

R&D Spirits

Toward Communication Systems That Can Convey Feelings

Minoru Kobayashi

Senior Research Engineer

Human Communication Group

Human Interaction Project

NTT Cyber Solutions Laboratories



The Human Communication Group of the Human Interaction Project at NTT Cyber Solutions Laboratories is researching new human interfaces with a view toward establishing deeper means of communication. In addition to developing advanced technologies, it pursues the essence of communication with original ideas and aims to uncover sophisticated ways of expressing and supporting human communication. We asked Dr. Minoru Kobayashi, a senior research engineer and the driving force behind the Human Communication Group, to tell us about *communication systems that can convey feelings*, a central theme of this group.

Exploring human interfaces based on novel concepts

—Dr. Kobayashi, what is the Human Interaction Project?

The Human Interaction Project that I belong to was established just under a year ago to perform new tests on human interfaces. It encompasses a wide variety of research topics from robots to image processing that might initially appear to have no consistent theme. But in this project, we treat these technologies as communication-support platforms with possible interrelationships to study how interfaces between people and media should really be as our main theme.

—What particular theme are you pursuing within it?

As the name implies, our Human Communication Group is researching environments that make it easier for people to communicate with each other. For the last few years, this group has been researching ways of facilitating human-to-human conversation by skillfully using media to interpret various types of signals that exist in real space. While past research on communication and human interfaces mainly aimed to improve the quality of voice and images, research of the Human Communication Group revolves around

human senses and has been given the name “Kimochi-communication” to distinguish it from conventional approaches. This form of communication includes the transmission of decisions and acknowledgements in addition to feelings. So why are we researching communication centered about human (user) senses? Because the ability to feel that one is conveying and understanding intention is expected to be extremely important in future communication media. We refer to this as a “sense of mutual understanding,” and we feel that the quality of mutual understanding in addition to voice-and-image quality will play a significant role in communication media of the near future.

—Could you tell us about any trials that are now taking place?

Yes. In one trial, we are asking subjects to engage in multiple conversations and collecting data on physical characteristics such as pulse and body temperature while recording those conversations. This data can then be compared with the content of conversations along the time axis and analyzed accordingly to investigate, for example, what kind of phenomena might occur before a person speaks and what to do when something that a person wanted to say

could not be said. In this way, we believe that we can establish a basis for developing media that steer topics toward the person that has just spoken and thus promote smooth conversation.

We are also developing haptic displays as part of our research into tactile interfaces (**Fig. 1**). In one of our haptic displays, “pressing” a three-dimensional computer graphic on a table generates a gush of air from below to produce a sense of resistance just like when touching a soft surface. In contrast to general haptic interfaces that connect the human body by arm mechanisms or wires in a somewhat unpleasant manner, the use of air in our haptic display results in a very “clean” medium that feels comfortable to the user. This research has demonstrated that the act of touching can be an effective means of supporting communication just like seeing and hearing.

—*What are the ultimate goals of your research?*

We have three ultimate goals. The first is to make it easier to express what one is thinking. For example, a medium that could make it easy to “draw” what one is saying in a picture would make it difficult for misunderstandings to develop in a conversation. The second is to support the recording of communications. In other words, equipment that could make it easy to remember when one thought about something would prevent a great idea that could not be jotted down from being forgotten. And finally, our third goal is to detect lapses in mutual understanding. For example,

there are many words that might be given different meanings and used differently depending on a person’s value system and background knowledge. Here, a medium that could detect such an instance might also be able to convey nuances and/or emotions not expressed by the word itself. It could make conversations all the more satisfying. These are our ultimate goals, and finding solutions to reach them is our challenge.

Working to eliminate breakdowns in communication

—*Dr. Kobayashi, how did you develop an interest in human interface research?*

In graduate school, I selected man-machine interfaces as a research theme, and for my master’s thesis, I constructed an information-browsing interface using books as a metaphor and implemented it on a computer. It would therefore appear that I have been on this path from the very start, but in fact, it was slightly different. The first time I encountered human-interface research was during my undergraduate years when I occasionally worked part-time in the creation of computer-aided-design (CAD) systems. At that time, general-purpose CAD applications were not commercially available and companies or organizations that wanted to use them had to have them developed individually. It was also a time when the mouse had not yet become standard equipment on

