Ghatcha: GHost Avatar on a Telework CHAir

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Abstract. There has been much discussion on remote communication support for a telework that will enable employees to work at remote offices. We have already developed a remote communication support system via embodied avatars based on users' behaviors. However, there are various problems associated with an avatar-mediated interaction, particularly with regard to the relation between users and their avatars. In this study, we propose the concept of a presence sharing system Ghatcha [GHost Avatar on a Telework CHAir] in which the users' embodiment is not indicated by the avatars but by the chairs that suggest the presence of avatars. This system provides the same communication space for the users' embodiment, thus creating a feeling of working alongside remote workers. In this paper, we propose the concept of this system and develop a prototype system. Moreover, the effectiveness of the prototype system is confirmed in the experiment.

Keywords: Embodied Interaction, Avatar, Remote Communication, Telework, Remote Operating Chair.

1 Introduction

Employees now have the option of working from a remote location away from their home offices, using information communication technology such as the Internet. A telework increases productivity and operational efficiency by offering employees the flexibility to work from their home offices. A telework would gain popularity as it can be utilized in different ways. However, the quality or efficiency of work might deteriorate as a result of a telework as it leads to a sense of isolation or a lack of concentration. Thus, it is important to examine remote collaboration support in detail.

Remote collaboration has various purposes and applications, and it is expected to support for each situation. The subjects of this research are not remote users performing a group task but individual users performing their own specific tasks wherein all their co-workers also perform tasks with the same aim such as a job of a home-based

A.A. Ozok and P. Zaphiris (Eds.): Online Communities, LNCS 5621, pp. 216–225, 2009.

worker or individually pursuing online distance learning. For example, these include software developments, data inputs, and assembling parts together. There has been an intensive discussion on and a remarkable improvement in the remote collaboration support systems for the group task [1],[2],[3]. These systems are constructed by a video image, voice, or virtual reality technique, and these techniques are quite effective for remote collaboration or realistic communication.

In the case of tasks that are not synchronized, however, the video image might contradict our expectations. In order to solve the problem, Honda et al. proposed a virtual office system “Valentine” using an awareness space and provided a work support environment for home-based workers [4],[5]. Moreover, various media communication methods have been proposed for practical use, such as the design of a communication environment, which aims at maintaining and fostering human relations for family members living apart, or a communication system wherein the furniture or daily necessities, which are separated in different rooms, can be linked [6],[7].

However, when a user’s own avatar is used as a communication media for an embodied interaction, many issues arise with regard to the relation between the users and their avatars. For example, if a human-type avatar is used, the correspondence of the user’s motion and that of the avatar’s would be hindered by input devices. Otherwise, the appearance of an avatar cannot appropriately represent a user’s embodiment.

We have developed an avatar mediated communication system for remote users using a human type avatar called a “VirtualActor” and an abstract wave type avatar called a “VirtualWave.” The importance of the relation between the users’ behavior and that of their avatars’ has been confirmed by the communication experiment [8]. Furthermore, an embodied avatar called “PuppetAvatar” based on a user’s hand motion with a glove sensor or a 3D trackball has been developed, and the effectiveness of the system has been confirmed by another experiment [9]. These systems comprise an interface design focused on the embodied avatars of remote users. The interaction media should consider the inclusive input/output relations of not only avatars but also the environment information.

In this research, we propose a new communication system using not the explicit virtual avatar but a chair in which a user’s embodiment is represented. The chair motions indicate the presence of the remote users with the implicit avatar in the same communication space. Wesugi et al. have so far developed a chair communication system called “Lazy Susan” as a motion sharing system for remote users [10]. Their system introduces the presence of remote users by sharing the mutual chair motions of the users, which is linked to the partner’s chair motion. However, the system was not evaluated from the viewpoint of the interaction with the avatar in the same virtual communication space. Some studies have proposed that a user’s condition can be estimated by examining the sitting behavior of that user. Such estimations do not consider environment information as the relation between the user’s chair motion and the avatar’s chair motion. Moreover, the study of the evaluation of the chair motion on the basis of the user’s stance has been performed on the intentional autonomous behaviors of an artifact [11]. In human interaction, both users would interpret the chair motions in a different manner on the assumption that the partner behaves in the same way within the same interface. The present study aims to recreate the environment in which remote users interact with their co-workers in the same virtual office, and enhance their motivation in performing their tasks. In this paper, a prototype of the system using a virtual environment is developed, and the effectiveness of this system is demonstrated by an evaluation experiment.

