

Experience of Immersive Virtual World Using Cellular Phone Interface

Tetsuro Ogi^{1,2,3}, Koji Yamamoto³, Toshio Yamada¹, Michitaka Hirose²

¹ Gifu MVL Research Center, TAO
Intelligent Modeling Laboratory, The University of Tokyo
2-11-16, Yayoi, Bunkyo-ku, Tokyo 113-8656, Japan
{tetsu, yamada}@iml.u-tokyo.ac.jp

² Research Center for Advanced Science and Technology
The University of Tokyo
4-6-1, Komaba, Meguro-ku, Tokyo 153-8904, Japan
hirose@cyber.rcast.u-tokyo.ac.jp

³ Mitsubishi Research Institute
2-3-6, Otemachi, Chiyoda-ku, Tokyo 100-8141, Japan
koji@mri.co.jp

Abstract. The cellular phone has become a popular portable information device. In this study, the i-mode of the cellular phone was applied to the interface with the immersive virtual world. By using the cellular phone interface, the user can experience the immersive virtual world easily using his own device. The interaction using the i-mode was experimentally evaluated in the walk-through application. In addition, by integrating the cellular phone interface with the transparent immersive projection display, an invisible immersive interface that enables the user to experience the virtual environment in the real work place was constructed. This system was applied to several fields of application such as the visualization of data and the telecommunication.

1. Introduction

Recently, mobile media such as the cellular phone and the PDA (Personal Digital Assistance) have become very popular, and they are used as personal devices being carried everyday. By using these devices, the user can easily access information everywhere and at any time in the daily life. However, in these devices, the displayed information is restricted because only the small LCD (Liquid Crystal Display) is equipped.

On the other hand, immersive projection display such as the CAVE or the CABIN can generate a high presence information space around the user [1][2]. However, in order to use this kind of display system, the user must operate the graphics workstation to run the application program and interact with the virtual world using a special device such as the wand or the wanda [3]. Therefore, it is difficult that the ordinary people experience the high presence virtual world in the immersive projection display.

In this study, an interface technology with the immersive virtual world using the personal device of the cellular phone was developed in order to experience the high presence virtual world easily. In this system, the user can also experience the immersive

environment in the real world, by integrating the transparent display system with the cellular phone interface. This paper describes the system construction, the features and several applications of the immersive environment using the cellular phone interface.

2. Cellular Phone Interface

2.1 Features of Cellular Phone Device

In order to experience the high presence virtual world using the immersive projection display, the user must operate the graphics workstation to run the application program and interact with the virtual world using the special interface devices. For example, in the CAVE developed at the University of Illinois, the wand and the wanda are used for the interface devices. In the case of the CABIN developed at the University of Tokyo, the Nintendo64 Controller, the VibroPointer, and the Twiddler are used for the joystick, the haptic pointer and the character input devices respectively [4][5]. In particular, it is difficult to input characters in the three-dimensional immersive virtual environment. Although the practiced user is able to input characters rapidly using the Twiddler by one hand, it is hard for the unfamiliar user to use this kind of device efficiently. Therefore, it is desired that the everyday device that is carried in the daily life should be used for the interaction so that a large number of people can experience the immersive information space easily.

On the other hand, the recent cellular phone has been used to access Internet, and the cellular phone device itself has several functions. For example, the dial button can be used to input characters as well as to dial telephone numbers, and the LCD is used to display information. The pager motor is often installed to inform the phone call using the vibration sensation, and it can be used to display haptic information. In addition, the cellular phone device that is equipped with the Internet access function such as the i-mode or the WAP (Wireless Application) can be used to transmit data to the computer as a kind of computer terminal. Therefore, we can consider that the cellular phone that is used in the daily life can be used as an interface device with the virtual world effectively.

2.2 i-mode Interface

In this study, an interface technology using the i-mode was developed to interact with the immersive virtual world. The i-mode is an Internet access service for the cellular phone provided by the NTT DoCoMo Inc., and the user can access web information using the dial button and the LCD [6]. Currently, in Japan, about twenty-three million people are using this service, and it has become a popular portable information device.

The i-mode was applied to realize the interactions such as the walk-through and character input in the virtual world. In these interactions, the dial button of the cellular phone is used for the button and the keyboard functions. Since the LCD is also equipped on it, the user can perform the input operation in the local feedback, without displaying the three-dimensional input window or the menu in the virtual world.

