned} \varepsilon &= \frac{1}{1+\sqrt{2^2+2^2}} \\ &= \frac{1}{1=2\sqrt{2}} \\ &\approx 0.261 \end{aligned} \tag{4}$$

Therefore, when the similarity is greater than the threshold 0.261, the stitching point which is found at present is the closest matching point. The usual criteria for judging the degree of precocious maturity of chromosomes are the size of the difference between the maximum adaption value and the average fitness of the chromosome, that is:

$$\Delta = f_{\max} - f_{ave} \tag{5}$$

when Δ is relatively large, the chromosomes are quite different and the population maintains a good diversity. Otherwise, when people are relatively small, it shows that the chromosome individuals in the population are closer, and the local or global convergence appears. One of the drawbacks of such a criterion is to consider the poor fitness of chromosomes, which do not really reflect the convergence of a good individual. So the criterion is improved to the D-value between the maximum adaptive value and the mean of all the adaptive values of the chromosomes exceeding the average fitness value:

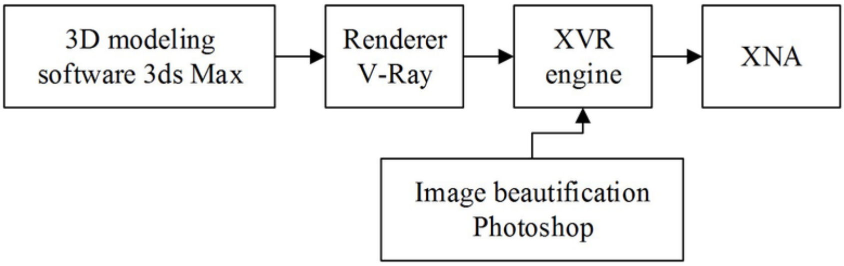
$$\Delta = f_{\max} - f_{ave(\max)} \tag{6}$$

By calculating the algorithm, the skeleton becomes the final shape that should be presented at this time. The fifth step is to calculate all bones with the transformation matrix as a key step in the skeleton animation, which is responsible for the ability to move the vertex together with the skeleton. In this step, for each vertex in the skin grid, the new position and orientation in the world coordinates need to be calculated one by one.

4. RESULT ANALYSIS AND DISCUSSION

Based on the above analysis, Autodesk's professional modeling software 3dsMax is used to build the geometric model of the virtual scene. V-Ray, Photoshop and other software are applied to render and beautify the model. Then it is exported as a FBX model file, and then in the way of programming in the XVR engine, the model FBX file is loaded into the scene. Finally, after rendering the model by renderer, the final model is displayed in the window, and users can interact with each other through keyboard and mouse, such as field control, switching scenes, etc. Figure 4 is a flow chart of the experiment.

Figure 4. Design flow chart of virtual reality system



Making a good model in 3dsMax is only the first step in the implementation of the system. The next produced files need to be exported to FBX format, then the exported FBX file is added to the Content folder on the solution resource manager window of VisualStudio2008 development. Finally, the work of adding the model file to the developer is completed. Because the display can support the limitation of resolution, the test was done at 800 X 600, 1024 X 768 and 1280X1024 four resolutions, and at each resolution, the adjustment of the quality of the four level of the model was carried out. In the actual test, the test is performed automatically, and the running picture is moved from the beginning to the end. The FPS engine uses the record function in the whole process to record the time (60 seconds) the average frame range, in order to test the performance of the algorithm under different settings.

X 600 resolution is the lowest resolution of the test. As shown in Figure 5, even under the super high picture quality, the FPS of the system can still remain at about 37, indicating that the XVR engine can run smoothly. The resolution is increased to 1024 X 768, and the FPS of the system can be maintained at 35 when the image quality is super high. Moreover, it can be seen from the graph that the overall operation speed of the system is not much different from that of the 800 X 600 resolution under the same picture quality. Finally, the resolution is increased to 1280 X1024. The test result is shown in Figure 6.10. Even under the super high picture quality, the FPS of the system can remain at 35, and the overall running speed of the system is not much different from that of the 800X 600 with the same picture quality.

Table 1. The advantages of the algorithm

<table>
<tr><th></th><th>Node data amount (one)</th><th>XML file size (KB)</th><th>Traditional brute force algorithm time consuming (S)</th><th>This paper studies the time consuming of algorithms (S)</th><th>Improvement (%)</th></tr>
<tr><td>Low quality</td><td>99</td><td>16</td><td>0.761</td><td rowspan="2">0.171</td><td rowspan="2">76.99</td></tr>
<tr><td>Medium quality</td><td>210</td><td>32</td><td></td></tr>
<tr><td>High quality</td><td>288</td><td>16</td><td></td><td>0.522</td><td>82.85</td></tr>
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Figure 5. The advantages of the algorithm in this paper