2 Avatar-Mediated Interaction

The schema of a remote embodied interaction system is shown in Fig. 1. In avatar-mediated interaction, the relation between users and avatars is developed from avatar information, environment information, and the input devices that connect a user to the system. This relation is shown in Table 1. The avatar information is characterized by the avatar's behavior or appearance. The functions of gesturing, nodding, gazing, and making facial expression include the same functions of a real face-to-face communication, such as emblem, illustrator, and regulator. The environment information about an arrangement, a background, or a network delay leads to the formation of social properties such as closeness, initiative, and participation.

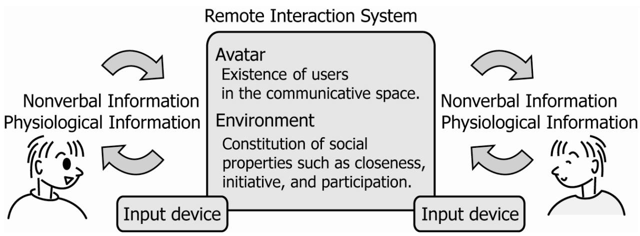

Fig. 1. Embodied avatar-mediated interaction

Table 1. Classification of the information of avatar-mediated communication

Information	Classification	Function
Avatar	Gesture, Nodding Gaze line Facial expression	Similar functions as is the case in real face-to-face communication, such as emblem, illustrator, and regulator
	Utterance	Verbal message
	Physiological information	Affect display, the sense of being alive
	Shape	Social identification, anonymous participation
	Contact response	Sharing the same communication space
Environment	Arrangement Background Delay Participants Collaboration	-- Formation of social properties such as closeness, initiative, and participation -- Constitution of the role of the shared communication space
Input devices	Mouse, Keyboard, Joystick Camera Various sensors Exclusive devices	Construction of the relations between users and their own avatars

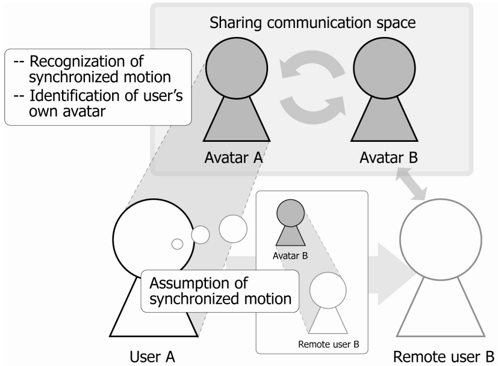

Fig. 2. Recognition model of interaction awareness via communicative avatars

This information constitutes the role of the shared communication space. The input devices affect the relation between the users and their avatars as these devices serve as the function controls for the avatar information and the environment information. It would be necessary to analyze and synthesize these factors systematically for the development of a human-oriented interaction support system.

In addition, the recognition model of interaction awareness via communicative avatars is shown in Fig. 2. User A identifies avatar A as "himself/herself" in the virtual communication space through the recognition of the correspondence between his/her behavior and that of the avatar's. Avatar A, which visualizes the communicative behaviors of user A and avatar B as the substitute of user B, can have embodied interaction in the same space. User A would regard the representation of avatar B for user B in the same way as the representation of his/her own avatar A as long as both avatars work within the same limits of working range. After all, user A would perceive avatar B's behavior as the behavior of user B. The embodied relation of a user and his/her own avatar is very important when designing the interface as it enables effective interaction awareness in the shared communication space.

