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Special Feature Articles

NiCT

MASTAR Project

Aiming to Be the Global Center for Speech and Language Research

Dr. Nakamura holding a mobile device

Satoshi Nakamura
Executive Researcher

After having completed his university study. he had received his Ph.D. in Information Science from Kyoto University. From 1981 to 1993, he worked for Sharp's Central Research Laboratory in Nara. From 1994 to 2000, he was the associate professor of the graduate school of Information Science at the Nara Institute of Science and Technology. From 2000 to 2005 was the department head and the director of ATR Spoken Language Communication Research Laboratories. He is currently the executive researcher and the director of the MASTAR project at Knowledge Creating Communication Research Center, NICT. He also serves as an honorary professor of University Karlsruhe, Germany and a professor at Keihanna Joint Graduate School.

Speech and language research project

What are the research topics of MASTAR Project?

Nakamura: MASTER project is a research project, which started in April 2008, and the topic of our research is speech and languages. The research scope of speech and languages is quite extensive, but one of the most well-known applications of the research is the translation technology used to translate written sentences into that of another language. You can find a variety of translation softwares on the Internet these days; however, they all fall short for practical use. In our project, we are doing research on speech translation that can translate spoken languages. It is a technology more akin to interpretation than translation. We are also doing research on the spoken dialogue system where a machine understands human speech and gives pertinent replies. Our goal is to accomplish this with multiple languages. Not only is the MASTAR Project a large-scale project by world standards but also a provocative and challenging project because it encompasses multiple languages in its scope. We want NICT to become the global center for speech and language related technologies and resources.

Network-based speech translation—interpretation by machines

Please tell us more in detail about your research.

Nakamura: There are four main categories in the research. The first category is the development of technologies related to the network-based speech translation. It is the technology required for machines to recognize and translate human speech and output replies using the same language the listener uses. Our project has been pursuing the research for the last 20 years and it is starting to bear fruit in recent years. During the Beijing Olympics, we have asked some of the Japanese tourists going to Beijing and the Japanese living in Beijing to use our prototype equipment, and have received valuable feedback from them.

So, you have already succeeded in developing the prototype equipment?

Nakamura: That is correct. We have developed two types of equipments. One of them is a small PC that is used as a stand-alone device. The other system is a type that uses a mobile phone—the data is first sent to the NICT server, where speech recognition, translation, voice synthesis are carried out, and the output is then sent back to the mobile phone. Some users have commented that the processing took too long, but the upside of this type of equipment is, of course, that you can enjoy the benefit of an interpretation service by just having your mobile phone. For example, there are many Brazilian factory workers in Nagoya; the speech translation service is very useful there. A local government office equipped with 24-hour Portuguese speech translation service can answer questions by Brazilian workers visiting the office. This speech translation technology was approved to be included in the list of technologies of "Innovation 25," which is a long-term strategy initiative for the technology innovation contributing to the growth with an eye on the year 2025, put forth by the Cabinet Office. Further, the speech translation technology will be a part of "The Pioneering Projects" for Accelerating Social "Return", which had started in April 2008. It is not going to be an endeavor that takes 10 to 20 years to produce results; the technology is expected to be available in five or six years' time.

You think you will have created something that people can use in five or six years?

Nakamura: I think so. First, we want to develop something that can be used during travel. The languages used by the system will be limited to Japanese, English, and Chinese at first, but the number of supported languages will increase in time.

Machine translations using the large database of examples

What is the second category in the research?

Nakamura: The second category is the machine translation services, which I mentioned earlier. We are thinking of industrial usages as the main application of this technology—translation of instruction manuals and research papers are good examples of it. We will be working together with the companies using the service to collect data from the networks so that we can build

the necessary database of vocabularies and original and translated sentences; this will help in the continuous development of the machine translation technology. The data that is specific to the company is handed over to the company, while the other data that is more general in nature can be utilized in various other fields of new businesses.

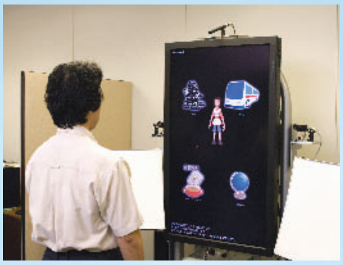
What are the methods used for the machine translation?

Nakamura: Dr. Makoto Nagao, the former president of NICT, is a pioneer in machine translation in Japan, and NICT has a history of pursuing the development of the example-based translation that he advocated. Our development effort has now expanded into the statistical translation method, which takes probabilities into account. To be able to machine translate, you must first develop "bilingual corpus." It is a collection of sentence pairs; for example, a Japanese sentence and a corresponding English sentence. For a Japanese sentence "Watashi wa gakko ni iku," an English equivalent, "I go to school," is paired. You prepare a collection of such pairs—a lot of them. We use bilingual corpuses that comprise more than million of such pairs. Further, when you put the bilingual corpus into machine learning, it would generate the probability data. We would know, for example, the usage percentages of "Watashi ga" corresponding to "I." Or, we would know that "to school" corresponds to "Gakko e" more frequently than "to university." Therefore, the probability component is used in machine translation. Further, the word order differences that exist in different languages are made consistent using bilingual corpuses comprising a large number of examples. Once the bilingual corpus for a specific language such as Chinese, Indonesian, and German is developed, machine translation across multiple languages becomes possible. The accuracy of the translation is another matter, but the merit lies in the fact that just pairs of sentences are required for this type of translation to become possible.

Natural communication between man and the machine

What is the third category in your research?

