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R&D of Applied Technology of Shared Virtual Reality (VR)

NICT Scalable VR Research Center

Project members

In addition to SVR project members, many organizations and experts are engaged in this project to study educational applications of SVR: Production of VR of Copan ruins: Honduran Institute of Anthropology and History (Mr. Nakamura, Researcher). Studies in the field of education: National Institute of Multimedia Education (Associate Professor Kato); Keio Yochisha Elementary School (Mr. Aiba, Supervisor, and others); Kanazawa University Junior High School (Mr. Matsubara and others); Waseda University (Mr. Terasaki, Instructor); Wakayama University (Prof. Okudo, Guest Professor, National Astronomical Observatory of Japan). We have been conducting long-term demonstration experiments, including lab classes, in collaboration with various schools as well as art and science museums such as the National Science Museum.

Introduction

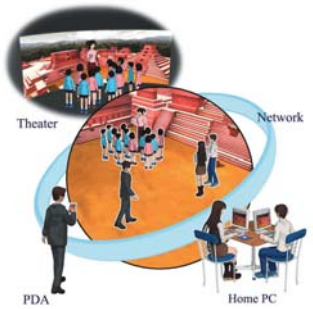
Thanks to the continuing advance of computer technology, not only large computers designed for graphics but also small terminals such as mobile phones are now capable of displaying high-definition computer graphics. This means you can now display virtual reality (VR) images using a wide range of terminals, from very large theater screens to very small portable screens.

We are engaged in R&D of technology that will connect these various terminals to a network and allow users to share a single VR space at the same time using any of these terminals according to their various needs. This project aims to promote educational application of this technology by conducting R&D in collaboration with organizations and experts in this field.

Overview of Scalable VR

To apply scalable virtual reality (SVR) to education, we are working to create a "shared VR environment" in which various types of VR terminals (such as theater-based, home, and mobile types) can be connected at multiple points. As shown in Figure 1, for example, a theater-type terminal will offer images so realistic that viewers will feel as if they are within the action on-screen. With home and mobile-type terminals, users will easily be able to join a single VR space from their homes/classrooms and outdoor locations. When these terminals are interconnected on a network, all VR terminal users will be able to join this VR space at the same time.

Figure 1: Conceptual drawing of scalable VR



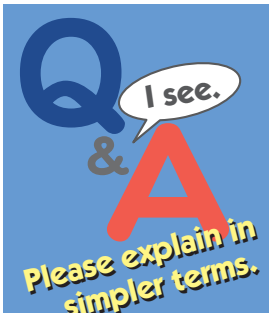
To turn these concepts into reality, we will first design a model for effective learning, and will then develop VR content, educational programs, and easy-to-use user interfaces based on a model that incorporates these concepts. To this end we are developing a software platform to control a shared VR space providing educational content. With this platform, it will become possible to develop a wide range of effective educational content.

Progress of R&D

Constituent Technologies

First, as a constituent technology in achieving scalable VR that can support various VR terminals, we developed a Scalable Scene Graph (SSG). An SSG is a collection of basic information (or meta-information) that describes objects (a building, a person, etc.) contained in a VR world. VR terminals usually share an SSG. When images are rendered, each terminal obtains graphic data suited to its display performance, based on this meta-information.

Second, to coordinate participant users (in this case, students) in educational SVR, we developed a synchronization system based on the concept of a school field trip (field-trip metaphor). This system loosely coordinates users on a virtual tour led by a guide or teacher, and allows users to participate in a story or program with full interactivity (Figure 2).



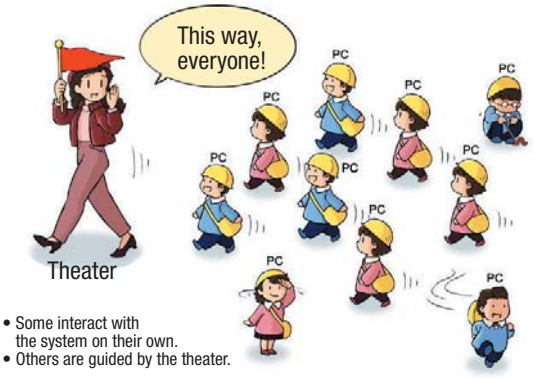
Q What's scalable VR?

