Virtual Walking Tour of Ryoanji Temple using Locomotion Interface

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ABSTRACT
This paper describes an application of VR (Virtual Reality) system that combines locomotion interfaces which we have developed up to now from the viewpoint of communications that allow both shared experiences and shared emotions. In the context of communication, in order to mutually understand the emotions and the excitement of that moment, it is not enough to pass on information only through words or images -- the environment surrounding that experience and the physical sensations are also important. To accomplish this, we have been developing "Locomotion Interface," as a kind of communication equipment that can give the user the feeling that they are actually walking and talking with a conversation partner who is in fact in a remote location. We have recreated Japanese Ryoanji Temple on a computer through VR technologies, and, using equipment that simulates the sensation of walking, have made it possible for users to experience a realistic "walking tour" of the historical and valuable temple built 550 years ago.

KEYWORDS: VR, locomotion interface, walking simulator

INTRODUCTION

Immersive virtual reality is the sensory experience in which a participant feels him/herself immersed in a computer-generated world, including avatars of other participants and, potentially, subsets of his/her own physical environment. Using current VR technology, many research and development projects are attempting to create high-fidelity simulated real worlds or to enhance the reality of the real world in a virtual world. Most of these projects, however, focus on the "*Visual Reality*" of a simulated world. Humans also have other sensations, i.e., auditory, tactile, somatic and so on. These sensations are a very important part of the whole human sensory mechanism, but current VR technology is insufficient in stimulating them. To cope with this problem, we are developing a VR device that can stimulate these "non-visual" sensations.

Some VRML viewers, called a "walkthrough simulator," allow a user to visually move around in a virtual world on the screen. The user merely controls the direction and speed of the viewing point by using a mouse. We believe it is much more important to actually walk than to change the viewing point using a joystick or a mouse. Using a mouse or joystick cannot give the user the sensation of walking, because this is just like driving a car without realistic feedback for locomotion.

Walking is the most basic way of moving around for humans, and plays an important role in recognizing the environment. Humans can sense complicated impressions about the environment, i.e., the feeling of distance, the feeling of spending time, and the feeling of space, from locomotion. As the saying goes, people won't get lost where they actually walked. This is one of our main reasons for developing the virtual locomotion interface (VLI) in VR technology. VLI is a control technique for allowing a person to move in a natural way over long distances in the virtual environment, while remaining within a limited small space.

VLI can be used for: training, evaluating architectures, communications between people at different locations, and entertainment. We have proposed the locomotion interfaces called ATLAS [1] and GSS [2], which allow a user to get a true feel, even when walking on a remote, uneven ground. As an application of ATLAS and GSS, we created "Virtual Walking Tour of Ryoanji Temple."

LOCOMOTION INTERFACES

ATLAS (ATR Locomotion Interface for Active Self Motion) [1]

In the ATLAS system, an active treadmill is installed on a motion platform with 3-axis rotation, and there is a function that freely tilts the walking surface (Fig. 1). ATLAS can cancel out the forward motion of a person walking via an actively operating treadmill. In order to achieve this canceling-out function, a method is required to detect the walking movements of the user. Because it uses a non-contact, non-restrictive sensor, ATLAS offers the advantage of not interfering with the natural walking motion of the human user. Furthermore, by rotating or tilting the entire treadmill with the motion platform, it is possible to give a sensation of turning, or to generate or recreate the slope of a graded path.

In the ATLAS system, a CCD camera fixed at the front of the treadmill ahead of the user's position records an image of the front user's feet; through image processing, walking speed is detected by obtaining a movement pattern at the front of the feet. An ultra-red filter is fixed to the CCD camera, and an ultra-red floodlight is positioned on approximately the same axis. In this way, the user only needs to affix a reflective marker to the front of his shoes; there is no need to wear or carry any other special equipment or sensors. The available walking area of ATLAS is 145cm (L) x 55cm (W), and the treadmill is 4.0 m/s.

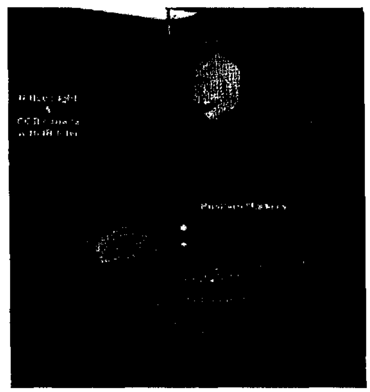

Figure 1: Locomotion interface: ATLAS [1]

GSS (Ground Surface Simulator) [2]

Figure. 2 shows an external view of the GSS. Because the GSS can recreate an uneven walking surface, the user can experience the sensation of walking on uneven terrain in a remote location, or on an uneven surface that has been generated virtually. The GSS has the form of a treadmill, but with the following significant features:

1) Based on walking movements and ground formation

information stored in a computer, the pattern of irregularities on the ground is recreated on the walking surface of the belt.