Nakamura: The third category is the spoken dialogue system. I have briefly touched on this earlier; an example is a robot that understands what I speak and gives pertinent replies. There is a system we are working on right now, which is being used in Kyoto's tourist information center. If you told the machine, "Tell me about the Golden Pavilion," it would, for example, give you some information gathered from Wikipedia. If appropriate information was not found in Wikipedia, web search would be used to obtain the information. If you asked, "How do I get there," it would answer "You can go there by bus" and display the bus timetable. It is more helpful for such information system to use animation characters on the display in addition to using synthetic voice to help convey messages; the one in Kyoto uses the animation characters as well. We are still at an early stage, but we aspire to develop in the future, a type of machine that can carry on natural conversations with people, like the ones we see in the animation or science fiction movies.



Demonstration of Speech Translation

Like Doraemon?

Nakamura: Yes.

It seems to me, there are many other useful applications of this system.

Nakamura: Yes, there are plenty of other possible applications besides the use in tourism. Especially, when the multi-language support is implemented, the local governments of communities with many foreign residents will be greatly benefited by this system. The call centers are another example.

Collection and distribution of linguistic resources

And, the last category of your research?

Nakamura: The fourth category is the distribution of linguistic resources worldwide. Dictionaries and databases of languages are used to provide the type of services we are developing, but the languages are always changing. We would like to incorporate new words and word usages that are gathered from the Internet and media, and compile databases and distribute them periodically.

Multiplicity of development for natural language processing

It seems to me that the coordination with the businesses is important for the advancement of your research.

Nakamura: Yes, exactly. Till now, this kind of research tended to be outsourced, but in the MASTAR Project, we will be asking the companies to send personnel to join the research of the MASTAR Project. We are also preparing to launch R&D forum, where the companies can participate in discussions.

It looks like the development of the MASTAR Project will be headed in diversified directions.

Nakamura: The spoken language and written language that we use in our everyday life is called natural language. Until recently, machine translation was the only application of the technology that utilizes natural language, but now the technology is starting to be used in various other fields as well. A very exciting future awaits us.

Thank you very much.

Field Experiments of the Cellular Phone Speech Translation Service at the Beijing Olympics

Toru Shimizu / Satoshi Nakamura

Profile

Toru Shimizu

Knowledge Creating Communication Research Center Research Manager, Spoken Language Communication Group

After completing his master's course and before taking up his current position, he worked in Kokusai Denshin Denwa Co., Ltd., (current KDDI Corporation) R&D Laboratories and Advanced Telecommunications Research Institute International (ATR). He is engaged in research and system development of speech synthesis, natural language processing, and speech recognition.

The development of the world's first "cellular phone speech translation service"

Under the MASTAR Project, Knowledge Creating Communication Research Center strives for the realization of technologies that enable recognition, translation, and synthesis of spoken language in various environments, and translation of various information on the Internet. This project is expected to both eliminate language barriers and to realize borderless communication.

As a part of this project, we conducted field experiments with the cellular phone speech translation service in Beijing from August to September of 2008. This experiment served to advance the multi-lingual speech translation technologies, and to promote our latest speech translation system.

We have developed the world's first "Japanese-Chinese cellular phone speech translation service" which translates daily conversation in the travel domain. In this experiment, Japanese travelers who were attending the Beijing Olympics Tours and Japanese residents in Beijing tested our service for communication with local Chinese people while sightseeing, shopping, and getting directions.. Recorded conversations and questionnaires are used to analyze the system performance.

The photo shows an image of how this cellular phone speech translation service is used. The service introduces the following new features.

1. The voice characteristics of the user can be pre-registered by speaking a few sentences into the mobile phone.
2. The user can choose an appropriate dictionary according to the location and the situation.
3. The translation result can be voice-synthesized.
4. The translation result can be checked by re-translating it into the original language.

Realization of the user-friendly system by analyzing the usability and accuracy

For this experiment, we have developed a proper noun lexicon with Tsinghua University which includes several thousand Beijing specific proper names necessary for sightseeing, shopping, transportation, or dining. In addition to the "cellular phone speech translation service", we have also used the "handheld speech translation system" in which all functions for Japanese-Chinese speech translation are implemented in an Ultra-Mobile PC about the size of a small pocketbook. From the questionnaires, we have learned that there is considerable expectation for the speech translation technologies, and that there are many users impressed with the advancement of the translation technologies who expect the realization of commercial products. On the other hand, there were also various feedbacks from users requesting improvements in some areas, including: more accurate recognition and translation of various expressions in daily conversations, more proper nouns such as restaurant names and souvenirs should be registered, faster processing so that the conversation can be carried out without interruptions, a high usability graphical interface, and better speech recognition accuracy of Chinese.

We are now conducting an analysis of the data obtained from the experiment and applying it to accelerate the research and system development for realizing a more user-friendly speech translation system.

Experiments of the Cellular Phone Speech Translation Service in a Real Environment

Text Translation Services used in the Beijing Olympics and for Sightseeing in Beijing

●Profile●

Hitoshi Isahara

Executive Researcher

After completing his master's course, he joined the Electrotechnical Laboratory （ETL） Ministry of International Trade and Industry （MITI）. In 1995, he joined the CRL (current NICT). He is engaged in the research on natural language. He has a Ph.D. in engineering.

