CAVEMAX, PLUGIN FOR 3D STUDIO MAX FOR REAL-TIME VISUALIZATION AND NAVIGATION IN VIRTUAL REALITY CAVE-LIKE ENVIRONMENTS

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ABSTRACT

This research describes the software CaveMax, plug-in for Autodesk 3D Studio Max (3ds Max) that increases the 3ds Max in order to allow both visualization and editing of three-dimensional models in a CAVE (Cave Automatic Virtual Environment) environment. Then, it allows visualization and editing of CAD models, like buildings, vehicles or oil platforms projects, without conversion of file formats from 3ds Max to other third party software of visualization in CAVE. Moreover, it permits easy installation, real-time navigation, remote update and visual fidelity, causing a great sense of immersion to the user. First, some similar software is addressed. Then the main objectives are described and then your client-server structure. Finally, a brief description of use and possible future works are addressed too.

Keywords: 3D Studio Max, CAVE, virtual reality, real-time navigation

1. INTRODUCTION

The software Autodesk 3D Studio Max (3ds Max) is one of the three-dimensional modelling software most used in the market. However, its use in virtual reality environments, that promote the sense of immersion, is complex and costly, requiring the purchase of visualization management softwares, and conversion between file formats. One of these environments, introduced in (Cruz-Neira, Sandin, DeFanti 1992), is called CAVE and uses projectors to display images in full size projection screens around the user. In this way, the user feels immersed in the three-dimensional scene.

Such environments can be used in conjunction with 3ds Max because of their modular construction. This structure, under which the 3ds Max was built, allows independent developers, i.e., those not subjected to Autodesk, to add new functionalities to the software by creating plug-ins (Autodesk 2007).

The main goal of this paper is let the reader to understand the advantages of CaveMax related to CAVE visualization. It allows engineers, architects, designers and related professionals see their projects developed inside 3ds Max on such virtual reality environments. For instance, an engineer would be able to see a designed car, remove its wheels, open its doors or turn it to another angle of view, all this using the 3ds Max. Another example would be an oil platform model, where involved professionals could visualize and navigate through its installations viewing all the details collectively.

2. CURRENT ALTERNATIVES

This section will discuss some existing software that enables viewing 3ds Max models in CAVE. In general, they require conversion between file formats, so that there may be loss of information from the scene, making the visualization in the CAVE different from the visualization in 3ds Max.

2.1. The CaveUT System

The CaveUT system (Jacobson 2005), is a CAVE visualization software that uses the Unreal Tournament engine. Its big advantage it is open source so it reduces drastically the costs. It is only required to acquire the engine. However, it requires conversion from 3ds Max model to the Unreal format.

Originally, this implementation did not support head tracking neither stereoscopy (Jacobson, Renard, Lugrin 2005). But it has introduced this support as part of ALTERNE project (Cavazza, Lugrin, Hartley 2004) since the 2.0 version.

2.2. VR4Max

VR4Max is a commercial software developed by Tree C. Technology to work with virtual reality in 3ds Max (Technology 2009). This software is distributed in two versions, Generator and Extreme. The Generator is composed of Translator and Navigator Pro. The first is a 3ds Max plug-in which handles the scene exporting. The second is the software used to navigate and interact with the exported model. Thus, this software converts the 3ds max model to a file format that is directly managed by the Navigator Pro component. The Extreme version is able to connect many computers into a cluster to provide output for VR environments like a CAVE one.

2.3. Walkinside

Walkinside is "a powerful software application for 3D real-time visualization and simulation (…)" developed by VRcontext (VRcontext 2009). It has a patented real-time collision detection and gravity system which helps the user to walk in the virtual model through a virtual human agent. The Core Builder is required to convert 3ds Max scenes to the Walkinside VR Model.

2.4. Conduit

The Conduit (Mechdyne 2009) is other software for visualization in immersive and real-time CAVE-like environments. Differently from the others, the Conduit works directly from 3ds Max or other modelling applications. This key feature is made by intercepting OpenGL calls done by the modelling software and sending them to the CAVE computers. Then, these computers apply their camera transformations to show the right perspective for their wall. For this reason, this software does not need to convert file formats to keep the compatibility.

The disadvantage of this approach is when the modelling application optimizes the OpenGL calls. This means the application does not send all geometry to OpenGL, sending only that used to show the current view. If this occurs the other CAVE views will not be rendered correctly because the lack of information and the model visualization will be harmed.

3. OBJECTIVES

The CaveMax key points addressed in this section are ease to use, cost-effectiveness, efficiency and fidelity.