2) As in the case of ATLAS, the user need only walk normally on the belt, and his position is constantly maintained at the belt's center. This is accomplished with measurements of the user's walking movements and automatic control of the belt speed.

With these two functions, GSS can provide the user with the sensation of walking on uneven terrain.

The size of the walking surface that recreates the irregularities is 150cm (L) x 60cm (W). Underneath the surface of the walking belt, there are six panels with corresponding actuators for the irregularity simulation function. The panels are positioned in strips (25cm wide) lying at right angles to the direction of the belt's movement. The movement of the simulated irregularities is one-dimensional, in the direction of the walking movement, and the maximum height of the irregularities is 15cm.

Figure 2: Locomotion Interface: GSS [2]

WALKING TOUR OF VIRTUAL RYOANJI TEMPLE USING LOCOMOTION INTERFACE

Ryoanji temple was built in 1450 in Japan, and is most famous for its stone garden called *Sekitei*. *Sekitei* is made from only white sand and fifteen stones, with no trees or grass. Each visitor finds enjoyment in his or her own personal interpretation of the garden. Since people, however, are not allowed to enter the Sekitei, they can not see the room from inside the garden. They can not feel the space of the garden by moving around, either.

In the virtual walking tour of Ryoanji temple using the locomotion interfaces (ATLAS and GSS), the temple recreated by CG is projected on a large screen or on a HMD worn on the head of the user. Visual information alone, however, is insufficient to provide a spatial awareness of the size of the garden of the temple or the positional relationship between objects (stones). We think that actual movements of one's own body is essential to spatial awareness. A walking simulator therefore becomes an important element of the "virtual tour," in order to provide this spatial awareness in virtual space or when experiencing unfamiliar locations.

By using such locomotion interface, unlike visual tours in which the user moves around inside the virtual space by manipulating a control pad, it is easier for the user to actually feel how large Ryoanji temple is. At the same time, the sense of reality is increased, making it seem as though the user was actually in the temple. In addition, by connecting several walking simulators as shown in Figure 3 through telecommunication lines, people in various remote locations can enjoy talking to one another while taking "virtual group tours."

Figure 3: Virtual group tour using ATLAS and GSS

Along with developing the two types of locomotion interfaces described earlier, the authors are also conducting a test production of the mobile equipment, called a Tele-GSS, which becomes the user's counterpart and moves around in a remote location as a reflection of the user's movements. The Tele-GSS is equipped with a sensor that measures the irregularities in the ground; as it moves, it sends information on the measured irregularities to the locomotion interface. In this way, as the changes in the ground are recreated on the walking surface of the GSS belt, the user on the GSS is able to experience the sensation of the irregularities in the surface of a remote location. The Tele-GSS has a TV phone function, one of the goals of which is to create a channel for conversation and at the same time take the place of the person speaking in a remote location to bring out a feeling of actually being there. ATLAS also can control tele-GSS. Figure 4 shows the Tele-GSS controlled by a walker on the ATLAS in a remote location. The walker with an HMD (Head Mounted Display) walks on the ATLAS while watching the image sent from the Tele-GSS. As shown in Figure 5, by remotely controlling the Tele-GSS in the real Ryoanji Temple, a person in a remote location could take a walk with a friend. By sending information regarding the movement of the Tele-GSS to the locomotion interfaces, both the friend in the Tele-GSS side and the walker on GSS or ATLAS can feel the same sensation of moving together in Ryoanji Temple.

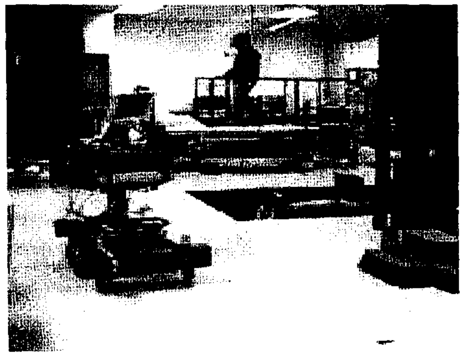

Figure 4: Tele-GSS controlled by a walker on ATLAS

Figure 5: Taking a walk with a friend in a real environment by remotely controlling Tele-GSS

CONCLUSION

In this paper, we presented Virtual-walking system as a part of the research being carried out to creating the optimal environment for communications between people using VR technologies.

The system applies a locomotion interface and remote-controlled moving equipment as means of communication.

The system makes it possible to stimulate dynamic physical sensations, such as the sensation of walking or the sensation of moving and thus provides a realistic environment in which the persons involved can share physical experience.

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