Multilingual information service during the Beijing Olympics

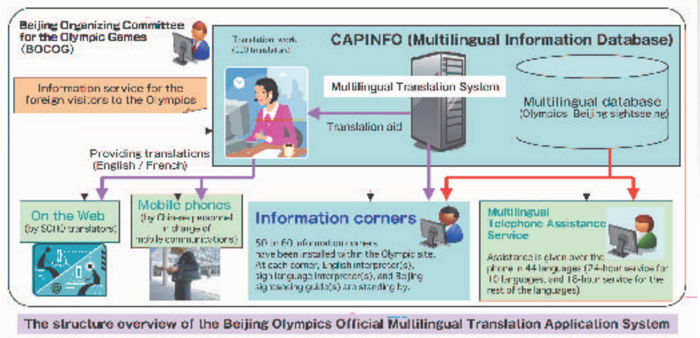


Fig.1:
Configuration of the Beijing Olympics' Official Multilingual Information Service System

During the Beijing Olympics, the Beijing Olympic Committee was operating an official multilingual information service as a part of services extended to the many foreign tourists visiting Beijing to watch the games. The overview of the service is shown in Fig. 1. Many different types of official services were being provided within and without the Olympic sites using the multilingual integrated information database as the core of the information. In these official services, a text translation system was used to build the core database; for example, the translation of news from the committee. The system was also available at the information booth installed within the site(Fig.2) .Capinfo Co., Ltd., was the company that was in charge of this multilingual database operation. NICT and Capinfo Co., Ltd., had signed an official memorandum in December 2008 on research and development; as one of the collaborators, we have been offering our technical assistance to them in the Chinese-Japanese text translation system. To express their gratitude for our assistance, Capinfo Co., Ltd., has presented us with a letter of appreciation on Oct 15 after the Olympics saying to the effect that the success of the Chinese-Japanese information service during the Beijing Olympics was due to the collaboration of NICT.

Fig.2: Information Booth

Text translation system

Since 2006, with the subsidy of the Special Coordination Funds for Promoting Science and Technology, NICT has been engaged in the development of Japanese-Chinese/Chinese-Japanese machine translation system in cooperation with Kyoto University, the University of Tokyo , Sizuoka University, and Japan Science and Technology Agency. The development of the system was based on the translation engine developed by Kyoto University. We created a bilingual corpus database from the Chinese documents related to sightseeing in Beijing and Olympics; the data was provided by Capinfo Co., Ltd. A sophisticated system specific to the purpose was developed; namely, the service to be used during the Beijing Olympics.

For our translation system to be incorporated into the official system of the Beijing Olympics Committee, the standard set by the committee has to be met and verification by an independent organization is required. We have improved the system's performance by enhancing the alignment technology and creating the bilingual corpus database; we were certified by the Chinese Academy of Sciences（Institute of Computing Technology）since we met the requirements of the Beijing Olympics Committee standard.

Beijing tourist information system

Fig.3: Beijing Tourist Information System which Functions in Japanese

NICT, in cooperation with Capinfo Co., Ltd., has developed a tourist information system, utilizing the database that was created for the purpose of improving the translation engine(Fig.3). The system was installed in the area having a large number of Japanese audiences throughout the entire period of the Beijing Olympics; the reactions of the Japanese audiences were favorable.

Capinfo Co., Ltd., and NICT have agreed to continue with the collaboration regarding Beijing's tourism, even after the Beijing Olympics; this text translation system is our first effort. We plan to continue moving forward with the collaborative work with Chinese organizations such as Capinfo Co., Ltd., centering on Beijing tourism.

The Frontier of Quantum Information Communication Technologies

Profile

Masahide Sasaki
Group Leader, Quantum ICT Group New Generation Network Research Center

After having completed his doctoral course, Dr. Sasaki joined NKK (current JFE Holdings, Inc.). In 1966, he joined the Communications Research Laboratory, Ministry of Posts and Telecommunications (current NICT). He is engaged in research and development of quantum information communication technologies. Ph.D. in science.

Quantum information communication to supersede optical communications as the limitations of the latter loom large

The widespread popularity of broadband services and technologies such as optical and IP telephony have familiarized us with optical communications. Though the rise of information and communication technologies seems to be boundless, some limitations of the technology have come to light. The expansion of communication capacity by wavelength division multiplexing, which enables the injection of large amounts of optical powers into optical fibers that are as thin as human hair, has reached the saturation limit. Issues such as ensuring high levels of security in electronic commerce transactions need to be dealt with urgently. Since the mid 1990s, new technologies (such as those used in quantum computers) that can instantaneously break the most sophisticated cryptography have emerged. Currently, information communication technologies are based on 19th-century classical physics, including electromagnetism and optics. It is hence necessary to change the manner in which information is handled to comply with 20th-century physics, namely, quantum mechanics. Quantum information and communications technology (quantum ICT) based on quantum mechanics can be used to develop quantum computers that can perform massively parallel computation. Furthermore, quantum cryptography that cannot be broken even by quantum computers can be developed. Finally, quantum coding, which can help achieve the maximum transmission efficiency per photon, can also be developed. Research and development strategies for quantum ICT were developed early on by the Ministry of Internal Affairs and Communications and the NICT; the R&D of these technologies has been promoted strategically and comprehensively since 2001.

Quantum ICT is most suited for the direct control of photons, atoms, and the quantum mechanical characteristics of electrons. Besides quantum coding, which can help achieve the highest transmission efficiency, quantum ICT includes quantum cryptography for ensuring the absolute security of information and quantum internet by which quantum computers can be connected via quantum teleportation. Quantum ICT is the ultimate means for fast information transmission wherein large amounts of data are protected from eavesdropping. This technology can be applied to medical services that are essential to our day-to-day lives. For example, results of medical tests can be safely sent to multiple medical institutions for referral; this would make very precise medical diagnosis and appropriate treatment possible. The use of quantum ICT is also expected to become common in areas in which its use is not immediately conspicuous at present.

Quantum cryptography is expected to become available for leased government lines in the next four or five years. On the other hand, it might take more than a decade for quantum coding, which is the ultimate communication system based on quantum mechanics, to be put to practical use. At first, this technology is expected to be used as a means for the implementation of high-speed links in communication channels under extreme conditions in which amplifiers cannot be used, such as in optical space communications. The receiving ends of such high-speed links have to be capable of extracting the maximum amount of information from as few photons as possible. Ground-based optical fiber networks, on the other hand, are expected to be capable of handling communications up to 2020 because of the possibility of the extension of the existing optical fiber lines. This is because innovations in optical fibers, high-performance amplifiers, etc., are expected to occur. It is not easy to predict the course of current technologies after the year 2020 , but currently, quantum ICT is the only known means of rapid and secure transfer of ultrahigh-definition images and other types of content the global network that integrates ground and space networks.

