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Video Communication System that Facilitates Informal Communication among Distributed Offices

●Akihiko Obata ●Kazuo Sasaki

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This paper presents our prototype system called OfficeWalker, which supports informal communication among distributed offices. It allows quick and easy access to a remote recipient by checking the recipient's availability prior to conversations by video connections. And it facilitates unintended interactions with the recipient's neighbors by notifying them of the identity of the caller and presenting them as a virtual visitor. We conducted a user experiment to evaluate the impact of the system on distributed cooperative work. The results showed that OfficeWalker allows quick and easy access to remote partners and partially facilitates unintended interactions. The experiment results also suggested that OfficeWalker enhances awareness of remote partners' situations, which is believed to be important for coordinating activities for a successful collaboration.

1. Introduction

With the recent progress towards more inexpensive video capture cameras, efficient image compression software technology, and higher-performance personal computers, people are now able to employ practical desktop conference systems which enable face-to-face meetings between people at remote locations. However, conference systems based on video image communications are not so popular, probably because little is known about how advantageous such systems are in terms of cost and because people underestimate the value of images depicting only faces. In this paper we present a video mediated communication system called OfficeWalker[1] that effectively uses video communications and demonstrate the impact of the system by describing a user experiment we conducted on distributed collaborative work.

It is widely reported that most interactions in the working environment are informal communications. We spontaneously put questions to our colleagues as they come to mind. Sometimes we meet our colleagues in hallways by chance and exchange important information when we say hello. Kraut et al. estimated, through a questionnaire survey, that 52% of interactions are unintended.[2] Whittaker et al. found through their field observations that 92% of interactions were not pre-arranged.[3] Kraut et al. have pointed out that such informal communication plays an important role in generating collaborative relationships, as well as maintaining existing ones.[4] Issac et al. found through interviews in a large organization that people obtain essential information mainly from unintended interactions.[5]

We designed our video-mediated communication system to facilitate such frequent, informal, and unintended interactions among distributed offices while addressing the drawbacks of previous systems. We then conducted a user experiment on remote collaborative work to evaluate the impact of using the system.

2. Human interface issues of previous systems

There have been a number of experiments conducted to evaluate video communication as a technology for supporting informal communication.[5)-9)] These experiments pointed out several important issues. Previous research systems can be classified into overview and hallway models. Overview model systems (e.g., Portholes[7)]) simulate a virtual room by providing a matrix of slowly scanned continuous video images of each member. These systems allow informal and unintended interactions; however, support for informal interactions is available only to members who have been predefined as collaborators.

Hallway model systems (e.g., CRUISER[6),8)]) simulate visits to remote private offices through virtual hallways by providing glance functions prior to conversations. Hallway model systems provide the glance function by opening a several-second video link with a recipient. Then, based on this link, the participants can decide whether to start a conversation. For privacy, the video link is reciprocal. These systems do not need predefined collaborators; however, two other problems come into play.

CRUISER's experiment[6),8)] revealed that the method for initiating conversations was abrupt and intrusive. The screen suddenly displays the image of the caller, which and exerts too much pressure to respond to it. This causes the caller to worry about the possibility of being intrusive. Sometimes, this results in a reluctance to use the system. Montage[9)] introduced a fade-in video effect to reduce the feeling of abruptness. Users, however, commented that a glance was more of an interruption than someone walking down the hallway and peeping into their rooms.

Another drawback of the hallway model is the lack of a mechanism for unintended interactions. The hallway model makes a connection on demand when a request for conversation arises. This means that it does not support unintended interactions. CRUISER[8)] provides a random connection service called Autocruise, which simulates encounters in hallways. However, experiments showed that few autocruises actually resulted in conversations. In addition, many users disliked this feature since they also perceived it as being intrusive.

3. User interface design

3.1 Interaction model

We decided to base our new system design on the hallway model, as the overview model systems cannot support unintended interactions with unexpected partners. In this section, we propose an interaction model that would solve the two problems of intrusiveness and the lack of support for unintended interactions that commonly exist in hallway model systems.