A The SVR (scalable virtual reality) Project is designed to establish a mixed VR environment by interconnecting different VR terminals and to make use of this environment, mainly in educational applications. Research in this project has to date been carried out in two parts: creation and application of scalable VR content, and development of technologies of transmission, encoding, and so on.

Q What activities were carried out at museums?

A Various experiments took place in a number of museums. For example, in a "gallery talk," a VR theater was used to conduct virtual tours of Mayan ruins and to hold Q&A sessions. Virtual tours of Mayan ruins were also offered, with an actor or actress as a guide, as well as demonstration experiments on applications to education.

Figure 2: Conceptual drawing of field-trip metaphor



Demonstration Experiments

Here we'll briefly explain our research on the use of scalable VR technology in museum exhibits and in astronomy education.

• Application to museums exhibits

At the Mayan Civilization Exhibition in 2003 held at the National Science Museum in Tokyo, we used a VR theater to recreate Copan ruins—both in past and present forms (Figure 3). In this theater, more than 100 visitors enjoyed hyper-realistic images at once in front of a huge screen four meters by thirteen and a half meters. A guide standing beside the screen led this virtual tour, explaining the history and other characteristics of Mayan civilization.

Figure 3: VR Theater

We placed PCs outside the theater so that other visitors could experience the same images and sound without having to enter. Using these PCs, we performed a demonstration experiment on a control method that we refer to as the "field-trip metaphor." This method coordinates PC users as follows: while viewing VR images, you may follow a virtual tour designed by the theater; however, by operating the game controller on your PC, you can leave the tour to wander around the ruins on your own; if you stop operating the controller, you will be brought back to the tour automatically.

With this experiment, we demonstrated that even from distant locations, home-type terminal users can attend the same virtual guided tours enjoyed by those in the theater. In addition, we conducted an experiment on so-called "remote learning," in which we connected this theater to home-type terminals in an elementary school in Tokyo, allowing the schoolchildren to discuss Mayan civilization with the tour guide over the network.

• Application to astronomy education

Using a VR space that can recreate the solar system with remarkable precision, we are conducting experiments on astronomy education in elementary, junior high, and high schools. In astronomy, it is important to address the concept of time in addition to the concept of space. We adopted the field-trip metaphor and developed a time controller as an interface to control the time axis (Figure 4). Students can use this controller to move forward and backward freely in time. The theater-type terminal, operated by a teacher, shows bird's eye views of the solar system, and home-type terminals operated by students show views from the ground. As a result, students can observe an astronomical phenomenon from different viewpoints and combine their observation results to understand what they have seen.

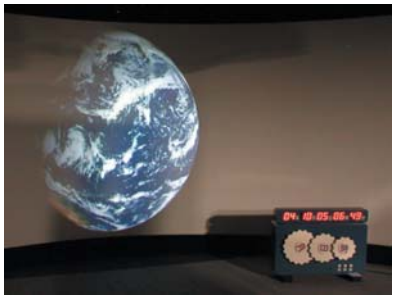


Figure 4: Earth projected on the screen and time controller

Conclusion

This project aims at the development of a truly practical system for educational use. To this end, we have been carrying out "content-oriented" R&D—specifically, we have included experts in museums and education to the research group, identified the essential points in educational use, and are working to develop a system to meet these requirements.

There are many examples of the use of VR in learning. However, our system is unique in that it adopts a collaborative learning method (designed to improve students' understanding through observation from different viewpoints) and a control method based on a field-trip metaphor (a model that facilitates smooth class participation). It is fair to say that these features are considered highly original, even when considering the worldwide state of the field. Together these represent the fruits of content-oriented R&D.

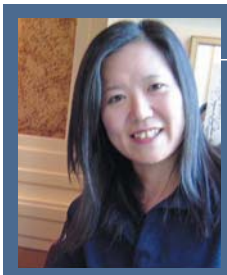
We intend to promote the adoption of newly developed content within as many educational institutions as possible so that the benefits of this R&D are made available as widely as possible throughout society.

Life & Technology

● Potential for use in interactive learning and teaching

Although VR has been used mainly in industry and entertainment, the development of scalable VR is likely to expand the applicability of VR to education, culture, and art. In particular, through the creation of a VR environment that can support various terminals ranging from small (e.g., mobile-type) to large (e.g., theater-type), it will become possible to provide the public with the opportunity to make use of VR in a wide range of social activities. For example, the application of the "gallery talk" format is expected to bring about more effective means of interactive learning and teaching.