Controlling photon superposition states — the key to the emergence of quantum coding

Our latest achievements in the development of quantum coding are briefly discussed below. The key to the emergence of quantum coding lies in the control of the superposition of photon states in which multiphotons exist simultaneously in different states. NICT has mastered the generation of superposition states

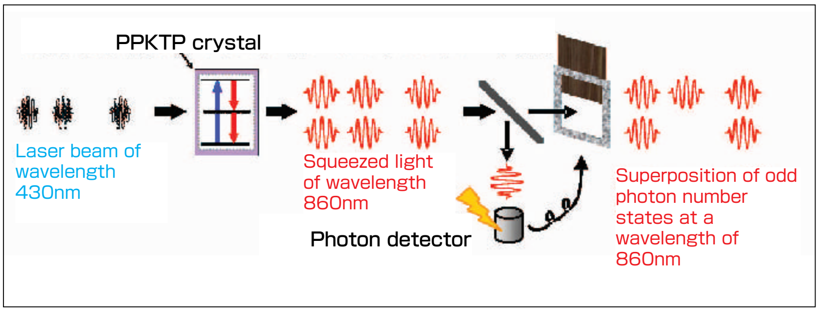


Fig.1: Superposition of Odd Photon Number States (Conceptual Diagram)

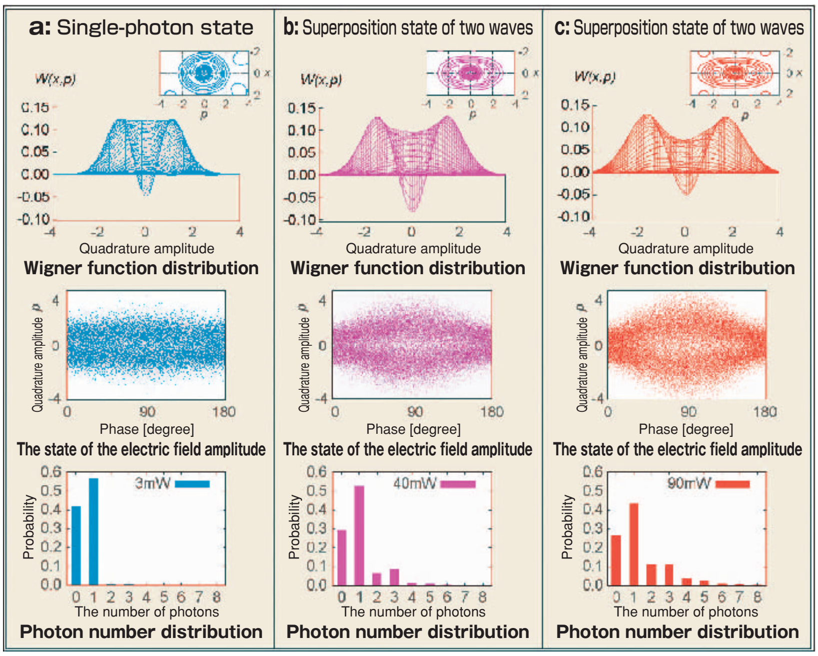


Fig.2: Measurement of the Superposition of Odd Photon Number States (See the text for Explanation.)

containing multiple photons, say up to five photons or more. We are one of the three organizations in the world that have accomplished this. Fig. 1 outlines the generation of this superposition state. Far-red light with a wavelength of 860 nm is generated by exciting a special crystal with blue light of a wavelength of 430 nm. Inside the crystal, optical parametric down conversion occurs — a single photon with a wavelength of 430 nm is converted into two photons with wavelengths of 860 nm, and squeezed light containing only an even number of photons is generated. Subsequently, a part of the squeezed light is guided to the photon detector by a low-reflection mirror so that the squeezed light passes to the right side of the detector when photons are detected. By this process, a single photon can be subtracted from the squeezed light. The state generated by this method can be measured using an optical tomography method called homodyne tomography. An example of the measured data is shown in Fig. 2. The state of a single photon generated by weak pumping is shown in Fig 2-a. The distribution charts at the bottom reveal that the probability of two or more photons existing at the same time is almost zero. On the other hand, the probability of zero photon (the vacuum state) remains finite. The reason for this is the unavoidable light loss caused by the experimental setup. The second image from the top in Fig. 2 shows the time oscillation of the single photon field. The location of the two bands corresponds to the electric field amplitude of the single photon. When energy is fixed, as in “one photon,” the phases of the wave (peaks and troughs) become random. This can be explained by the uncertainty principle. Two time-independent bands are formed because of this reason. A normal laser beam is characterized by a sine-wave oscillation with peaks and troughs. The topmost image in Fig. 2 show a specialized expression of the optical tomography results called the Wigner distribution. The deeper the area of negative values shown in this figure, the stronger is the indicated quantum effect.

An advanced vision for the development of new ICT

As the number of photons is increased with the intensity of pumping beam, waves with peaks and troughs begin to emerge, as shown in the central image in Fig 2-b. Fig. 2-c shows the state in which the excitation intensity and therefore the number of photons is further increased. Note that the peak and trough appear simultaneously at the time-reference point on the horizontal axis, indicating that two waves with 180° phase shifts are superposed. In this case, only an odd numbers of photons are observed, since even number photons interfere with each other and disappear (In reality, some even-number photons remain because of the light loss). This is impossible in classical mechanics. The superposition state that the NICT successfully generated in Autumn 2006, such as the one shown here, has displayed the strongest quantum effect observed so far (indicated by the negative values in the Wigner distribution shown in the topmost images in Fig. 2). This result has not been surpassed by anyone as of November 2008.

