FreeWalk: Supporting Casual Meetings in a Network

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ABSTRACT

FreeWalk is a desktop meeting environment to support informal communication. FreeWalk provides a 3-D community common where everybody can meet and can behave just as they do in real life. Each participant is represented as a pyramid of 3-D polygons on which his/her live video is mapped, and can move freely. Voice volume is proportional to the distance between sender and recipient so that many participants can talk without confusion. Various behaviors have been noted so far, such as approaching a talking couple from a distance to secretly listen to their conversation.

Keywords

Video conference, casual meetings, informal communication, tele-presence, 3-D space, shared space, community common, communityware, CSCW.

INTRODUCTION

Matching the advance of computer networks, various computer systems for supporting collaborative work have been studied. Those systems often provide desktop conferencing tools for the support of business meetings. However, meetings are not always of business or formal. Casual meetings such as chatting at a coffee break or in a passageway enrich our life. Though casual meetings also take an important role in collaboration, research has tended to ignore this aspect.

Casual meetings are characterized by accidental encounters, unlimited participants and unpredictable topics of conversation. To enable people to experience accidental encounters in a network, a common 3-D space just like a real life park or lobby should be offered.

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We think that conventional desktop conferencing tools, which multi-cast pictures and voices, cannot support casual meetings. In such systems, the faces of all participants are always displayed and this strains conversation. Furthermore, those systems hinder many people from participating simultaneously.

We have been developing a series of communityware products under the project Socia[4][14]. The project aims at supporting everyday activities by forming a community through computer networks. FreeWalk is our latest product and is being distributed widely in Japan. In FreeWalk, our approach is not to extend conventional meeting systems, but to provide a 3-D community common where everybody can meet and can behave just as they do in real life. As a result, many people can meet in a more relaxed atmosphere.

In this paper, Section 2 describes the design philosophy of FreeWalk. Section 3 shows how meetings are performed in FreeWalk, while its detailed implementation is given in Section 4. Section 5 reports preliminary evaluation results.

DESIGN PHILOSOPHY

FreeWalk encourages casual meetings among many people. We describe the inherent features of such meetings, and show how FreeWalk can support them.

Casual Meetings

Casual meetings are characterized by accidental encounters, unlimited participants, and unpredictable topics of conversation. In conventional meeting systems such as `Office Mermaid`[13], however, participants turn on the system when they start a meeting. Whenever the system is in operation, the faces of all participants are displayed on their workstations, and this hinders free conversation. Since the participants are listed up before the meeting starts, an accidental encounter with an unpredictable participant cannot occur.

Several video conferencing systems have tried to extend their functions to support casual meetings. `CRUISER`[8] randomly selects some of the participants and displays their faces to the other participants. This interesting feature, called *Autocruise*, simulates accidental encounters. FreeWalk aims to provide a casual meeting environment. For this purpose, the

