Tele-Nursing System with Realistic Sensations using Virtual Locomotion Interface

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Abstract. The authors have been conducting research into new methods of communication via virtual space created by VR (Virtual Reality) technologies, including communication teleconferencing systems with realistic sensations. In addition, the authors have proposed "Tel-E-Merge" - a system in which the user can enter the environment of another person in a remote location to carry on a conversation - and are conducting research into new VR equipment aimed at the practical application of this system. This paper describes one application for making this system a reality: a "Tele-Nursing" system that combines locomotion interfaces which we have developed up to now with a wheelchair typed moving equipment from the viewpoint of communications that allow both shared experiences and shared emotions using VR technologies.

1. INTRODUCTION

We have been concerned with communication media, especially media for daily communications. Our primary consideration is when we want to have a chat. For example, when a person travels alone in a foreign country or when a person views an impressive picture alone, he or she may want to share this feeling with family members or friends. We have therefore proposed "Tel-E-Merge" as a new communication method for such a situation, i.e., "I wish you were here" [Miyasato 98]. We coined the term Tel-E-Merge with a double meaning, i.e., Tele-Merge and Tel-Emerge. More specifically, we want to make it possible to merge a remotely located person, a tele-visitor, into a tele-inviter's space through VR systems.

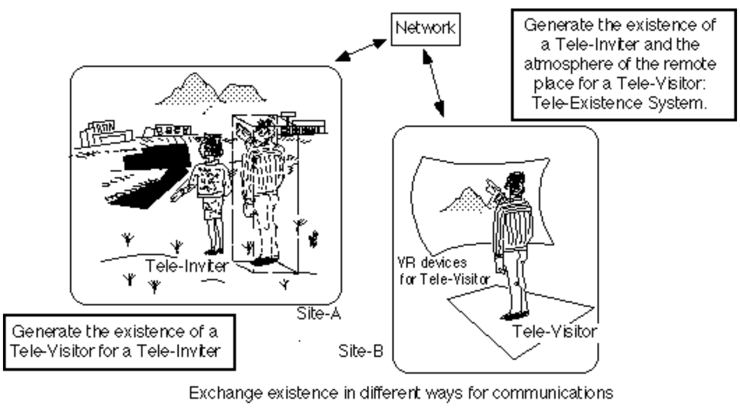

Figure 1. Concept of Tel-E-Merge

One form of Tel-E-Merge that we imagine is as shown in Fig. 1. In the figure, a friend (Tele-visitor) who is in a foreign country is invited into the communication booth of one's own home for a chat. In this case, the friend is invited into a scenic spot where the tele-inviter is, and the tele-visitor's image is superimposed on some mobile robot. On the tele-visitor's side, too, the image may become an image of that person visiting the scenic spot with some VR devices. In this research, we intend to shape Tel-E-Merge into a type of medium that allows conversations to take place between remotely separated persons while they walk together. In particular, our focus is on the sense of locomotion, the sense one feels while walking on the real ground.

This paper introduces a Tele-Nursing system with realistic sensations using locomotion interfaces that have been developed up to now. The Tele-Nursing system with realistic sensations focuses on shared experiences from the perspective of non-verbal communications between the helper and the patient in the context of nursing in a remote environment.

2. WALKING SENSATIONS

When people walk together, their walking motion is sometimes felt to be synchronous. Moreover, they can find out a lot of information, like the sound, scale, hardness, humidity, and so on of the space by walking on foot. People usually do such a complicated task unconsciously and can pay a great deal of attention to their partner. Such an unconscious interaction while walking on foot can be thought of as a key point for the enhancement of reality or the existence of one's partner.

We have been investigating a series of development programs for communication devices using locomotion for the Tel-E-Merge system. We have developed two types of locomotion interfaces, ATLAS (ATR Locomotion Interface for Active Self Motion) [Noma 98] and GSS (Ground Surface Simulator) [Noma 2000] for applying Tel-E-Merge. ATLAS and GSS are walking simulators that make it possible to walk in a virtual space. The development of these systems focused on the realization of a situation in which a user in one indoor location feels exactly as though he were walking and talking with another person in a remote location, via a virtual space.

3. LOCOMOTION INTERFACES

3.1. ATLAS (ATR Locomotion Interface for Active Self Motion) [Noma 98]

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. 2).

The notable feature of ATLAS is a function that smoothly matches human walking movements, canceling out any forward motion. That is to say, 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.

As shown in Fig. 2, 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 treadmill used in ATLAS is a modified version of a commercially available treadmill, with a maximum belt speed of 4.0 m/s. The available walking area is 145cm (L) x 55 cm (W), and the response delay after receiving speed commands is 0.1 seconds.

