

Support for Cooperative Work of Teleworkers with Disabilities

Koichi Takeuchi Naotsune Hosono
Takashi Tsuda Ryoji Kimura

Introduction

The possibilities of working beyond the limitations of time or place increase with the use of technology, by the advancements of information and communication technologies. This enables an environment for people, who find it difficult to move about or go out of their homes due to their physical disabilities, to work at home¹⁾. A strong demand exists for a system friendly to humans that creates an environment wherein people can work without the constraints of time, place or physical condition.

Oki WorkWel Co., Ltd., which is an exceptional subsidiary of Oki Electric, has been promoting the employment of physically disabled persons working at home, teleworkers, since 1998, ahead of all other companies. As of August 2006 the company employs 26 teleworkers²⁾. The teleworkers are primarily engaged in the subcontracted development of web content. Business operations assigned to teleworkers are generally tasks that are complete on their own, created by dividing general work into modules. The characteristic feature of the work done at Oki WorkWel is that multiple teleworkers comprise a team, working under a coordinator (a non-disabled person working at the head office), who manages the team and a central director (a teleworking team leader) who carries out a cooperative works (Fig. 1). By choosing to conduct operations in this manner, works are relatively large in scale and complex in nature.

Close communications between the relevant persons, with an emphasis on cooperative works, are essential for work to be carried out in such a manner. There are many occasions when multiple parties must communicate with other parties, rather than just one to one

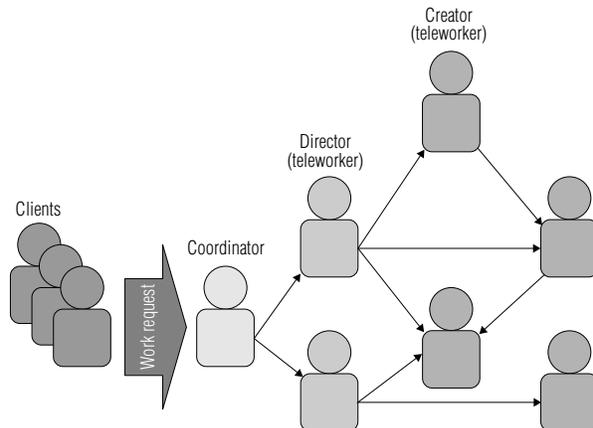
communications, in order to carry out the work. At the present, such communications are performed via electronic mail or telephone calls. However, interactive communication is difficult for question and answer or those involving the issuing of instructions to all relevant parties together at once, or discussions with multiple participants. Furthermore, there is also the issue of mounting telecommunication costs, which in turn make it difficult to freely ask questions or to start discussions. Furthermore, when people share the same place of work it is possible to determine the progress status from the daily conversations at work, while becoming aware of who needs assistance, as well as when to engage in joint efforts to provide the necessary assistance or to learn from people working in the vicinity. However, for teleworkers, the benefits that are apparent when a place of work is shared, such as being able to recognize one's status or to learn from one another, are difficult for the workers at home to recognize³⁾.

The results obtained from a trial conducted in the field at locations where persons are actually teleworking using a multiple point audio conferencing system by means to resolve such problems, as well as the knowledge gained through the process, are described in this paper.

Trial of multipoint audio conferencing system

As mentioned before a mechanism to enable teleworkers to conduct free discussions involving multiple persons in real-time was requested by these persons as support for cooperative works. A multipoint audio conferencing system, the Vocal Village, was selected to realize this requirement for the trial.

The Vocal Village is a multipoint audio conferencing system using VoIP (Voice over Internet Protocol), developed at the University of Toronto. This system incorporates a function that makes it possible to determine which direction a voice originates, according to the location of the speaker displayed on the screen, through the use of acoustic processing. For example, the voice of a person positioned on the right in Fig. 2 and Fig. 3 is heard from the right side, while the voice of a person positioned on the left is heard from the left side. Cooperative works are made possible over the network, while creating an environment similar to people being seated next to each other in an office⁴⁾.



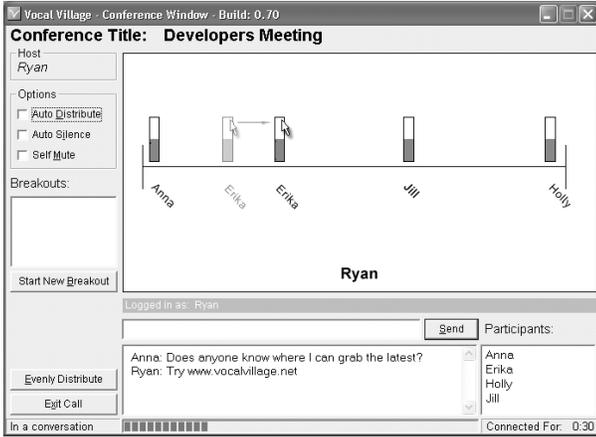


Fig. 2 Multiple site audio conferencing system, Vocal Village (original version)



Fig. 3 Multiple site audio conferencing system, Vocal Village (Japanese version)

Since all the homes of the teleworkers were linked with always-on broadband lines, all calls using the Vocal Village were free of charge and, because the Vocal Village was connected at all times, speaking through the system immediately resulted in a response from the party spoken to, therefore, it was possible to create an environment where an audio conference involving multiple persons could be started at any time.