Conversion of Web Content into TV-program-type Content



Akiyo Nadamoto

Researcher, Interactive Communication Media and Contents Group
Keihanna Human Info-Communication Research Center
Information and Network Systems Department

Joined Communications Research Laboratory (currently NICT) in 2002 after working at several private research institutes. Engaged mainly in research on conversion and convergence of Internet and broadcasting content. Ph.D. in engineering.

Introduction

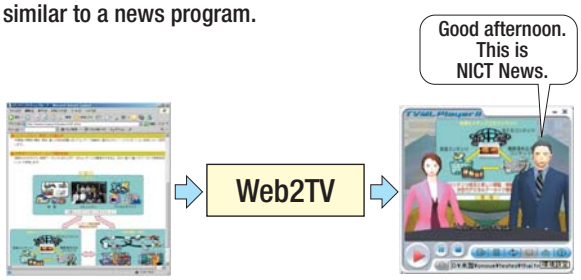
We can possively obtain information from TV by simply watching and listening. Anyone on any age in the household can absorb information from television, whether lying on the floor in front of the set or working on the other works. On the other hand, the Internet is now developing into a media as common as television and radio. Even if you can operate a computer, it's easy to get the information you're looking for on the Internet. However, the current web environment requires users to make active operations: clicking, scrolling, reading. People who can't operate computers in this way therefore miss out on the benefits of gathering information on the Internet. And even those who can operate computers would probably prefer that web use be more convenient—in a sense, more like television. In response, we are now conducting research specifically targeting automatic media conversion of web content into TV-program-type content. We believe that if Web content could be automatically converted into content similar to a TV program (what we can refer to as "TV-program-type content"), everyone would enjoy the increased ease, fun, and accessibility of web-based information.

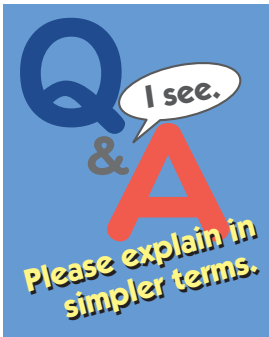
System Overview

As shown in Figure 1, we are working on development of a system that converts web pages into TV-program-type content automatically by using cartoon animation and synthesised speech. We call this system "Web2TV." Web2TV uses synthesised speech to make cartoons read web-page text aloud, and presents related images in a synchronized manner. Technically, this system analyzes the logical structure of web pages (i.e., the structure of the underlying HTML documents) to find descriptions of images and to extract sentences to be read aloud by the characters. One of the important elements of this automatic conversion of TV-program-type content involves the addition of effects such as cartoons animation, camera work, and lighting—the same issues dealt with in actual TV program production. Accordingly, we are conducting studies to determine the effects that could be applied to render content easier to grasp. Web-page text is usually written in declarative sentences. If an animated character merely reads the text aloud, the user will not be impressed. Our approach is thus to treat the automatic conversion of Web page text as a dialogue between two animated characters, in the theory that this could render the process and content more appealing. More specifically, we're developing a system that can convert original sentences into pairs of questions and answers based on keywords extracted from the web pages in question; the system will also guess at the meaning of difficult words and paraphrase in simpler language.

Using this dialogue-creation mechanism, we are working to convert web-page text into dialogues that sound like manzai, a

Figure 1:
When you specify a Web page, Web2TV will automatically convert it into TV-program-type content, as shown on the right. In this example, a web page is converted into content similar to a news program.





Q Please explain the mechanism behind Web2TV.

A Web2TV first analyzes the structure of the underlying HTML (web text language) to find areas in which images and sentences are in sync and to extract text to be read aloud by the characters. The system then extracts keywords from the web page and creates a dialogue script based on these keywords. After effects are added, this script is converted into TV-program-type content in TVML format. TVML is computer language developed by the NHK Science & Technical Research Laboratories for use in TV program production.

Q You say Web2TV will also be available on mobile phones in the future—how?

A You'll use a special search system on your mobile phone to specify a desired web page and to send this page to the Web2TV system (server). The system will first convert the specified page into broadcast content, and then further convert this content into motion pictures. Receiving video web content will be easy and fun.

