

# TELE HYPER VIRTUALITY

Nobuyoshi Terashima

ATR Communication Systems Research Laboratories  
2-2 Hikaridai, Seika-cho, Soraku-gun, Kyoto 619-02, JAPAN

*Abstract*— In the future, remote images sent over communication lines will be reproduced in virtual reality(VR). This form of virtual telecommunications, which will allow observers to engage in an activity as though it were real, is the focus of considerable attention. The system will offer the experience of being in a place without having to physically go there.

Taken a step further, real and unreal objects will be placed in a single space to create an extremely realistic environment. Here, imaginary and other life forms as well as people and animals in remote locations will gather via telecommunication lines that create a common environment where life forms can work and interact together. Words, gestures, diagrams and other forms of communication will be used freely in performing work.

Actual construction of a system based on this new concept will not only provide people with experiences that would have been impossible in the past, but will also inspire new applications in which people will function in environments where it would have been difficult if not impossible for them to function until now.

This paper describes Tele Hyper Virtuality concept, its definition, applications, the key technologies to accomplish it and future prospects.

## INTRODUCTION

In the future, remote images sent over information super highways will be reproduced in virtual reality(VR). This form of virtual telecommunications, which will allow observers to engage in an activity as though it were real, is the focus of considerable attention. The system will offer the experience of being in a place without having to physically go there.

Taken a step further, real and unreal objects will be placed in a single space to create an extremely realistic environment called Hyper World. Here, imaginary and other life forms as well as people and animals in remote locations will gather via super highways, to a common environment called The Coaction Environment, where life forms can work and interact together. Words, gestures, diagrams and other forms of communication will be used freely in performing work.

Actual construction of a system based on this new concept will not only provide people with experiences that would have been impossible in the past, but will also inspire new applications in which people will function in environments where it would have been difficult if not impossible for them to function until now.

This paper describes the concept, the technologies accomplishing it and the future prospects.

## CONCEPT OF TELE HYPERVIRTUALITY

Inhabitants, such as people and animals in remote locations as well as imaginary and other life forms, will be able to coact; that is, they will be able to work and interact together, in a Hyper World where real, unreal and other worlds are fully integrated.

### *Hyper World*

Hyper World is an advanced form of reality where real-world, computer graphic and other images are systematically integrated. Here, real-world images shot by camera and recognized by Computer Vision(CV) are realistically reproduced in Virtual reality(VR). These images may then be sent from remote location via super highways.

### *Coaction environments*

Inhabitants, such as people, animals, and imaginary and other life forms, will be able to work and interact together using words, gestures and other forms of communication in the Hyper World environment. This interaction is referred to as coaction.

Coaction not only allows people in remote locations to work and play together as though they were in the same room, but it also allows people to interact with imaginary life forms.

#### (1) Definition of a coaction environment

This highly realistic environment provides interrelated objects with a common site, that is, a workplace or an activity area. The environment offers a means through which activities such as designing buildings, sharing activities and playing catch can be performed while communicating through words and gestures. The manipulation of physical bodies not only requires that objects conform to the laws of physics, such as moving like they are supposed to move, and changing shape when they collide, but that various life form activities take place, such as plants wilting and blooming according to their exposure to sunlight.

New environments are created by the interaction of coaction environments. In other words, multiple independent coaction environments interacting to form an integrated coaction environment exchange knowledge for integration. Sometimes these environments return to their original state after they stop interacting.

Dynamic changes such as those just described are a feature of coaction environments.

(2) Advanced operation

The basic function of an advanced operation is to enable activities such as automobile design or a recreational event using words, gestures, diagrams, voice and other forms of communication.

(3) Coaction control

This provides control functions and a site for interactive work and activities. The control functions include common area control, as well as integration, separation and other common area activities corresponding to the interaction of the inhabitants.

DEFINITION

*Technologies for creating highly realistic environments*

S: Highly realistic environment

This is defined as follows.

$S = \{S_E, S_{CA}, S_{CG}, S_{CV}\}$

$S_{CA}$ : Nature, buildings and other objects shot with a camera

$S_{CG}$ : Objects created through computer graphics

$S_{CV}$ : Nature and other objects recognized and reproduced by Computer Vision

$S_E$ : Real objects

*Definition of inhabitants*

I: People, animals, and imaginary and other life forms found in S

This is defined as follows.