It is not unusual that more than half a century passes before a great invention finds practical applications. The impact of the introduction of an application is often much greater than that of the invention itself. For example, mobile phones, which are used by almost everyone today, are based on Marconi’s invention (the radiotelegraph system) in 1899 and the coding theory presented by the then 32-year-old Shannon in 1948. We aim to contribute to the area of information communication technology — an area that has great importance in today’s society . In order to accomplish this, we will continue exploring uncharted territories in our field, equipped with a vision that is a few decades ahead of its times.

Realization of 3D Imaging of Actual Moving Objects by Holography

Profile

Makoto Okui

Group Leader, 3D Spatial Image and Sound Group, Universal Media Research Center

After completing his master's course, he joined the Japan Broadcasting Corporation in 1980 and was engaged in research on stereoscopic television systems etc. Since 2006, he has been involved with research on 3D imaging for communication, particularly with 3D spatial images and sounds. He also has a Ph.D. in engineering.

"3D imaging" as a cutting-edge technology

Though everyone is familiar with the idea of three-dimensional imaging, it is still a relatively new concept. We have all seen or read about 3D images in science fiction movies and novels depicting the future. Some of the basic principles of 3D image displaying methods date back to more than a century. Although the basic idea is not new, high-utility 3D video imaging involves advanced technology that requires a great deal of novel display and imaging methods; further research and development is required in order to develop such methods.

Three-dimensional images are very popular attractions in theme parks and events. It is also drawing attention as it opens up new business opportunities, for e.g., the production, distribution, and screening of 3D films have now become commonplace, with possibilities for family use as well. In 3D films, a display method known as stereoscopic display method is used; this method reproduces the effect of binocular parallax*. Special glasses are usually required for viewing such displays.

Though the stereoscopic method is a practical method, the extent to which the display method appears natural and realistic is insufficient for some of the possible future applications. The Ministry of Internal Affairs and Communications is promoting research and development in 3D image that can be used for communication with remote areas, for educational purposes, or for use in various interfaces. In order to realize these aims, the extent to which a displayed image appears realistic should be one that has so far not been achieved. It is necessary to realize displays that facilitate the viewing of 3D images from various angles, the manipulation of the images in combination with other senses (for example, sense of touch), etc.

Importance of holography for realistic 3D image reproduction is drawing attention

Besides binocular parallax mentioned earlier, there are other visual clues used by our eyes for the perception of depth. Successful reproduction of natural and realistic images depends on how closely we can reproduce these visual clues. One of the imaging methods that can reproduce most of the visual clues relating to the perception of depth is holography, and it is sufficiently realistic for many applications envisioned for the future.

Other imaging methods such as photography record the intensity of light received from the object, whereas holography, by taking into account the wave nature of light, creates and records what is known as an interference fringe. By recording the interference fringe, information on the directions from which light beam is incident in addition to the intensity of light received from the subject can also be recorded and played back. Using the information thus obtained, 3D images can be reproduced. (Fig. 1a)

Typically, the size of the interference fringe is less than or equal to one micrometer. In order to record the interference fringe, special dry plates (recording material) are used; these plates are capable of recording thousands fringe patterns within a space of one millimeter. Further, because holography is based on the wave nature of light, a special type of light (laser) is used for recording and reproducing images. For the holography of still images, considerable efforts have been made for the reproduction of color images and images using normal light. As a result, the holographic 3D image of a still image has attained an ultra-realistic quality that is not present in images created by other 3D imaging methods.

Since holography is capable of producing ideal 3D images, expectations for the use of holography in communication technology and future information communication possibilities such as 3D television etc. are on the rise. In order to fulfill expectations, we require an electronic system (electronic holography) that can (1) acquire, display, record, and transmit data electronically and (2) acquisition of actual moving object data. However, the reproduction of wavefront using interference fringes, which is unique to holography, has remained confined to R&D activities in the realm of basic research, and it is yet to reach the level of full-scale R&D of other 3D imaging methods. Therefore, in order to realize electronic holography, NICT is taking the initiative for the research of

***Binocular parallax:**
When we view an object with both eyes, there are some differences in the images formed on the retina of our eyes due to the distance of the object. This is called binocular parallax, and it is one of the factors responsible for our perception of depth.

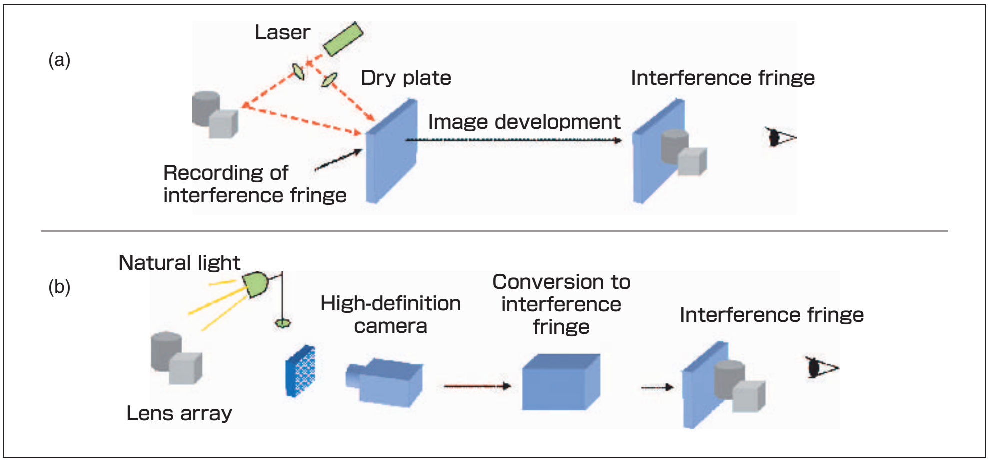


Fig.1:
Data Acquisition and Reproduction of Holographic Image
(a) Conventional Holography (Still Image)
(b) NICT's Electronic Holography (Actual Moving Object)

challenging issues that have to be resolved.