3 Presence Sharing System for a Telework: Ghatcha

3.1 Concept of the System

We have developed an avatar-mediated communication system using a human type avatar called "VirtualActor" and an abstract type avatar called "VirtualWave" for the embodied interaction in the previous chapter as shown in Fig. 3, and the effectiveness of the system has been confirmed [8]. Moreover, we have investigated the importance of a mutually shared embodiment by the communication experiments using the system.

However, as shown in Fig 1, the embodiment is not always indicative of the avatar information in the input/output of the embodied interaction system. It would be useful to integrate the embodiment with the environment information for the development of an effective interaction support system. Hence, this paper proposes a new presence sharing system called Ghatcha: GHost Avatar on a Telework CHAir. The Ghatcha

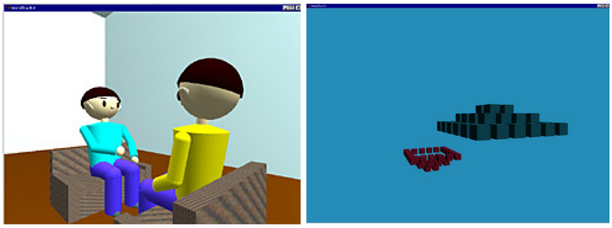

Fig. 3. VirtualActor and VirtualWave

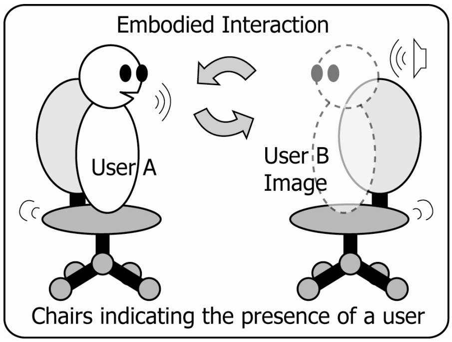

Fig. 4. Concept of the system

system is based on the embodiment of the environment information of the chair motion rather than that of the avatar.

The concept model of the system is illustrated in Fig 4. The user is able to identify the existence of someone from the motions of the chair, which responds to the user in the same space. In the case of voice speech, the voice of the partner leads the user to assume that the partner is present. As mentioned above, according to the study of the intentional motion of the chair as the intentional autonomous behaviors of an artifact, the chair evinces the existence of the user [11]. Therefore, the aim of this study is to develop a presence sharing system wherein a user's presence would be indicated by the motions of the chair.

3.2 Development of the Prototype System Using CG

The prototype system using a CG avatar was developed based on the concept mentioned in the previous section. At first, the prototype system was designed as shown in Fig. 5. In this system design, the chair motions are measured by various sensors such as a gyroscope, an accelerometer, or a magnetic sensor.

The virtual chair motions are represented based on the measurements, and is shared on the network. The mutual motions of each user are transmitted to the office model from the shared communication space. This collaborative system determines the third interaction space with the chairs for each remote co-worker. The CG prototype system is generated by an HP workstation xw4200 (CPU: Pentium4 3.6GHz, RAM: 512MB, NVIDIA Quadro FX3400), OS: Windows XP Professional SP1, and DirectX9.0b.

