R&D Spirits

Creating New Markets with a New 3-D Display System

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The first new stereoscopic system in several decades is now being readied for the market. How does this system, which is based on a phenomenon discovered at NTT Laboratories, differ from past 3-D displays? Does it have the potential to change the way we communicate? Shigenobu Sakai, Project Manager at NTT-IT Corporation (NTT-IT), has been involved in the development of 3-D display equipment since his days at NTT Laboratories. We sat down with him to get his answers to these and other questions about this system and to hear about another interesting project that he is involved in.

New 3-D display system: revolutionizing the way we display images

—Mr. Sakai, could you give us a brief description of NTT-IT and the R&D themes that you are currently involved with?

The mission of NTT-IT is to introduce technology developed by NTT Laboratories to the outside world through the combined power of the NTT Group. While there are other companies in the NTT Group with similar missions, NTT-IT is known for its focus on human interfaces for communication purposes. To give you some examples, we are developing a world-class multipoint IP videoconferencing system, a voice portal system and associated services based on speech synthesis and recognition technology for the Japanese language, and a health-management support system using AI technology. I myself am working on the business development of new 3-D display equipment and a general-purpose communications adaptor. The former is a joint project with NTT Laboratories that just began this spring. The latter is a collaborative project with NTT DoCoMo that got under way last year.

—Could you explain the first project for us? What exactly is this new 3-D display equipment?

It is basically a liquid crystal display (LCD) that can present 3-D images without producing unnatural psychological effects and without the user having to wear polarizing glasses as in the past (**Fig. 1**). Long-term viewing with this equipment does not cause fatigue. In addition, the amount of data used for presenting these 3-D images is only about 1.3 times that for 2-D images. This means that transferring such 3-D data over a network will not create an excessive load. The hardware consists basically of two overlaid LCD panels, resulting in a very compact configuration (see Selected Papers in this issue, “A Compact Depth-fused 3-D Display Using a Stack of Two LCDs,” pp. 35-40).

—How would the widespread use of this equipment change society?

The traditional mission of telecommunications is to overcome the obstacles of distance and time. This includes high-reality communications that enables people at remote locations to speak to each other in a face-to-face manner. A 3-D display is one way of achieving high-reality communications.

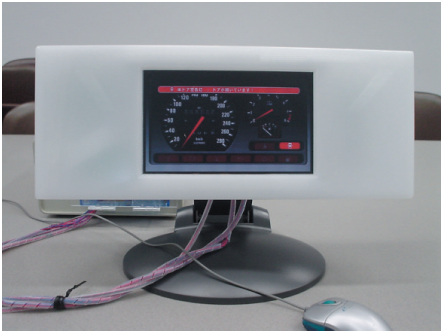

Fig. 1. 3-D display equipment.

As you know, 3-D display systems using polarized glasses are already being used for amusement and entertainment purposes. No doubt our 3-D display equipment could be introduced to the outside world through such applications. In contrast, the use of 3-D images in the business world is almost nonexistent. One reason given for this is that 3-D viewing is very tiring, making it unacceptable for long-term tasks. To put it another way, 3-D displays based on conventional systems make use of polarized glasses or other means to "trick" the brain into seeing stereoscopic images even though the eyes are viewing a 2-D screen. What the eyes see is therefore different from what the brain perceives, and it is this contradiction that can be very stressful to the viewer. Our new system does not induce fatigue even during long-term viewing. This property should help high-reality 3-D displays find widespread use in both business and daily life.

—What is the advantage of using 3-D displays in business?

Many of our customers ask the same thing. They wonder what kind of benefits could be obtained from using 3-D displays for work. While they agree that viewing a 3-D display can be interesting and fun, they don't see any particular advantages. I beg to differ, however. Taking TV broadcasts as an example, the change from black-and-white to color displays made bright, colorful broadcasts possible, significantly increasing the amount of information received by viewers. This system migration also made the reception of information more efficient. It is our belief that the addition of depth to an image should have a similar effect and that 3-D displays should make it easier for human beings to interact with machines.