Why does the problem of intrusiveness occur in hallway model systems? We believe that the problem of intrusiveness is caused by the lack of a sense of distance between users in the network and the violation of proxemics rules. Hall[10)] has argued that people possess unspoken proxemics rules that specify the inter-person distances that are appropriate for daily relationships. Nishide[11)] further categorized these distances into the following five zones according to the appropriateness of starting a conversation:

1) The zone of recognition
   It is possible to recognize acquaintances, but facial expressions cannot be discerned.
   Greetings rarely occur.
2) The zone of mutual recognition
   It is possible to discern facial expressions. In this zone, greetings usually occur.
3) The zone of proximity
   This is the zone you must enter to start a conversation. It is possible to enter this zone without immediately starting a conversation.
4) The zone of conversation
   In this zone, conversations take place. When you enter this zone, a conversation is mandatory.

5) The zone of exclusion
Others are not allowed to enter this zone.

We propose that the hallway model systems put users directly in the zone of conversations and do not provide sufficient distance for people to be able to ignore each other.

How can we create a sense of distance in communication systems? The sense of distance conveyed by a 3D virtual world is meaningless when recipients are not involved in the activities of the virtual world. The manipulation of avatars in a 3D image is also not practical in business communications. We tried to introduce a sense of distance by creating public places that are shared by anonymous people and private places that are used by specific people in the network. A caller approaches a recipient from a public place instead of directly intruding into the private place of the recipient. Encounters in public places may generate behaviors such as recipients greeting each other or simply ignoring each other, but they do not present any social imperative to start a conversation. A caller also has the opportunity to encounter the neighbors of a recipient in these public places.

Figure 1 shows the concept of our interaction model. It consists of a public place that is shared by neighbors as a hallway and private places that are used by these neighbors as their offices. When a caller wishes to initiate a conversation with a recipient, the caller visits the public place instead of directly visiting the recipient's private place. At this distance, the recipient and the recipient's neighbors might recognize the caller but they do not know who the recipient of the visitor is. Therefore, there is no social pressure to respond to the caller at this distance. The caller also can check the availability of the recipient prior to conversations without interrupting the recipient's activity. In this situation, unintended interactions with neighbors might occur. The caller might talk with a neighbor of the recipient, or some of the neighbors might initiate conversations with the caller. Moreover, it is possible to talk with other people who are visiting the same hallway.

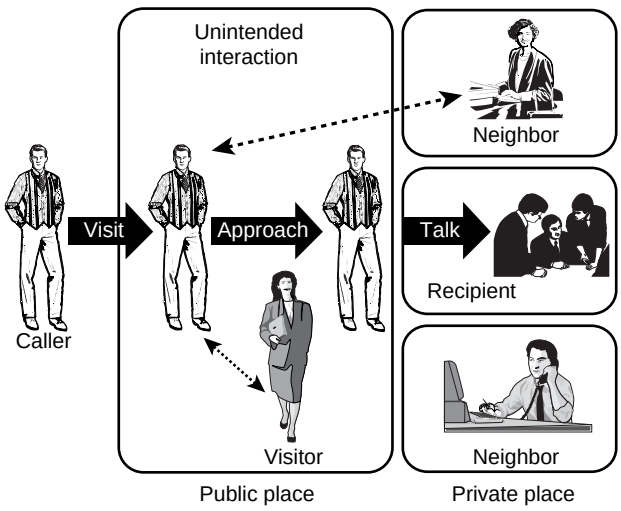

Figure 1
Interaction model.

After the caller decides to contact the recipient, the caller approaches the recipient's private place. The caller and the recipient can see each other at a closer view. Staying at this distance for a while without having a conversation is uncomfortable for both of them, so the caller needs to decide whether to interrupt the recipient or temporarily give up the attempt to initiate a conversation. If the caller or the recipient decides to talk, a conversation begins.

3.2 User interface

Based on the proposed interaction model, we implemented a prototype system called OfficeWalker. The client software of OfficeWalker runs on personal computers with Windows95, a voice modem, a TCP/IP network, and a video capture camera for taking a close view of the user. The system also needs server systems for managing the status of the virtual hallways and server systems with video capture devices for taking distant views of users.