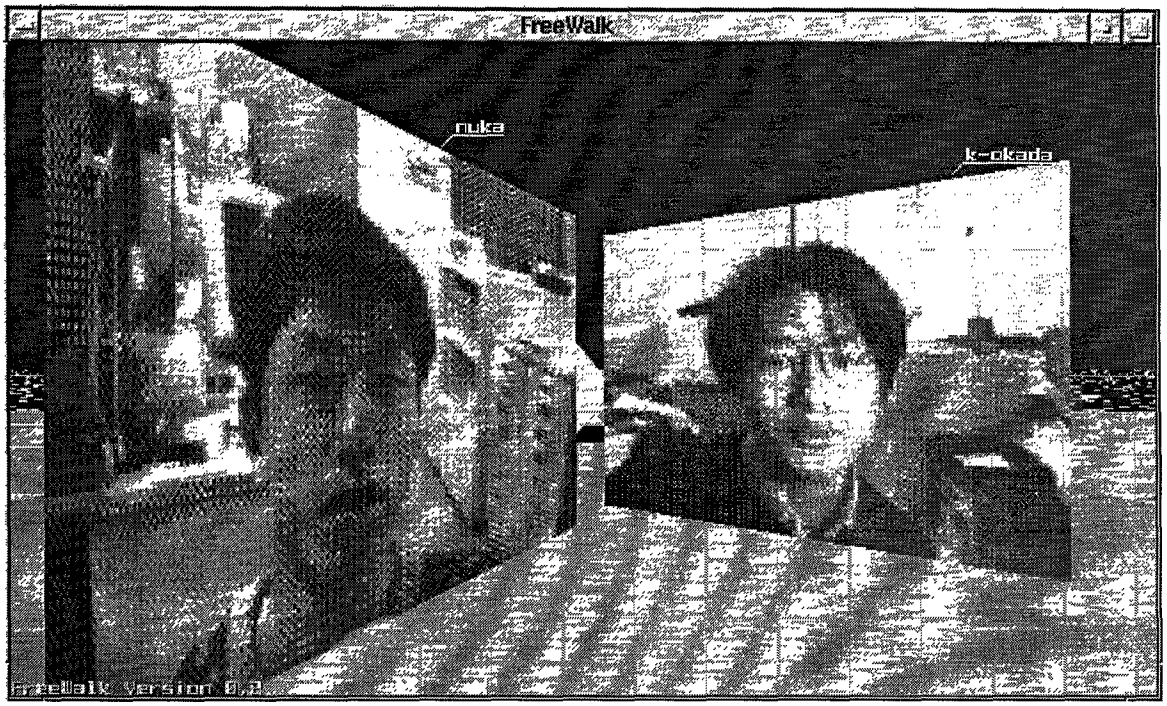


Figure 1: FreeWalk Window

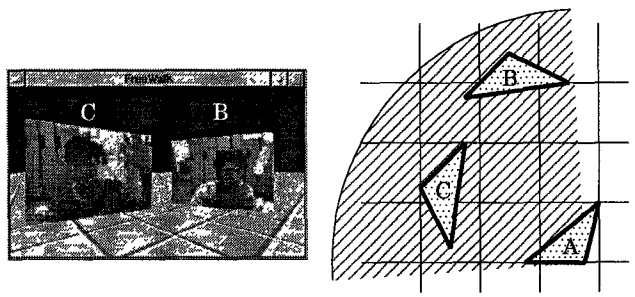
faces of participants are displayed only when their bodies meet. To provide maximum freedom to the participants' activity, FreeWalk does not promote any system-directed encounters, but instead, continuously provides a 3-D space wherein participants can move and meet by themselves.

Meetings with Many People

In our real life, a meeting often consists of many people. In such meetings, like classes or parties, several tens of participants simultaneously exist in the same space.

In conventional teleconferencing systems, participants have neither locations nor view directions, and thus the faces of all participants are usually displayed at once. This makes it difficult for the teleconferencing systems to involve many participants. Meeting systems with special equipment, such as MAJIC[6] and a multi-media environment of ATR[12], cannot be used by many people simultaneously, simply because such equipment is quite rare. An interesting approach is taken in VENUS[5], where each workspace is formed as a *room*; participants can observe the behavior of other participants through the *pilot window* of the room.

In FreeWalk, however, participants have locations and view directions. The participants can change them freely according to their own will. People can wander around before approaching and talking to someone. People can also watch other participants from any location or view direction. We designed FreeWalk to naturally reproduce human behavior in a 3-D space so that many people can meet without confusion.



(a) A's view (b) Map

Figure 2: Participant's View

MEETINGS IN FREEWALK

3-D Community Common

FreeWalk provides a 3-D community common where everyone can meet. People can enter the space by specifying the server IP address. Each participant can move and turn freely in the space using a mouse just as in a video game. Locations and view directions of participants in the space determine which pictures and voices are transfered. Figure 1 shows an image of a FreeWalk window.