Efforts towards the realization of electronic holography

As shown in Fig. 2, there are many challenges to be overcome in order to develop a method for electronic holography. A narrow viewing zone and limitations in acquiring the real moving object data are the major hurdles, and NICT considers these obstacles as subjects of research. Let me talk about some of our research achievements so far.

As mentioned earlier, holography requires a means of recording and displaying a fringe pattern that is less than or equal to one micrometer in size. At present, there are no electronic devices with sufficient resolution to display such fine patterns, and instead, display devices with a pixel size of around 10m are used. Although this is an order of magnitude coarser than the required resolution, 3D images can still be displayed by adjusting the recording and displaying conditions; however, there is a decrease in the size of the viewing zone.

The immediate goal of our research at NICT is the achievement of a viewing zone that is sufficiently wide for an image to be viewed as a 3D image with both eyes from a close range. The key to achieving this lies in the use of high-density devices, technology to combine multiple devices, and various signal processing methods

By using these techniques, we have succeeded in creating a 3D image that can be viewed with both eyes from a distance of 40 cm.

Another area that we are researching is data acquisition from actual moving objects. The conventional method of data acquisition is to illuminate the subject with the laser beam(in a darkroom with no other light source); however, the acquisition of data from various moving objects using this method is very difficult. In order to solve this difficulty, we have developed an unconstrained method of data acquisition called integral photography that can be employed under normal lighting conditions. This method uses a lens array for data acquisition and then converts the data into holographic data(Fig. 1b). At NICT, we have recently succeeded in performing the real-time conversion of data into holographic image and the display of the holographic color image by using this method of data acquisition. (Fig. 3)

Overcoming the hurdles

We have to cover more ground before holography is put to practical use, but what we have achieved so far goes a long way toward realizing its various future applications. Many issues such as the expansion of the viewing zone, the improvement of the image size and image quality, etc., have to be ironed out.

Further, in order to accelerate the widespread use of 3D images in society in the coming years, it is important to promote the advantages of not just holography, but 3D imaging as a whole; this will in turn encourage research in discovering the technical possibilities of 3D imaging. The study from the point of view of the contents is also indispensable. In this regard, we shall also be making efforts to promote cooperation among the government, industry, and academia for the support of Ultra-Realistic Communications Forum (URCF).

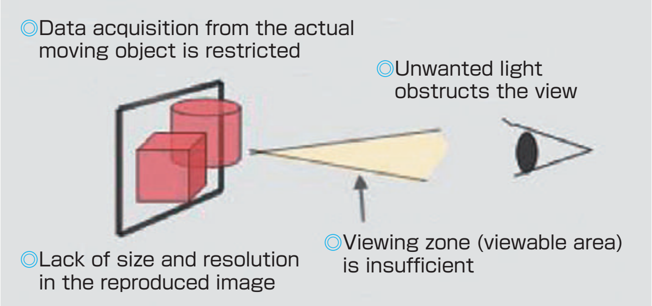


Fig.2: Challenges Facing Electronic Holography

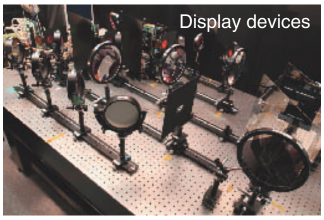
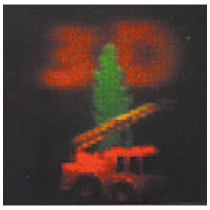


Fig.3:
Experimental Apparatus of Holography and the Reproduced Image

Subjects



Holographic Reproduction

Development of Small Mobile Satellite Terminals

Telecommunication services for secure and pleasant society — anytime, anywhere, and with anybody

Profile

Shinichi Yamamoto

Senior Researcher, Space Communication Group, New Generation Wireless Communications Research Center

He joined the Radio Research Laboratory, Ministry of Posts and Telecommunications (current NICT) in 1975. He is currently engaged in research on mobile satellite communications, tracking methods for automotive antenna , etc., using ETS-V, EVS-VI, COMETS, and ETS-VIII.

Mobile satellite phones today

During serious disasters, cellular phone services and fixed-line phone services may be disrupted, because of which the need for an alternative means of communication becomes necessary for efficient disaster management and effective execution of rescue operations.

Satellite communication is highly effective during disasters or in places where no other means of communication is possible, since it is not susceptible to damages caused on the ground and can be used as long as the satellite is visible. The equipment used for satellite communication must be compact, lightweight, and portable.

The mobile satellite services that are currently available in Japan are Iridium, Widestar (NTT docomo), and Inmarsat. Iridium uses handheld terminals, while Widestar and Inmarsat terminal use a rather large flat antenna about the size of a notebook PC.

Engineering Test Satellite Ⅷ (ETS-Ⅷ) and mobile terminals

An Engineering Test Satellite Ⅷ"Kiku No.8" (ETS-Ⅷ) was launched from Tanegashima Space Center in December 2006. EST-Ⅷ is equipped with two large deployable antenna reflectors in the S-band (2.5/2.6 GHz). Because these antennas could provide an equal performance of a parabolic antenna of a diameter of about 13m on orbit; the miniaturization of communication devices was enabled on the ground. An overview of the ETS-Ⅷ is shown in Fig. 1, and that of the small mobile satellite terminal (mobile terminal) is shown in Fig. 2.