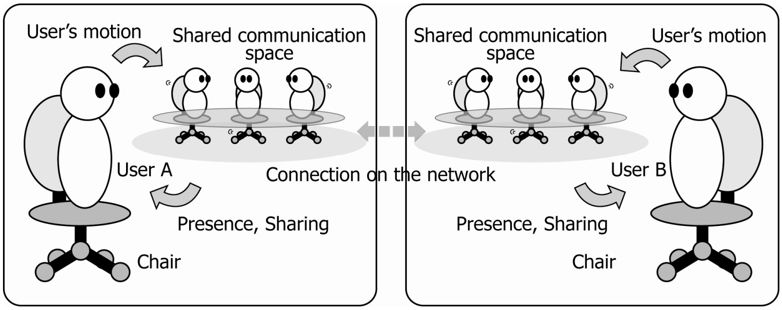

Fig. 5. Communication system design

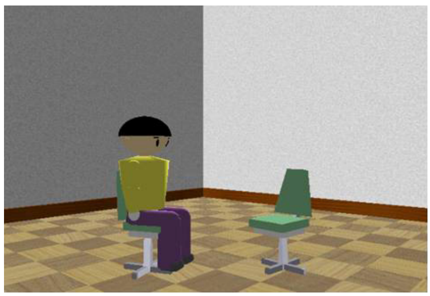

Fig. 6. Communication scene using the prototype system

The frame rate is 30 fps. The chair motions are measured by a laser sensor mouse (Logicool MX Air) attached under the chair. The communication scene using the system is shown in Fig. 6. This example displays only the user's human type avatar.

4 Evaluation of the Experiment

4.1 Experimental Setup

The system evaluation experiment was performed by the prototype system using CG in the previous chapter. The experimental setup is shown in Fig. 7. The subjects consisted of 10 pairs, and they worked on a simple task wherein they made paper cranes by folding pieces of paper. The task was repeated twice using two scenes: one where the chair system was connected with the motions of the user and another where they were not connected.

The subjects were ordered to fold the papers as much as they could. After the task was finished in each scene, the user's behavior was observed during a waiting period of 3 minutes. The only information that was shared through the system was the motion of the chair. Only the user's human type avatar was displayed in addition to both the users' chairs. Thus, the user makes his/her presence felt not as the chair but as the avatar. The partner's avatar was not represented in the virtual space. The subjects answered the questionnaire after the task in each scene. They were provided an explanation of the conditions and the setting of the experiment, and they agreed to the

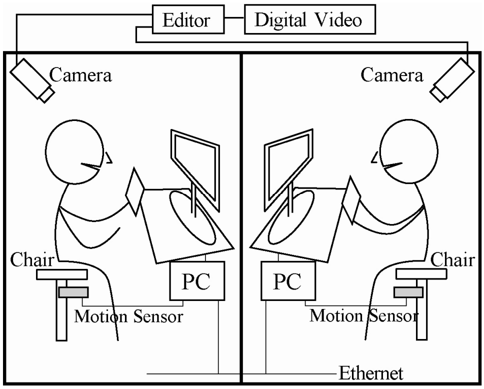

Fig. 7. Experimental setup

experiment before the experiment started. The time taken to conduct the experiment was about 40 minutes on average including the waiting time and the time taken to answer the questionnaire. The example of the evaluation experiment scene is shown in Fig. 8.

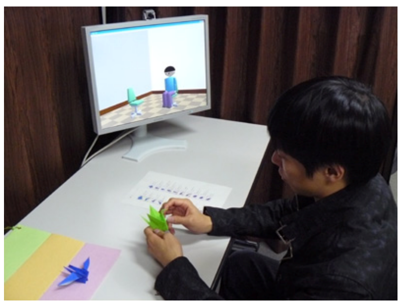

Fig. 8. Example of an evaluation experiment

4.2 Sensory Evaluation

The two scenes were evaluated on a seven-point bipolar rating scale ranging from –3 (lowest) to 3 (highest), in which 0 denotes a moderate score. For the sake of convenience, the results of the means and the standard deviations are shown in Fig. 9.