When you start OfficeWalker, the doorway to your virtual hallway is opened (**Figure 2**). You

can see slowly-scanned video images of yourself and your neighbors who share the same virtual hallway. The doorway might also show virtual visitors who might wish to communicate with you or one of your neighbors. Neighbors can be defined independently from their physical location, and are therefore called virtual neighbors.

All video links are reciprocal so as to protect privacy. When other users close their windows, you cannot see their images. Your neighbors and visitors have the same view and can initiate unintended interactions by activating a recipient child window and selecting communication commands such as "talk," "e-mail," "shared electronic whiteboards," and "approach."

To talk to a member outside your virtual hallway you select the member from a directory. Then, the virtual hallway of the member (hereafter, called the recipient) is displayed (**Figure 3**). At the same time, your child window is created as the window of a virtual visitor in the recipient's hallway. Your video image is shown to the recipient, the virtual neighbors of the recipient, and to other virtual visitors who are currently visiting the same virtual hallway. These people might not feel social pressure to respond to your presence, because they do not know who your recipient is at this phase. Thus the problem of intrusiveness is drastically reduced. Moreover, unintended interactions with virtual neighbors and visitors might occur in this situation. After visiting the recipient's hallway, you can select the appropriate communication command. In this example, the recipient is talking to his colleague. In such a case, you can use the approach command, which simulates an approach to the recipient.

Figure 4 shows the recipient's view after you select the approach command. In this figure, your

Figure 2
User interface of OfficeWalker.

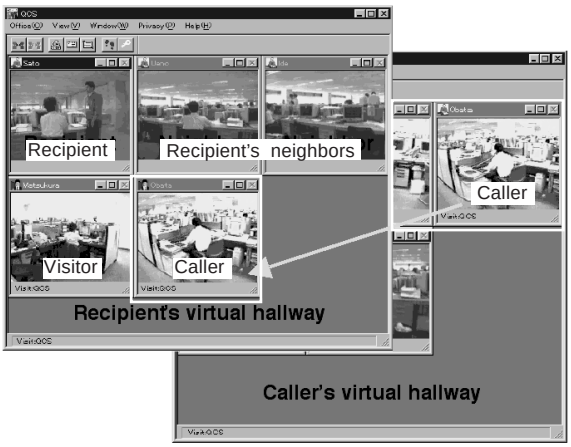

Figure 3
Visiting another virtual hallway.

Figure 4
Recipient's view.

video image has changed to a closer view to indicate your approach to the recipient. You then need to decide whether to interrupt the recipient or temporarily give up the attempt to initiate a conversation. If you and the recipient decide to talk, a conversation begins.

3.3 Usage scenario

In this section, we describe an example scenario of unintended interactions that are possible with OfficeWalker.

Bob, the manager of the Planning division, is concerned about the progress of a current project. He virtually visits Tom, who is responsible for the project, by clicking on Tom's name in the directory. The virtual hallway connected to Tom's office is displayed. The video image of Tom shows that he is talking with his superior. Bob decides to wait in the virtual hallway. Steve, a neighbor of Tom, notices that Bob has appeared as a virtual visitor in his hallway window. He guesses that Bob is waiting for Tom to become available. Steve selects the talk command from the menu displayed in Bob's child window and starts a conversation with Bob. While Bob is talking with Steve, Bob notices that Tom has finished his conversation with his superior. Bob suspends the conversation with Steve and selects the talk command for Tom.

4. User experiment

4.1 Method

We examined the following three questions in our user experiment:

1) How much is the problem of intrusiveness reduced?
2) How frequently do unintended interactions occur?
3) Does OfficeWalker lead to an increase in communication frequency?

We compared communication behaviors in the following three phases: before OfficeWalker has been introduced, during use of OfficeWalker, and after OfficeWalker has been removed. We set up a brief experiment because the communication frequency and members might have varied over the phases of their projects. We asked the subjects to place a call using their conventional telephones instead of using the talk command of OfficeWalker to avoid the Hawthorne effect in the frequency of calls. We also asked the subjects to describe each conversation they had with remote colleagues using one or more of nine categories we had chosen. The categories were as follows: generating ideas, solving problems, making decisions, assigning tasks, scheduling meetings and tasks, reporting work status, asking questions, discussing non-work-related topics, and greetings. The latter categories are the more informal and spontaneous. We expected the latter categories of conversations to be mostly influenced by the introduction of OfficeWalker.