—What are some of the features of this 3-D display equipment?

The most outstanding feature is the mechanism for 3-D viewing, which is based on a principle discovered by NTT Laboratories. Specifically, when the same image is presented on two transparent displays with different brightnesses and these displays are stacked one on top of the other, the image will appear to float between the two displays. The image can be made to move forward or backward by simply changing brightness levels. Wondering whether this phenomenon could be used to achieve stereoscopic viewing without the need for polarized glasses, the researchers in charge performed a variety of trials and were surprised to find that a mechanism for implementing this principle was actually quite simple. Why, they asked, was this mechanism not previously

known? This prompted a news release announcing the discovery of the first new stereoscopic viewing system in several decades. The researchers who discovered this phenomenon finally received an IEICE Best Paper Award last year.

From a technological perspective, we encountered no particularly difficult problems because much of the equipment consisted of combinations of technically mature devices such as LCDs. However, as our overall objective is to incorporate the system in ordinary personal computers, we are finding that preparing images for such an implementation and developing a signal interface are somewhat difficult.

—What issues arise in applying this 3-D display equipment to business?

A major issue is cost. Anyone that watches our demonstration expresses lots of interest at first, but after realizing that our equipment uses twice as many LCD panels as conventional systems, they inevitably ask whether it is twice as expensive. For our part, we would prefer to at least double the price for equipment that delivers this amount of added value. But if we put ourselves in our customers' shoes, we might see more parts but still only one display, and from this point of view, perhaps their response is only natural. In short, establishing a market for 3-D display equipment in business depends on whether costs can be lowered. NTT-IT, though, possesses no manufacturing capabilities, and for this reason, we are forming an alliance with a manufacturer and working with it to bring costs down.

Another issue is reflected by the question, "What will we use 3-D display equipment for?" Even if costs can be lowered, the price of this equipment will be considerably more than before, and for the user, that extra cost must correspond to added value. Making proposals for what this equipment can be used for is also an important aspect of our work.

—Are there other R&D efforts in 3-D display equipment in Japan and overseas?

Because NTT holds a patent for this new system, there is really no competition in terms of our 3-D display equipment. That is not to say that there are not other systems, but they have not penetrated the market. On the other hand, the absence of competition may give our research a chance at becoming a world standard. While we are not yet sure whether our 3-D display equipment will eventually provide genuine high-reality communications, we would be delighted to see it become the first step to an entire new way of using displays.

General-purpose communications adaptor for environmental applications

—Could you tell us about the DTU, your other project?

The data transfer unit (DTU) is something that I am working on in collaboration with NTT DoCoMo. It is a general-purpose communications adaptor for monitoring and controlling sensors and measuring devices installed at remote locations (**Fig. 2**). As you know, DoCoMo has extensive experience with data transmission technologies in wireless communications. This product is an enhancement of a previous product developed for collecting data on inventory and change in automatic vending machines. It is being developed jointly because of the need for new hardware to eliminate some of the weak points in the previous product. This DTU represents an "all-in-one" package that compensates for lost transmission data due to congestion or cutoffs on the wireless section while also performing various communication functions, protocol conversion, and data logging. It is a product with very high added value that we expect to be useful in a wide range of applications. NTT-IT has received approval from DoCoMo to act as a vendor of the DTU, and we are currently in the process of making business proposals. While this is quite a different field from that of the 3-D display equipment we were just talking about, they both involve hardware for an information device, so in this sense, I don't see them as so dissimilar.

—What results have you obtained so far with the DTU?

