COLLABORATION SUPPORT SYSTEM FOR NIGHTSCAPE DESIGN BASED ON VR TECHNOLOGY

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Abstract. This paper reports the collaboration support system for nightscape design based on virtual reality (VR) technology. The developed system consists of two subsystems: a) the semi-spherical screen VR system, b) the desktop VR system. The schematic design of Asagiri pedestrian bridge has been done using these systems.

1. Introduction

In this paper, the public design for a night-time slot (from evening till daybreak), when people depend on artificial lighting is defined as “Nightscape Design”. Nightscape design process is a kind of a social activity. So it is very important to collaborate with many participants who are not only professional people such as designers and engineers but also non-professional people such as clients and citizens. Though this process consists of planning, design, construction, and completion, actually there is no ideal nightscape design process which keep from planning to completion with a consistent philosophy in Japan. Adding to this social problem, the problem of design tools also exist. Until now as the setting up of nightscape simulation circumstance and simulation take many days, the designer can’t use this simulation in design stage except in the last presentation stage just before construction. But both hardware and software for nightscape simulation have been developed during these years.

The developed collaboration support system is based on virtual reality and network technology. It is used in real design projects as we need to evaluate this system, and to present this new design process and tools to the public is a much better way compare to traditional design process and tools.
This paper is organized as follows: Section 2 describes the developed systems. Using these systems in real design project has been represented in section 3. And section 4 concludes with the result.

2. Two VR Systems

2.1. CONCEPT

In collaboration circumstance which include communication and decision-making among design participants, the system with which they can share the design image in an intuitive way and allow real time their feedback is needed. To realize this, we develop two collaboration support system based on VR technology: the semi-spherical screen VR system and the desktop VR system. The one is different from the other in concept.

The hardware of the semi-spherical screen VR system consists of semi-spherical screen, six projectors, high performance graphics computer, and so on. To install this, the room which is at least 10 meters in length, 7 meters in width, and 6.5 meters in height is needed. And once this system is installed, it is difficult to move. Moreover this system is very expensive (more than 100,000,000 yen). So we can't imagine each participant has this system at one’s office. As a result, when participants use this system, they have to gather at the installed place. This system isn’t seamless in time and place. But the three dimensional (3-D) virtual space can be reviewed in the most precise, quality, and quantitative condition.

The hardware of the desktop VR system is based on personal computer (PC-AT clones). Participants can access the 3-D virtual space via network with their own PC. The system is seamless in time and place. But the 3-D virtual space can be reviewed in the less precise, quality, and quantitative condition than that of the semi-spherical screen VR system.

2.2. SEMI-SPHERICAL VR SYSTEM

The semi-spherical VR system consists of semi-spherical screen, six projectors, graphics computer (Silicon Graphics ONYX Infinite Reality2 (MIPS R10000) computer using 3 processors and 640Mb RAM), LCD shuttering stereo glasses, and I.R. emitter (Figure 1). The size of screen is 6.8 meters in its diameter. Using six front projection type projectors, the system generates a picture as wide as 180 degrees in horizontal direction, and 90 degrees in vertical direction. This angle is wide enough to cover participants’ view. The graphics computer generates right-eye view pictures and left-eye ones reciprocally. The edges of projectors are seamlessly blended using edge blending system.
The following explains the main functions of the semi-spherical VR system for design tool:
1) Plural design participants can experience the 3-D virtual space and share concrete images at the same time.
2) Participants can understand the scale easily because the projection of images is full-scale digital mock-up.
3) Participants can review to switch some alternatives, daytime view and night-time view in real time.
4) Using some input devices such a joystick or mouse, participants can walk-through in the 3-D virtual space.
5) Participants can understand the 3-D virtual space more easily because this system can create stereo images.

2.3. DESKTOP VR SYSTEM

The desktop VR system is developed on personal computers (PC-AT clones). The software consists of a VRML browser such as Cosmo Player 2.1.1 and Java applet on a popular Web browser such as Netscape Navigator 4.7. A 3-D virtual space model format is the Virtual Reality Modeling Language (VRML97), a powerful standard for representing real time interactive 3-D environments. And the VRML External Authoring Interface (EAI) connects design interfaces of Java applet with the VRML scene graph. The followings are design interfaces we developed (Figure 2).
2.3.1. Sharing viewpoint information in a 3-D virtual space and plan view
When a participant walk-through in the 3-D virtual space of wide area with a VRML browser, he/she can’t arrive at the place which he/she wants to review and he/she loses one’s way at the worst time. One of this problem is that a VRML browser doesn’t have the function which he/she can understand one’s own position.

