An Interactive Teleconference System for Small Groups

Sang Yun Oh[*, **], Sang Chul Ahn[*], Hyoung-Gon Kim[*], HanSeok Ko[**]
Imaging Media Research Center, Korea Institute of Science & Technology,
39-1 Hawolgok-dong, Sungbuk-gu, Seoul, Korea 136-791[*]
Department of Electronics and Computer Engineering, Korea University[**]
{syoh, asc, hgk}@imrc.kist.re.kr

Abstract

This paper proposes a new teleconference system for small groups. The proposed system provides table and wall displays as shared workspaces for efficient teleconference. It also provides multiple mice and marker recognition system for easy interaction with the shared workspaces. With the system, people can easily discuss and collaborate with remote people, and even access their remote computers at conference table, which reduces data movement and print of discussion materials. The proposed system is focusing on remote discussion and collaboration while existing teleconference systems are mainly focusing on video conferencing and chatting.

Key words: Teleconference, CSCW, SDG, Multiple Interaction

1. Introduction

Teleconference enables people to have a meeting together on a subject from remote locations. Teleconference can increase productivity by removing waste of travel time and delay of decision-making, which could occur when insisting on a face-to-face meeting. Recently there are some teleconference systems. However, they are mostly video conference systems, and are not enough for efficient conferencing especially in group-to-group conference or meeting. An efficient teleconference system should provide a shared workspace and effective methods for interaction with it. In a face-to-face meeting, people usually sit around a table, and discuss over or work on some materials on it. The table plays a role of a shared workspace where people can share their data and work collaboratively by hands. As meeting environment is rapidly computerized, OHP(Overhead Projector) has been replaced by data projector connected to a computer. Further, it becomes usual that participants bring his notebook computer to a meeting table. It happens because most of data is digitalized and stored in computers these days. Thus, there is a need to change a shared workspace from a table to a computer display. This need is quite strong in computer-based teleconference environment since people have to share discussion materials, and it is easily accomplished with a computer display.

In the researches on computer-based teleconference systems, most of studies have focused on efficient provision of video and audio communication channels. [1,2,3,4] are some examples of such studies. Raskar et al. proposed "Office of the future" as an immersive teleconference system by combining computer vision and graphics technology[1]. However, interaction problem in a shared workspace is not clearly solved in their works. Most of the other teleconference systems provide only whiteboard or blackboard style shared workspaces. Situation is the same even for commercial teleconference systems[5,6]. NetMeeting[5] of Microsoft, that is widely used, shows the typical configuration of teleconference system of these days. It has a video window for visual communication, and provides an application sharing mechanism for collaboration. However, it is one-to-one meeting system and collaboration mechanism is not efficient because permission should be obtained before interaction.

As other related works, there are some researches to utilize a table-top display as a shared workspace in a conference environment[7,8]. Rekimoto and Saitoh[7] implemented HyperDragging technology to exchange digital data by dragging among user's notebook and computers for table and wall displays in a meeting environment. Even though it is not a teleconference system, the interaction method is most advanced among others.

This paper proposes a new computer-based teleconference system that provides table-top display and wall display as shared workspaces and multiple mice interaction for efficient teleconference of small groups.

2. Proposed Teleconference System

2.1 Overview

The main concept of the system is to share computer displays as workspaces with remote people as well as local people, and to provide efficient interaction method with the workspaces. Figure 1 shows both sides configuration of the proposed teleconference system. The system provides table and wall displays, which show the screen of a main computer. The system also provides multiple mice for interaction with the displays or the main computer. Video camera, under the wall display, is used for capturing and transferring video images of local group to remote group. The system provides microphones for every participant. The voice captured by the microphone is rendered by 7.1 channel speakers at remote site. Additionally, the system contains an active IR(Infrared) camera and IR reflective markers for easy interaction with displays by predefined commands.