$I = \{I_E, I_{CA}, I_{CG}, I_{CV}\}$

$I_E$ : Real people and animals

$I_{CA}$ : People and animals shot with a camera

$I_{CG}$ : Imaginary life forms created using computer graphics

$I_{CV}$ : People or animals recognized and reproduced by Computer Vision

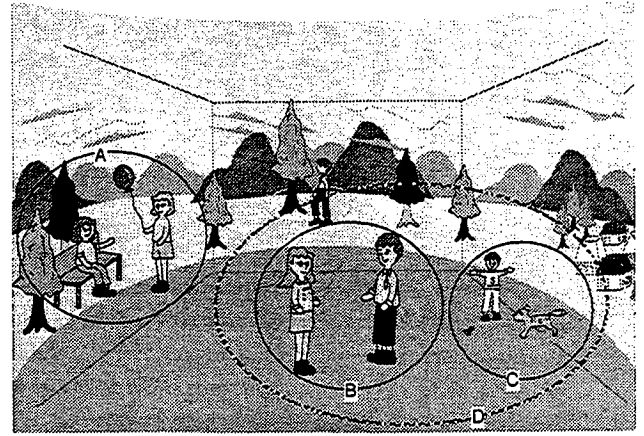


Fig.1 Hyper World and Coaction Environment

*Coaction environments(CE)*

A coaction environment(CE) is a group of individual coaction environments(CEi) in a realistic space(S) where inhabitants(I) are coacting.

$CE = \{CE_i\}$

A CEi is an individual environment where inhabitants(I) are coacting.

Individual CEi dynamically integrate and separate repeatedly through CEi interaction. Coaction environments are shown in Fig. 1.

A, B and C are coaction environments.

If we assume that the ball in C rolls into B, the human figure in B picks up the ball and returns it to the human figure in C, then environments B and C are integrated to form coaction environment D. When the human figure in C accepts the ball and starts playing with the puppy, environments B and C are separated once again.