For our experiment, we added command logging and video logging features to the original version of OfficeWalker. All commands were logged. Video still images of recipients when callers issued commands were randomly sampled. Because Japanese office environments are too small to place cameras that take distant views of users, we had to compromise by using video cameras that only take closer views.

4.2 Subjects

Ten employees of Fujitsu Limited in Kawasaki and Fujitsu Kyusyu Communication Systems Limited in Fukuoka participated in our experiment (Kawasaki and Fukuoka are more than 1000 km apart). These employees collaborate on designing digital switching systems and promoting the sales of these systems. Five employees work on design, of which three are located in Kawasaki and two in Fukuoka. The other five employees work on sales promotion: two in Kawasaki and three in Fukuoka. All participants are acquainted with each other. Their neighbor relationships are defined according to their working group rather than their location.

4.3 Results

Unfortunately, we could not obtain the checklists from three of the subjects because our explanation of the experiment procedure was insufficient. The following data shows the total number of times OffceWalker was used by seven subjects during the two weeks. The total number of accepted phone calls were as follows: 8 calls in the week before the system's introduction, 37 calls over a period of two weeks using the system, and 26 calls in the week after we removed the system. There were 154 visits to another virtual hallway and 692 instances of activating child windows. There were 6 instances of a shared whiteboard and only one instance of invoking application sharing.

To evaluate the problem of intrusiveness, we examined how many of the virtual visits resulted in conversations. We found that many of the visits did not result in conversations, even when recipients seemed available (**Figure 5**). We looked at 85 video logs that were randomly sampled from 154 visits. Recipients seemed available in 39% of the visits. However, only 7% of the visits resulted in conversations. We asked the subjects why they did not make calls even when recipients looked available. Many of the subjects answered that they just wanted to see the situation of their remote partners and did not have any important need to communicate. From these results we can conclude that OfficeWalker at least allows callers to freely glance at a recipient without having any important issues and that the glance mechanism did not force a conversation with recipients.

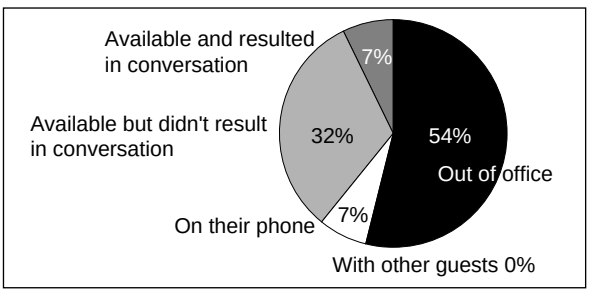

Figure 5
Frequency of conversations.

Next, we examined how frequently unintended interactions occurred during the experiment. We found that unintended interactions occurred to some extent, however, they occurred much more seldom than has been observed in real world settings (**Figure 6**). Of the 16 conversations that occurred in the experiment, only 4 (25%) resulted in unintended interactions with neighbors and there were no unintended interactions with visitors. In real world settings, on the other hand, we have observed 40% of visits resulting in conversations with neighbors. Moreover, the unintended interactions we have observed in the real world and in the experiment showed different patterns. In the real world, visitors often talked to neighbors in addition to their recipients, and in many cases these secondary conversations were "greetings" or "non-work-related" conversations. In contrast, in the experiment there were no instances of visitors talking to multiple participants in

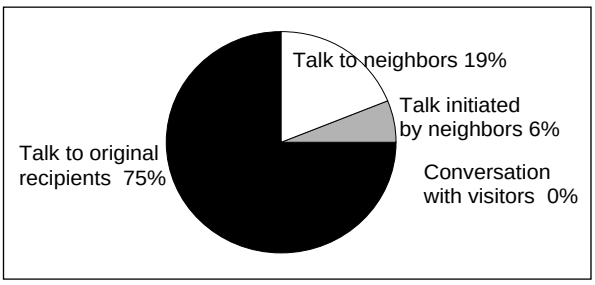

Figure 6
Frequency of unintended interactions.