Figure 2: Example of comedy TV-program-type content

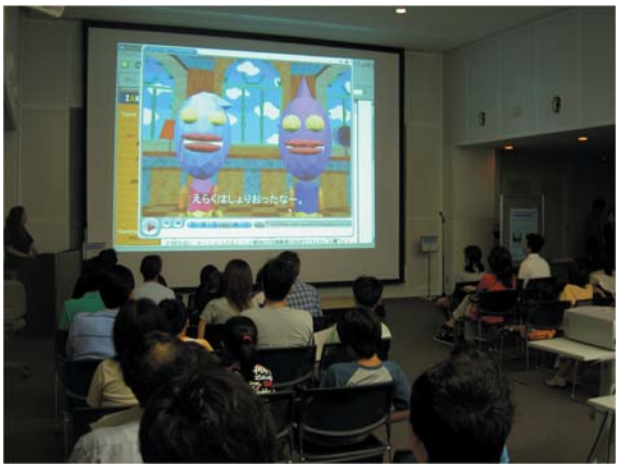
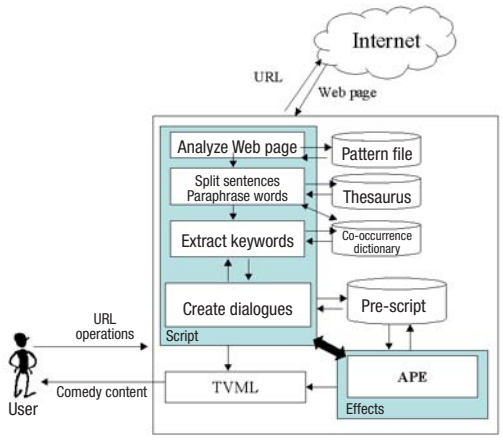


Figure 3: Presentation of research results during NICT open house

Figure 4: System configuration of Web2Talkshow



type of Japanese stand-up comedy. We developed Web2Talkshow, a system for creating comedy-style broadcast content, in the belief that this type of content could be enjoyed by people of all ages. When you specify a web page, Web2Talkshow will instantly convert it into comedy broadcast content (see Figures 2, 3, and 4). This system will thus give you your online news as if you were watching a comedy show on TV.

Application to Mobile Phones

Relative to computers, mobile phones have smaller screens, fewer manual operation buttons and a more limited number of functions. So you can't really use a mobile phone to view web pages designed for computers. To address this problem, we're also developing a system that adapts Web2TV to mobile phones (see Figure 5). When you specify a web page, this system will convert it into TV-program-type content similar to a news program and then send it to your mobile phone in video format. So you'll be able to get web content on your mobile phone even outdoors.

Figure 5: Application to mobile phones

Conclusion

If web pages can be converted into TV-program-type content, getting information from the web will be easier, more fun, and hassle-free, even if you're not a computer whiz or you're just too busy to sit down at your screen. This technology could also evolve into an effective means of addressing the digital divide. Furthermore, with the advent of terrestrial digital broadcasting, there is a good deal of concern about a shortage of TV content. I believe that if we can improve the quality of these newly developed systems and content to rise to the level of actual TV programs, this shortage of content could quickly become a thing of the past.

We are conducting this research as part of the Keihanna Open Laboratory project entitled "Development and Social Application of Content Convergence Environment" in collaboration with NHK Science & Technical Research Laboratories and Nomura Research Institute.

Life & Technology

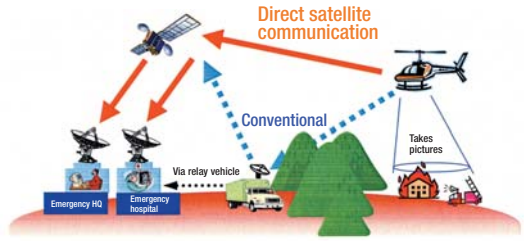
● Convergence of communication and broadcast content will solve a wide range of problems.

Although still in the experimental stage, we have already succeeded in creating comedy dialogue from a web page and converting it into TV-program-type content, using cartoon animation and synthesised speech. We presented these research results at the Keihanna Human Info-Communication Research Center during its open house days in July 2004. The completed development and widespread use of this technology is expected to overcome the digital divide and to remedy the shortage of content in digital TV broadcasting.