In this 3-D community common, each participant is represented as a pyramid of 3-D polygons. His/her live video is mapped on one rectangular plane of the pyramid. The participant's view point is located at the center of this rectangle. The view of the community common from his/her view point is displayed in the FreeWalk window. Figure 2(a) shows an example view of participant A when three participants A, B

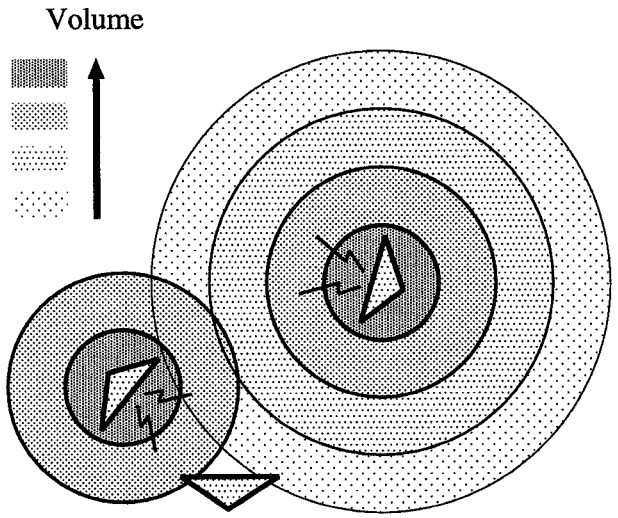


Figure 3: Voice Transfer

and C are located as shown in Figure 2(b).

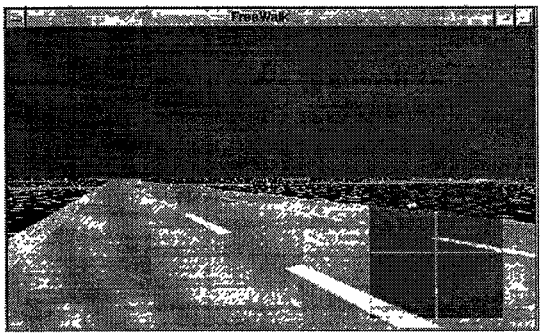
Participants standing far away appear smaller and those near are larger. Participants located beyond a predefined distance are not displayed. Voices are also transferred under the same policy. Voice volume is proportional to the distance between sender and recipient. Figure 3 shows the change in voice volume.

Simulating Real Life Behavior

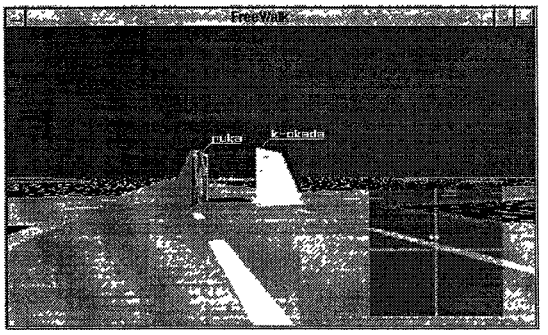
In FreeWalk, people show up in a 3-D meeting space, wander freely inside the space, and encounter each other accidentally. Since the locations and view directions of the participants are reflected by pyramid orientation, he/she can watch what other people are doing from a distance. Figure 4 shows how you can meet people accidentally.

The meeting participants can rearrange their locations if necessary. Since each participant is represented as an object in the space, the participant can observe the distances/directions of other participants in the view. He/she can also observe the participants around him/her by turning by his/her head. The spatial distance between participants may reflect their mental distance. Figure 5 shows the view changes of participants A and B while participant B circles A.

The voice of the speaker is heard by not only the participants of the conversation but also anyone in the neighborhood. Thus people can join the conversation that attracts their interest since they can guess the subject. On the other hand, people can keep a conversation secret by keeping away from others. The volume of voices attenuate in proportion to the distance between sender and recipient. Voices are not transmitted if the predefined distance limit is exceeded. Therefore, people can form separate meeting groups without bothering each other.