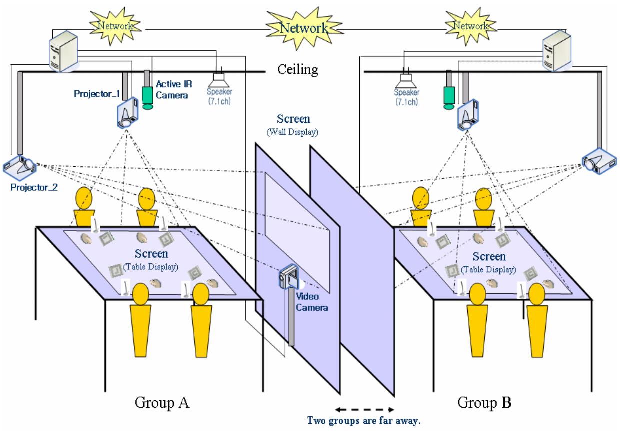


Fig. 1 Configuration of the proposed system

Figure 2 shows functional diagram of the proposed system. In the diagram, VNC is used for remote computer access and workspace sharing. VNC was originally developed by Olivetti Research Laboratory (ORL) in Cambridge, UK[9]. It is used for sharing a computer with remote people. In the proposed system, VNC is used in two ways. First, table and wall display are shared with a remote group using VNC so that people can see the same screen for discussion. Secondly, participants can access their own computer using VNC at the conference table. In this way, people don't need to bring their computer to the conference. Multiple wireless mice are used to control the computers at local and remote sites through VNC.

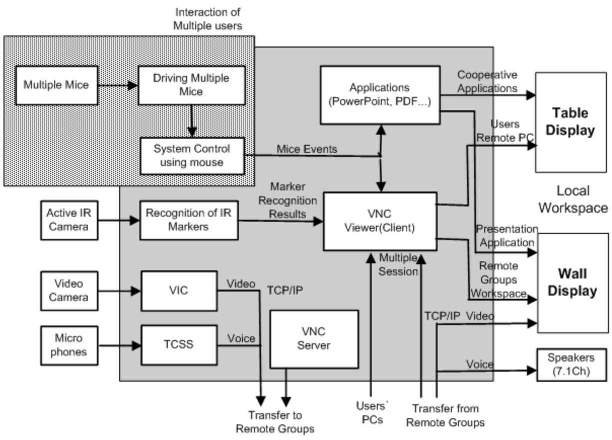


Fig. 2 Functional diagram of the system

2.2 Wall Display

Table and wall displays are connected logically, and show the dual screen of the main computer. The wall display plays a role of data sharing space with remote group as well as local group. We discuss first the functions of the wall display.

Firstly, when people discuss over a material, it can be shown on the wall screen. Using VNC function, local and remote people can see the same screen on the wall screen. Local and remote people can point an item on the wall display with their mice, too. Connecting to their remote PC through VNC, users can show or present data on the wall display using applications such as power point and PDF viewer. The information can be displayed on the wall display of remote group at the same time, which is shown in figure 3. When a user presents his data, he can control both of wall displays at local and remote site at the same time through the table display. Figure 4 shows an image where a user controls wall display through table display.

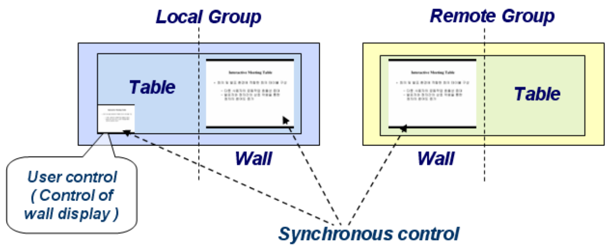


Fig. 3 Simultaneous control of wall displays for presentation

Fig. 4 Presentation control

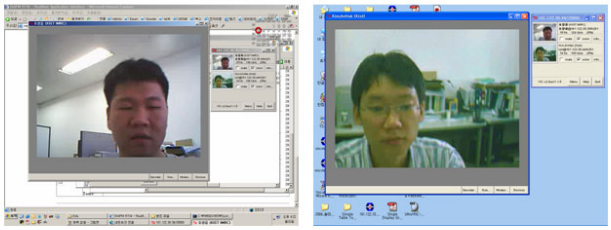
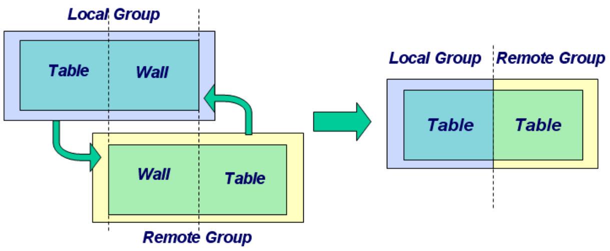


Fig. 5 Video transfer using VIC

Secondly, the wall display is also used for video channel display. On one side of the wall display, video image of remote people can be displayed for video communication. The video is captured by the video camera located under the wall display. A tool used to transmit video to both sides is VIC (VIdeo Conferencing). VIC is a video conference application developed by the network research group at the

Lawrence Berkeley National Laboratory[10]. This tool supports real time multimedia service for video conferences on internet. Figure 5 shows screen views of video transfer using VIC.

