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Outlines of Immersive Virtual Environment System, “TEELeX”, and its application for higher education

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Abstract

An immersive virtual environment system, "TEELeX" with high intensity displays had been developed for using in various learning environments fields in higher education. We have been developed interactive interfaces, and some contents in language learning, space recognition, music theory learning and scientific learning using TEELeX.

1. Introduction

A virtual environment system, "TEELeX", was designed and developed for higher education at the National Institute of Multimedia Education (NIME)[1]. The TEELeX uses immersive projection technology that a multi-screen display enables one or more persons to experience the sensation of being completely surrounded by high-resolution and three-dimensional video and audio in the three-meter square cube. In order to create natural environments for learners, we designed the display with high intensity using LCD (liquid crystal display) projectors, and circular polarization 3D display technology makes using simple and lightweight glasses.

The TEELeX has been used for several research purposes in higher education. For development of a user-friendly virtual reality system, we are developing easy and natural 3D pointing interfaces without any machines or equipments on learners’ bodies. Language educational materials, walk-through contents for space recognition trainings and scientific educational materials have been developed. Tele-education, tele-conferences and tele-collaboration between locations at a distance will be experimented by using high-speed networks. Research on the psychological and physiological influences to human beings in immersive environments have also been conducted.

We are outlining the features of the TEELeX system, and development of interactive interfaces and some contents for higher education.

2. TEELeX System

2.1. Display

(1) Video display screen

The display of TEELeX is a cubic screen with three meters square, and the boundary gap between the screens is less than 50 millimeters to make seamless graphics space.

The front, left side, right side and rear screens are fully projected from behind. The ceiling screen is projected from behind, but the floor screen is front-projected from the ceiling of the building as shown in figure 1.

(2) Video display projector

The most significant feature of TEELeX is to use high intensity projectors. The projectors (DLA-S10/ JVC) are based on the technology of liquid crystal (D-ILA elements), instead of CRT, with 1,000 ANSI lumens for each eye. They project 1,000 dots by 1,000 dots images on each eye.

(3) Three dimensional video display

We use circular polarization in order to display stereoscopic images on screen. The circular polarization offers several advantages, such as the fact that glasses are lighter than by the shutter method, and enabling us to install an eye tracking system into the display.

(4) Audio display

Eight speakers on each apex of the cube make 3D audio environment, because audio is as important as video for experience virtual reality.

(5) Graphics computer

In order to display synchronous 3D seamless images with the mixture of real images and computer graphics among the different screens at high density, we adopted the high performance graphics computer with six video pipelines (Onyx2 Reality Monster).