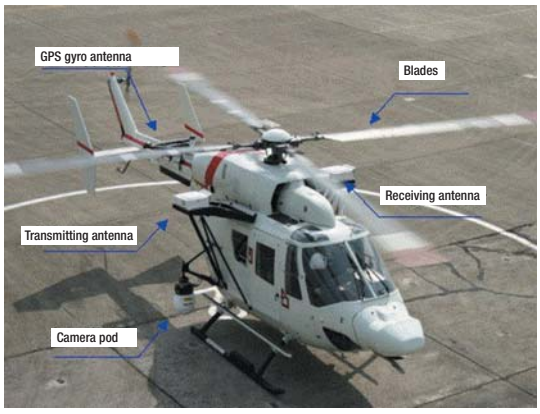
Successful Development of Helicopter-Satellite Communications System

— Open Experiment on Real-time Picture Transmission Also a Great Success —

Masaki Sato
Senior Researcher, Mobile Satellite Communications Group
Kashima Space Research Center, Wireless Communications Department



Comparison of conventional and newly developed (unexploited) helicopter transmission systems



Helicopter equipped with communications equipment and camera

Open experiment on Helicopter-Satellite Communications System (at Shizuoka Heliport)

Picture of Gifu University sent from helicopter via satellite (received at Kashima Space Research Center) (640 x 480 pixels)

A helicopter is highly mobile and thus effective in quickly determining the details of damage when a disaster occurs. However, to send pictures of a disaster area taken by a helicopter's on-board camera to a destination in real-time, a relay vehicle or ground station is needed. Unfortunately, it's often difficult or impossible to relay transmission in this way in the case of a large-scale disaster, for several reasons—for example, roads to the disaster area may have been devastated; or the disaster may have occurred offshore. If the helicopter could communicate directly with a relay satellite, the problem could be resolved – disaster-related information could be issued from anywhere, as a free communications path will in theory always be available. Moreover, eliminating the relay vehicle or ground station makes the most of the helicopter's mobility. In the first figure, the newly developed helicopter transmission system is compared with a conventional system.

The helicopter emits radio waves upward to the relay satellite. However, this communications path is cyclically blocked by the propeller's blades. Moreover, radio waves reflected by the blades may cause interference with respect to nearby satellites or ground stations, in addition to the deflection from the intended path. To address this problem, we adopted a mechanism in which the radio waves are sent to the satellite through the brief gaps in the rapidly spinning blades. Through the application of these technologies, we have developed what is undeniably an unparalleled helicopter-satellite communications system.

This system also provides a number of important functions: (1) data communications between the helicopter and emergency headquarters; (2) accurate satellite tracking when the helicopter attitude is unstable; (3) MPEG4-based semi-motion picture transmission at 384 kbps; and (4) accurate determination of a disaster location using three-dimensional maps.

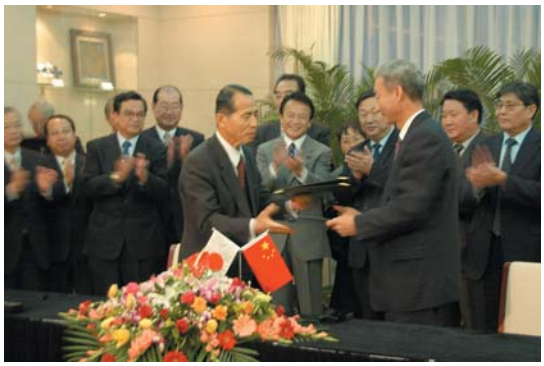
We held an open demonstration on December 2, 2004 in which we exhibited a helicopter equipped with this new stationary satellite system at Shizuoka heliport and at the Kashima Space Research Center. We demonstrated real-time picture transmission, using a helicopter to take motion and still pictures of Gifu City from above and to send these images to the center directly via a stationary satellite. There were about 70 participants in total at these two sites, mainly from government agencies, the media, and private-sector companies, all anticipated future clients of helicopter-satellite communications systems. These participants expressed interest in the onboard equipment and picture transmission functions, with many requesting early commercialization of this system, while others pressed for miniaturization and higher transmission speeds. In collaboration with disaster-prevention organizations, we intend to continue to contribute to society with the ongoing development of these technologies.

We'd like to express our gratitude to the many people who offered their assistance in holding this demonstration.

