The Sense of Togetherness in HyperMirror:
an Explanation using Cognitive Modes

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Abstract

In this paper, the effects of HyperMirror are classified through the observation of conversation and action to explain the sense of togetherness HyperMirror elicits. HyperMirror is a video communication system in which the participants watch images that display them together by superimposing their mirror reflections. Participants feel physically together with people displayed next to them on a HyperMirror image. This sense of togetherness is generated with the HyperMirror operation image that users interpret as being together, and is strengthened by the intentional interaction between interlocutors, such as a handshake. Also, when users are together and an unconscious gesture is expressed correctly, the sense of togetherness is further enhanced.

Keywords: HyperMirror, sense of togetherness, video mediated communication, shared space, cognitive mode.

1. Introduction

In this paper, the effects of a synthetic image are classified into three kinds through the observation of conversation and action, and the sense of togetherness acquired in HyperMirror is reviewed.

Researchers have reported obtaining the sense of togetherness in video communication systems [1][2][6][7]. Most of them are intended to make a remote communication approximate one that occurs in real space.

In a HyperMirror system, a video communication system that sets up a new communication space suitable for remote communication, users easily sense togetherness with other participants [4][5]. The talking images used are projected from the interlocutors in various places onto the mirror. The interlocutor does not have to be physically in the room. HyperMirror uses synthetic images to display all participants together to give them the sense of togetherness. The sense of togetherness is vital in various scenes of conversation when enjoying talk rather than transmitting information, such as in chats with family and friends. It is also important in decreasing the psychological distance when a new remote service is achieved, such as cooperative work, medical interviews, workshops, and parties.

2. What is HyperMirror?

HyperMirror is a new virtual space for communication composed by the image and the sound in which a remote space is united. When entering into the HyperMirror space, participants sense being together and talk with other participants in the remote location. Though it is a remote communication, it is possible to speak intimately, as in face-to-face communication.

The system that embodies the HyperMirror conversation space is called the "HyperMirror system." A HyperMirror system consists of cameras, monitors, and an image mixer (Fig. 1). The mixer integrates images from the cameras to show all participants in a single image, and distributes mirror reflections of the resultant images to the monitors.

In HyperMirror, people can point at objects in the space of another participant (Fig. 2 top). The two men and the woman were in different places. The standing man was instructing the women to put an object on a shelf behind her.

In HyperMirror, people act as if they are in the same place. That is, people talk feeling that their participant is just beside them. In the bottom photographs, the woman did not notice the man was addressing her. Thus, the standing man tried to tap her on the shoulder. The sitting man turned back to talk to her.

Since she was in a different place, the man could not tap her. The sitting man could not see her, but saw the wall (blue curtain) behind him when he turned back.

Though they understood that they were participating in a remote conversation, the man tried to tap the woman's shoulder instinctively, and the other man turned around to see her. These actions are considered normal when there is a woman physically with them.
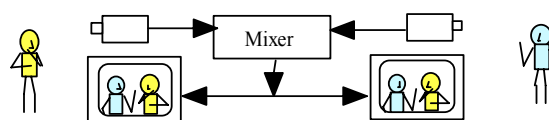

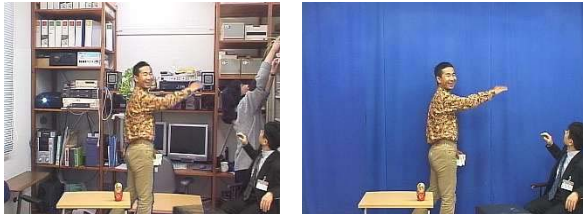Fig. 1 Connection diagram of a HyperMirror system

Fig. 2 When a person feels togetherness with a conversation partner, behaviors similar to face-to-face conversations are observed. A man trying to attract the attention of a woman in a remote place by tapping her on the shoulder, and a man turning back.

3 COGNITIVE MODES IN HYPERMIRROR

People obtain the sense of togetherness when viewing the HyperMirror images. The man trying to tap the woman's shoulder is a typical example of this sense. However, not all interlocutors of the HyperMirror conversation feel the sense of togetherness. Our six-year observation of HyperMirror conversations has shown that whether people feel the sense of togetherness or not is determined by the quality of the synthetic image, and users interpret HyperMirror spaces in at least three different ways (Table 1). In Mode 0, people completely ignore the position on a synthetic screen of the self-image and the other party image. In Mode 1, a synthetic image is understood flatly in two dimensions, and in Mode 2, it is understood spatially in three dimensions.

We determined these modes not only from the observation in the environment that controlled the condition, as in a psychological experiment, but also from the observation data that included many cases, for instance, a demonstration of a laboratory general opening to the public, laboratory visitor's appearance, video business conference, and remote classes at an elementary school or university.

Table 1   Three cognitive modes in HyperMirror conversation

Cognitive mode	Use self-image in conversation?	Construct 3D space?
0	No	No
1	Yes	No
2	Yes	Yes

CASE 1

In the case of visitors who came to our laboratory, the participant had not experienced the HyperMirror conversation. The equipment was a " two-site chromakey" version of the HyperMirror (Fig. 3). Wiring is connected directly with the audio and video (AV) cable. The standing positions of the interlocutors were 300cm from the center of the screen in a room with a real background, and 360cm from the center of the screen in a room with a blue back curtain. The area above the knees of participants is photographed, and the camera is set on the right of the screen in one of the rooms, and on the left in the other room to photograph participants facing 20 degrees inward when they see the reflections of the partners. The HyperMirror video signal was a chromakey synthesis of the video signals from the cameras in each room. It was sent to each room and its reverse image was projected on each screen.

Entering the room in which the blue background was set, the participant found the experimenter on the screen and she tried to move in front of him. Their images then overlapped and he shouted upon seeing it (Fig. 4).

