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A CONVERTOR AND USER INTERFACE TO IMPORT CAD FILES INTO WORLDTOOLKIT VIRTUAL REALITY SYSTEMS

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INTRODUCTION

Virtual Reality (VR) is a rapidly developing human-to-computer interface technology. VR can be considered as a three-dimensional computer-generated Virtual World (VW) which can sense particular aspects of a user's bahavior, allow the user to manipulate the objects interactively, and render the VW at real-time accordingly. The user is totally immersed in the virtual world and feel the sense of transforming into that VW.

NASA/MSFC Computer Application Virtual Environments (CAVE) has been developing the space-related VR applications since 1990. The VR systems in CAVE lab are based on VPL RB2 system which consists of a VPL RB2 control tower, an LX eyephone, an Isotrak polhemus sensor, two Fastrak polhemus sensors, a folk of Bird sensor, and two VPL DGII DataGloves. A dynamics animator called Body Electric from VPL is used as the control system to interface with all the input/output devices and to provide the network communications as well as VR programming environment. The RB2 Swivel 3D is used as the modelling program to construct the VWs. A severe limitation of the VPL VR system is the use of RB2 Swivel 3D, which restricts the files to a maximum of 1020 objects and doesn't have the advanced graphics texture mapping. The other limitation is that the VPL VR system is a turn-key system which does not provide the flexibility for user to add new sensors and C language interface.

Recently, NASA/MSFC CAVE lab provides VR systems built on Sense8 WorldToolKit (WTK) which is a C library for creating VR development environments. WTK provides device drivers for most of the sensors and eyephones available on the VR market. WTK accepts several CAD file formats, such as Sense8 Neutral File Format, AutoCAD DXF and 3D Studio file format, Wave Front OBJ file format, VideoScape GEO file format, Intergraph EMS stereolithographics and CATIA Stereolithographics STL file formats. WTK functions are object-oriented in their naming convention, are grouped into classes, and provide easy C language interface.

Using a CAD or modelling program to build a VW for WTK VR applications, we typically construct the stationary universe with all the geometric objects except the dynamic objects, and create each dynamic object in an individual file.

VWs, define the form, behavior and appearance of objects, are the core of a VR system. "From the standpoint of Virtual Environment (VE) construction, geometric modelling is a vital enabling technology whose limitations may impede progress. As a practical manner, the VE research community will benefit from a shared open modelling environment." (Nathaniel Durlach, Anne Mavor 1995)

One of the important aspects of a VR system is the modelling of VWs. At NASA/MSFC, there are lots of existing CAD files in different file formats for each project. It is very beneficial for the CAVE lab to have the capability to import these existing CAD files, such as AXAF CAD files in IDEAS or CATIA file formats, into the WTK VR system.

It is critical to provide a convertor and the user interface allowing the WTK VR systems to import VWs from existing files in various CAD file formats. A few existing VWs in different CAD file formats are being investigated and imported into the WTK VR system. A configured master file is used to organize all the dynamic objects in different CAD file formats and a user interface is provided for user to access all the existing WTK VR applications.

OBJECTIVES

The objectives of this effort are to find a path to import existing AXAF CAD files in IDEAS and CATIA file formats into WTK VR system, to provide a user interface for accessing multiple CAD files in different file formats, to integrate the Polhemus Fastrak sensors, Spaceball sensor and its associated button commands, and distributed network communications into a complete 3D VR environment for space-related VR applications.

APPROACH

In order to access existing CAD files in MSFC, several widely used CAD file formats are investigated. There are several CAD file formats supported by WTK. But, the IDEAS and CATIA CAD files used in AXAF are not supported by WTK directly, therefore they must be transformed before importing into the WTK environment. Fortunately, an IDEAS UNF to Sense8 NFF convertor is obtained from the WTK user's group. A convertor to tranform CATIA files into stereolithographics STL files is available. In order to generically import various CAD files into WTK VR system, a

convertor is generated to transform CAD files in any WTK acceptable file formats into either DXF or NFF file formats. The WTK VR system normally deals with tremendous amount of data. Therefore, a friendly user interface is created to allow the users to access the CAD model files stored in different formats. These CAD files can be located in one single diretory or specified in a configured master file. In a typical application, the universe will be constructed with static objects, while each dynamic object will be created in an individual CAD file. Once the AXAF CAD files in IDEAS and CATIA file formats can be imported into the WTK environments, an integrated 3D VR environment needs to be created for the user to study the experiments of AXAF project.

CONCLUSIONS

Several CAD file formats are studied and the path to import IDEAS UNF files and CATIA stereolithogrphics files into WTK VR Applications is identified. The WTK-based VR system is able to import VWs in different CAD file formats, such as Sense8 NFF, AutoCAD 3D Studio, AutoCAD DXF, Wave Front OBJ file format, VideoScape GEO file format, Intergraph EMS stereolithographics STL and CATIA Stereolithographics STL file formats. The CAD files can be imported as single file, multiple files located in a single directory, or multiple files specified in a configured master file. The Spaceball and its buttons are defined for the user to navigate through the VW and to issue several frequently used commands. They are also defined to allow the user to pitch, yaw and roll the user's viewpoint, to allow the user to modify the sensitivity of sensors, and to control the switch between ntsc and rgb modes. The network communications are created to achieve the synchronization and image rendering between two SGI machines. A complete networked immersive VR system with Fastrak sensors and Spaceball control is integrated to study the AXAF experiments in VR environment. One of the Fastrak sensors is attached to the eyephone to track the user's movement, while the other is attached to user's hand to interact with those dynamic objects. A predefined 10 locations can be specified in a file to allow the user to be repositioned during the experiments. A path can be loaded or created during the experiements, and replayed at a later time.

A set of IDEAS UNF files from IOWA State Visulization Lab are imported to WTK VR environment. Several CATIA stereolithographics STL files from AXAF and TRW are also imported into the WTK VR environment. An airlock in Intergraph EMS stereolithographics STL file format is also imported into the WTK VR environment. These experiments proves that

the WTK 3D VR environment is capable to process and review these CAD files and its simulations successfully.

RECOMMENDATIONS

Due to the high fidelity of the airlock file, the performance drops to less than one frame per sencond on the SGI 4D/310 with 24MB RAM system. It is recommended that a partition scheme be adopted to allow the VR system to import high fedelity VW as well as the real time performance. It is recommended that a hierarchical structure and the dynamic attributes of objects to be specified in a file to perform the reach envelope and human factor engineering studies. It is also recommended that higher performace hardware be used to provide the needed processing power on high fidelity VWs in the space-related applications.

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