Virtual Human Motion Real-time Rendering Technology

Ren-jie XU* and Luo-hua ZHAO
Academy of Armored Forces Engineering, Beijing 10072, China
*Corresponding author

Keywords: Virtual Human, Real-time rendering, LOD.

Abstract. In this paper, we summarized the existing three-dimensional virtual human body model representation method with real-time and realistic requirements as a starting point, and proposed several virtual human motion rendering method to realize virtual human real-time drawing.

Introduction

The last few years have seen great maturation in the computation speed and control methods needed to portray 3D virtual humans suitable for real interactive applications. The model representation and real-time rendering of 3D virtual human body is the basis of the research of large-scale virtual population motion rendering technology, which directly affects the efficiency of large-scale virtual population movement drawing.

In the large-scale scene rendering display, there are three main categories of basic algorithms, namely Visibility Culling (Visibility Culling), based on the grid simplification method (Level Of Detail, LOD), based on the image display method (Image Based Rendering, IBR). Motion mapping of large-scale virtual population can also be accelerated by the above-mentioned general techniques, such as the algorithm proposed in [1], but if simply applying static rendering acceleration techniques may result in a decrease in rendering quality or an increase in drawing time, It is necessary to combine these common real-time acceleration rendering techniques to find a unique real-time rendering technology suitable for large-scale virtual population movement drawing. The following analysis of each method, and a brief analysis of virtual human motion rendering unique acceleration technology, Which will be based on those method for the large-scale virtual population movement rendering technology research.

Visibility Removal Method

Visibility Removal Method [2] The principle is to remove the current point of view is not visible patch, only draw visible surface, in order to achieve the purpose of rapid drawing [3]. Visibility Culling is an important algorithm for quickly judging invisibility, which estimates the visibility or invisibility of a drawing element group to quickly reject those that are clearly invisible Draw the element to get a Potentially Visible Set (PVS), that is, all or most of the visible drawing elements and some invisible rendering elements. The objective of the object removal is to estimate the occlusion relationship between the objects by the spatial relationship between the geometric objects in the scene. Visibility calculation methods include Back-Face Culling, View Frustum Culling and Occlusion Culling, as shown in Figure 1. Among them, the method of visual culling and back counting has been relatively mature, often combined with the scene of the spatial level and multi-resolution organization for the application, can effectively remove the scene of the corresponding invisible part of the blockade must take into account the scene. The interdependent relationship between the drawing elements is more complex and is the focus of the study of the visibility.

In recent years, with the development of GPU programming technology, the mainstream graphics hardware basically provides a hardware blocking query function [3]. Staneker et al. Avoidance of occlusion tests of visible scene graph nodes by occupying graphs; Bittner et al. [2] and Kovaleik et al.
Proposed hierarchical occlusion caching algorithms based on hardware occlusion queries to reduce the unnecessary occlusion of the scene using spatial consistency of visibility Test; Gao Yu et al [3] by optimizing the selection of each frame block query, further reducing the number of occlusion tests in the scene.

Method Based on Grid Simplification
J. H Clark proposed the concept of a multi-level detail grid model in 1976, and then the grid simplification algorithm has been proposed and experienced a static LOD, dynamic LOD and perspective-related LOD and other stages of development. In recent years, from the simplified static model, the researchers have proposed some algorithms to solve the problem of the simplified model of moving objects. This section will analyze this.

Simplification of Static Model and LOD
The static LOD generates a limited number of substitutes with different complexity by simplifying the original model. The application model determines the model substitution instead of the original model based on the size of the observer's distance or the size occupied on the screen. These substitute models and selection mechanisms form the static LOD method. The most typical of these algorithms are Mesh Optimization [5] and Simplification Envelopes [4]. The former is optimized by the energy function to optimize the geometric position of the points in the grid and its topology connection and reduce the vertex of the model. The final simplified model is generated by continuous edge folding, edge switching and edge segmentation. Simplification Envelopes creates the "enclosing" inner and outer enclosing bodies for the original model, and the geometries that are generated or changed during the constraint simplification process are not allowed to go beyond the enclosed areas of the two "envelopes" Control the simplified global error and achieve a very good effect. Static LOD simplifies the algorithm to reduce the cost of display and increase the size of the display. However, due to the separate generation between the various levels, the transition between the alternatives, often in the visual lead to "unexpected" phenomenon, and storage capacity increased dramatically. In view of this, the researchers made a smooth transition between different substitutes as part of the simplified algorithm, resulting in dynamic LOD.

Dynamic LOD uses the original model and a series of simplified records to construct a series of simplified models with continuous changes in complexity, reducing storage capacity, emphasizing the continuity of visual transition, and facilitating the gradual transmission of grid models over the grid. The typical algorithm is Progressive Meshes [6], which uses the energy function simplified by Mesum Simplification as the objective function, and constantly performs the edge folding operation.
on the current model, and obtains a series of simplified records. The simplification is similar to Mesh Optimization, and the efficiency is greatly improved. However, the model of simplifying 70,000 polygonal patches still needs nearly one hour.

Dynamic LOD and J. H. Clark's original idea of a multi-resolution model led to the emergence of viewpoint-related LODs. First, the dynamic LOD calculation is carried out on the model. Secondly, the simplified records are clustered and organized into a tree structure according to the simplified local correlation. The simplified model is generated by the hierarchical traversal calculation. With the help of the tree structure, the nodes in the current perspective or the back of the cutting point, the distant, relatively flat area nodes rough said, the contour, the curvature of the region, toward the observer side of the fine, reduce display costs, improve display quality, such as Hoppe et al. [7].