3.1. Ease to use

The installation step, as the first faced by the user, must be quick and easy. Thus, an installer was created using the NSIS (Nullsoft Scriptable Install System) (Nullsoft 2009).

The CaveMax needed to be integrated into the 3ds Max so that the 3ds Max user could access it easily through interfaces already known within 3ds Max.

The configuration is a relevant task for the right projection on the CAVE walls. Therefore, must be possible to be done by users that have only little basic knowledge about the CAVE structure. This means that, in the case of the CAVE is already ready for use, should not be necessary to ask help of a technician, as a network administrator, to configure the software. The basic configuration should also be made inside 3ds Max.

3.2. Economy of resources

The economy of resources is another key point in the development of CaveMax. In addition to licensing CaveMax, only the licensing of copies of 3ds Max is required. However, in a modelling studio, such licenses already exist, avoiding the purchase of new ones. Otherwise, more than one instance of 3ds Max can run on a single machine using de same license copy. Moreover, the CaveMax need to work with various versions of 3ds Max by increasing the chance to use it without purchasing new licenses.

Its integration with 3ds Max avoids costly and time-consuming with staff training to start using. As will be discussed later, only a few clicks are needed to start displaying the model in the CAVE and update the scene.

3.3. Efficiency and fidelity

The CaveMax is also based on the efficiency of navigation and the fidelity of the graphics and textures displayed in the CAVE. The real-time navigation works efficiently without large consumption of network bandwidth, ideal for viewing on CAVE. To navigate in the scene, the user must use only the Walk Through tool of 3ds Max, or other similar. Therefore, this process is also transparent to the user.

The fidelity of graphics aims to avoid the loss of information between the version of the model used by the user in 3ds Max and the one used by computers that project images on the CAVE. This is achieved by transferring the user's 3ds Max file directly through the network to the others 3ds Max instances (that project on the CAVE) without any conversion.

Another item, which combines both efficiency and fidelity, is the remote update of the 3D model. It allows changes in the scene made by the user to be reflected in the CAVE only by a click and a few minutes.

4. SOLUTION STRUCTURE

This section will discuss the structure of the used solution with some basic technical explanations about CaveMax operation.

4.1. Plug-ins overview

A plug-in as described in (Autodesk 2007) is a DLL (Dynamic Link Library) file of the Microsoft Windows operating system written in a specific location on the disk that 3ds Max can find and read. This file contains code that adds functionality to 3ds Max. The CaveMax installer undertakes to install this plug-ins to make them accessible for 3ds Max.

The solution used here specifies two types of plug-ins: the client plug-in and the server plug-in. The first is located in the user's computer and adds a few buttons on the 3ds Max interface and it is directly manipulated by the user. The second is in the machine responsible for rendering the images projected in the CAVE becoming completely invisible to the user.

4.2. Client-server model

Figure 1 illustrates the client-server model used by CaveMax. The client plug-in is located in the user machine (a) and communicates through the network (b) with the server machines (c) that render the images and project in the CAVE.

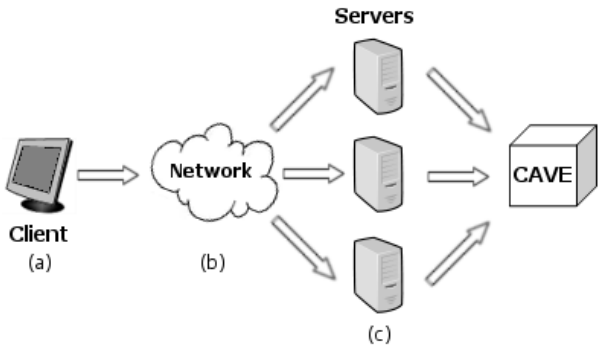

Figure 1: Client-server model

The server machines work in two stages, one step is implemented by the server application (SVRAPP) and the other by the server plug-in. Figure 2 below shows a server machine scheme. As can be seen, SVRAPP receives UDP and TCP/IP packets come from the network (more precisely from the client plug-in) and convert them into COM (Box 1998) commands which the server plug-in can understand and execute. Component Object Model or COM is a Microsoft technology that lets you create interfaces for communication between programs. As (Autodesk 2007) says the use of this technology is desirable.

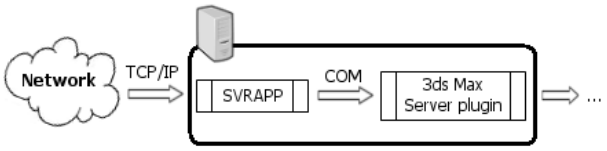

Figure 2: Server machine more detailed

The entire process of communication can be summarized as follows:

1. Client plug-in sends TCP/UDP commands;
2. SVRAPP receives commands from client;
3. SVRAPP invoke COM commands of server plug-in;
4. Server plug-in performs the requested operations.