In addition, the cellular phone device can also be used as a pointing device by attaching the position tracker to it. In this system, a Polhemus electromagnetic sensor was used to



Fig. 1. Cellular Phone Interface with Position Tracker

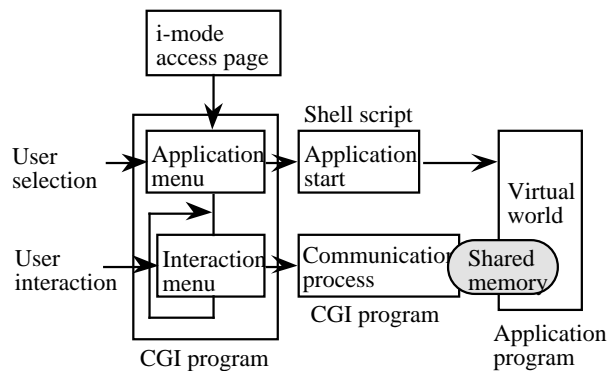


Fig. 2. Software Construction of the i-mode Interface

track the position of the cellular phone. In this case, when the cellular phone communicates with the Internet, it generates an electromagnetic wave that causes a tracking error. Therefore, the position tracker was attached about 8 cm away from the body of the cellular phone to reduce the influence of the electromagnetic wave as shown in figure 1.

2.3 Software Construction

The i-mode interface is used both as a computer terminal to start the virtual reality application and as an interface device to interact with the virtual world in the application program. Figure 2 shows the software construction of the i-mode interface.

In order to start the virtual reality application program, the user first accesses the graphics workstation through the DoCoMo i-mode Center. The application program runs when the user selects the menu item or inputs the name of the application in the i-mode web page. This i-mode page is written in CGI (Common Gateway Interface), and it runs the shell script to start the application program. By using this method, the user can start the virtual reality application without using a computer terminal.

After starting the application program, the CGI program moves to the interaction i-mode page. When the user inputs characters or selects menu item in the interaction i-

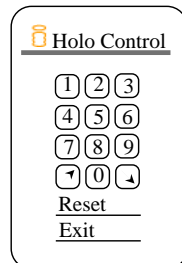


Fig. 3. Interaction i-mode Page for the Walk-through



Fig. 4. Walk-through Using the i-mode Interface in the CABIN

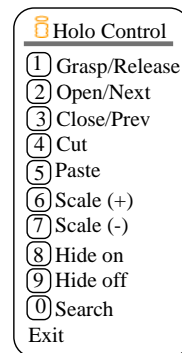


Fig. 5. Interaction i-mode Page for the Data Manipulation

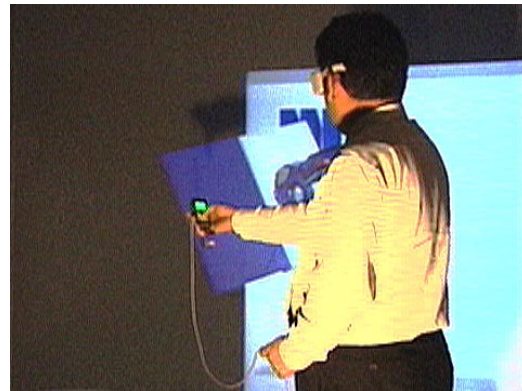


Fig. 6. Data Manipulation Using the i-mode Interface in the CABIN

mode page, the CGI program generates a communication process that transmits the interaction command to the application program. This communication process is generated every time the user interacts with the virtual world, and this interaction command is transmitted to the application through the shared memory.

For example, figure 3 shows the interaction i-mode page to walk through the virtual world. In this example, the dial buttons are assigned to several moving functions such as “go ahead”, “stop”, “turn right”, “turn left”, “go up” and “go down”, and the user can walk through the virtual world freely by operating these dial buttons. Figure 4 shows the user walking through the virtual town by using the i-mode interface in the immersive projection display CABIN.

Figure 5 shows the other example of the interaction i-mode page to retrieve data and manipulate it in the virtual world. When the user selects the “search” button and input keywords, the data is retrieved from the database system and is visualized in the virtual world. And when the user reaches his hand for the visualized data and pushes the “grasp”