Thirdly, the wall display can connect remote site and show remote table display using VNC for effective collaboration. Figure 6 (a) shows the process of exchanging table displays between two groups. As the result of it, each group can see table displays of both groups, and share the workspace as one space, which can be seen in figure 6 (b). Figure 7 shows an implementation result of exchanging table displays. Because the teleconference system was implemented only at one site, a single PC on a desk is used as the remote system.



(a) (b)

Fig. 6 Workspace sharing between two groups

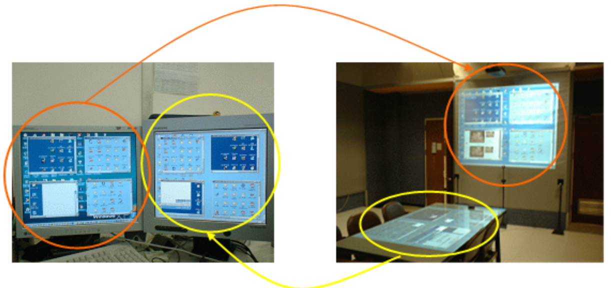


Fig. 7 Workspace sharing

2.3 Table Display

The table display is used mainly by local people. They access their own computers at the table display remotely, and share the screen with others. Originally, the table display shows the screen of the main computer at conference site. People can control the main computer and run applications by multiple mice. We will discuss implementation of multiple mice in the next chapter. Using VNC, people can connect their remote computers and access data in them. For this use, we modified VNC so that VNC screen can be rotated as shown in figure 8. It is useful when people have to see the VNC screen upside down because of their seats. Figure 8 shows the image of table display that displays 4 VNC windows for 4 people. It is assumed that 2 people take seats along each side of the table. The upper 2 windows show upside down screens so that users can see the right view. Considering the number of users and the resolution of the whole display, we decided to reduce the size of VNC window to almost 1/4 of the whole display at the initial stage.

Fig. 8 Rotation of VNC windows along the user position

When a user wants to show the screen of his remote computer to others, he can move the VNC screen to the wall display. In this way, people don't have to move data for discussion from their computers to the main computer at conference site. For easy use of this functionality, the system provides a marker recognition system with an active IR camera and IR reflective markers. Users can easily open the VNC client screen for their remote computers by putting the markers on the table. User can move the VNC screen to the wall display by moving his marker to the center of table display, which is a predefined position. Figure 9 shows the process of the IR marker usage. Figure 4 shows images, where the IR marker is located at the center of the table display, and the screen of the lower left window is displayed on the wall display.

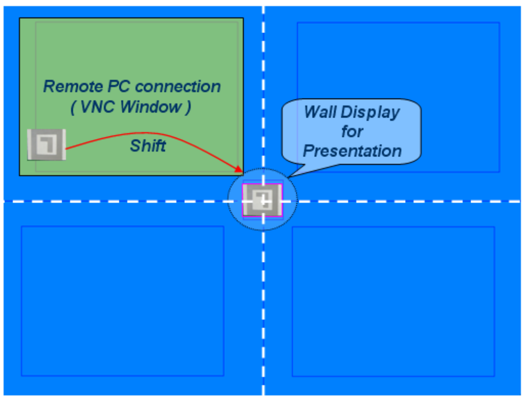


Fig. 9 Process of the IR marker usage

Figure 10 shows the process for IR marker interaction. In the offline process, users have to register the addresses and passwords of their PCs to the markers. They can bring the markers with themselves to the conference site. Then, users are recognized by IR markers recognition process, and they are assigned their work area through VNC connection to their own PC on the table display. If a marker is removed from the table, PC connection is also removed and VNC window disappears.