In recent years, with the graphics hardware processing capabilities continue to increase, the use of static model LOD to complete a certain scale sports scene display has gradually become possible. The Swiss Federal Institute of Technology (EPFL) Virtual Reality Labs used a static LOD approach in the restoration of the ancient Roman theater [8]. They are in the theater for each audience modeling four LOD, OpenGL display list to store the layers of LOD, different LOD different gestures, are corresponding to a display list of OpenGL. However, a large number of manual modeling work increases the burden, and the practice of framing the motion model's posture as a static model hinders a smooth transition between the frames, so that the static model is simplified based on the study of motion. The model's realistic simplification technique is a problem before the researchers.

Simplification of Dynamic Model and LOD (LOD animation)

The dynamic model LOD algorithm is divided into three categories. The second class is the attitude-independent LOD control method. Firstly, the LOD control method is used to analyze the game. And then the simplified algorithm is used to generate a simple simplified record. Finally, the deformation of the model is used to generate the simplification of multiple gestures. The coupling of the algorithm is stronger than that of the model. The third kind is the simplification and simplification of the attitude. Specifying a specific frame, the generated single simplified record can be used for multi-frame by means of the deformation algorithm, and the coupling of the algorithm to the model attitude is the weakest.

Shamir et al. Independently simplify the frame, using a data structure called T-DAG (Time-dependent Directed Acyclic Graph) to fuse all the simplified records [9] [10], as shown in Figure 2, each node in the structure has its own Survival time. The advantage of this structure is that it

Figure 2. T-DAG graph of 5 time series.
has nothing to do with the topology of the grid and the deformation algorithm that produces each animation frame. The disadvantage is that there is no correlation between the simplification of each frame, and the data structure is large. Every time it needs to start from the root node of the graph Traverse to generate the appropriate gesture of the appropriate LOD representation. Kircher & Garland has made improvements in this context [11]: simplifies the first frame first, and then the simplification of each frame begins with a simplified result of the previous frame, and the continuation of the edge transformation operation and the update calculation make the current simplification result closer to Actual gesture. The method is at the expense of a certain approximation effect, but reduces the amount of storage and makes the transition between the frames smoother.

Decoro & Rusinkiewicz's method is based on a linear fusion of skin deformation methods (also known as SDD) and Qslim simplification algorithms. The linear fusion method is based on the static model and the skeletal structure, and the movement of the vertex is expressed as the weighted sum of the effects of the movement of the center of the different bones. The main idea is to express the quadratic error matrix into the spatial function of the vertex position in the model animation. The final quadratic matrix is calculated by the weighted integral of the function, and the simplified record of the static model is generated, and the simplified method is generated by the skin deformation method. Of the animation frame. The calculation of the second error takes into account the probability of each possible posture and the probability of occurrence, thus improving the quality of the LOD animation. The disadvantage of this method is that the selection of the integral region affects the final result, and the simplified process is still tightly coupled with the animation frame, affecting the application of the simplified results.

The geometric properties of the dynamic model vary from one pity to a specific pose, and cannot be handled simply by the static model, but only on the former, otherwise it will cause relatively large aliasing. The fully simplified algorithm can generate very good approximation effect, but the tight coupling with the animation frame leads to the increase of the storage capacity and the decrease of the real-time performance, which is not suitable for the drawing of the large-scale virtual population movement. The attitude-independent LOD control method can Generating a good quality frame approximation body, and generating a simplified state of many gestures, but because of its simplified process depends on the attitude of the model, therefore, the scope of application of simplified records is limited. It is ideal to simplify the attitude of nothing. Although there is a certain loss in the quality of the simplified approximation, but in the case of strict quality requirements, the use of the generation process and model attitude has nothing to do with the same simplified record processing of various sports state, very suitable for large-scale crowd model more abundant movement attitude.

**Image-based Display Method**

The first article based on the image display was published in 1976 by Blinn et al. [12]. They normalize Catmull's concept in 1975 [13], map the texture to the surface of the object, and present the concept of environmental mapping. Used to imitate the curved and polished surface after the reflection of the surrounding, used to predict the scene to display the picture, Lipman extended this environment map, the entire scene as a series of images of the combination. In his essay, the three-dimensional display of a town is made up of discrete viewpoints and panoramas of each viewpoint. Chela uses images to represent a single object, and then implements a system called "object movies" that uses the same method to construct images of other objects of the same object. Another way to reconstruct other view images is to map the resulting image to a rectangle through a texture, and to display the rectangle from a different perspective, the so-called "imposters".

**Virtual People Unique Accelerated Rendering Technology**

The large-scale virtual population motion drawing can also be accelerated by the above-mentioned general techniques. For example, the algorithm in [14] draws near the avatar grid when drawing a
scene containing a large number of virtual human models. Image caching techniques, farther virtual people with texture rendering on a single polygon. This is roughly the same as the real-time rendering of general scenes. But because people are different from other parts of the scene, with some unique properties, such as complex skeletal structure, the number of degrees of freedom and so on, and people are moving, so the mapping technology should be adjusted accordingly, just simply apply static drawing acceleration technology May result in a decrease in the quality of the drawing or an increase in the drawing time. For example, in the work of Tecchia et al. [15], the human body is drawn with a pre-sampled texture, and when the viewpoint is close, the rendering is significantly reduced. People are of higher importance than other objects in the scene, which usually require a higher priority to be given to the virtual man when scheduling the drawing time of each object. Therefore, the need to combine these real-time rendering acceleration technology, to find a suitable for large-scale virtual population movement of the unique real-time acceleration technology.

References