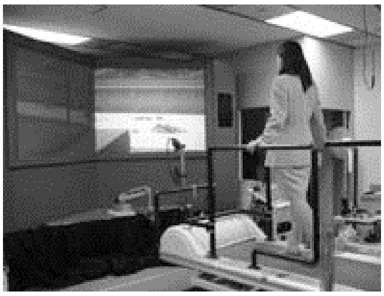

Figure 2. Locomotion interface: ATLAS

3.2. FGSS (Ground Surface Simulator) [Noma 2000]

Fig. 3 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 in the ground is recreated on the walking surface of the belt.

2) As in the case of ATLAS, the user needs only to 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.

Figure 3. Locomotion interface: GSS

The size of the walking surface that recreates the irregularities is 150 cm (L) x 60 cm (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 (25 cm 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

15 cm. The maximum elevation speed is 15 cm/sec, such that the shape of the terrain can be simulated without delay in following the user's walking movements.

The maximum height of the irregularities that actually move up and down is 15 cm, but it is possible to generate level differences of over 15 cm. For example, in the case of a graded path that has a continuous slope, it is necessary to give the user the sensation that the slope has a continuous angle. This is accomplished with the following process:

(1) Before the stepping foot is set down, the elevator panel in front is raised,
(2) While the lowered foot is carried backward by the belt, the panel carrying that foot is returned to level,
(3) When the foot on the opposite side is raised and before it is lowered, the next panel in front is raised as before.

Using this method, it is possible to create a sensation of slope that is larger than in the case of methods that simply create a maximum elevation difference of 15 cm. It is also possible to create an endless upward or downward staircase.

4. TELE-NURSING SYSTEM WITH REALISTIC SENSATIONS USING VIRTUAL LOCOMOTION INTERFACE

The Tele-Nursing system with realistic sensations focuses on shared experiences from the viewpoint of non-verbal communications between the helper and the patient in the context of nursing in a remote environment.

We move around on foot every day without being particularly conscious of that activity. But for people who cannot move around freely, particularly for reasons such as aging or physical disabilities, the very act of walking can be extremely difficult. For this reason, the wheelchair is a very important means of transportation that takes the place of walking. It is said, however, that human beings are social animals; even if a person is able to move, this is not enough. A person alone is isolated, and human beings need to communicate with others.

The authors are aiming to develop a means of communication that allows a sharing of physical sensations and emotions through Tel-E-Merge, which uses VR technologies. So, we propose one practical application of the Tele-nursing system, using the locomotion interfaces.

Along with developing the two types of locomotion interfaces described earlier, the authors are also conducting 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 in 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 in his site. 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. Then, a helper in a remote location can, remotely control the Tele-GSS with a patient on it.

Following are the features of the Tele-GSS:

(1) Controlled by a person (helper) in a remote location via a communication line. In this case, the speed is equivalent to the walking speed of the remote helper.

(2) The helper's voice and an image of the helper's face are projected through the display segment. At the same time, the movements of the helper turning his or her head are also recreated in the equipment.

(3) Visual and audio information from the environment surrounding the patient and the Tele-GSS are sent to the helper in a remote location.

From the point of view of the patient on the Tele-GSS, the voice of the "remote helper" can be heard from behind, and it seems as though the helper is pushing the wheelchair. It is also possible to carry on a conversation. In addition, the helper's face is also visible to passers-by through the display.

Fig. 4 shows the Tele-GSS controlled by a helper on the ATLAS in a remote location. The helper with an HMD (Head Mounted Display) walks on the ATLAS while watching the image sent from the Tele-GSS. In order for the remote helper to manipulate the Tele-GSS easily, it is important to create realistic sensations, as though the helper is actually pushing the Tele-GSS like a wheelchair in which the patient is sitting. In this sense, because Tele-Nursing via the Tele-GSS brings about stimuli of the dynamic physical sensation of walking, the helper can share physical experiences with the patient in a remote location. Although the connection is made through communication lines, the experience created is one that would have been difficult to achieve using existing communication methods.