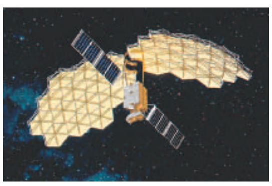


Fig.1:
Overview of Engineering Test Satellite Ⅷ (ETS-Ⅷ) (Photo: Courtesy of Japan Aerospace Exploration Agency)

Fig.2:
Overview of the Portable Terminal (Weight: 266g; Volume: 264cc; Battery not included)

During the development of this mobile terminal, we miniaturized by using a ceramic patch antenna for a transmission and reception antenna and put it in the terminal body. Also, we have developed a new high-efficiency power amplifier to reduce power consumption.

The air interface of this mobile terminal is 8kbps, BPSK-SCPC; further, PSI-CELP (5.6 kbps) is used for voice CODEC, and voice sound quality equivalent to an early digital cellular phones has been obtained.

Calls can be made directly to the target terminal by key inputs the ID number(same as dialing a telephone number) of the target terminal.

Ongoing satellite communication experiment

At NICT, we are advancing the communication experiment now using ETS-Ⅷ and mobile terminals. At present, we cannot use the large deployable antenna reflector for reception in ETS-Ⅷ because of the fault of the low-noise amplifier, this fault was detected during the initial checkout after the launch of the satellite. As a substitute for this deployable antenna reflector, we are using an antenna with a diameter of 1 m for High Accuracy Clock (HAC).

To compensate for the receiving capability of the satellite, we use a parabola antenna with a diameter of 0.68 m in place of the ceramic patch antenna in the mobile terminal.

We have modified the operational parameters of the mobile terminals on the basis of the results of the satellite communication experiments; we are now able to establish the communication channel about 100% for satisfactory voice communication.

Future prospects

The Ministry of Internal Affairs and Communications has entrusted NICT with research and development toward realization of the Satellite / Terrestrial Integrated Mobile Communication System. Thereby, We started a five-year plan for the examination of practical use of this communication system. Please expect future development of a mobile satellite phone system.

Ionosphere — A Part of Space Nearest the Earth

Continuous Observations and Prediction of Ionospheric Disturbances that Can Affect Radio Communications

Profile

Takuya Tsugawa

Expert Researcher,
Space Environment Group,
Applied Electromagnetic Research Center

After having completed his doctoral course at Graduate School of Science, Kyoto University, and working as a JSPS Research Fellow, Dr. Takuya Tsugawa joined NICT in December 2007. He is currently engaged in research on prediction of ionospheric disturbances that can affect radio-wave propagation.

Commencing ionospheric observation research as a "service to society"

The ionosphere is a layer located roughly between the atmosphere and the outer space, and it extends from a height of approximately 60km to 1000km above the earth's surface. In the ionosphere, some of the atmospheric molecules / atoms are separated into electrons and ions due to the extreme ultraviolet radiation from the sun, resulting in the ionization state. The sudden change in the electron density in this region can degrade communications with the satellite. NICT (and its predecessor organization) has been engaged in observation of the ionosphere for more than 60 years. Now we have four ionospheric observatories in Japan (Wakkanai, Kokubunji, Yamagawa, and Okinawa) and some observation instruments in Antarctica. In addition, we have installed many instruments in Southeast Asian countries such as Thailand and Indonesia to observe severe ionospheric disturbances.

The expert researcher, Dr. Takuya Tsugawa, who says, "NICT's facilities for the ionospheric observation are one of the best in the world," started his research on the ionosphere during his graduate school days. He was originally interested in the study of the planet Mars but later shifted his focus to space research, which is more directly related to the day-to-day lives of people in the region close to the earth. His graduate school adviser recommended him to begin research studies on newly developed ionospheric observations using GPS.

Understanding and predicting abnormal ionospheric phenomena that affect our daily lives

Since I joined the Space Environment Group of NICT, I have been carrying out observations of the equatorial ionosphere using the observation facilities in Southeast Asia countries. We examine the vertical profile of the electron density by transmitting radio waves into the ionosphere in different frequencies and measuring the time lag of echo back. "The observation facilities are located in remote areas, but visiting the actual observation site is a worthwhile experience."

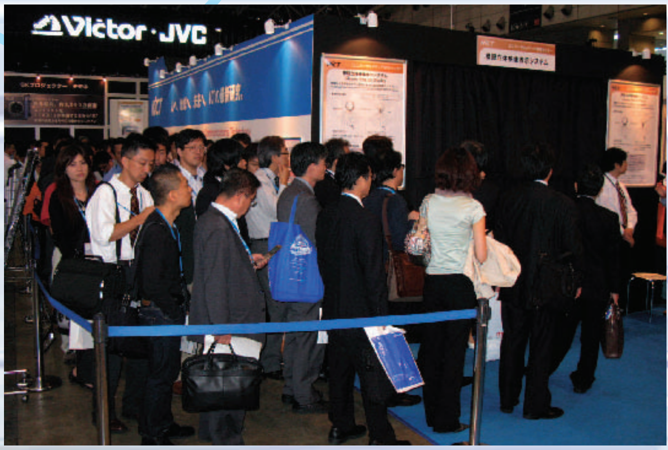
In the equatorial ionosphere, there is "equatorial anomaly", a region where the electron density is very high. There also exists a "hole" with a very low electron density called "plasma bubble", which is generally formed after sunset. "The equatorial plasma bubble develops along the earth's arch-shaped magnetic field line. Sometimes it grows up into high altitudes in the equatorial region, resulting in that the northern edge of the bubble reaches over Japan. This can degrade GPS navigations and cause ground-to-satellite communication failures" says Dr. Takuya Tsugawa. He is also engaged in research on the generation mechanism of these phenomena and the prediction of them. Research on the ionosphere, which plays an important role in our daily lives, is of significance not only for the citizens of Japan but also for people residing in other countries.

Report

NICT Super Event 2008

The Latest Research on ICT — for People, for Earth, and for Future

We held One Day Symposium titled "Promoting until Here on New Generation Network and Universal Communications."