(1) Find other people on radar



(2) Watch a talking couple

(3) Join their conversation

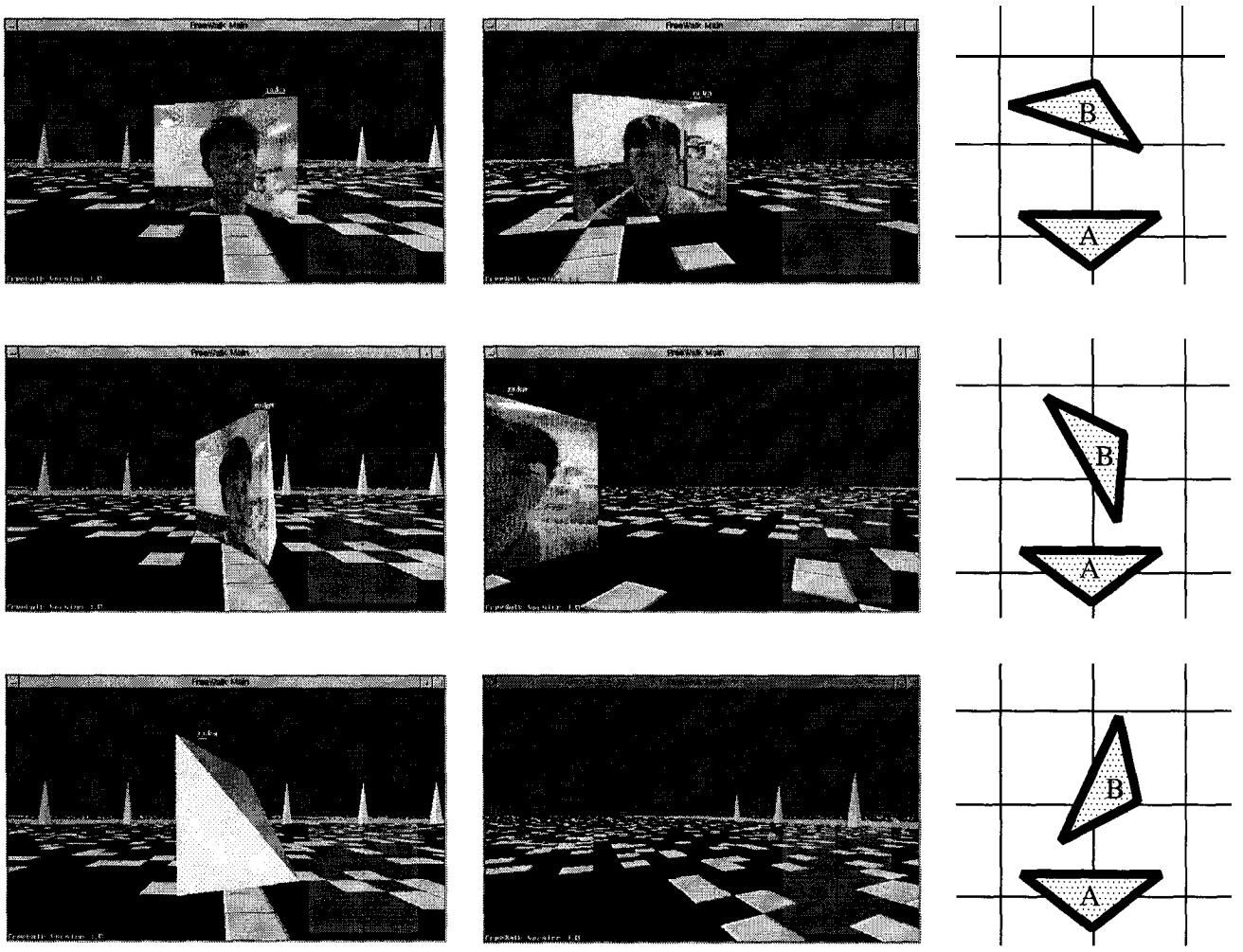
Figure 4: Accidental Encounter

Organizing Meeting Groups

Conventional meeting systems provide various functions to support the organizational behavior of participants such as speaker selection. Although these functions enable participants to manage multiple conversation threads in parallel, they also damage the freedom that we aim at.

FreeWalk does not take this approach. The common 3-D space used in FreeWalk gives a casual feeling to communication. Participants can introduce the various communication styles of their real life into the FreeWalk space. Many participants can simultaneously exist in the same space without confusion, since they can grasp what is going on in the space with one glance.

People make a group by standing close to hear the voices and view each other. Figure 6 shows this situation. If there is



(a) A's view of B (b) B's view of A (c) Map

Figure 5: Changes of Participants' View

enough distance between groups, the voices of people in one group are not heard by people in other groups, This feature makes FreeWalk an effective tool for holding a party with many people.