The Vocal Village system was originally designed for persons without any physical disability, living in English-speaking regions (Fig. 2). Localization to the Japanese environment and modifications to the design, such as making the operating screen easier to use, based on interviews with teleworkers, was incorporated into the system (Fig. 3).

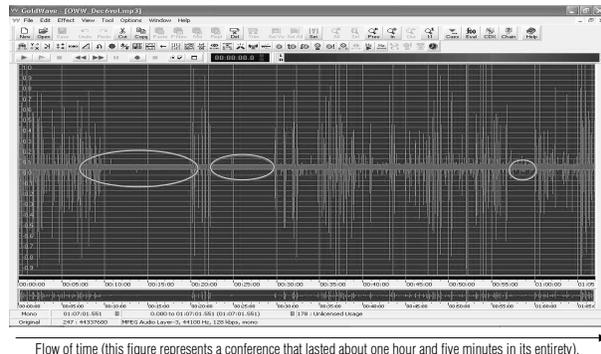
Summary of the trial

A trial of the Vocal Village in an actual web development work (creation of home pages) was conducted during a two-week period in December 2005. Seven teleworkers participated in the trial. Participants kept the Vocal Village connected at all times while they were working and they could talk to any of the other members at any time as they worked. A glimpse of the trial is shown in Fig. 4.



Fig. 4 A glimpse of cooperative work using Vocal Village

We visited the homes of seven teleworking employees during the trial and interviewed them for about two hours each. We were able to extract information regarding the way how the work was currently being conducted and the issues relating to the processing of the work operations. During the trial, all conversations were recorded and were analyzed to determine the types of conversations and their frequency (Fig. 5). As shown in Fig. 5, no one spoke during individual operations (highlighted by circles) and the Vocal Village was generally used to perform discussions only when the communication became necessary.



Flow of time (this figure represents a conference that lasted about one hour and five minutes in its entirety).

Fig. 5 Recorded conversations in the trial

When the trial period finished, surveys were distributed and interviews were held to determine the usefulness of the system, about the frequency of the telephone and electronic mail changed and the way they worked changed⁵⁾.

Results of the trial

(1) Evaluations of the system

The results of the survey relating to the evaluation of the system itself are shown in Fig. 6. This survey was conducted using the IBM Computer System Usability Questionnaire (CSUQ)⁶⁾, which was translated into Japanese by the author. The survey form was sent out to the trial participants when the experiment was completed. The system as a whole was evaluated using this survey on three aspects of usability, quality of information and quality of interface.

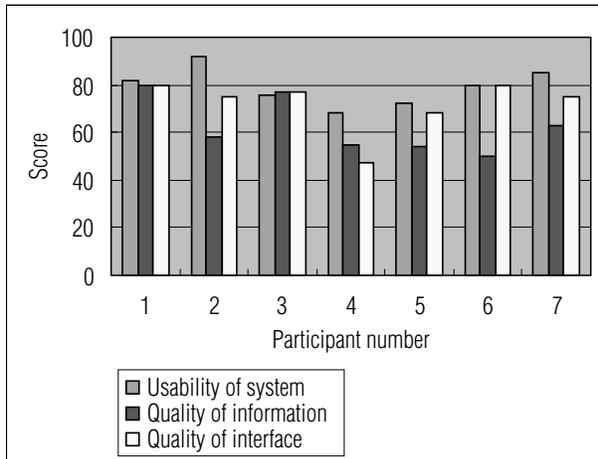


Fig. 6 Evaluations of the system

Usability of the system was highly evaluated according to this figure. The evaluation for the quality of information was dispersed, since the meaning of “quality of information” was ambiguous. Many people interpreted it as sound quality and for this reason some expressed their dissatisfaction regarding the quality of sound and stability of the connection when the number of participants in conferences increased. Except for trial participant number four, all others appeared to have felt that the quality of the interface was user-friendly.

(2) Evaluations relating to work satisfaction

The results of the survey relating to work satisfaction are shown in **Fig. 7**. These results were obtained by comparing the situation before and after the implementation of the system and evaluated with a five point score. Furthermore, a score of three indicated that there had been no change due to the implementation of the system, whereas higher points indicated more improvements were seen as a result of implementation of the system.