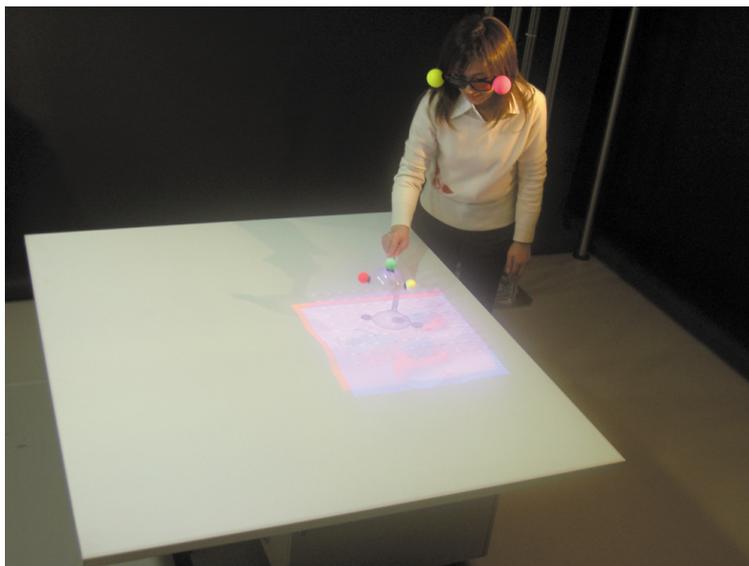
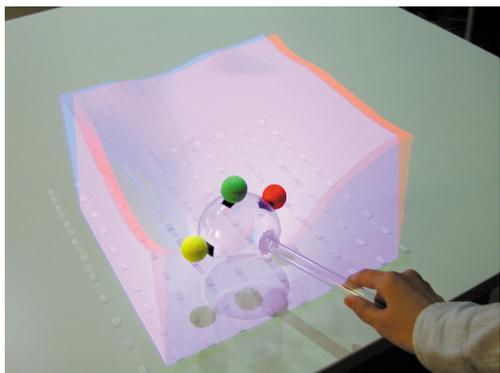


Fig. 1. Haptic interface using air jet.

personal computers, and those of us students who were working at this part-time job would often discuss the merits of using a mouse or a tablet for a particular system. Come to think of it, this work itself was a form of interface research, but I would say that my deep interest in interface research began after reading “The Human Interface” from the MIT Media Laboratory, a book that fellow part-time workers who were already graduate students introduced me to.

—Could you tell us something about your research history?

Well, soon after entering NTT, I became involved with the development of video-based groupware as part of NTT’s research on computer-supported cooperative work (CSCW). Here, I proposed the ClearBoard concept (Figs. 2 and 3) after being greatly motivated by the TeamWorkStation system developed by Hiroshi Ishii, Kazuho Arita, and Masaaki Ohkubo. The TeamWorkStation system provided a joint work-support environment through video conferencing based on the concept of an open and shared workspace. It made geographically remote users feel as if they were using the same whiteboard. This system had a big impact as it could reflect the writing motion of participants in real time while overlapping the video of participants’ desks on the screen. Unfortunately, the shared workspace and the video space for displaying users’ faces were separate in TeamWorkStation, and it was not possible to make use of gestures and eye movement in a natural manner. To eliminate this drawback, ClearBoard unites the shared workspace and user video space, making them one and the same.

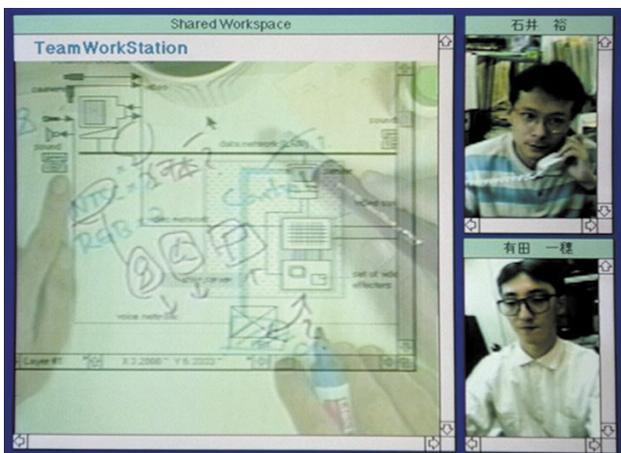


Fig. 2. TeamWorkStation.

