A Communication Support System for Tele-collaboration based on Situational judgments of User workload.

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Abstract

By constant connection between two remote sites with video conferencing system, project members can get a casual contact anytime with the members at the remote site without setting up sessions. This allows two remote office spaces to be virtually regarded as one office space. But, in such case, it seems difficult to infer the situation of a member at the remote site only with conventional video conferencing system. In existing studies, some solutions were proposed by sharing situational information of users. But this will cause user's hesitation in communication. A transmitting person loses the chance of the conversation and a receiving person doesn't receive necessary information easily. Therefore the disadvantage is raised for both a transmitting person and a receiving person.

In this study, communication support system based on situational judgment of user workload was proposed. To avoid those disadvantages, user workload is estimated from mouse displacement and key typing collected from user's PC. Then the system automatically selects optimal communication tools by weighing with the situation information of member at the remote site. From experimental result, communication of bothering members was decreased, in spite of increasing total communication. This suggests the proposed system effectively supports remote communication.

1. Introduction.

In recent years, demand for collaboration support system between remote sites has been increasing with growth of broadband connections and globalization of business. For instance, many studies and products have been presented for video conference system, which connect between multiple remote sites spread to the world. In our previous studies, constant connection of remote sites using video conference with large size display system, not only for typical conferencing but for usual work aimed to support informal communications for randomly occurring collaboration [1][2].

But in such systems, some confusions of user has risen, because it seems difficult to infer the situation of each member. For example, a member who was very busy for his own work won't wish to receive casual communication from other members, but others cannot be aware of it on such systems. If users of this system will feel such kind of suspicion, this will cause user's hesitation for communicate through this system each other.

In this study, communication support system based on situational judgment of user workload was proposed and evaluated. Situation information, based on user workloads were estimated from mouse displacement and keyboard typing collected from each user's PCs. The system automatically selects optimal communication tools by weighing with the situation information of each member.

2. Approach to solution.

2.1 Existing study and problems.

Already, there are some studies on estimating and sharing user workload [3]. This should be effective, but a problem still remains. Especially on the business office, almost users usually think they are busy every time, so that the display will be filled with "busy" state signs. In terms of "informal communication", this would work suppressive. To avoid user's hesitation to make informal communication, communication method is clearly specified even if others displayed to "busy".

2.2 Characteristics of Communication tools.

There are many methods to communicate to others, like phones, fax, e-mail, visit (face to face communication), etc. It can be possible to classify the methods into two or three groups in terms of synchronous/asynchronous methods [4].

Synchronous (real-time communication)
Face-to-face communication
Phones
Voice chat, etc.
Asynchronous (this can be "stacked")
Physical mail or memos
Fax
E-mail, etc.
Synchronous/Asynchronous (can be chosen)
Text chat (instant messenger), etc.

Synchronous (real-time) communication will spend quite a bit of user's work time, and other methods will be much flexible.

In this system, proposed here, automatically selects communication methods (tools) based on situational judgments. So a user who wants to communicate with other member, doesn't bother for when and how is adequate, and feel free to communicate.

2.3 judgment of user work contents.

If the users concentrated in their own work, informal communication will be felt as a disturbance. But if the user works with collaboration work, it seems to be opened for communication with other member. Our preliminary experiment shows that the degree of satisfaction of communication will surpass the disturbance for collaboration work (Fig.1). From this result, a work content of user has to take into account.

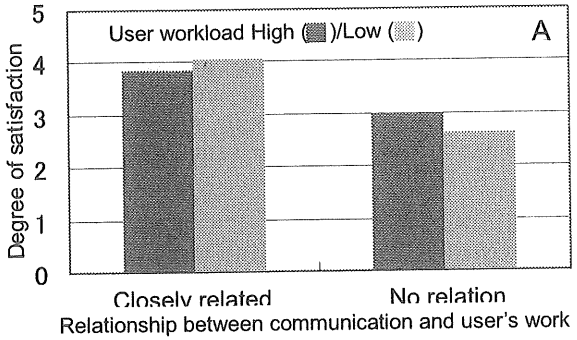


Figure.1 Influence of relationship, between communication and user's work, on degree of satisfaction (A), and averaged decrements of degree of satisfaction plotted against user workload (B).

3. System outlines.

3.1 Situational Judgment.

Estimation of user workload is derived from two elements, the frequency of key strokes and mouse displacements, which is based on the previous study of Honda, S. et. al[5]. User workload is classified into 9 levels, determined from the ratio of the idle time of input devices. Those input device are continuously monitored and judged the level per minute. If the idle time ratio exceeds 67%, the level reduces by one degree and if the ratio is under 43%, the level rises one degree. When the ratio is intermediate, the level is left unchanged.