The questionnaire consisted of eight categories: four categories on the impression of the work and the other four categories on the evaluation of media communication. In most of the categories, the significant difference between the two scenes was obtained by administering the Wilcoxon's rank sum test; a significance level of 0.1% for the items of "Do you feel like sharing the same space with a partner?", and "Do you feel like working together with a partner?" A significance level of 1% was obtained for the items "Do you enjoy your task?" "Do you believe that you could associate yourself with the character?" and "Do you recognize a partner's motion?" The effectiveness of the prototype system is evinced by the positive evaluation of each category in the scene that the chair motions were connected. The scene that the chair motions

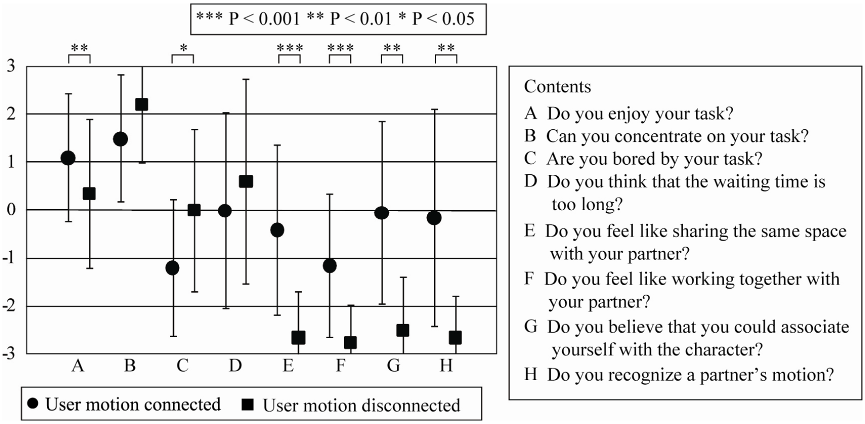

Fig. 9. Results of the questionnaire

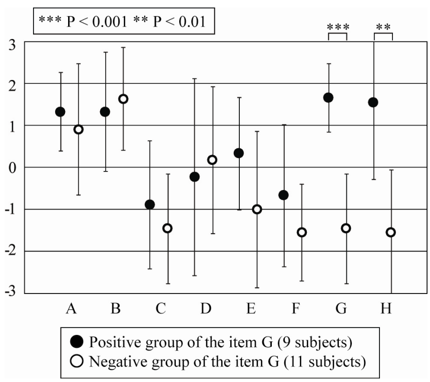

Fig. 10. Results of the questionnaire for the divided groups

weren't connected has a negative evaluation that is significant at the 5% level for the item "Are you bored by your task?"

Although the user motion connected scene has a positive evaluation, the means are near 0 and the standard deviations are large for the sake of convenience. Then the results of the questionnaire for the divided groups (Positive: 9 subjects, Negative: 11 subjects) based on the item "Do you believe that you could associate yourself with the character?" is shown in the Fig. 10 from the viewpoint of assuming the character of the avatar. A Mann-Whitney U test was conducted and a significant difference was observed between the two groups: a significance level of 0.1% was observed for the item "Do you believe that you could associate yourself with the character?" and a significance level of 1% for the item "Can you recognize the partner's motion?" Thus, the users in the positive group of the possession to the avatar could effectively perceive the motion of the partner. In addition, comments such as "I didn't move too much while folding pieces of paper into the figure of a crane" and "I was pleasant to manipulate my chair after working the task" are obtained as responses of a free description of the respondents' opinions in the questionnaire. The effectiveness of the system can be observed in the waiting time after working rather than during the working time.

5 Consideration

The task in the evaluation experiment of the prototype system was a simple one where participants had to fold a piece of paper into a figure of a crane. The waiting time for carrying out the task was arranged. This experimental setup was prepared for evaluating the shared interaction awareness during the time when the users worked so as to reduce their sense of isolation or lack of concentration. The experimental time was about 40 minutes on average. Therefore, the essential effectiveness of this system may not be determined for the purpose of long-term support. These studies should be further investigated. The users in the positive group of the possession to the avatar were effectively evaluated for the item on the recognition of the partners' motion. In other words, if a user cannot place himself/herself in the communication media, the interaction awareness would be obstructed by the indifference of the partner. By "self media-izing" a user can assume the role of the avatar in the media space, and this would lead the user to identify with the avatar in the interaction space. Accordingly, these features are important for the development of an effective interaction system. A more direct interaction design would be required using the user's embodiment for interaction awareness.