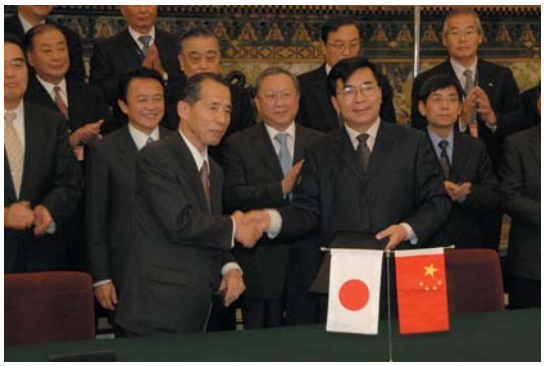
Signing of Information and Communications Technology Memorandum of Agreement with China

— Top Corporate Executives from Both Countries Attend Symposium Organized by NICT —

Takahiro Sumitomo
Senior Researcher
International Alliance Division, Strategic Planning Department



Signing ceremony with China Academy of Telecommunication Research, MII



Signing ceremony with Chinese Academy of Sciences

President Nagao's address at Japan-China Symposium for Cooperation in Industrial Technology (at Great Hall of the People in Beijing)

Against the backdrop of exchanges between Japan and China in recent years, the 14th Japan-China Symposium for Cooperation in Industrial Technology took place on January 6 (Thurs.) at the Great Hall of the People in Beijing and 7 (Fri.) in Hangzhou City.

This was the first time that NICT served as an organizer of this symposium, a gathering that has been contributing to the promotion of exchanges at various levels of industry, academia, and government between the two countries around a specific theme of technology. We organized this year's symposium around the theme of information and communication technology (ICT), in collaboration with the Research Institute of Telecommunications and Economics (RITE) and the China Institute of Communications (CIC). Although the event took place just after the New Year, over 100 people—including Internal Affairs and Communications Minister Taro Aso and a range of leaders interested in ICT from industry, academia, and government—visited China in this effort to continue to promote these bilateral exchanges.

Prior to this symposium, NICT President Nagao signed a memorandum of agreement relating to a research partnership in ICT with the China Academy of Telecommunication Research (CATR), the Ministry of Information Industry (MII). The signing ceremony was held on Wednesday, January 5, with attendees from industry, academia, and the governments of both countries, including Internal Affairs and Communications Minister Aso and MII Minister Wang Xudong. Further to this agreement, we intend to establish long-term, stable cooperative relationships through the selection of specific research subjects, the exchange of researchers and information, and implementation of joint research.

On Thursday, January 6, President Nagao then signed a memorandum of agreement covering a research partnership in ICT with the Chinese Academy of Sciences (CAS). This signing ceremony was held at the Great Hall of the People, China's parliament building. Based on mutual cooperation and goodwill, the agreement frames the plans of NICT and CAS to exchange researchers and information, conduct fellowship programs, hold symposiums, and pursue joint research. Specific areas of focus will include natural language processing, global environment and disaster monitoring via remote sensing, space environment information networks, time and frequency standards, Japan-China joint experiments in e-VLBI, nanotechnology, ubiquitous wireless multimedia communications, and next-generation Internet and broadband applications.

Through the signing of memorandums with these two organizations, in addition to the agreements concluded until last year with Tsinghua University and Beijing University of Posts and Telecommunications, NICT has established a firm basis for research partnerships in China. Moreover, NICT has signed a memorandum of agreement for a comprehensive research partnership in ICT with the Computer Network Information Center (CNIC), CAS; further, NICT's ultrahigh-speed network (2.4 Gbps) between Japan and China via Hong Kong was connected with CSTNET and CERNET, two major high-speed communications networks in China. These and other bilateral research partnerships are expected to grow, undoubtedly leading to significant research results.

We'd like to express our gratitude to those who offered their assistance in holding this symposium and the signing ceremonies.

Japan Prize Awarded to NICT President Nagao

Dr. Makoto Nagao, President of NICT, was named a laureate of the Japan Prize 2005 for his "pioneering contributions to natural language processing and intelligent image processing." The Japan Prize is awarded to individuals worldwide whose original and outstanding achievements in science and technology are recognized as having advanced the frontiers of knowledge and served the cause of peace and prosperity. Two prize categories are designated each year; President Nagao received the prize in the category of "Information and Media Technology." The Awards Ceremony is scheduled on April 20 in the presence of their Majesties the Emperor and Empress. Some 1,000 people will attend this ceremony, including the Speaker of the House of Representatives, President of the House of Councilors, Chief Justice of the Supreme Court, and foreign ambassadors and ministers to Japan.

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