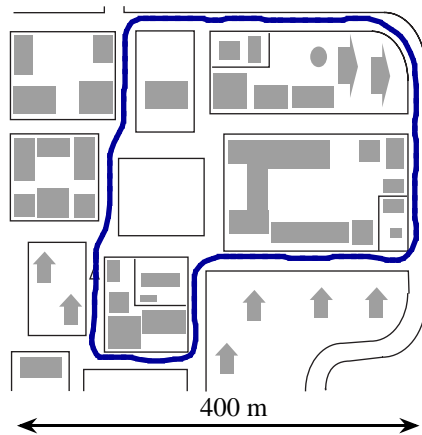


Fig. 7. Typical Track of the Walk-through Using the Nintendo64 Controller

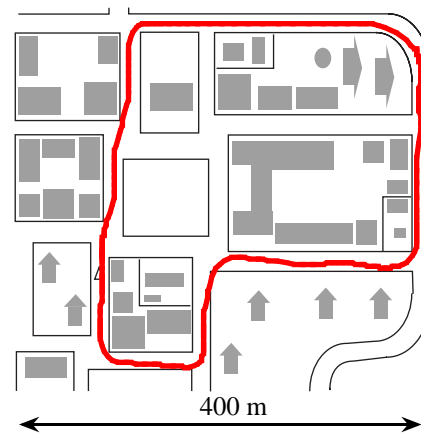


Fig. 8. Typical Track of the Walk-through Using the i-mode Interface

button, he can grasp and manipulate it as an object in the virtual world. Figure 6 shows the user manipulating the visualized data in the virtual office. In this application, since the retrieved data is visualized being filed in the book, the user can manipulate data by grasping it or browse data by turning the pages of the visualized book.

2.4 Evaluation of i-mode Interaction

In the interaction using the i-mode, the user accesses the graphics workstation through the Internet by connecting with the DoCoMo i-mode Center via the 9600 bps packet communication. Then, we cannot avoid a problem of the time delay in the real-time interaction. Although the exact value of the lag depends on the network condition, in the ordinary use, the average lag between the command input and the change of the displayed image was about 0.48 sec.

The influence the time delay has on the interaction with the virtual world must be fully investigated. In the case of the command type interaction such as selecting a menu item or grasping the virtual object, a small lag would be an insignificant problem. However, in the continuous interaction such as walking through the virtual world, we are afraid that the time delay has a severe influence on the real-time interaction.

In this study, we conducted an experiment to investigate whether the user can walk through the virtual town smoothly using the i-mode interaction. In this experiment, the subjects were asked to move along the indicated way, and the tracks were compared between using the Nintendo64 Controller which was directly connected to the serial port of the graphics workstation and using the i-mode interface. In the case of using the i-mode interface, the interaction method shown in figure 3 was used, and then the user moved the virtual town using the dial button operation.

Figure 7 and figure 8 show the typical results of the tracks along which the subject moved by using the Nintendo64 Controller and the i-mode interface respectively. In both cases, the maximum speed of the movement was about 35 km/h. When the subject

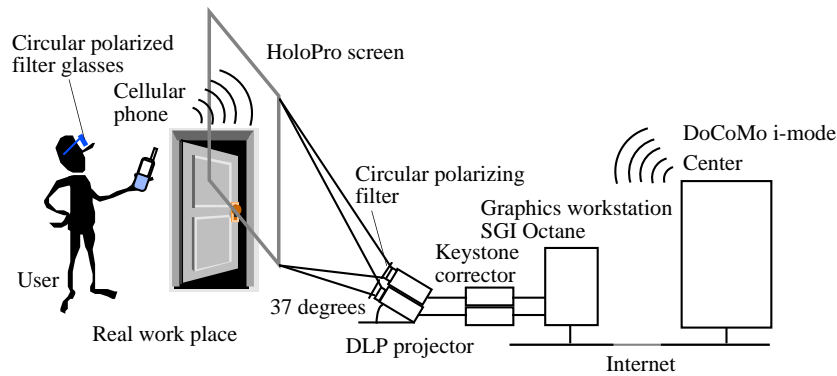


Fig. 9. Invisible Immersive Interface System Using HoloPro Screen and i-mode Interface

turned a corner using the i-mode interface, he occasionally strayed off the course being caused by the time delay and the difficulty of the dial button operation. However, on the whole, the subjects could walk through the virtual town smoothly by using the i-mode interaction.

3 Invisible Immersive Interface

3.1 Transparent Display

Although the user can easily interact with the virtual world using the cellular phone interface, the display system also should be equipped in the real world so that he can experience it everywhere. However, if the immersive projection display such as the CAVE was equipped in the real work place, it would obstruct the working space of the user. In this study, a transparent immersive projection display that can present a high presence virtual world in the air without disturbing the user's view was introduced. By using this display system, the user can experience the three-dimensional immersive virtual world in the real work place only when it is necessary.

As for the transparent screen, HoloPro screen made by G+B Pronova was used [7]. This screen is constructed by laminating a gelatin light directing film inside the multi-layer glass. Since the image projected from the specific angle between 35 degrees and 40 degrees is redirected in the direction of the viewer, the projector can be placed on the floor or on the ceiling behind from the user's view. Moreover, since the polarization of the light is preserved when it goes through the screen, the polarizing filter method can be used to generate a three-dimensional stereo image. This screen can also be used outdoors in daylight, because the projected image is hardly affected by the ambient light. Therefore, this system can be used in the real work place as a real world oriented virtual reality system.