Contents of a user's work is determined whether mutual collaboration work or user's own work, by the filenames. The filename for the mutual collaboration work was ordered to be a specific form, in advance.

3.2 communication tools.

According to the user workload, the system selects optimal method for communication. Selection algorithm is shown in Fig.2. In this system, three communication tools were chosen as following, voice-chat for synchronous (real-time) communication, text-chat (instant messaging) for synchronous/asynchronous communication, e-mail for asynchronous communication.

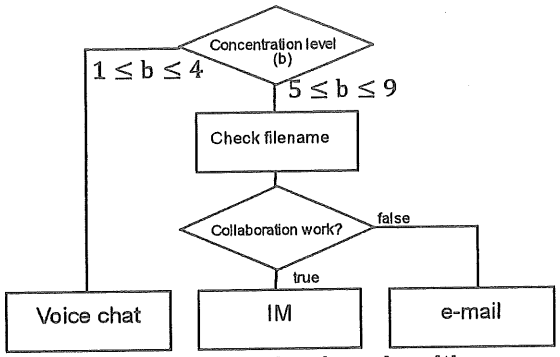


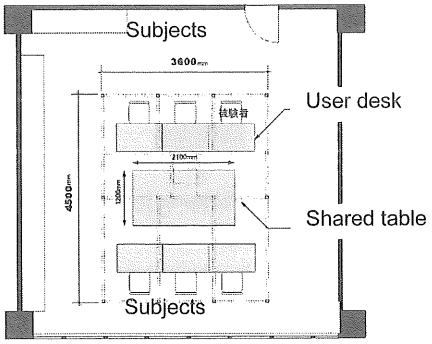
Figure.2 Selection algorithm

3.3 Implementation.

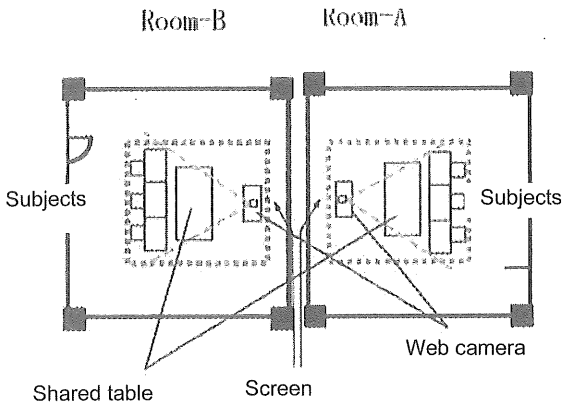
Software was developed with Skype-API on Microsoft Windows XP. The application window has "Access" buttons provided for each member. When a button clicked, the system select adequate communication tool according to the "situation" and establish a session. Skype is launched for voice/text chat, and user-setting default e-mail client is launched for e-mail. A screen capture is shown in Fig.3.

4. Experimental.

Experiments were carried out by a comparison between one room environment and two rooms environment with/without this system. The room layout is shown in Fig.4. The one room environment, all workers were in the same room, was prepared without this system, and regarded as a "usual" office environment as a reference. The latter environment was prepared for simulating remote office, and equipped this communication support system and video conferencing system with constant connection to regard as the virtually connected office. Six students were participated in this experiment as workers. In both environments, they were working with their own work and mutual collaboration project provided for this experiment. For each environment, experiments were carried out for two days, 8 hours/day.



One room environment.



Two rooms environment.

Figure.4 Room layouts and a snapshot of experiment.

Numbers of communication, impressions for each communication, and the system impressions were collected in the form of questionnaire.

5. Results and discussion.

5.1 Number of communications for each conditions.

In all conditions, ratio of neighboring communication is exceeded a half of all communications (Fig.5). Especially condition B shows high ratio, it seems that face to face communication via video conferencing system on virtually connected office is rather difficult for users.

Table.1 Abbreviations for experimental condition

A	One room environment
B	Two rooms environment without proposed system
C	Two rooms environment with proposed system

But on the other hands, condition C shows same as much as A in spite of having a same difficulty of B. This result suggests the system efficiency of communication support.

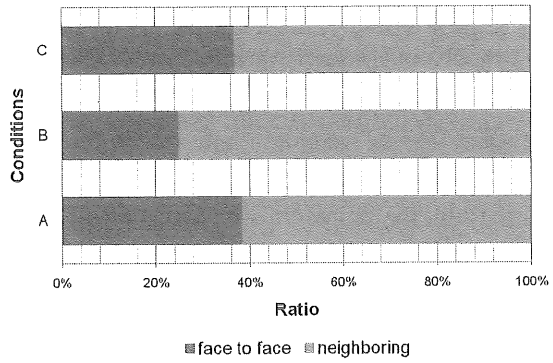


Figure.5 Comparison of ratios of neighboring communications between the conditions.