Since the voice is attenuated through distance, the participant must approach the others in order to talk to them. This limitation forces people to combine actions and conversations in the space. People can leave a conversation just by leaving the group, and join a conversation by approaching the group. People who meet each other by chance may start a conversation. This means that meetings can be start with an accidental encounter. To encourage this, FreeWalk provides a special place with a landmark.

SYSTEM CONFIGURATION

Community Server

The FreeWalk system consists of a community server and clients, each of which includes vision and voice processes. Figure 7 illustrates the interaction among the community server and clients.

When a participant makes a move using his/her mouse, the corresponding client calculates the new location and orientation, and sends them to the community server. The community server then compiles information from all clients into a list of client IP addresses with their locations in the 3-D community common. The server finally sends the list back to each client for screen updating.

Since only control information is transferred between the server and clients, the community server can efficiently maintain a global view of the ongoing activities in the community common.

Quality of Service

When a client receives a list of the other clients, the vision process of the client sends its owner's picture to the other clients on the list. On receiving pictures from other clients, the vision process redraws the display based on the information in the list and the pictures received.

Because some clients cannot be seen from a client, it is not necessary for a client to send its picture to all others. We do

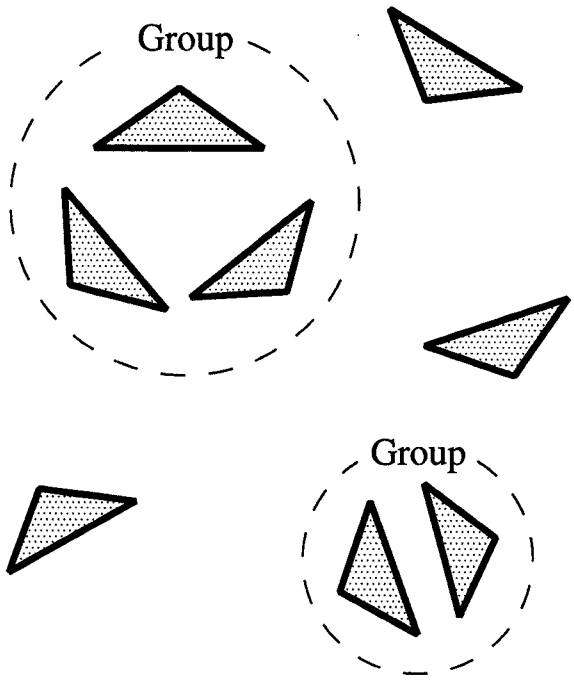


Figure 6: Meeting Organization

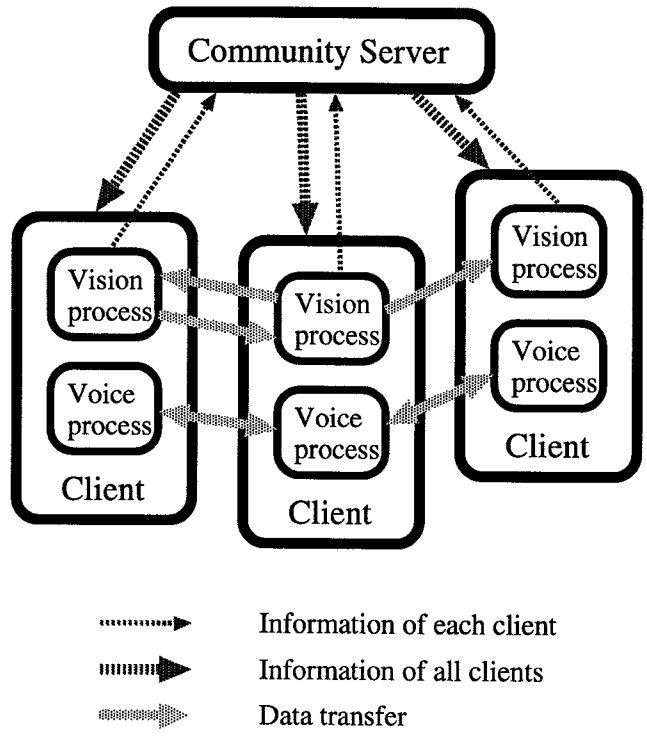


Figure 7: FreeWalk System Configuration

not send full size pictures to clients far away. FreeWalk uses these characteristics to optimize the bandwidth of video communication as follows.