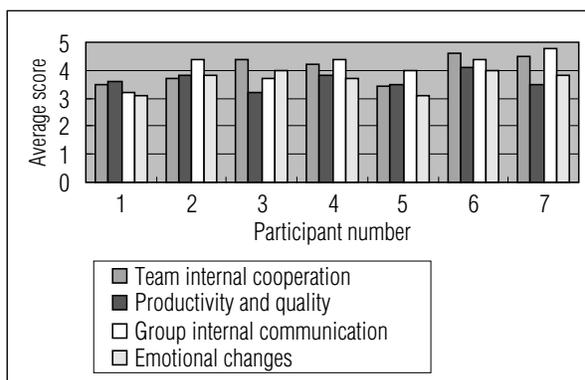


Fig. 7 Evaluations of work satisfaction

These results indicated that many participants felt communications within the team improved. Prior to the implementation of the system some participants exchanged as many as 20 to 30 e-mails per an hour.

Since implementation of the Vocal Village, such interactions were often taken care in the conversation.

We also obtained results indicating that many people felt improvements in cooperation and then had been made within the team. In particular, a significant number of participants pointed out that there had been emotional improvements, reflected by their awareness of working together as a team and they mutually offered assistance knowing that the opinions of individuals were being reflected in their work.

Even though the director (teleworking team leader), who needed to make adjustments with the teleworkers, appeared to have felt that there had been a great benefit in terms of productivity and quality improvements, there were others who did not feel that there had been much of a change. Some participants responded in a contrary manner by indicating that the necessity of listening to sounds during work was disturbing.

There seemed to be personal differences regarding how the emotional changes relating to pleasure and the feeling of oneness at work took place. The hypothesis of the authors anticipated improvements in this area, but interviews indicated that there was an opinion relating to those people who have no experience of working in offices and for them working at home by themselves were actually quite normal from the very start and therefore, they did not feel lonely working on their own. There was also an opinion indicating that there had always been adequate communication with other team members and loneliness was not an issue. It appears that being physically segregated and having feelings of loneliness do not necessarily go hand in hand.

(3) Results of interviews

Besides the surveys the following points obtained during interviews were cited as benefits for implementing the system.

- Unlike e-mails it was possible to work while having real-time discussions on issues.
- It was easy to talk to multiple number of people or to give instructions.
- It was a good learning experience as we had an opportunity to listen in on other people's conversations and assist each other.
- It was possible to talk freely rather than finding it necessary to make phone calls. We also had chats.
- Realistic environments were provided by the sound effects (the function that identified the direction of a sound source depending on the person talking).
- It felt as if we were also working in the same place of work with our desks arranged next to each other.
- Camaraderie with the feeling of working together as a team strengthened.
- The sound was better than a mobile phone since it was much easier to listen to conversations.
- No call charges were billed for calls made using this system.

On the other hand, issues and requests, such as the following, also clarified.

- The lingering background noise, when no one was talking, was disturbing.
- There are times when one forgets to turn the microphone on or off. Since the connection is on at all times, privacy is an issue of concern.
- Since work is done at home, there are always interruptions but when a person leaves his or her desk or needs to attend to something, that person becomes disengaged from an ongoing conversation.
- There are issues relating to compatibility with other software and there is some difficulty in the setup of the software. It would be good if a dedicated system were available with a singular function for providing the features of this system.
- It would be good if a mobile version was made available for the coordinator to bring with him or her when meeting with clients, since this would make it possible for teleworkers to participate in such discussions as well.

Conclusion

Multipoint audio conferencing systems, such as the Vocal Village, implemented on trial for the verification experiment, were found to be useful for cooperative works of teleworkers with disabilities.

However, it also became clear that there are issues, such as striking a balance between privacy and usability, as well as improvements that are required of the human interface and which are compatible with a diverse range of disabilities, or issues relating to the installation and support of the system.

By proceeding with improvements on the system through verification experiment in joint efforts with Oki WorkWel we intend to realize a system that provides communication with realistic environments, giving a feeling of working together in the same place of work even when the participants are remotely located. Furthermore, Oki WorkWel is conducting remote training on IT skills for persons hoping to work from home, as a subcontracted business from the Metropolitan Government of Tokyo. We hope to apply the system in such applications as well. In the future we will also be considering not only the employment of persons with disabilities as users for the system but also people who are home-bound due to child rearing or who have nursing care demands. We hope to realize an environment that is friendly to humans, where people who had to abandon work due to a variety of reasons to find work that is suitable for their capabilities and conditions, while allowing such persons to be themselves and be happy.

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Authors

Koichi Takeuchi: Corporate Research and Development Center, Human Interface Laboratory

Naotsune Hosono: Oki Consulting Solutions Co., Ltd.

Takashi Tsuda: Oki WorkWel Co., Ltd.

Ryoji Kimura: Oki WorkWel Co., Ltd.