In this study, the invisible immersive interface system was constructed by combining the HoloPro screen and the cellular phone interface technologies as shown in figure 9. The diagonal size of the HoloPro screen is 50 inches, and the SGI Octane graphics



Fig. 10. Visualization of Design Model Using the Invisible Immersive Interface

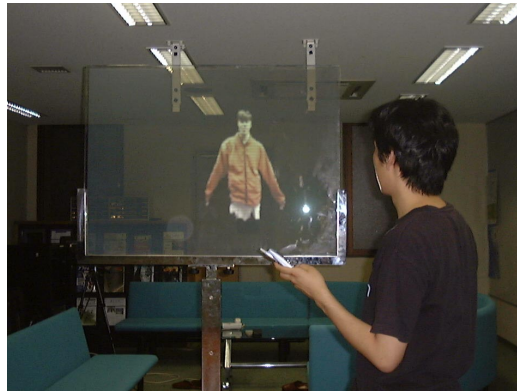


Fig. 11. Telecommunication Using the Invisible Immersive Interface

workstation is used to generate parallax images for the left and right eyes. These two images are transmitted to the NEC LT140J DLP (Digital Light Processing) projectors, and are projected from the angle of 37 degrees through the Analog Way Keystonix KC-100 keystone correctors. When the user accesses the graphics workstation using the cellular phone, he can see the stereo image in the real world by wearing the circular polarizing filter glasses.

3.2 Applications

By using the invisible immersive interface, the user can easily experience the immersive virtual environment in the real work place. In this study, this system was introduced into the meeting room in the Intelligent Modeling Laboratory at the University of Tokyo. The designers often discuss the design data looking at the drawing. When this system is used, they can visualize the three-dimensional design model in the meeting room by accessing the data using the cellular phone. Figure 10 shows the example in which the

designers are discussing the design model in the real meeting room.

This system was also applied to the high presence telecommunication between remote places. The authors have been studying the communication technology using the video avatar in the networked shared virtual world [8]. The video avatar is a three-dimensional video image that is constructed using the depth data calculated from the stereo video images. In this system, the video avatar was applied to the communication between the real worlds as shown in figure 11. When the user calls the remote user using the cellular phone, the video avatar of the remote user appears in the real space projected onto the transparent screen, and they can communicate with each other with a high quality of presence.

4 Conclusions

In this study, the interaction technology using the i-mode of the cellular phone was developed to experience the virtual world easily. In this method, the user can run the virtual reality application program without using the computer terminal and interact with the virtual world using the cellular phone. In addition, by integrating the cellular phone interface with the transparent immersive projection display, the invisible immersive interface was constructed which enables the user to experience the immersive virtual world in the real work place. This system was introduced into the meeting room and was applied to the visualization of the design model and the telecommunication between remote places. In this method, the user can interact with the virtual world easily by using his own cellular phone that is carried in the daily life. Future work will include applying this technology to the more practical fields of application and evaluating the effectiveness of this technology.

References

1. Cruz-Neira, C., Sandin, D.J., DeFanti, T.A.: Surround-Screen Projection-Based Virtual Reality: The Design and Implementation of the CAVE, Proceedings of SIGGRAPH'93 (1993) 135-142
2. Hirose, M., Ogi, T., Yamada, T.: Integrating Live Video for Immersive Environments, IEEE Multimedia, Vol.6, No.3, July-September (1999) 14-22
3. Browning, D.R., Cruz-Neira, C., Sandin, D.J., DeFanti, T.A., Edel, J.G.: Input Interfacing to the CAVE by Persons with Disabilities, Virtual Reality and People with Disabilities (1994)
4. Ogi, T., Watanabe, H., Hirose, M.: Interactive Scientific Visualization in Immersive Virtual Environment, 3rd International Immersive Projection Technology Workshop (IPT99) (1999) 223-230
5. Ogi, T., Yamada, T., Kano, M., Yamamoto, K., Hirota, K., Hirose, M.: Multimedia Virtual Laboratory on the Gigabit Network, The Tenth International Conference on Artificial Reality and Telexistence (ICAT2000) (2000) 98-103
6. <http://www.nttdocomo.com/i/index.html>
7. <http://www.holopro.com/>
8. Ogi, T., Yamada, T., Tamagawa, K., Hirose, M.: Video Avatar Communication in Networked Virtual Environment, INET 2000 The Internet Global Summit Proceedings (2000)