- The sender adjusts the size of the picture to the size needed by the receiver.
- No picture is sent between clients who cannot see each other.

Figure 8 shows an example of video transfer in FreeWalk. Since client A is located near client C, a large picture is sent from client C. In contrast, client C sends a small picture to client B which is located far away.

To further reduce the communication bandwidth, FreeWalk clients send pictures in an interlaced fashion, neighboring vertical lines are sent by turns, rather than sending a full picture. If a picture were changed quickly, this would instantaneously disorder the picture in the FreeWalk window. This is not a major problem, however, since such a situation is rare when FreeWalk is used for desktop meetings where participants do not move violently.

Voice communication is performed in a similar fashion. FreeWalk clients do not send voice data to those clients that are too far away to hear the voice. The volume of voice is determined by the receiver, since voice volume does not contribute to bandwidth reduction.

The two major hazards of voice communication are voice discontinuity and delay. Playing the voice packets immediately upon receipt causes discontinuous voice. To avoid that, voice packets are first buffered, and played as one sequence. This buffering method, however, causes some delay in voice transfer. To reduce this delay, if voice playback lags the arrival of voice packets, a small part of these packets is discarded.

Window Design

The FreeWalk window is drawn in real-time. The rate of live video communication and the size of window can be specified before running FreeWalk. In addition, the size of window might also be changed while FreeWalk is in operation. When the window size and live video size is small, the time consumed to draw the window is also small. This saves network and CPU resources.

Participants can find the locations of other participants by referring to a radar screen which occupies the right corner of the window. To identify each participant, their name is displayed above the pyramid. The default name of the participants is their login name but participants can specify their name before they start FreeWalk. Figure 9 shows the design of the FreeWalk window.

EXPERIMENTAL EVALUATION

We organized six clients in different rooms of our department and validated our implementation policy. Although we only used a 10Mbps Ethernet for transferring data, the six participants could meet and talk naturally. Figure 10 shows the situation. In this experiment, a SUN workstation and six SGI Indy were used as the FreeWalk's server and clients, respectively. The major results we have obtained are as follows.

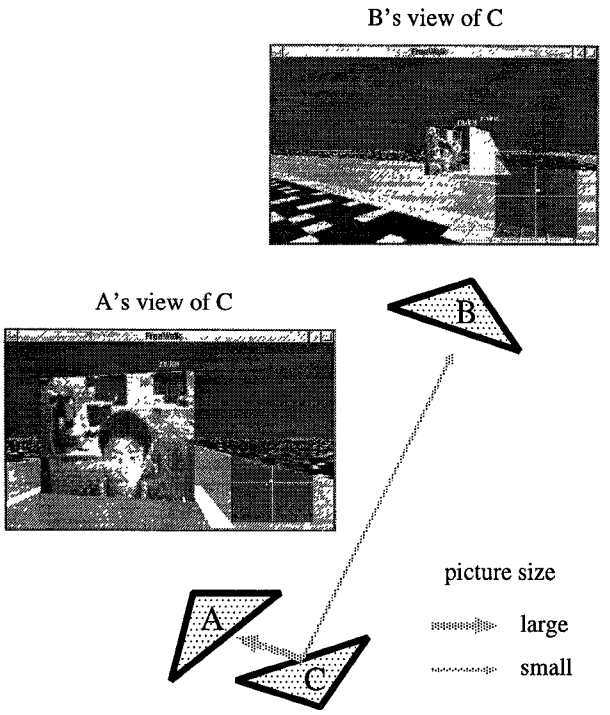


Figure 8: Video Transfer

- Each participant moves according to his/her own will. The six people formed several groups from time to time. People reported that they could share the same space without confusion. Various behaviors have been noted so far, such as approaching a talking couple from a distance to secretly listen to their conversation, chasing a moving participant while calling him/her to stop, and a female researcher who prefers to use her doll as a character for herself. Most of the participants enjoyed the experience due in part to its relaxed atmosphere.

- When the resolution of the window is 320 × 180, FreeWalk runs 10 frames per second. This frame rate is roughly inversely proportional to window resolution. A client machine spends most of its CPU power on drawing the space.