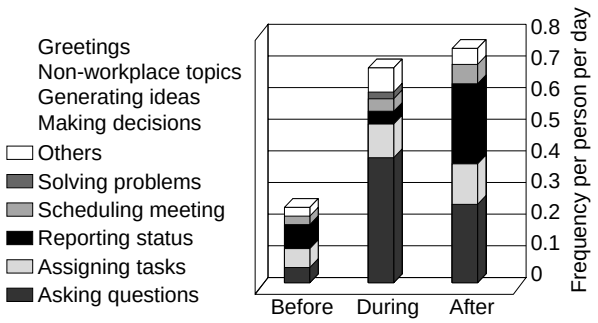

Figure 7
Transitions of communication categories.

the same session and none of the conversations were categorized as "greetings" or "non-work-related." Also, there was no strong evidence that visitors had conversations with neighbors about topics unrelated to their original purpose for visiting, which suggest that in all of the secondary conversations, the recipient was unavailable so the visitor talked about the matter in hand with a neighbor of the recipient (i.e., the neighbor acted as the recipient's proxy.)

Figure 7 shows the average daily number of calls per person before, during, and after the period when OfficeWalker was in use. We expected that the frequency of conversations using OfficeWalker would be significantly higher than the frequencies before OfficeWalker was introduced and after it was removed. As can be seen in Figure 7, the frequency of "asking questions" conversations was significantly higher when subjects used OfficeWalker ($F(1103) = 4.22, p<0.05$). Some of the subjects commented that they could freely ask questions to remote partners. However, we could not obtain evidence that OfficeWalker increased the total number of conversations. The overall frequency of communication significantly increased after the introduction of OfficeWalker, however, the frequency remained at the same level after we removed it. Interestingly, the frequency of "reporting work status" conversations significantly increased after we removed OfficeWalker. Analysis of variance results showed a marginally significant difference between the periods of use and non-use of OfficeWalker ($F(1103) = 3.16$, $p<0.10$). The participants had a lesser need to report their work status when they were using OfficeWalker. This suggests that OfficeWalker enhances the awareness of remote partners' situations. This awareness is believed to play an important role in coordinating one's own activities to achieve a successful collaboration with other people.[7)]

5. Conclusion

We have presented a prototype system called OfficeWalker that supports informal communication among distributed offices that effectively utilize video communications. We proposed an interaction model that addresses two problems of previous hallway model systems; namely, the problem of intrusiveness and the lack of support for unintended interactions.

We conducted a user experiment using OfficeWalker that embodied this model and confirmed that the model drastically reduced the problem of intrusiveness. Unintended interactions with neighbors were partially supported. Our user experiment showed that the system facilitates conversations that we have categorized as "asking questions" conversations. The participants were freer to ask their remote colleagues questions than with conventional phone conversations. The experiment also showed that the participants had a lesser need to report work status information when they used OfficeWalker. This data suggests that OfficeWalker enhances awareness of remote colleagues situations, which is believed to play an important role in coordinating activities for successful collaboration.

OfficeWalker, however, failed to promote casual interactions that begin with greetings or social conversations. Unintended interactions were partially supported; however, they occurred much more seldom and in different patterns than in real-world settings. We will continue to explore these issues by conducting other user experiments.

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Akihiko Obata received the B.S. degree in Electronic Engineering from Waseda University in 1984. He joined Fujitsu Laboratories Ltd., Kawasaki in 1984. From 1984 to 1998 he was engaged in research and development of communication services and human interfaces, including research and development of computer integrated telephony, desktop conferencing, and visual communication. His current work focuses on usability engineering. He is a member of the IPSJ and ACM.

E-mail: obata@flab.fujitsu.co.jp

Kazuo Sasaki received the B.S. and M.S. degrees in System Engineering from Kobe University in 1994. He then joined Fujitsu Laboratories Ltd., Akashi, Japan, where he has been engaged in research and development of communication services, including desktop conferencing and visual communication. His current work focuses on text-based communication systems with an awareness protocol. He is a member of the IPSJ.

E-mail: ksasaki@flab.fujitsu.co.jp