His voice made her understand that she had bumped against him on the image. He was watching the same image, and her standing position was important for
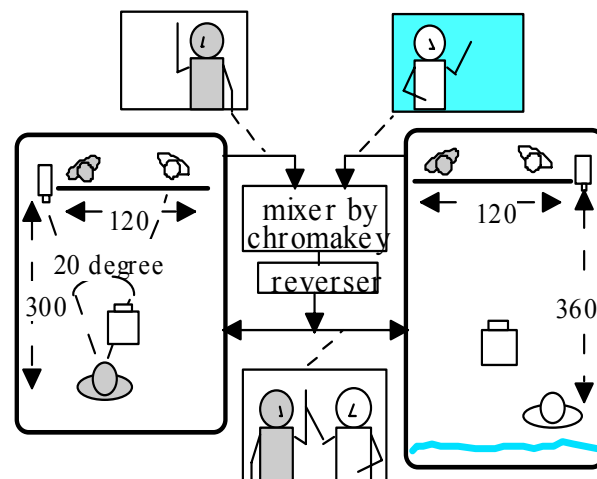

Fig. 3 HyperMirror System used for observation

Fig. 4 The visitor ignored the position relation in the synthetic image and stepped into the experimenter's space. The experimenter guides her to an appropriate position.

constructing the HyperMirror space on the screen. As a result, she was able to select an appropriate personal space on the screen. This case shows that at first she understood the synthetic image in cognitive mode 0, and, after hearing his shout, she changed to mode 1.

CASE 2

In the case with visitors who came to our laboratory, the participants have not experienced the HyperMirror conversation. In this case, we prepared a KOKESHI doll on the desk in front of the experimenter and participants.

The participants alternatively experienced the HyperMirror conversation. First a participant talked in standing situation, and then participated in the conversation sitting down in the chair on the right of the screen.

A participant in this case extended his hand to the front and pointed to the television behind him after pointing out two KOKESHI dolls (Fig. 5, upper left side of the uppers). However, the man sitting on the chair, who experienced standing conversation in HyperMirror just before, said "The television is behind you." The participant and the experimenter pointed to the television behind them (Fig. 5, upper right). The participant at this time didn't touch the televisionbut actually felt the blue background curtain.

After that, only the participants talked in HyperMirror conversation. They enjoyed trying to tap the shoulder of the woman in the other room (Fig. 5, bottom).

Though the participant first pointed to the television on the screen (Mode 1), his friend's comment, "The television is behind you," made him change to Mode 2. This meant that he was able to understand the screen three-dimensionally.

4. SENSE OF TOGETHERNESS IN HYPERMIRROR COMMUNICATION

For people to obtain the sense of togetherness in HyperMirror, which is a marked advantage of the system, they need to be in Mode 2. When seeing a HyperMirror image, people in Mode 2 construct a virtual three-dimensional space in their mind, which does not actually exist but is where the HyperMirror image can be photographed. In other words, the sense of togetherness in HyperMirror is the sense of self-reflection being immersed into the HyperMirror space.

HyperMirror images must naturally show all participants together for the participants to construct a coordinated three-dimensional space in their mind and to be in Mode 2. If it is difficult for participants to construct a virtual 3D space, they cannot enter Mode 2, and they cannot obtain the sense of togetherness.

The arrangement of the camera and the monitor, the difference of expansion rate, camera angles, and delay time of the self-image display significantly influence HyperMirror images.

For instance, there is a 10% difference in enlargement ratios of participants A and B. With a TV phone, this has no influence in a dialog. However, imagine that two persons with the same height of 150cm are standing in a HyperMirror image. It will become very unnatural, because one side is projected as 165cm. The sense of togetherness will be lost if the camera angle is not adjusted appropriately. In this case, one of the

Fig. 5 Changing scene from mode 2 to mode 3. At first, the man on the left extended his hand to the front and pointed to the television behind him, but his colleague corrected him, and he pointed backwards. When the participants talked in HyperMirror conversation without the experimenter, they enjoyed trying to tap the shoulder of the woman in the other room.

participants is projected as if he is floating in air.

Besides HyperMirror, there are telecommunication systems that display self-reflections such as Reflection of Presence by Stefan et al. [8], ALIVE by Maes et al. [3], and See-through Video Avatars System by Yasuda et al. [9]. An analysis of these systems in terms of cognitive modes revealed that Mode 1, such as pointing, is used in conversation, but Mode 2, which constructs a three-dimensional space where people share a space and acquire the feeling of togetherness, is not attained in these systems.

In Mode 1, participants consider their self-image as a cursor which directly points out things. So they can point out their partner or the things at the partner's side. They don't consider their self-image to be a necessary element of a dialog. A self-image is seldom influenced by the arrangement of a camera setup and can be a silhouette. Therefore, when there is no necessity for users to point, displaying a self-image may be obstructive.

5   CONCLUSION

To promote effective utilization of communication media, we must understand how people interpret the conversation environments of the media. This paper analyzed how people interpret HyperMirror images, and proposed mechanisms for explaining the sense of togetherness among participants. The sense of togetherness in HyperMirror is created by HyperMirror images that make participants believe they are together. The sense is enhanced by experiences that support the belief, such as shaking hands and tapping on each others' shoulders. The sense makes the participants use gestures and other visual cues. When the participants find the cues to be effective, the belief is further enhanced. Such cognitive feedback stabilizes the sense of togetherness.

HyperMirror systems can be used for new remote services that are difficult with conventional video systems, such as cooperative projects, medical interviews, lectures and parties. To provide such services, we must correctly set camera positions, lighting, photographing area, enlargement ratio, screen size, and screen brightness to capture quality images and sound so that users can understand HyperMirror image in Mode 2.

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