PAPER • OPEN ACCESS

High Performance CAD Conversion Processing and High Performance Display Technology for VR Virtual Application

To cite this article: JiuXin Cui and JunSheng Wang 2018 *IOP Conf. Ser.: Mater. Sci. Eng.* **452** 042134

View the article online for updates and enhancements.

High Performance CAD Conversion Processing and High Performance Display Technology for VR Virtual Application

JiuXin Cui[1, 2, a], JunSheng Wang[1, 2]

[1]State Grid Electronic Commerce CO., LTD. / State Grid Xiongan Financial Technology Group CO., LTD., Beijing 100053, China
[2]Power Finance and Electric Commerce State Grid Corporation Laboratory, Beijing 100053, China

[a]cuijiuxin118@163.com

Abstract. Virtual Reality (VR) is a new computer technology used to create and experience virtual worlds. It has been widely used in aerospace military, complex equipment, automotive, BIM, medical, education and other industries. Based on the background of VR technology application and industry needs, this paper introduces the key technologies of 3D data conversion processing and high performance 3D display required to realize VR technology application.

1. Overview and requirement analysis of virtual reality

Virtual Reality (VR) is a popular computer 3D application technology in recent years. VR technology is a collection of various technologies such as computer graphics, human-computer interaction techniques, sense technology, artificial intelligence, etc. It uses VR hardware devices to generate realistic 3D experience. Users can experience roaming and interaction in the virtual world by wearing a VR device. In recent years, VR technology has gradually moved from laboratory research projects to practical applications. At present, VR technology has been widely used in aerospace military, complex equipment, automobiles, BIM, medical, education and other industries.

Human-computer interaction and immersive experience are two core features of VR technology, which is the basis for the design and use of VR applications. Human-computer interaction refers to the interoperability between the user and the virtual analog world in a real-world interaction mode, and outputs and feels real-time feedback from the virtual world through specific hardware devices. Immersive experience means that the user seems to be completely immersed in the virtual world and experience a specific scene. Good VR technology can make the user's experience difficult to distinguish from the real world.

The 3D CAD design system with intuitive and efficient data management, improve the design efficiency and quality and other characteristics. It enables designers to capture their design intent more agilely and stimulate design inspiration. [1]. It is an important tool for enterprise designers to innovate. At present, UG, CATIA, PRO/E, SINOVATION, etc. have been widely used in aerospace, motor-dom, parts, mold and other industries. In actual VR applications, most of the data can not be re-modeled, but the output conversion processing needs to be performed from 3D CAD, which can greatly reduce the model processing workload. In many complex applications, the 3D model is very large, and can reach about 100,000 pieces. It takes more than 20G memory to open this model. Such a large model, VR

application can not be directly processed. Through SView 3D model lightweight processing technology, this project can transform the existing complex CAD model into lightweight format to achieve high-performance 3D display applications, such as scaling, rotation, content display, etc., to enhance the actual VR application experience.

2. The key technology of three dimensional for virtual reality VR application

High-quality virtual reality VR technology needs to solve various technologies of three-dimensional data reading, conversion, weight reduction, storage and display in the application. The overall process is shown in Figure 1. The key technologies in this paper include CrossCAD 3D data conversion processing technology, SView 3D lightweight technology, SVL 3D lightweight data storage technology, VR display parallel computing scheduling and processing technology and VR display acceleration technology, and so on.
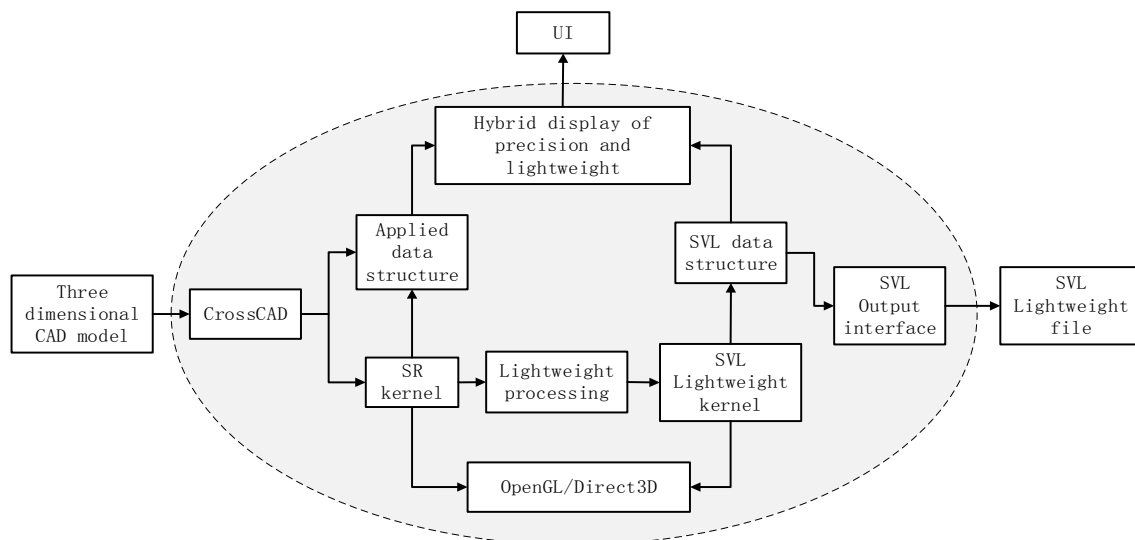