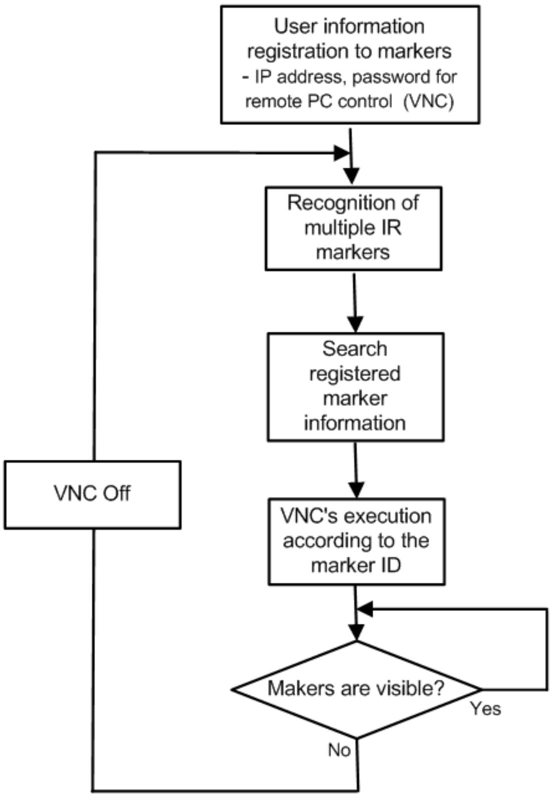


Fig. 10 Process for IR marker interaction

2.4 IR marker Recognition

It is required to recognize users for assignment of individual workspace at table display in the conference system. The proposed conference system uses IR reflective markers as interface devices. If a user brings an IR reflective marker, takes a seat, and puts the marker on the table, then the system recognizes the marker using computer vision. Since the proposed conference system is using projectors and the light is better to be dimmed in the projection display environment, it is difficult to recognize a marker using a general PC camera. Thus, we used an active IR camera and IR reflective markers because light condition on the table is bad and changing. We call the 'active IR camera' because the IR camera has an IR light source with it. The IR camera can be made with a normal video camera and a cold mirror as an IR filter. The cold mirror is an IR filter that absorbs IR rays while reflecting visible rays. We used a cold mirror that absorbs the rays of above 800nm in wave length. Figure 11 shows the active IR camera that contains IR LEDs as an IR light source.

(a) Front view (b) Top view

Fig. 11 Active IR(Infrared) camera

Figure 12 shows the IR reflective markers. The IR marker was made with retro-reflective material so that it can be viewed best from the camera with IR light source. The size of a marker is 10cm x 8cm considering the distance from the Active IR camera. We used library functions in ARToolkit [11] for marker recognition.

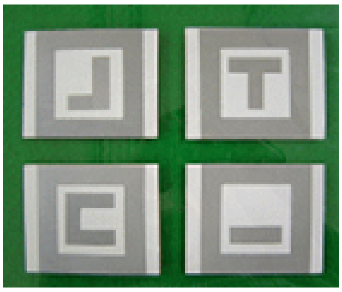


Fig. 12 4 IR reflective markers

2.5 Remote PC Control

The proposed system uses the VNC to control remote PCs. VNC windows are used as individual workspaces at the table display. Using the VNC, users can get the effect of bringing their familiar PC workspaces to the conference site. We can also solve inconvenience of moving meeting agenda or materials to the conference system using storage device before the meeting. It also reduces the need to print brochures for the meeting by showing the material on the table display. A User can share conveniently the resources of his own PC with other users using VNC. For instance, a user can show presentation data within his remote PC to the wall display. He can also transfer the presentation data file to the conference system computer so that other users can see it on the table display, which plays the role of brochure. He can also show the result of an application such as simulation that is executed in the remote PC directly. It can minimize load of conference system because of the usage of remote PC's resources.

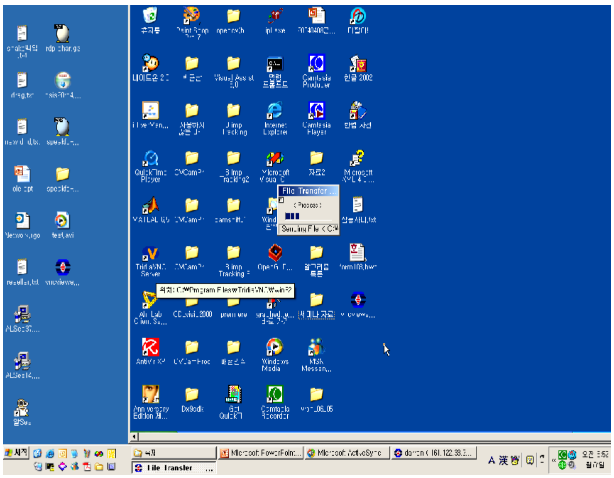


Fig. 13 File Transfer from conference system to remote computer by Drag & Drop

When a user connects to remote PC using VNC in conference system, a new VNC window is created. VNC window is separated from other VNC window or desktop screen, and it can be interacted by transferring mouse and keyboard information. Therefore, a file cannot be copied by drag & drop action. Original VNC offers only a separate FTP window to exchange files. However, it is not convenient to use the FTP window. Thus, we modified VNC so as that we can transfer a file to a remote PC using Drag & Drop action of a mouse. Figure 13 shows a screen shot where a file is being transmitted from conference computer to a remote PC by Drag & Drop action of a mouse. In this case, a progress bar pops up and tells the progress of the transmission like the file copy of Windows.