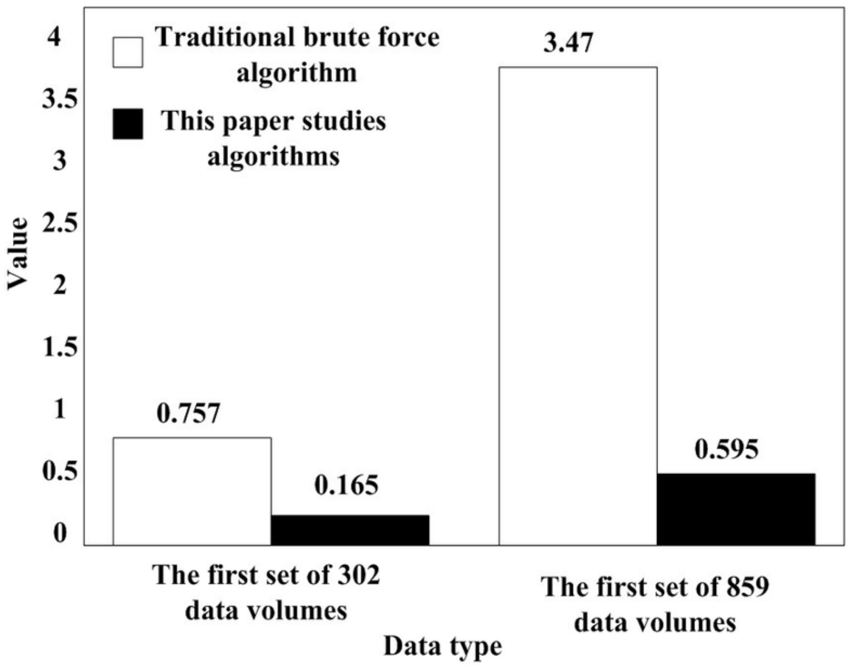
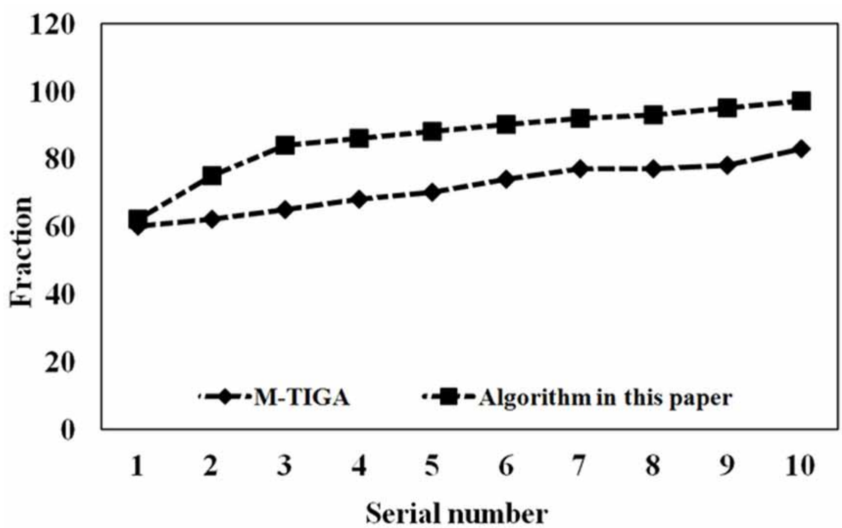


Figure 6. Comparison between the algorithm of this paper and the M-TIGA algorithm



From the above tests, we can see that the virtual reality system built using the XVR engine is not very resource - consuming. But there is a great difference in the performance of the system for different qualities. The use of super high quality can be a good way to experience the quality of the picture, but the speed of running is greatly influenced. Under the condition of low image quality, the system performance can easily break through 150 frames. At this time, the quality of the picture has been greatly lost, but this can ensure the smooth operation of the system for the low configuration computer. Therefore, different drawings can be used to meet the requirements of different users on the quality and fluency of the picture, and balance between the quality and fluency of the picture. In a word, as a practical technology, virtual reality technology is becoming more and more mature and more and more widely used. With the improvement of hardware performance, the game engine has been completely comparable to the high-end virtual reality engine, both in technology and in the quality of the picture. If we can successfully apply the game engine to the production of virtual reality, it will well balance the three difficult factors of picture quality, running speed and development cost in virtual reality application. Therefore, the use of game engines to make virtual systems has a good commercial application prospect. In addition, the engine is based on platform development, which is an engine for small 3D games and virtual reality systems. It provides programmers with rendering, animation, special effects, input, physics and sound effects modules, and provides particle effect editor, scene editor and other auxiliary development tools.

5. CONCLUSION

As a practical technology, virtual reality technology is becoming more and more mature and more and more widely used. With the improvement of hardware performance, the game engine can be compared to the high end virtual reality engine in technology and picture quality. If you can successfully apply the game engine to the production of virtual reality, it will be a good balance of the various factors in the virtual reality application. The application of intelligent algorithm in the animation design of 3D graphics engine is studied in this article. First, the development status of virtual reality at home and abroad is briefly introduced. Meanwhile, the advantage of XNA platform is utilized, and a XVR engine is developed independently, and its overall architecture and core module design are analyzed in detail. The XVR engine is developed on the XNA platform, which is an engine for small 3D games and virtual reality systems. Finally, two different virtual reality design algorithms are implemented using the XVR engine. Then the basic uses of the main functions such as rendering, animation, special effects, GUI, input, physics, AI, and sound effects are described. Finally, the algorithm is tested. The test results show that the engine and corresponding algorithm designed in this article can be effectively applied to 3D animation design, and it is feasible to further promote.

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