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**MARSHALL SPACE FLIGHT CENTER
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**THE INFRASTRUCTURE OF AN INTEGRATED VIRTUAL REALITY
ENVIRONMENT FOR INTERNATIONAL SPACE WELDING EXPERIMENT
(ISWE)**

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The infrastructure of an integrated Virtual Reality environment for International Space Welding Experiment

1. INTRODUCTION

This study is a continuation of the summer research of 1995 NASA/ASEE Summer Faculty Fellowship Program. This effort is to provide the infrastructure of an integrated Virtual Reality (VR) environment for the International Space Welding Experiment (ISWE) Analytical Tool and Trainer and the Microgravity Science Glovebox (MSG) Analytical Tool study. Due to the inavailability of the MSG CAD files and the 3D-CAD converter, little was done to the MSG study. However, the infrastructure of the integrated VR environment for ISWE is capable of performing the MSG study when the CAD files become available. Two primary goals are established for this research. First, the essential peripheral devices for an integrated VR environment will be studied and developed for the ISWE and MSG studies. Secondly, the training of the flight crew (astronaut) in general orientation, procedures, and location, orientation, and sequencing of the welding samples and tools are built into the VR system for studying the welding process and training the astronaut.

2. EXPERIMENTAL APPROACH

The objective of the infrastructure of the VR environment is to integrate the essential peripheral devices into the VR system and provide the procedures and orientations, and locations of the welding samples and tools. There are five peripheral devices studied in this research: the Polhemus Fastrak sensors, the 6-DOF Spaceball, the MSFC/CAVE RMS hand controller HC-Hand, the VPL Dataglove model II hand, and the mouse. The device drivers of the 6-DOF Spaceball, the Polhemus Fastrak sensors, and the mouse are provided by the Sense8 WorldToolKit. The device driver of MSFC/CAVE HC-Hand and the VPL Dataglove model II hand are studied and developed as part of this research effort. One of the Polhemus Fastrak sensor is attached to the Kaiser Electro-Optics Vim1000HRpv Head-Mounted-Display (HMD) to track the head movement of the user. While the other Polhemus Fastrak sensor is attached to the VPL Dataglove to track the hand movement of the user. The Dataglove hand gestures are defined to rotate the drum, pick up, carry, and release the welding tools. The Dataglove hand gestures are also used to select button commands from the control panel. Texture mappings are attached to the buttons of the control panel to simulate the ISWE button selection. The texture mappings of all sides of the drum, buttons, and the control panel are attached to the polygons to improve the realism of the ISWE model. The MSFC/CAVE RMS hand controller HC-Hand consists of two 3-DOF devices. The left hand is used to control the X, Y, and Z coordinates of the navigator, while the right hand is used to control the Pitch, Yaw, and Roll of the navigator. The HC-Hand control button is used to switch among the navigation modes. The coarse/vernier switch is used to control the speed of the navigation. The two momentary switches are used to rotate the drum and the astronaut. The HC-Hand is connected to the RMSPC analog-to-digital device and the digital data are sent through the network to the VR system. This also provides the remote control capability of the VR system as well as the remote networked simulations. This HC-Hand can also be used in the VR environment for the networked battle field simulations by attaching each HC-Hand to an individual soldier. Since the data is sent through the network, it is not limited by the number of the serial ports available of the VR system. The 6-DOF Spaceball not only provides the X, Y, Z, Pitch, Yaw, Roll six degree of freedom, but also provides eight buttons keys for simulation tasks. Two of the button keys are used to increase and decrease the sensitivity of the sensors. One button key is used to switch among the object picking/moving/flying modes. One button key is used to zoom all the universe. While the other button key can be used to define tasks for specific VR applications. The mouse is used to navigate through the ISWE as well as the picking/moving/flying dynamic objects.

The tasks of the ISWE study includes:

1. To perform the viewing analysis of the ISWE model.
2. To navigate the astronaut along the Y-axis of rack-rail and to yaw to the left and right.

3. To rotate the drum of ISWE model.
4. To pick up the welding tools, move to the drum area, and perform welding process.
5. To perform the specific tasks by selecting the buttons from the control panel.
6. To view the safety of the work performed by the other astronaut.
7. To perform the orientation and position as well as welding process as the astronaut.

In the ISWE study, the movement of astronaut, foot stand slider, control panel, buttons, welding tools, and the hand should be done simultaneously. In this VR environment, the buttons, control panel and astronaut are attached to the foot stand slider. The hand is attached to the astronaut when the VR system is in the astronaut moving mode, and attached to the viewpoint when it is in the free navigation mode. The welding tools are attached to the hand when they are intersected by the index finger tip and a grab gesture is made. The welding tools are released when the release gesture is made. In the astronaut flying mode, the position and orientation of the navigator is set to the astronaut while the VR system remains in the flying astronaut mode. A stereo mode VR environment is also studied and developed by interleaving the two rendering images to each eye to achieve the 3D stereo vision effect. All the peripheral devices used in the above mentioned immersive VR environment can be used in the stereo mode VR system except the HMD. Instead, a pair of Crystaleyes shuttle glasses are used to view the stereo ISWE model. The advantage of stereo mode VR environment is that it can be viewed by several people simultaneously. It is very attractive in the viewing analysis review and training applications. It is also very valuable in the educational environment because it can be used by many students simultaneously with a relatively low cost. In the immersive VR environment, the VPL dataglove and HC-Hand should be used as the major sensors. While in the stereo mode VR environment, the 6-DOF Spaceball, VPL Dataglove, as well as the HC-Hand are served equally well to navigate through the universe and manipulate the dynamic objects.

3. CONCLUSIONS

The Summer Faculty Fellowship has been really challenging and interesting. A lot of difficult tasks have been studied and solved at great pleasure. It has been thrilling from time to time when great break-throughs were made. I am eager to take my research and experience back to Alabama A&M University Computer Information Science Department to share with fellow faculty, administrators, and students. The infrastructure of an integrated VR environment for ISWE built at MSFC/CAVE can be used as the teaching material of the Virtual Reality course at AAMU graduate school. It can also be used as the foundation of my three years research project from NASA/MSFC Equal Employment Office -- Development, Assessment, Validation and Evaluation of Human Anatomy Instruction (DAVE).

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