ClearBoard introduces an entirely new concept in allowing people to converse and draw from both sides of a transparent glass panel. In developing ClearBoard, I first thought of creating an L-shaped display to combine the user video screen and joint workspace, but in this case, the space between the vertical and horizontal portions of the L-shaped display could not be represented. Then, after giving this problem a lot of thought, I finally came to the conclusion that I could fold over the L-shaped display. In other words, I realized that a transparent glass panel was the way to go! With hindsight, this seems simple, but the evolution of this concept was a significant breakthrough in human-interface research. In short, while my initial goal was just to connect what was originally two different spaces, I eventually found on making that connection that the reactions of the other user could be recognized and understood much better than expected. Understanding what the other party is looking at makes it clear what that user is interested in and what should be done next in the session. We have named this property “gaze awareness” and this term is becoming standard usage in media research.

After completing a major portion of the ClearBoard research, I had the opportunity to study abroad at MIT Media Laboratory, where I received my second master’s degree. There, I took on research dealing with the creation of an interface for simplifying access to aural information by mapping of the aural time axis to space. A simple metaphor of this process is a radio that is turned on and emitting sounds while moving about. Mapping of this type can connect aural information with spatial recording. It can also be used to understand aural data in its entirety and to listen to various locations simultaneously. I worked on developing this peculiar but interesting form of technology.

On returning to Japan, I did some work in virtual reality and developed an interface called GAVA that used a box-type display and computer graphics to provide face-to-face communication. This system made it possible to convey the other person’s eye movements, which increased that person’s sense of presence. I therefore discovered that eye movement could also play an important function in virtual communication.

—What have you personally been pursuing through your research?

The first is to find ways of eliminating breakdowns in communication. At first glance, computer



Fig. 3. ClearBoard.

research and communications research might appear to be very distant fields from the viewpoint of people's lives. Communication media, however, have come to play a big role in modern society, and they can sometimes give rise to quarrels and disputes due to miscommunications and may even be a source of depression and crime. Against this background, I came to believe that communication media might be one field that could help people in their lives in a way different from that of medicine and pharmacology. To be honest, I initially only wanted to create communication media that simply felt good, but I gradually came to attach more significance to communication media as my research continued.

Furthermore, though it might sound like bragging, I also considered how a research laboratory should be run. Research in a private company tends to connect near-term results with clear and obvious needs, but I have always made it a personal rule to take on more challenging research. This is because I believe that a research laboratory is essentially a place where difficult problems should be directly confronted. Here, to be able to continuously output things that people feel are amazing and interesting and that they want to use, we must face difficult issues head-on while realizing that failure is part of the process. If NTT is to be a place that promotes communication media research, it must be an institution that can tolerate detailed research in a step-by-step and steady manner even if results are not quick to materialize. It is in that spirit that I have been carrying out my research up to the present.

Tying up with overseas organizations in pursuit of more breakthroughs

—Dr. Kobayashi, what is currently going on in human-interface research overseas and in Japan?

Communication media research is now being undertaken by many companies and universities as broadband networks continue to expand. But I don't believe that there are many corporate research laboratories that are taking on somewhat advanced research themes dealing with intangible things like "feelings" as in our research projects. While there is some competition at least in part, this is mostly coming from universities. In fact, human-interface research is comparatively active in Canadian and American universities and there are even some areas in which they are taking the lead.

—Are you collaborating with other research institutions?

At this point in time, we are not, but we do welcome collaboration with overseas organizations. We have had contacts with several research institutions. Looking back at past inventions dealing with human interfaces, many of them arose from an encounter with different values, so it is important that collaboration be pursued with people having a different sense of values. Of course, various sets of values can also be found within NTT and we are pursuing serious discussions and research in-house as well. But if we confine ourselves to only one research institution, it can-

not be denied that there may not be enough energy to bring about major breakthroughs, and it is my desire to incorporate more values from the outside from here on.

—What has been the outside reaction to NTT research achievements in human interfaces?

In a newspaper article distributed at the 2002 Computer-Human Interaction (CHI) conference commemorating the 20th anniversary of that society, the presentation that Hiroshi Ishii and I gave on ClearBoard in 1992 was selected as a “most memorable event” in one person’s opinion that presentation led to a continuous stream of inquiries from many countries around the world indicating that ClearBoard has had a big impact in various ways. But, sad to say, the ClearBoard concept was never commercialized, and the only remaining unit of ClearBoard equipment that anyone can operate can be found in the city of Kumamoto in Japan as it was obtained by the Contemporary Art Museum in Kumamoto the year before last. In all honesty, I would rather see it displayed in an NTT showroom than in a museum, but seeing children and the elderly getting a kick out of using this ClearBoard equipment gives me much pleasure.