The server application is an application for Windows that is constantly waiting for connection and orders from the client plug-in. These orders include initialization, logical configuration, updating, and real-time navigation.

The initialization is the process of starting 3ds Max on each server, enabling the respective plug-in. The logical configuration is that no related to the physical mounting of the CAVE, i.e., defines properties as the way to transfer files, network addresses of server computers, properties of each camera, screen resolution, etc.

The update allows the reflection of changes made in the model by the user while using the CaveMax. It consists of the transferring of files used in the model through the network and can be done in two ways as explained in the next section.

Finally, the real-time navigation requires only that the user has an active camera in the viewport of 3ds Max and navigates through the scene on his computer. Then, the CAVE is updated through the transfer of the camera transformation matrices. The advantage of this way is low network bandwidth consumption.

4.3. Modes of file transfer through the network

The two modes to transfer scene files are by shared folders and by private transfer. The first uses the shared folders (Lowe and Winograd 2007) feature of Microsoft Windows.

A disadvantage of this feature is the need to share files for all users of the network, allowing unwanted people from accessing these files. However, (Lowe and Winograd 2007) reports that it is possible to establish user's access rights, so it is necessary to set permissions for users who are allowed to access those folders. In addition, the server plug-in must be running on these accounts or the user will need to authenticate.

Figure 3 shows this scheme in which servers and client access the files from the same source (disk or network shared directory).

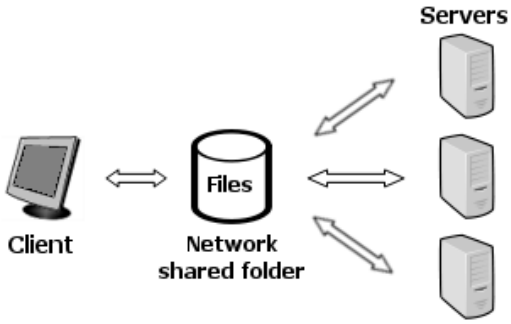

Figure 3: Scheme of file transfer by Windows sharing

To eliminate these problems of security and complexity, the CaveMax implements an internal transfer protocol that brings simplicity, speed and security. Thus, it is unnecessary to share folders and it also performs compression of files before they are sent and prevents access to the model by unauthorized persons. This is shown in Figure 4, where it is noticed that the files are read only by the client and it transfers them to the servers using TCP/IP.

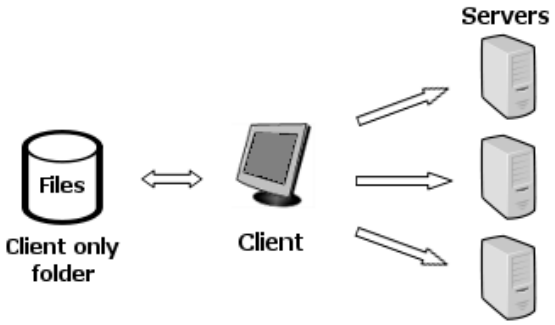

Figure 4: Scheme of private file transfer

4.4. Configuration

The CaveMax configuration can be performed by the basic method within 3ds Max or by the advanced method outside it.

On the basic method is possible to configure file transfer mode, number of servers, IP address of each server and their camera properties. Camera properties include FOV (Field of View) adjustment and, displacement and rotation in the x, y and z axis relative to the user computer's view. These camera properties can be performed while viewing allowing more detailed settings in real time.

Advanced configuration allows making additional settings related to the viewport of the servers. It is possible to set the position and dimensions of the viewport in pixels, as well as configuring full-screen, screen resolution and multiple monitors support. In the basic configuration, as these properties are not determined, the CaveMax uses the default resolution of the server and a maximized viewport. This method requires editing an INI file and uses a utility called ConfigGen installed along with CaveMax.

5. USE

This section will briefly discuss how the user must use the software CaveMax, showing the steps of installation, initialization, navigation and update of the scene.

The installation consists of a few steps and is made easily. The installer automatically detects the versions 7, 8, 9, 2009 and 2010 of 3ds Max and configures them to work with the plug-ins. The same installer is used for both client and server machines. A registration key is also required.