Figure 1. 3D digital-to-analog conversion, processing and lightweight technology for VR applications

2.1. CrossCAD three-dimensional data reading and conversion technology

The 3D information displayed in VR is usually modeled by CAD software, so it is necessary to support the data import of various 3D mainstream CAD digital models, including product information import, including BOM structure, attribute information, PMI and so on, in order to achieve the accurate use of upstream design information.Users can easily browse the 3D product digital model of the product in the VR application, and can also make VR maintenance instructions and VR virtual training and other functions.

CrossCAD 3D Data Conversion Interface supports reading from various mainstream digital-analog visual information, and then converts the read visual information into application data structure storage. These visualized data can be transformed into SVL lightweight kernel data through lightweight engine, lightweight and data compression, and output SVL file through SVL output interface.

Based on CrossCAD three-dimensional data conversion technology, data reading of various general three-dimensional CAD digital-analogs is realized, and converted into a three-dimensional lightweight format for storage, so that the three-dimensional data conversion process can be realized. Supports data reading of various mainstream CAD such as PRO-E/NX/CATIA, and supports data reading in standard intermediate formats such as STEP/IGES. From the aspect of reading content, it supports PLM core content functions such as PMI 3D annotation , product BOM structure and etc. to meet the needs of high-end applications.

IMMAEE 2018

IOP Conf. Series: Materials Science and Engineering **452** (2018) 042134

IOP Publishing

doi:10.1088/1757-899X/452/4/042134

2.2. SView lightweight technology

Section 2.1 after reading various CAD data using CrossCAD technology, it is necessary to use SView lightweight technology to perform 3D data reduction and compression, which greatly reduces the size of 3D data. For VR big scenes, network publishing, browsing, collaborative design and other operations, the operating speed is greatly improved, memory requirements are reduced, and usage efficiency is improved. In VR lightweight applications, mesh simplification technology, feature simplification technology and contour display technology are its core technologies.

(1) Mesh Simplification Technique: A simplified model is obtained by repeatedly "moving away" geometric elements (point, edges, faces) from the triangle. The "moving away" operation is divided into three situations: direct deletion, by merging two or more faces to remove edges or faces, and folding edges or triangles. The move or delete operation is performed until the model cannot be simplified or the user-specified approximation error is reached.

(2) Feature Simplification Technique: a series of standards are established to simplify the description, display, management and update of many details of parts (such as threads, holes, fillets, chamfers, etc.), or to suppress some unimportant features.Improve loading and display efficiency while reducing data volume and display time.

(3) Contour display technology: Through the display algorithm, the shell data of the three-dimensional graphics is extracted, and the detailed features inside the product are ignored, thereby reducing the data amount of the product, simplifying the display of the product, and improving the display speed.

2.3. SVL three-dimensional lightweight storage technology

High-performance VR applications cannot directly use bulky raw CAD files and require a completely autonomous lightweight 3D format. Based on the 2.2 three-dimensional lightweight processing technology, a file stream is added when processing components, which is used to store lightweight mode data, or save the data as a separate format file, named SVL, where the file is designed a special browser for browsing and network transmission of SVL files.

The SVL format supports direct conversion of various general-purpose CAD data. The compression ratio can reach about 1:50. It can realize high-performance browsing of over 10,000 parts and components, support different LOD level display, support SView embedded application, and can be transplanted to a variety of platforms to support VR needs.