- Voice transfer involved buffering with the result that some delay was caused. In the current version, however, the interruption and delay of voice do not significantly damage communication quality. Voice volume does not depend on sender direction, so when the receiver has two possible senders located at the same distance from the receiver, the receiver has some difficulty in distinguishing who is speaking. We are planning to use stereo sound to recognize the direction of voice.

The operation of FreeWalk is simple and the most people are satisfied with its performance. Some people found it hard to navigate the space since the moving speed is proportional to the distance of the mouse pointer from the center of the display. Since the radar view covers a wide area, it is not easy to distinguish adjacent participants. We are planning to make the range variable and customizable by users.

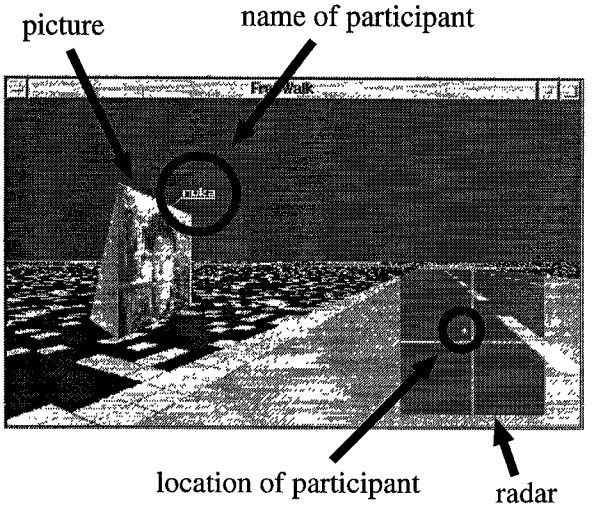


Figure 9: Window Design

CONCLUSION

FreeWalk supports casual meetings among many people. This system provides a 3-D community common where participants can behave just as they do in real life. We implemented a prototype system and validated our approach.

FreeWalk is spreading very quickly: Towa University is going to install FreeWalk on 120 INDYs in a computer literacy classroom. We are currently planning to hold a network party this coming spring with 3-screen SGI ONYX connected to several tens of PCs and workstations. Other ongoing plans include applying FreeWalk to tele-education between different universities. FreeWalk has been also used as a research testbed of market-based QoS control[15].

FreeWalk can be obtained from
http://www.lab7.kuis.kyoto-u.ac.jp.

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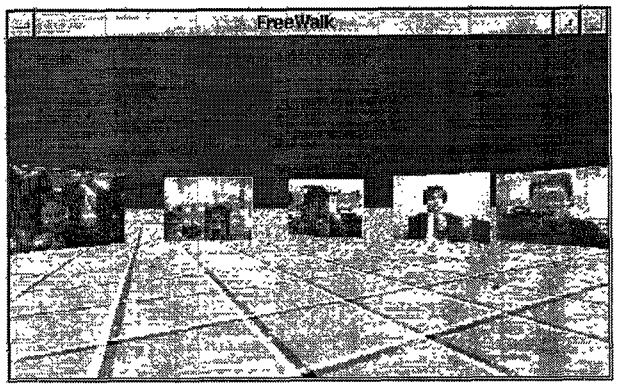
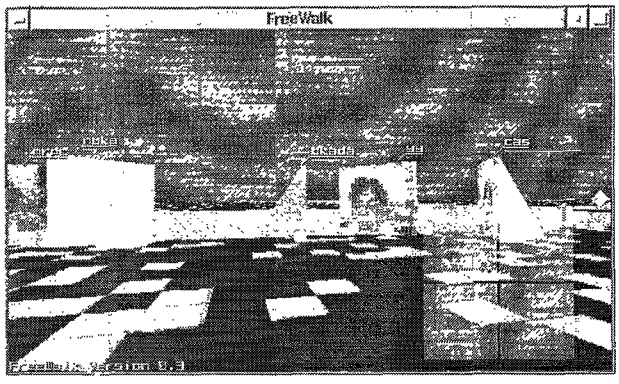


(a) a single group



(b) several groups

Figure 10: Six Participants in FreeWalk

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