To start the projection of the scene in the CAVE the user must first create a configuration using the “Opções” button of the plug-in interface (Figure 5) in 3ds Max. Once configured on your machine, simply click the “Iniciar CaveMax” button and wait CaveMax initialization. Right now, the servers start 3ds Max getting ready to project the images as soon as the user opens a model.

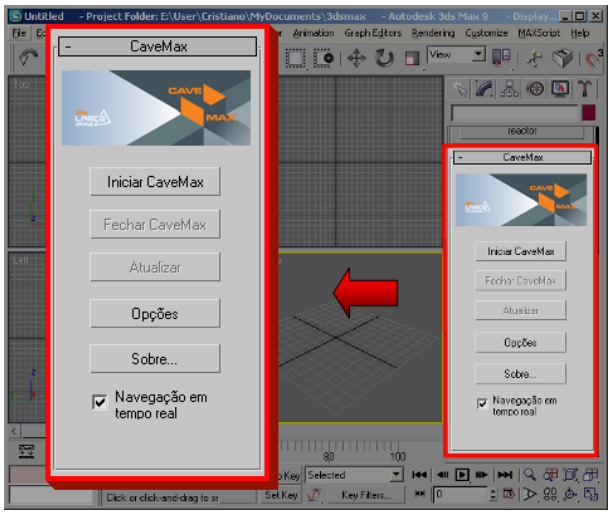

Figure 5: CaveMax client plug-in interface

After open a model and transfer it to the servers, it is possible to navigate using the 3ds Max tools like Walk Through. The user can make changes in the model and update the servers by clicking on the "Atualizar" button on the plug-in interface. To finish the display in the CAVE you just need click the "Fechar CaveMax" button.

6. FUTURE WORK

Some features not yet implemented will be researched and implemented when possible, providing a better experience to the user.

6.1. Visual configuration

Advanced configuration should be integrated into the 3ds Max, that is, should be possible configure from within the 3ds Max interface more friendly. This will eliminate the need to edit INI files with 3ds Max closed and import them through the ConfigGen tool.

6.2. Multiple viewports

Currently, only one viewport in each 3ds Max running on the server can be used to render. More than one viewport can be opened on the same server by opening more than one plug-in server, i.e. more than one instance of 3ds Max, but it consumes more machine resources and should be improved. The improvement would make it possible to open one or more viewports in the same 3ds Max, thus it would increase the performance in the projection when using more than one wall of the CAVE using the same computer server.

6.3. Stereoscopy support

Support for stereoscopic vision is important to increase the sense of immersion giving impression of depth and proximity of objects. For this, two images are rendered on each screen, one for the right eye and one for the left eye. As (Cruz-Neira, Sandin et al. 1992) says, to avoid flicker is necessary to use projectors capable of displaying at a rate of 120 Hz, 60 Hz for each eye, and 3D shutter glasses that can switch the images in sync with the pictures projected. The generation of the two images for each projection screen could be made in four ways:

- two servers, one for each image;
- one server with two instances of 3ds Max;
- one instance of 3ds Max with two viewports;
- from the 3D video driver directly.

However, the biggest challenge is to synchronize the images of the right and left eyes of all servers with the 3D glasses.

6.4. User localization

An important feature is head tracking to allow the user moves inside the CAVE and sees the images projected modifying. Thus, the user may have the feeling of walking in the virtual world without distortions that occur when moving away from the centre of the CAVE.

This would be implemented through a tracker in the user's head sending its position to the computer. From this information, the servers would change the projection matrices reflecting the new angle of vision.

6.5. Real-time updates

The update could also be performed in real time. This would allow the user to edit the model on your computer or notebook and update the CAVE views simultaneously without any additional click.

The difficulty in accomplishing this improvement is the need to map all the actions of the user and transmit them through the network for servers that update their models and exhibit such changes.

However, this approach could fail to identify some change and could produce differences that could only be corrected by conventional update, i.e., the same offered by CaveMax today.

7. CONCLUSION

Although some software allows visualizing models in 3ds Max in CAVE, they perform conversions of files that can miss important information. When there is no conversion in fact, there is interception of OpenGL (or DirectX) calls, which may not work properly when the modelling software does some kind of optimization. Thus, the CaveMax was developed in order to solve these two problems by using directly the 3ds Max viewports. As the features of real-time renderer of 3ds Max viewports are improved, as it has been happening since the older versions (7, 8 and 9) to the most recent (2009 and 2010), the CaveMax can evolve together providing views increasingly realistic.

Finally, future enhancements such as multiple viewports, stereoscopy support and user location can further increase the realism of the visualization and navigation in the CAVE. Therefore, this is a key step in the final maturation of the use of virtual reality in 3ds Max.

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