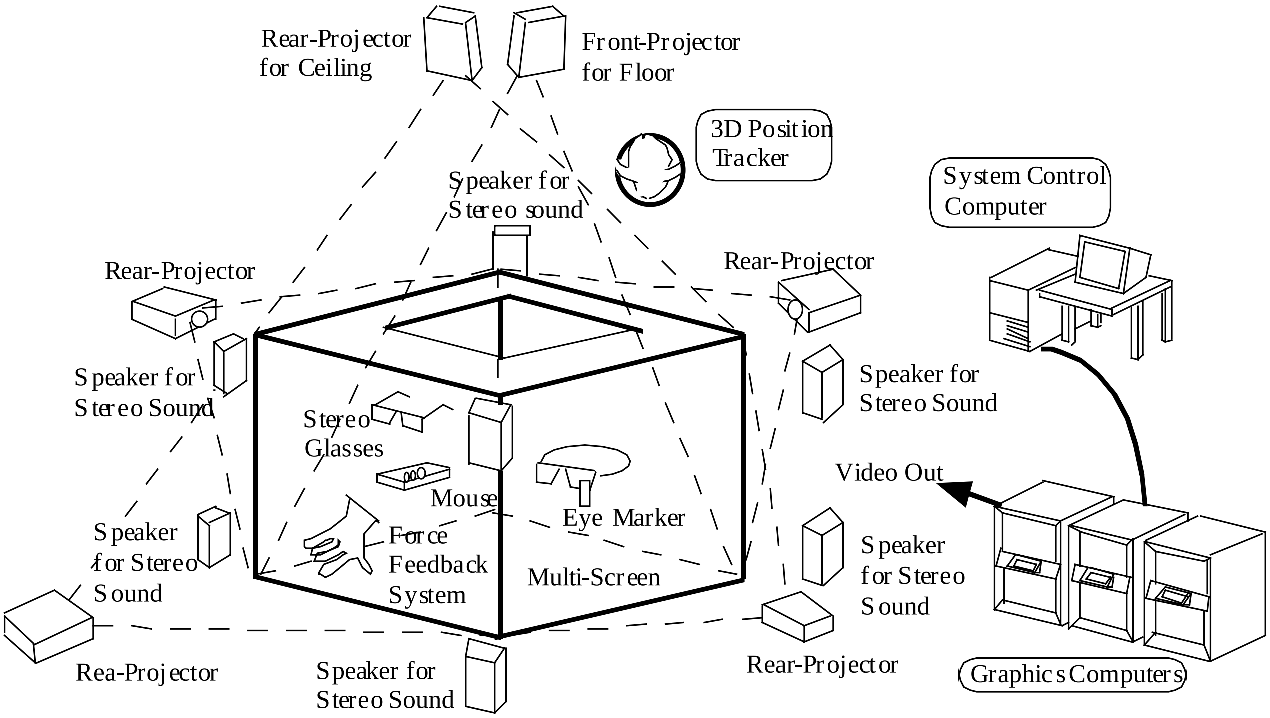

Figure 1 The TEELeX System

2.2. Interactive multimodal interface

Interaction between humans and machine is vital in the virtual environment for educational purposes, so we designed several interactive interfaces for TEELeX.

First, tracking equipment detects the user's head position at 6 degree-of-freedom, and controls the viewpoint. The 3D mouse, track ball, joystick and voice recognition are also prepared as input interfaces.

In addition to these instruments, force feedback system and finger pressure feedback are installed. We also developed a finger temperature feedback system so that one can feel the temperature of the virtual object in the range of 5 to 40 degrees centigrade.

The additional equipment includes a non-contact 3D digitizer, an eye marker, and a motion capture.

Each interface system is connected to the graphics computer through the Ethernet, and data are exchanged to control the 3D video, audio, and interface systems. Their operations are centralized with the system control computer as shown in Figure 1.

2.3. Software

An authoring tool and a run-time software have been developed. The authoring tool conducts selection of modeling files, retouch of the model, setting of a display, selection of interfaces, definition of objects, and preparation of scripts. The run-time software selects contents, and presents them in the virtual space. These are designed to make and display contents on the multi-screen for beginners to experts in programming skills.

As application software, basic tele-conferencing software and tele-collaboration software are also developed.

3. Development of interactive interfaces

The TEELeX has been used for a number of research purposes in higher education. For development of a user-friendly virtual reality system, we are designing easy and natural 3D pointing interfaces without any machines or equipments on learners' bodies by means of eye movements or gestures.

Mouses and joysticks are normally used for man-machine interfaces. But, the pointing, especially in the three-dimensional environments, is difficult for using these legacy devices. We are developing new pointing devices, such as picture recognition of the body movements (Figure 3), and direction of human eye.

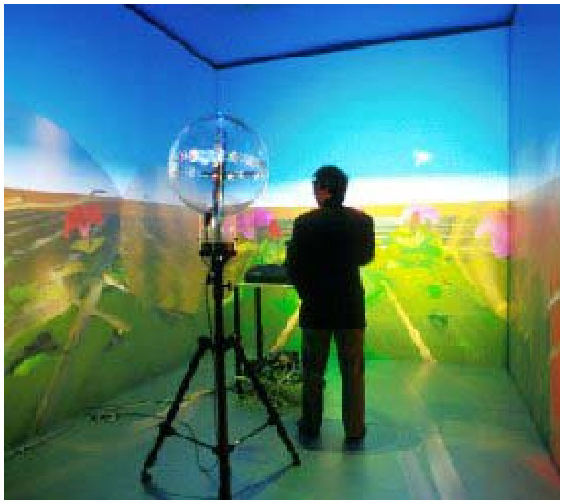

Figure 2 Outlooking of the TEELeX

Figure 3 Picture recognition interface

4. Development of basic educational contents

Language educational materials, walk-through contents for space recognition trainings, scientific educational materials, such as planetariums, interplanetary plasmas, and visualized computer programming educational materials in immersive environments have been developed. The following are some developing applications.