Although this business venture began only last year, several system proposals have already been adopted. For example, the water department of Kawasaki city in Kanagawa prefecture is using the DTU for transmitting data for water-quality surveys. This water department performs daily inspections of water quality at terminals in its waterworks. In the past, this was accomplished by sending out personnel daily to locations where water-quality meters are installed and having them collect and analyze water samples. The use of DTUs not only automates this process but also enables centralized monitoring and remote control on

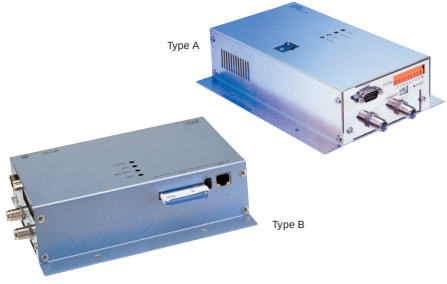

Fig. 2. Data transfer unit.

a 24-hour, realtime basis.

—What issues must be faced for future DTU business?

We must gain more experience and know-how in this field, and to this end, we must make effective application proposals. A DTU, which collects two-dimensional data from many sensors installed at key locations and transfers that data to centers via wired and wireless networks, is a very good example of an NTT product. We feel that we can expand business by proposing a broad range of applications that exploit this capability of collecting and processing data on a 24-hour system without additional labor. I cannot go into detail about these proposals, but I can tell you that we are concentrating on environmental applications. The DTU is an ideal device for measuring and processing environmental data such as for NOx (nitrous oxides) emissions. Some trials have already begun, and I believe this type of work is going to be around for a long time.

Aiming to create useful equipment for society

—What R&D activities have you been involved with up to now?

Well, at first, from the time that I entered NTT Laboratories in 1973 up until 1978, I was involved in the research of charge coupled devices (CCDs). The prototype for CCDs now widely used as image sensors in digital cameras was developed at Bell Laboratories in 1970. At that time, various applications for CCDs were being researched at NTT Laboratories, and on entering the Memory Components Research Laboratory, I found that an investigation of CCDs as memory devices had begun half a year earlier. Starting with a general study of semiconductors, I eventually became involved in the design and fabrication of CCDs as well. During these five years, I was basically a researcher and developer, and I successfully fabricated a 64-kb memory on a somewhat large chip. Unfortunately, that device was never commercialized.

Next, I took up the development of read-only memory (ROM) for kanji, or Chinese characters. In the past, the character patterns needed for Japanese-language displays were stored in the form of 24×24 dots. There are about 7000 characters making up the Level 1 and Level 2 kanji prescribed by the Japanese Industrial Standard (JIS), and it was thought that the technology and know-how developed with CCDs could be put to use here. Just the characters for Level 1, however, required about 1 million bits, and achieving a 1-Mb memory at a time when 64-kb dynamic random access memory (DRAM) didn't even exist yet was a formidable problem. Under these circumstances, I proposed a high-density ROM with a new structure. This ROM came to be incorporated first in an NTT portable kanji printer, the first of its kind in Japan, and then in some personal computers and cathode ray tubes (CRTs). This was my first research

achievement that came to be used in the real world.

Then, after performing some management-related work at NTT R&D Headquarters, I was transferred back to the Electronic Equipment Research Division where I undertook the development of LCDs. From that time on, display technology has been a major theme in my research. As with CCDs, this technology was still in its infancy. We started with an A5-size monochrome display and eventually worked up to a 2000 × 4000 pixel, 200-inch-diagonal display. Next, from 1996 on, I became involved in the research of high-reality communications as the Executive Manager of the Laboratory, and finally came to NTT-IT continuing in that role. In short, I have been involved with only hardware up to now. A researcher of this type is perhaps rare at NTT.

—What has been your goal in R&D up to now?