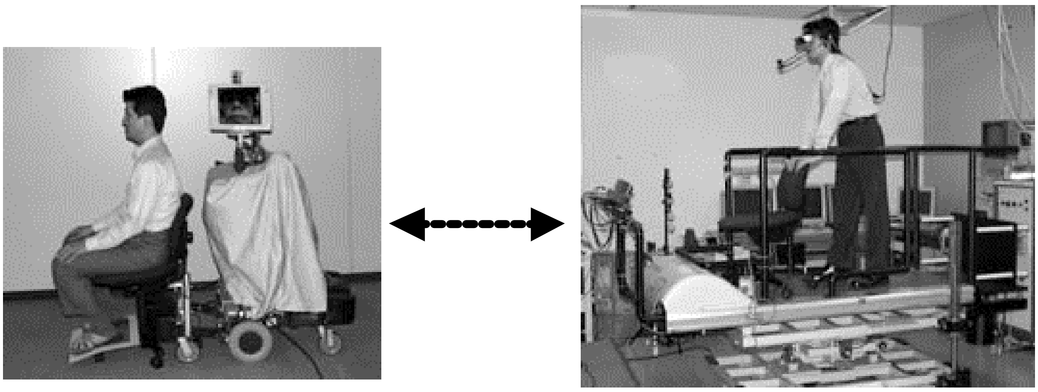

Figure 4. A patient on the Tele-GSS and a helper on the ATLAS in a remote location

Therefore, by sending information regarding the movement of the Tele-GSS to the locomotion interfaces, the patient in the Tele-GSS and the helper can feel the same sensation of moving together in a virtual space.

5. CONSIDERATIONS

5.1. Regarding methods of remote control for the tele-GSS

If we were only facilitating operation of the tele-GSS from a remote location, then manipulation by a mouse or joystick would be feasible method. Since the subject is a living human being, however, the helper operating the tele-GSS remotely would feel a psychological resistance to this method. Furthermore, the settings based on the relationship between the amount of movement in the operator hands during the remote operations and the movement of the wheelchair is a critical problem, from the perspective both of safety and the proficiency of the remote helper.

The goal of Tele-Nursing using the tele-GSS, which is a wheelchair Tel-E-Merge Apparatus, is communication between humans, and nursing operations that can be carried out easily by anyone.

5.2. Regarding conversation between remote locations

When two people communicate, the feeling of sharing the same environment is very important. Through this sharing, the persons involved can feel the temperaments of the other as well as the atmosphere of the particular location, or notice things that the other person is focusing his or her attention on. This allows the speakers to grasp key points in the conversation, so that the conversation progresses more smoothly.

If we were simply trying to facilitate a conversation between people in remote locations, then we could consider a conversation over portable telephones. With a portable telephone, however, there is no channel for non-verbal communication, which is important to smooth communications. Recently, we have seen the emergence of phones that can send images as well, allowing the users to transmit facial expressions and other types of non-verbal information, but even with these devices there is no physical interaction when the conversation takes place via a communications line.

On the other hand, the tele-GSS creates a situation in which the remote helper and the patient can interact through the wheelchair. A feeling of "actually being there" can be transmitted between the patient and the remote helper, via the actual body of the wheelchair. In this case, communication is not made possible simply because there is sound and images; as in the case of such devices as "In Touch"[Brave 98], the apparatus creates a basis for non-verbal communications through the physical sensations of the helpers operations.

As explained above, using Tele-Nursing using virtual locomotion, the sensations when the patient's wheelchair goes up a hill or across uneven ground can be transmitted to the remote helper. In this way, the helper can manipulate the wheelchair as though he were one with the patient.

6. CONCLUSION

In this paper, we presented Tele-Nursing system in relation to research being carried out with a goal of crating the optimal communication environment for communications between people using VR technologies.

The Tele-Nursing system applies a locomotion interface and a remote-controlled moving equipment, from the perspective of communication, and particularly non-verbal communication, with shared physical experiences between a helper and patient in the context of nursing in remote locations. The system makes it possible to stimulate dynamic physical sensations, such as the sensation of walking or the sensation of moving, thus allowing a communication environment in which the persons involved can share physical experience.

REFERENCES

[Brave 98] S. Brave, A. Dahley, P. Frei, and H. Ishii, In Touch, in *SIGGRAPH98 Conference Abstracts and Applications*, Orlando, USA, 1998, p.115.

[Miyasato 98] T. Miyasato, R. Nakatsu, User Interface Technologies for a Virtual Communication Space, in *IEEE and ATR Workshop on Computer Vision for Virtual Reality Based Human Communications*, Bombay, India, January 3, 1998, pp. 105-110.

[Noma 98] H. Noma, T. Miyasato, Design for Locomotion Interface in a Large Scale Virtual Environment, ATLAS: ATR Locomotion Interface for Active Self Motion, in *ASME-DSC-Vol. 64*, 1998, pp. 111-118.

[Noma 2000] H. Noma, T. Sugihara, and T. Miyasato, Development of Ground Surface Simulator for Tel-E-Merge System, in *IEEE VR2000*, New Brunswick, USA, March 18-22, 2000, pp. 217-224.