2.6 Multiple Mice Interaction

When people work together in the same place, they may share a workspace but use individual tools for effective work. However, the situation is different when a computer display becomes a workspace. Because control of a PC is given to a user, other people cannot use the PC while the user uses it. So, mouse interactions of multiple users should be asynchronous when multiple mice are used. The proposed conference system provides users a sharing workspace for collaboration using a single computer. For smooth collaboration of users, they need interaction tools with which every user can control the computer synchronously in this environment. The proposed system provides multiple mice for interactions with the shared workspace. People can use the main conference computer with the mice as if it is their own computer. Currently multiple mouse cursors are not supported in a computer. Thus, we implemented multiple mice so that every mouse has its own cursor to distinguish them. But, they share a system mouse at the execution of click or double click.

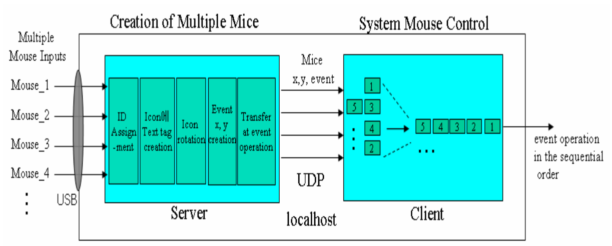


Fig. 14 Process of multiple mice interaction

Figure 14 shows process of multiple mice interaction. We can get ID information for multiple mice connected to USB ports. We can acquire coordinates and events of each mouse, too. In the process of multiple mice interaction, we draw a virtual cursor at the position corresponding to the coordinate of each mouse. Mouse cursors are made with bitmaps of 18x18 pixels. In addition, we can set the hotspot freely within the 18x18 pixels. The hotspot is the point where a mouse click takes an effect. Even though multiple mice are used, multiple mouse events are serialized and take an effect sequentially. Even when multiple users create mouse events using their own mice, there should be time differences among them. Therefore, they can be processed by the order of mouse event occurrence. In this case, single event such as a program execution is fine with it, but multiple events such as mouse dragging can be hindered by other mouse interaction.

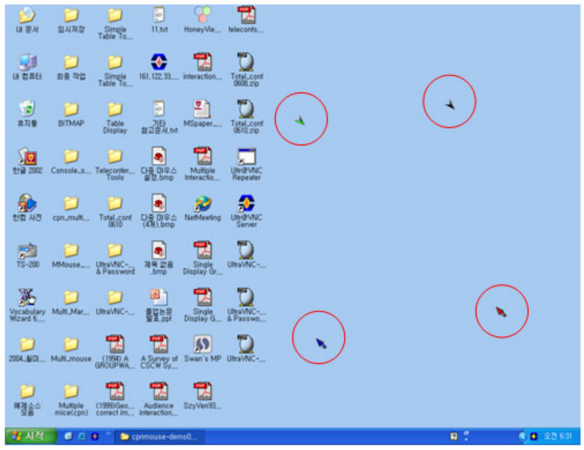


Fig. 15 Table display with multiple mice

Figure 15 shows an image of the table display, which contains 4 mouse cursors. Note that two of them are inverted according to the relation of user's location and the direction of screen.

3. System Implementation

3.1 System Setup

We implemented one side of the proposed teleconference system. It was designed for 4 local users. We installed two projectors and an active IR camera on the ceiling, which is shown in figure 16. One projector was for the table display and the other for the wall display.

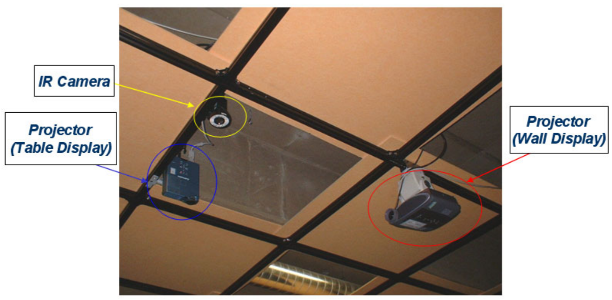


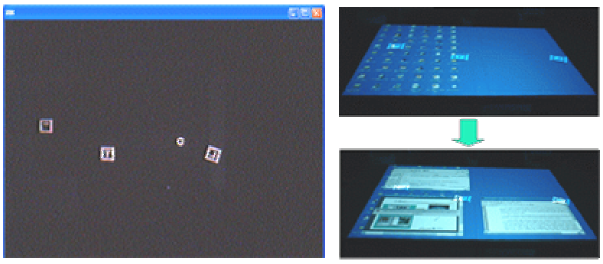
Fig. 16 Installed projectors and an active IR camera