Throughout the various research themes that I have been involved with, I have always wanted to create hardware that could help society evolve. For example, during the time that sufficient memory was lacking, my goal was to develop memory that could truly be used as a social asset. Now, after moving to display development, my goal is to create high-reality communication tools so that remotely located people will be able to communicate in a face-to-face manner via the network. And although I did not touch upon this when talking about the R&D themes that I have been involved with, I have also worked on "five-senses communication," and the communication of smell in particular, as the ultimate form of high-reality communications that goes beyond sight and hearing. But smell has no formative base like the three primary colors used to form other colors, so its synthesis is difficult even if the result is detectable. For reasons like this, I was not successful in communicating the sense of smell. Nevertheless, I have always thought that there is something useful for society in any research theme and in this frame of mind, I have always enjoyed my work.

—How do you view the issues that you now face based on past issues?

During my days at NTT Laboratories, I felt that talking about one's dream and determining how to achieve that dream was the stuff of research. That is how I approached my work. Now, however, my work is to create business, and I can't do that just on dreams. The manufacture of hardware is not what the NTT Group specializes in, and it cannot be denied that that is one aspect that makes business difficult. There are also not a few difficulties here that differ from those of pure technology. These present a new challenge for me.

Acting as a bridge between NTT Laboratories and the real world

—What are your aspirations for the future?

Well, to begin with, I want to commercialize our new 3-D display system and create new businesses based on it. It's been four or five years since the discovery of this new 3-D display system, and we have finally arrived at the point where we can put this system to work. I also hope to see this system installed in cellular-handset and personal-computer displays, but that is still many years away. For this to happen, however, there must be real benefits to using 3-D images. By this I mean more than just something that is interesting or amusing to watch. Three-dimensional images must provide tangible advantages such as making a Web browser or search engine easier to use. Since 3-D displays have never been used to any large extent, this is essentially new territory—coming up with new ideas for their use is not simple. Nevertheless, I am convinced that there must be advantages to 3-D displays, and finding them is my current mission. From a somewhat broader perspective, I would like to transform as many future-oriented research results from NTT Laboratories as possible into a form that can be used by many people in services and products. In short, I would like to act as a bridge between NTT Laboratories and the real world.

—What is it like working with NTT Laboratories?

Well, I do of course receive technical support for my work in promoting business, but what really surprises me is that the human network that I cultivated during my time at NTT Laboratories is still very much alive. It is not unusual for me to unexpectedly meet someone that I had associated with maybe ten years earlier in R&D activities or at academic societies and to then start up a new relationship with that person as a business partner. I appreciate this kind of human network very much and I think it is a very important asset of NTT.

—Could you leave us with a message for young researchers?

I'd be happy to. In recent years, the mission of NTT Laboratories has become much more pragmatic than before with an emphasis on business. While there's nothing wrong with this approach, I still think the main mission of NTT Laboratories is to discuss dreams and find ways of making them real. Many technologies now in use in society have come into existence simply because many of your senior colleagues talked to each other about their dreams. There may be some people who are out of touch with the practical world, but a place like NTT Laboratories would cease to exist if there were no talk about dreams. By all means, talk about your dreams and work hard to make them happen. Members of the NTT Group like NTT-IT will be there to take your technology, the stuff of your dreams, into the outside world. To fulfill this mission in the best possible ways, I would like to see even closer ties and cooperation between NTT Laboratories and members of the NTT Group.

Interviewee profile

■ Career highlights

Shigenobu Sakai graduated from Tokai University, Department of Electronic Engineering in 1973 and entered Nippon Telegraph and Telephone Public Corporation. In 1984, he moved to the Function Design Laboratory, Electronic Equipment Research Division. He researched and developed LCD equipment. He moved to Input/Output Device Research Group, Electronic Equipment Research Division, Electronic Applications Research Laboratories and became the group leader in 1989. In 1996, he became the executive manager of the Information Equipment Research Division, Input/Output Systems Laboratories. He researched and developed high-reality communications systems and large-density, large-capacity storage systems. In 2001, he moved to NTT-IT and developed business for file/image storage equipment. Since 2003, he has been developing business for 3-D display equipment requiring no glasses and for a general-purpose communications adaptor.