We develop the new function of sharing viewpoint information in VRML scene graph and plan view of Java applet. A user’s position, orientation, and field of view in the 3-D virtual space is represented on the plan view in real time. Furthermore when a participant sets position and orientation by dragging mouse on plan view which he/she wants to review, the viewpoint information is sent to the VRML browser and represented in the 3-D virtual space in real time.

2.3.2. Arranging new design element and changing color or texture mapping
When a participant walk-through and reviews the design alternative in a 3-D virtual space, he/she often wants to create and review new design alternative.

To realize this, we develop the new function of adding new elements such as lighting equipment to the VRML scene graph, moving or rotating, changing color or texture mapping, and saving the new VRML scene graph.

![Sharing viewpoint information in VRML scene graph and plan view](image1)
![Adding new elements to the VRML scene graph, moving or rotating, changing color or texture mapping, and saving the new scene graph](image2)

*Figure 2. Interface of the desktop VR system.*

The following explains the main functions of the desktop VR system for design tool:
1) Participants can review to switch some alternative, daytime view and night view in real time.
2) Participants can walk-through in a 3-D virtual space understanding their position.
3) Participants can change a viewpoint which they want to review with interactive operation.
4) Participants can translate and rotate a design element and add a new one from database.
5) Participants can change color or texture mapping of an element with interactive operation.

![Figure 3. Semi-spherical VR system (left) and desktop VR system (right).](image)

2.4. PROCESS FLOW

The operating systems used to run the software for creating VR data are Windows 95/98 and WindowsNT/2000. Figure 4 explains the process flow under this system. Participants can create 3-D data including geometry, coloring, and texture mapping in any modeling tool (in our case it is FormZ). As both VR systems share 3-D modeler and Lighting simulator, they can be used efficiently.
3. Application of the System to the Real Design Project

We are applying this system to some real projects. One of them is the schematic design of the Asagiri pedestrian bridge which is about 100 meters in length and 7 meters in width. This project is one of Akashi Ohkura Coastal Community Zone Project (Sasada, 1999).

3.1. DESIGN PROCESS

The site to be designed consists Akashi Ohhashi Pearl Bridge (Akashi Ohhashi) which is the longest bridge in the world, lit up at night-time, and about 2.5 kilometers away from the Asagiri pedestrian bridge, the design team has to design the night-time view as importantly as the daytime view. In this initial stage design process, members such as consultant, architect, lighting designer were organized.
The design team makes their design concept to use three sceneries: a) the scenery of the pedestrian bridge from its surroundings, b) the scenery of Akashi Ohhashi from the pedestrian bridge, and c) the scenery of both Akashi Ohhashi and the pedestrian bridge from the window of the JR Asagiri Station which is one of the main viewpoints (Figure 5). They also have to give priority to the safety of pedestrians.

Figure 5. Site and Concept.

To realize this, the interior space of the pedestrian bridge is separated into zones. Walking zone is designed with roof made of membrane on the west, and viewing zone to see Akashi Ohhashi on the east. At night-time, on the exterior space, the roof is lit up with floodlighting. The interior space is designed with the new lighting design technique with new product named light tube. Lighting designer designs some alternatives, and members of design team review with some CG still images and desktop VR system (Figure 6). Moreover they design the details. For example, the existing smallest diameter of light tube is 150 millimeter at first. The 150 millimeter version with CG still images and mock-up is reviewed and found this version mismatch with the structure. So lighting designer start to develop the diameter of the new 100 millimeter version and succeeded to create new lighting product (Figure 7).
We converted DXF data format of surrounding model of 60 kilometers which was made by Sasada Laboratory into suitable data format for the semi-spherical VR system and represented VR image on the semi-spherical screen (Figure 8). The design team applies this VR system to the south exit design. This is located in front of Akashi Ohhashi when people see from the window of the JR Asagiri Station. Many design alternatives have been reviewed (Figure 9).

The design team have designed for a year. After design and construction, this bridge was completed in November 1999 (Figure 10).
Figure 8. Photograph of design review with the semi-spherical VR system.

Figure 9. CG of the south exit design from the window of the station.
Figure 10. Photograph of completion: interior space (left) and from the window of the JR Asagiri Station (right).

4. Results and Conclusion

With this system, the design team can design “Nightscape Design” in the schematic design stage and create the new lighting design product to realize their concept. Because the semi-spherical VR system can indicate as actual scale, members can be convinced of its scale more concretely. And they can walk-through in the world and review from the viewpoint they want to review. It must be impossible to design like this if they use the traditional design process and tools. We are convinced that this example is the beginning of solving the traditional design process problems.

References