6 Conclusion

In this paper, the concept of the presence sharing system using a chair for telework was proposed, and the prototype of the system using a virtual environment was developed. Moreover, the evaluation experiment was performed using the prototype of the system, and the effectiveness of the system was demonstrated by a sensory evaluation.

The distinctive feature of this system lies in the usage of the chair as environment information based on a user's embodiment instead of the avatar as a substitute in the communication space. A cooperative work environment can be effectively created by this system because users can freely arrange a human-type or abstract character as their co-workers' avatars on each chair and perceive the relation among the co-workers.

Furthermore, this system can be applied to the educational system of private study. Private study at home or a study room might lead to a sense of isolation or lack of concentration like a telework. The system would be expected to support the users' motivation and change their attitude by sharing the presence of friends or students. Even if the partner is not an acquaintance, the system would solve problems like isolation or lack of concentration by the presence of the other user. An autonomous agent such as a superintendent or a teacher would urge the user to study more effectively within a tense atmosphere around the user's avatar. These applications need to be further examined.

References

1. Ishii, H., Miyake, N.: Toward an Open Shared Workspace: Computer and Video Fusion Approach of TeamWorkStation. Communications of the ACM 34(12), 37–50 (1991)
2. Takemura, H., Kishino, F.: Cooperative Work Environment Using Virtual Workspace. In: Proc. of CSCW 1992, pp. 226–232 (1992)
3. Kuzuoka, H., Kosuge, T., Tanaka, M.: GestureCam: A Video Communication System for Sympathetic Remote Collaboration. In: Proceedings of CSCW 1994, pp. 35–43 (1994)
4. Honda, S., Okada, K., Matsushita, Y.: A Home Office System Based on a Virtual Shared Room: An Environment Corresponding to Degree of Concentration. In: Masunaga, Y., Tsukamoto, M. (eds.) WWCA 1998. LNCS, vol. 1368, pp. 364–380. Springer, Heidelberg (1998)
5. Honda, S., Tomioka, H., Kimura, T., Oosawa, T., Okada, K., Matsushita, Y.: A company-office system "Valentine" providing informal communication and personal space based on 3D virtual space and avatars. Information and Software Technology 41, 383–397 (1999)
6. Miyajima, A., Itoh, Y., Itoh, M., Watanabe, T.: TSUNAGARI Communication: The design of the communication environment which aimed at keeping and fostering human relations and a field test for family members living apart. The Transactions of Human Interface Society 5(2), 171–180 (2003) (in Japanese)
7. Tsujita, H., Tsukada, K., Siio, I.: SyncDecor: Appliances for Sharing Mutual Awareness between Lovers Separated by Distance. In: CHI 2007 Conference Proceedings and Extended Abstracts, Conference on Human Factors in Computing Systems, pp. 2699–2704 (2007)
8. Ishii, Y., Watanabe, T.: An Embodied Avatar Mediated Communication System with VirtualActor for Human Interaction Analysis. In: Proc. of the 16th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN 2007), pp. 37–42 (2007)
9. Ishii, Y., Osaki, K., Watanabe, T., Ban, Y.: Evaluation of Embodied Avatar Manipulation Based on Talker's Hand Motion by Using 3D Trackball. In: Proc. of the 17th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN 2008), pp. 653–658 (2008)
10. Wesugi, S., Miwa, Y.: "Lazy Susan" Chair Communication System for Remote Whole-Body Interaction and Connectedness. In: Proc. of the Third IASTED International Conference Human-Computer Interaction, pp. 93–99 (2008)
11. Terada, K., Shamoto, T., Ito, A.: Human Goal Attribution toward Behavior of Artifacts. In: The 17th International Symposium on Robot and Human Interactive Communication (RO-MAN 2008), pp. 160–165 (2008)