Figure 17 shows the teleconference system that consists of a table display and a wall display. Screen material for projection is used for the surface of the table display and wall display. We put a glass plate on the table screen to protect it. Under the wall display is a camera for video communication. The camera is QuickCam Sphere from Logitech.

Fig. 17 A view of the implemented teleconference system

3.2 Implementation Results

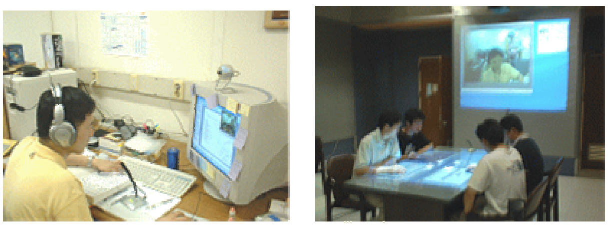
Figure 18(a) shows an image from active IR camera when 3 IR markers are located on the table. Distance from the active IR camera to the surface of the table is about 2.5m. We can see that the markers are recognized well in the changing light of projection environment. The ring shape at the center is the reflection of IR light source from the glass plate. The marker recognition enables users to connect to their own PC remotely. Figure 18(b) shows an image where 3 markers are put on the table display and an image where 3 VNC windows are created by the marker recognition.



(a) (b)

Fig. 18 Recognition result of IR markers

Figure 19 shows the images of teleconference between a person and a group of users. Users could work together in a workspace or control their remote PCs using multiple mice. We could find the effectiveness of the proposed system for teleconference and collaboration.



(a) (b)

Fig. 19 Teleconference between a person and a group of users

4. Conclusion

We proposed a new teleconference system for small groups. The proposed system provides table and wall displays as shared workspaces for efficient teleconference. It also provides multiple mice mechanism for easy interaction with the shared workspaces. The shared workspaces are used for sharing of data and interaction with remote group as well as video communication channel. The proposed system implements a marker recognition system to enable people to easily access their remote PCs and to share the screen and data at the conference table. We implemented the proposed teleconference system for 4 people and showed the result. The proposed system is focusing on remote discussion and collaboration while existing teleconference systems are mainly focusing on video conferencing and chatting. We are working on increasing naturalness and adding more features to the system.

References

1. Ramesh Raskar, Greg Welch, Matt Cutts, Adam Lake, Lev Stesin and Henry Fuchs, “The Office of the Future: A Unified Approach to Image-Based Modeling and Spatially Immersive Displays,” ACM SIGGRAPH, 1998.
2. A. Piszcz, E. Cheung, D. Debarr, N. Orlans, “Realizing a Desktop Collaborative Workspace,” The MITRE Corporation, McLean, VA 22102, 1998.
3. M. Billinghurst, H. Kato, “Collaborative Mixed Reality,” Proc. of First International Symposium on Mixed Reality (ISMR’99), 261-284, 1999.
4. A. Uyar, W. Wu, H. Bulut, G. Fox, “An Integrated Videoconferencing System for Heterogeneous Multimedia Collaboration,” Proc. of IMSA 2003, 2003.
5. NetMeeting, Microsoft Corporation, http://www.microsoft.com/windows/netmeeting
6. CU-SeeMe, CUworld Inc, http://www.cuworld.com
7. J. Rekimoto, and M. Saitoh, “Augmented surfaces: a spatially continuous work space for hybrid computing environments,” Proceedings of the CHI 99, pp. 378-385, 1999.
8. B. Johanson, A. Fox, T. Winograd, “The Interactive Workspaces Project: Experience with Ubiquitous Computing Rooms,” IEEE pervasive Computing Magazine, vol. 1, no. 2, pp. 71-78, Apr.-June 2002.
9. T. Richardson, Q. Stafford-Fraser, K. R. Wood, A. Hopper, “Virtual Network Computing,” IEEE Internet Computing, pp. 33-38, Jan. 1998.
10. Video Conferencing Tool(VIC), http://www-nrg.ee.lbl.gov/vic/
11. ARToolkit, http://www.artoolkit.org/