5.2 Impressions of each communication.

Fig. 6 shows the ratio of decrement the degree of satisfaction for each communication, which has highly related to the work concentrated at that time, plotted against degree of concentration. In all conditions, these ratios show small values. This means that in any conditions, communications with higher relationship to the user concentrated work will not be disturbance.

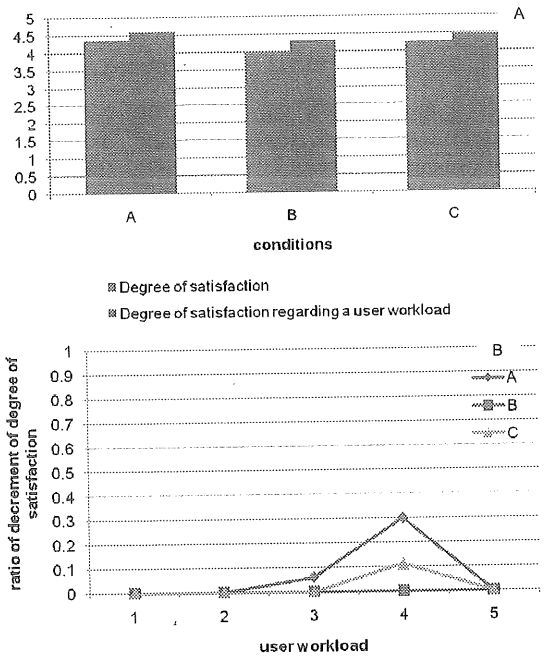


Figure.6 Degree of satisfaction with communications, which closely related to user's work, plotted against degree of concentration (A), and the ratio of decrement of degree of satisfaction plotted against user workload (B).

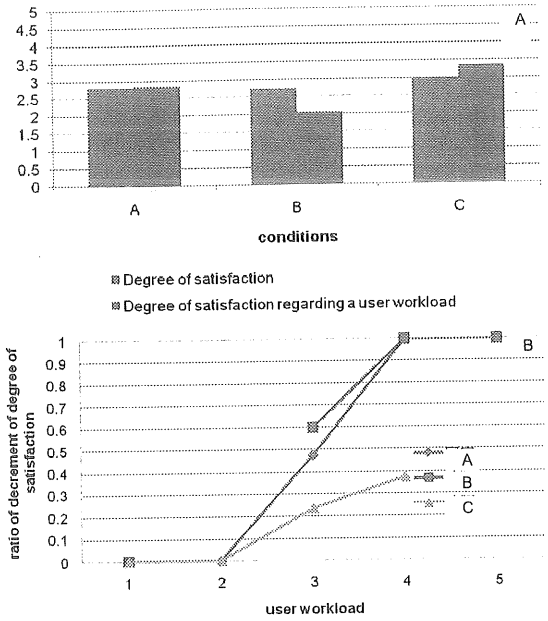


Figure.7 Degree of satisfaction with communications, which has no relation to user's work (A), and the ratios of decrement the degree of satisfaction plotted against user workload (B).

On the contrary, communications have lower relationship, the ratios growing lager, especially the region of degree of concentration over 2 (Fig .7).

Despite this, condition C shows rather lower values than other condition. This seems to be rather curious, because the ratio lower than the condition A, the same room situation. This will cause from that the system automatically selects e-mail when the user doesn't concentrate with mutual project work.

6. Conclusion.

From these results, the proposed system is expected to effectively support the communication among remote sites. But there are still problems such as, automation of finding relationship between user work and communication, flexibility of selecting communication tools has to be researched.

7. References.

[1] Miyake, Y., "Continuously Connected Environment for Collaborative Telework", *Master's thesis*, Kyoto Institute of Technology, 2006.

[2] Omatsu, Y., "A Communication Support System with Multi Conversation-channel in a Video Conference", *Master's thesis*, Kyoto Institute of Technology, 2006.

[3] Shimizu, K., Yamashita, K., Nishimoto, S., Kunijuji, S., "A System that Provides Personal Workload Awareness using Character Agent", *The 18th Annual Conference of the Japanese Society for Artificial Intelligence*, The Japanese Society for Artificial Intelligence, Tokyo Japan, 2004, 1B3-03.

[4] Ono, T., "Informal Communication Support System using Presence Information", *Master's thesis*, Tokyo University, 2005.

[5] Honda, S., Tomioka, H., Kimura, T., Oosawa, T., Okada, K., Matsushita, Y., "A Home Office Environment Based on the Concentration Degrees of Wokers : A Virtual Office System"Valentine"", *Transactions of Information Processing Society of Japan*, Information Processing Society of Japan, Tokyo Japan, May 1998, pp. 1472-1483.

[6] Iwata, S., *Skype API Book Vol1*, Talpa-Tech Inc., Tokyo Japan, 2006.