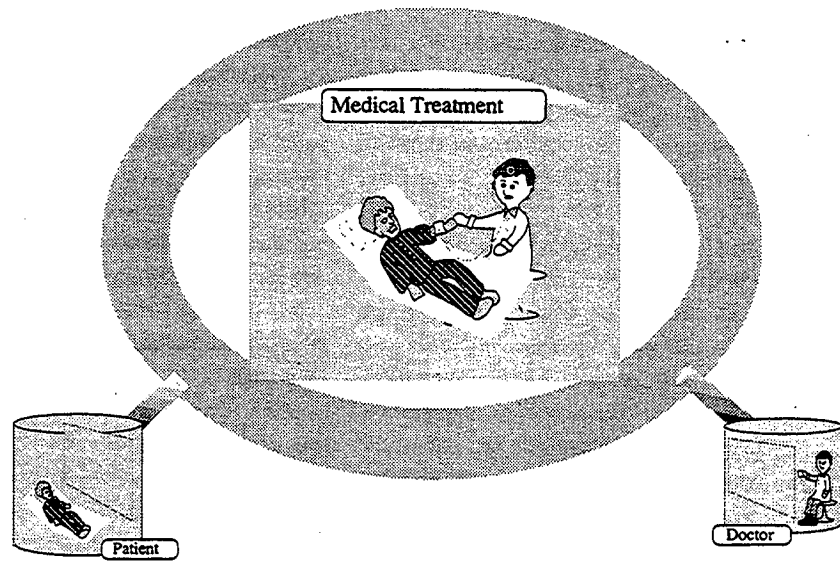


Fig.2 Medical Care

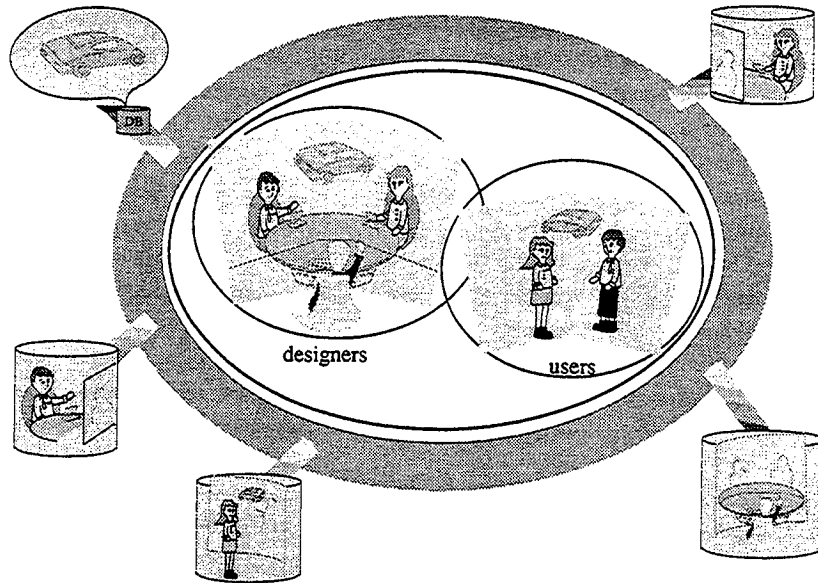


Fig.3 Coaction Environment

APPLICATIONS

Tele Hyper Reality enables coaction activities in highly realistic environments connected by communication lines.

This opens up possibilities for a variety of applications, ranging from medical applications, such as home care and home medical treatment for aging societies; various types of design work applications, such as automobile design; educational applications, such as remote classes and remote experiments; and entertainment applications, such as games and recreation. An image of medical treatment is shown in Fig. 2. An automobile design coaction is shown in Fig. 3.

IMPLEMENTATION

Real-time object image recognition

(1) Image recognition

In order to display images of a highly realistic environment from the observer's perspective, cameras are placed around the targeted natural and physical objects, and a method for switching the cameras position according to observer's perspective is being considered. In actuality, this method does not offer sufficient realism because of the lack of continuity during image switching.

To overcome these problems, the images of targeted natural and physical objects are first placed into a computer using Computer Vision, and then a method that creates from the observer's perspective and displays images in real time is used.

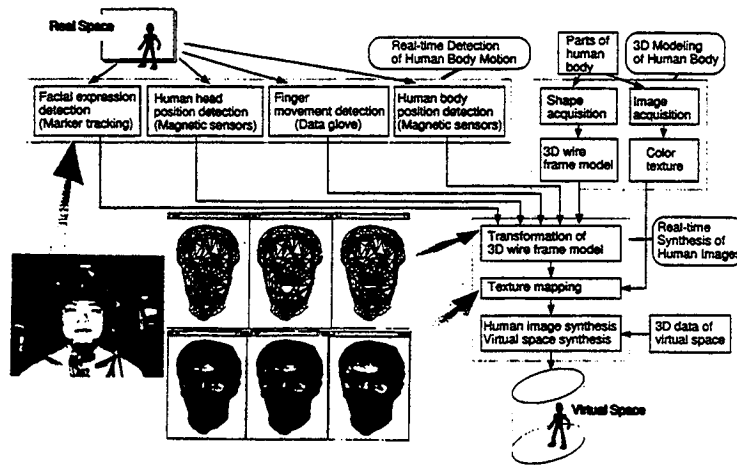


Fig.4 Real time recognition and generation of human image

This requires the technology to recognize targeted images, together with image creation and display technologies that create and display appropriate images, viewpoint and perspective detection technologies that detect the observer's perspective, and other technologies.

Fig. 4 provides details about the above technologies as they relate to human figures. Human figures are recognized and the wire frame model and texture are obtained and stored in the work station. Human figures are easy to model because they have many features in common, but natural and other physical objects are quite difficult to model because they come in all shapes and sizes. If a model can be created, the model is treated like a mannequin, and is then an easily recognizable target. However, new technologies will have to be developed in order to recognize natural and other physical objects that are difficult to model.

(2) Recognizing movement information

Information for head, hand and other movements by human figures will be detected in real time. Research is currently underway on non-contact movement detection methods as well as on detection methods in which sensors are placed on numerous parts of the human body.

Movement information for natural and other physical objects, on the other hand, is not that easy to detect. If we target a single tree, for example, some method will have to be found to detect the movement of each individual branch.

(3) Creating images

Information related to targets acquired in (1) as well as information related to movements acquired in (2) are used to create targeted images in real time using computer graphics.

(4) Displaying images

Images created in (3) are displayed on a large screen.

Since shutter glasses are used to create a three-dimensional perspective, images corresponding to the left and right lenses are switched and displayed at high speed. A three-dimensional image is obtained by viewing the image with shutter glasses.