We also held a demonstration of our haptic display as a type of tactile interface at a SIGGRAPH conference. There, more than 2400 people tried out this display one after another and we received many positive comments about it.

The attraction of working at NTT Laboratories having close ties to business

—For the future, how do you plan to expand your research?

Our research is still in its initial stage. Even with our development of ClearBoard and discovery of gaze awareness, our work in this area has not been an ongoing process since then. This is not really a problem of technology or ideas. Rather, as a communication tool, the ideal human interface is always changing as human lifestyles themselves continue to change. To give a simple example, the appearance of cellular phones brought major changes to everyone’s lifestyle, and as a result, a number of research themes that preceded the cellular phone era quickly became obsolete. In our research too, we must always be thinking about our next move while keeping an eye on an ever-changing society. With this in mind, our

ultimate objective is to establish a communication environment with mutual understanding so that people can communicate without misunderstandings and be more productive. It is in this way that I would like to connect communication media with human happiness.

—What is it about research and development work that you find interesting?

That’s a difficult question. Sometimes I myself find it unbelievable that I put so much energy and effort into research. Perhaps it’s the sheer pleasure of discovering something of great significance. For example, the instant that I hit upon the ClearBoard metaphor was very exciting and it’s a moment that I will never forget. Of course, there is no guarantee that such momentous events will occur often during one’s life, but just the same, I cannot stop wanting to experience that sensation again and again. I think that anyone that has been involved with the research process for a long time can sympathize with this desire. By the way, I do have several specific visions for the future, but, unfortunately, they are not yet at the stage where I can talk about them freely.

—What do you think is the most important attribute for a researcher?

I feel that researchers must be obsessive about their work if they are to have long and fruitful careers. Research, I believe, is an activity where all of one’s attention comes to be focused on one thing. Although a private company must be concerned with obtaining a return on its investments, work that only chases after greater efficiencies without that obsession with research can only weaken not only the researcher but also the research theme and research institution. Researchers should therefore reflect on their activities on a daily basis to ascertain whether they are doing something that they feel is important. But I also believe that each researcher must make a contribution to the company, while pursuing his or her obsession.

—Finally, what is the attraction of working at NTT Laboratories?

At NTT Laboratories, there are many people that have the mind of a researcher—that are well-informed about their field, are confident in their abilities, and are continuously moving forward with their research from one day to the next as leaders in their

field. That is especially attractive to me. In addition, as all NTT researchers fall under one corporate organization, we tend to follow a basic rule of mutual cooperation, which makes it easy to establish collaborative relationships and projects. Such an environment encourages people to ask for each other's help and even stimulates friendly competition. I believe that the ability to work in such a setting is very meaningful.

And if I may add one more thing, the fact the NTT Laboratories is a research center for a major telecommunications company is significant to me. On entering NTT to pursue communications research, the pressure that I felt from the communications-business side made me all the more energetic. We never felt anything like that at a university research laboratory. Although research is basically an endeavor that takes time, the pressure coming from the business side forces us to feel the urgency for results that are useful in the business world. This can lead to results that can contribute to the world at large. That is also why I have enjoyed working at NTT Laboratories.

Interviewee profile

■ Career highlights

Minoru Kobayashi received his B.E. and M.S. degrees from Keio University, Yokohama in 1988 and 1990, respectively. He joined NTT Human Interface Laboratories in 1990. Since then, he has conducted research on computer-supported cooperative work (CSCW) and video-based groupware design. He proposed the concept of ClearBoard and implemented the video-based prototype ClearBoard-1 and the computer-based system ClearBoard-2. He spent 1994 to 1996 at Massachusetts Institute of Technology, where he worked on a spatial human interface for audio data and received his second M.S. degree. He received his Ph.D. degree in instrumentation engineering from Keio University in 2000. His research interests include human-computer interaction, computer-supported cooperative work, and video-based groupware design. He is a member of the Association for Computing Machinery, Computer Society of IEEE, Information Processing Society of Japan, and the Institute of Electronics, Information and Communication Engineers of Japan.