4.1. Music theory learning material

We are developing a music theory learning material shown in Figure 4. Editing musical score and control of playing music can be made by moving musical notes in the three-dimensional field.

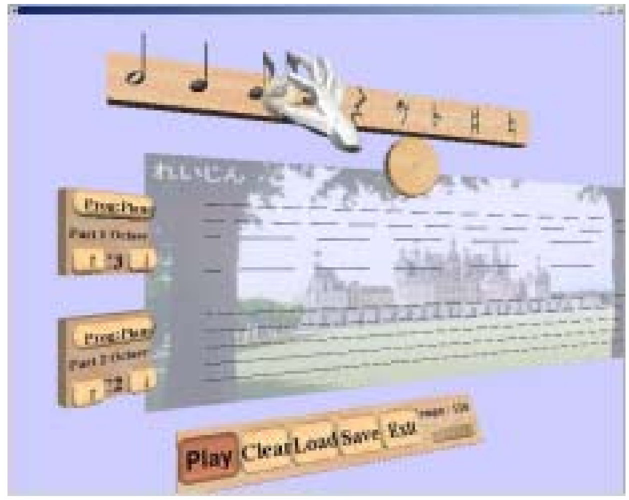

Figure 4 Music theory learning material

Figure 5 Space recognition material

4.2. Space recognition material

Walk-through inside the buildings or outside in an immersive environment can be quite effective in learning space recognition shown in Figure 5. We are developing several kinds of space recognition materials.

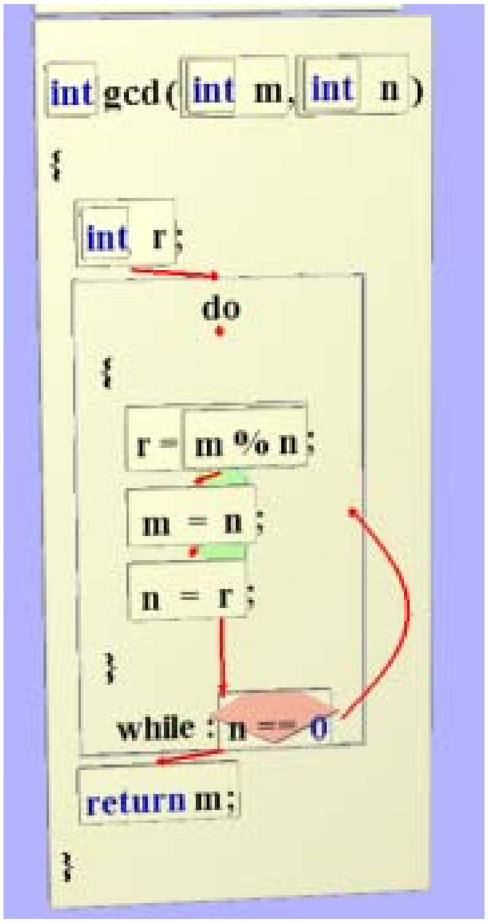

Figure 6 Computer Programming learning material

4.3. Scientific learning materials

(1) Visualized computer programming educational material

Visualization and hand manipulation of the computer programming in an immersive virtual environment helps to understand computer-programming languages for beginners. We are developing computer programming learning materials [2] shown in Figure 6.

(2) Planetarium

The planetarium using TEELeX is developing for understanding the movements, orbits of planets, satellites, comets, and the constellations (Figure 7).

Figure 7 TEELeX planetarium

5. Summary

We introduced the features of the TEELeX system, and development of interactive interfaces and some contents for higher education. We will continue to improve them, and to develop interactive interface systems and educational contents.

6. Acknowledgements

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7. References

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