The SVL lightweight data format stores various basic 3D feature information (constitution faces, boundary lines); stores and edits user comments; supports delayed loading; supports indexing of different LOD levels; supports data compression; provides geometric data for precision measurements provide data protection; provide a single, decentralized file structure to support multiple applications; in the future, you can design a "transaction" server to support multi-user collaboration; you can design an "online transfer" server (not saved locally when delivered, to meet the need for confidentiality); support PMI, two-digit drawing storage, become an excellent lightweight data storage solution. It can be ported to multiple platforms to support tablets and more.

The SVL format file is supported by various applications and is classified into two types according to the lightweight accuracy level: SVL1 format file and SVL2 format file. Among them, the SVL1 format file can be opened in the browser, and can be moved, rotated, scaled, labeled, etc. The file format is very small, and is mainly used for network transmission, product promotion, and the like. The SVL2 format file can be opened and operated in the browser, and can be opened in SINOVATION for simple editing.

2.4. VR shows scheduling and processing strategies for parallel computing

Parallel computing can be divided into parallel in time and parallel in space. Parallelism in time refers to pipeline technology, while parallelism in space refers to performing computations concurrently with multiple processors. Its main purpose is to quickly solve large and complex computing problems.

Applying parallel computing technology to the VR display engine will significantly improve the processing efficiency of each functional module in processing large-scale data. The problem of bottleneck of research system is analyzed, and the multi-threaded general interface is realized. The thread safety of display module and database module is analyzed and processed. The display data loading and processing technology is improved to improve the display problem of large data volume.

The multi-threading technology is applied in the VR display engine to utilize the parallel processing capability of the computer multi-core, and the processing and display speed of large-scale data is improved while occupying less system resources. The parallel processing of the display engine is mainly reflected in the loading and storage of data, the rendering calculation and display of graphics, and the processing of assembly relationships. Through parallel computing processing, aiming at the improvement of rendering function, can increase by 30% on dual-core graphics server and 40% on quad-core graphics server; research on refreshing technology of file, assembly and other panels in the case of large amount of data, improve refresh efficiency; multi-threaded processing to improve efficiency.

2.5. Research and application of VR display acceleration

By analyzing the latest mainstream display acceleration schemes, VR display acceleration uses display data recombination, LOD (level of detail) technology, GPU-based real-time rendering and other technologies, combined with the latest software and hardware resources of the computer to improve the display speed of VR large-scale data.

(1) The display data recombination technology is used to improve the VR display scheme and solve the problem of low display rendering efficiency caused by complex geometric model data.

(2) LOD techniques and algorithms mainly include vertex deletion method, redistribution method, energy function method, merged co-planar polygon method, triangle deletion method, edge degeneration method, and so on. Through screening, applying reasonable algorithm and model simplification based on geometric feature recognition, according to the approximation accuracy requirements of the original model, the geometric feature information in the model is identified and retained, and the redundant information is eliminated, so as to achieve the simplified purpose of the display model [2].

(3) The rapid development of GPU provides advanced graphics technology support for computer real-time graphics technology. Research based on the latest GPU real-time rendering technology will improve the following aspects in VR products: using pixel lighting calculations. That is, the light intensity can be calculated separately for each pixel instead of being interpolated by each vertex. Using pixel illumination, the illumination effect of the spotlight and the point source can be better exhibited, and the convex and concave effect on the surface is also stronger than the vertex illumination. Using a user-defined lighting model, users can use their own defined functions to calculate the color of each vertex or even each pixel without having to follow the lighting model in traditional Open GL; using real-time shadows to solve the aliasing in shadow mapping; using process textures to describe many textures in nature, such as marble, wood grain, etc., can easily obtain texture shape changes without actually taking texture photos [3].

3. Summary

After decades of development, virtual reality technology is currently undergoing an explosive application development phase. However, from now on, after solving the difficulties of VR application technology such as CAD conversion, lightweight processing, and high-performance display, the problems affecting VR promotion and application are problems such as insufficient user experience, insufficient content, and high price. With the reduction of production costs, cost-effective, high-performance and high-quality VR applications will gradually solve these problems, and VR will gradually develop into an application technology that profoundly changes our lifestyle.

References
[1]   Wang Gang's research on real-time collaborative design based on AutoCAD 3D modeling [D] .Southwest Jiao Tong University, 2011
[2]   Xiong Qinglei. Design and Implementation of Virtual 3D Scene Roaming System [D]. University of Electronic Science and Technology of China, 2013.
[3]   Ying Zhengming. The Technology Research for Hardware Accelerated Cad Display [D]. Zhejiang University, 2003.