A three-dimensional image will be achieved with the naked eye using a lenticular screen method that displays images corresponding to the left and right eye viewpoints, respectively, through 3.6-mm slits.

Lenticular screen method is shown in Fig. 5.

Coaction environments

The next step will be to create a coaction environment where inhabitants will work together and take part in recreational activities, such as playing catch. In the coaction environment, object manipulation by words and gestures is used to play catch, to perform design work, and to control physical movement according to the laws of physics. If coaction environments interact, an entirely new coaction environment is created in line with the specific form of interaction.

(1) Changes in the coaction environment due to interaction

Once two environments A and B interact, a new environment that includes both the original environments is created.

Coaction then occurs in the new environment. Fig.1 shows the merging of two environments.

(2) Basic manipulation, laws of physics, biological laws

An object manipulation method based on words, gestures and other forms of communication will be used. Here the laws of physics; illustrated by objects falling, dishes breaking, physical changes from objects colliding, as well as sounds, are faithfully reproduced. Biological laws, such as plant growth and wilting in sunlight, are also faithfully reproduced.

FUTURE PROSPECTS

We have proposed a coaction environment in which people, animals, imaginary and other life forms work and play together in a highly realistic environment that includes real as well as unreal objects. These objects may be sent over communication lines from remote locations.

By providing an environment that goes beyond reality as just described, people will be able to perform work and activities not possible in a real environment. This system will contribute tremendously to the welfare of humankind.

An example might be providing all-night care for invalid elderly family members by artificial life forms that will notify the family, and

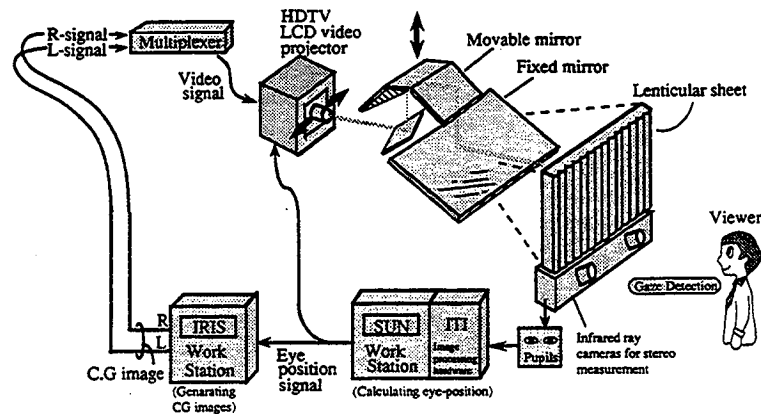


Fig.5 Eye-Position Tracking Stereoscopic Display System

take appropriate action at the appropriate time when there is a problem. Such a system will also provide heretofore unfathomable benefits, like helping people to function in particularly difficult environments, such as underwater, underground and in outer space.

#### REFERENCES

- [1] N. Terashima, "Basic Research on an Intelligent Communication System," IEEE Denshi Tokyo, 1992, pp.18-22, No.31.
- [2] N. Terashima, "Cooperative Work in Teleconferencing System with Realistic Sensation," Hypermedia '92 Bepu Bay Conference report, 1992, pp.115-119.
- [3] H. Takemura, "Cooperative Work Environment Using Virtual Workspace," Proc. of Virtual Computing, 1992, pp.171-181.
- [4] S. A. BENTON et. al., "Interactive Computation of Display Holoranis," Proc. of Virtual Computing, 1992, pp.129-149.
- [5] N. Tetsutani, "Stereoscopic Display Method Employing Eye-position Tracking and HDTV LCD-projector," Proc. of Int. Workshop on HDTV '92, 1992.
- [6] N. Terashima, "A New Concept for Future Telecommunication," Proc. of TAO First Int. Symp. on Three Dimensional Image Communication Technologies, S-4-5, 1993.
- [7] N. Terashima, "VR and Communication with a Sensation of Reality," Proc. of IEEE Denshi Tokyo, 1993, pp.21-26, No.32.
- [8] N. Terashima, "Virtual Space Teleconferencing System -A Distributed Virtual Environment-," Proc. of Broad band Islands '94, North-Holland, 1994, pp.35-45.
- [9] N. Terashima, "Telesensation -Distributed Virtual Reality- Overview and Prospects," IFIP Transactions Technology and Foundations, North-Holland, 1994, pp.49-59.