The autostereoscopic display system was one of our most popular exhibits. Everyday there was a long line of people queuing for the exhibit. Behind the blackout curtain, the 3D image emerged and with their naked eyes, they could see it from different angles by shifting their bodies.

The stereophonic speaker which let them hear sound coming from surrounding directions, as in natural hearing, was another popular exhibit.

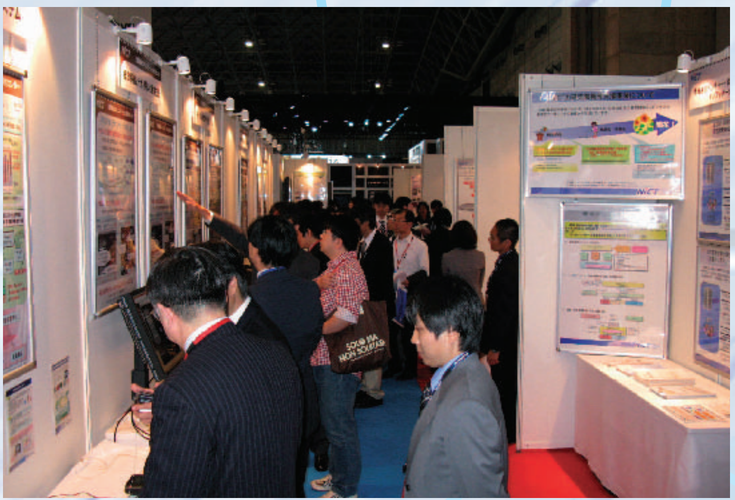
Transferable technology seeds originated by NICT were plainly explained in the presentation session for technology seeds.

To promote our overall effort as NICT, we have held "NICT Super Event" again this year from September 30 to October 4 at the CEATEC JAPAN 2008 site (Makuhari Messe). We held a One Day Symposium at the International Conference Hall, 61 exhibitions at the exhibition hall, and various presentations at the NICT booth inside the exhibition hall, etc. It was a great success — a total of nearly 200,000 people came to the CEATEC during five days, and approximately 48,000 people visited NICT booths. Our booths were surrounded by booths representing big companies, but the visitors seem to have liked the approach that our researchers were presenting themselves.

Our Events

- One Day Symposium:
  10:30-16:40, Wednesday, Oct. 1
- Press Interview:
  14:00-16:30, Tuesday, Sep. 30
- Presentation Session of Technology Seeds:
  13:00-16:30, Thursday, Oct. 2
- Basic Technology Promotion System for Private Sectors :
  11:00-12:00, Thursday, Oct. 2-Friday, Oct. 3
- Announcement of Government-Subsidized Project Results:
  13:00-16:30, Friday, Oct. 3
- Exhibition:
  10:00-17:00, Tuesday, Sep. 30-Saturday, Oct. 4

A visitor is being given a demonstration of the brain activity measurement by an instrument that uses near infrared light.



Our inside exhibition booths were also crowded with visitors who were listening to the researchers' presentation.

The overlooked view of the NICT's exhibition booths is shown.

PrizeWinners

PRIZE WINNER ● **Ferdinand Peper**
GROUP OF PARTICIPATOR **Li Jia**

Senior Researcher,Nano ICT Group,Kobe Advanced ICT Research Center

◎DATE : 7.1.2008
◎NAME OF THE WINNING PRIZE : Best Paper Award
◎CONTENTS OF THE WINNING PRIZE :
On Brownian Cellular Automata
◎NAME OF GROUP : Automata 2008:EPSRC Workshop on Cellular Automaton Theory

◎Comment by the winner:

I am very happy to have received this award, which is the result of years of in-depth discussions with my co-researcher, Dr. Lee Jia, on the fundamentals of computing on nanometer scales. We are presenting a novel thinking of probabilistic search with selections instead of the step-by-step method of classical deterministic approach. We are planning to expand our research into the communication model of micrometer scale.

PRIZE WINNER ● **Koumei Sugiura**

Research Expert, Spoken Language Communication Group, Knowledge Creating Communication Research Center

◎DATE : 8.20.2008
◎NAME OF THE WINNING PRIZE : Category Incentive Prize of the Meeting for Electronics, Information and Systems Society
◎CONTENTS OF THE WINNING PRIZE :
A Method of Designing the Morphology of Mobile Robots for Learning Multiple Tasks
◎NAME OF GROUP : The Institute of Electrical Engineers of Japan

◎Comment by the winner:

I am very honored to have received the award as incentive prize in the conference of "Electronics, Information and Systems Society in Fiscal 2007". I herewith, would like to thank everyone who has helped me. This award is truly encouraging me, and I want to push forward with research in NICT.

PRIZE WINNER ●
Okinawa Subtropical Environment Remote-Sensing Center

◎DATE : 9.12.2008
◎NAME OF THE WINNING PRIZE : Award of The Japan Coast Guard Commandant in the 137th Hydrographic Anniversary
◎CONTENTS OF THE WINNING PRIZE :
Contribution to Marine Information Affairs: Provision of "Marine Investigation" and "Marine Information"
◎NAME OF GROUP : Japan Coast Guard

◎Comment by the winner:

We, as Okinawa Subtropical Environment Remote-Sensing Center, have set up long range ocean radars at Ishigaki Island and Yonakuni Island, and observation and research of oceanic current, etc. are being carried out. The data obtained are given to the 11th Regional Coast Guard Headquarters and the Hydrographic and Oceanographic Department of Japan Coast Guard to be used for understanding the oceanographic condition, etc.

PRIZE WINNER ● **Katsumi Fujii**

Senior Researcher,Electromagnetic Compatibility Group, Applied Electromagnetic Research Center

◎DATE : 9.17.2008
◎NAME OF THE WINNING PRIZE : Communications Society : Distinguished Contributions Award 2008
◎CONTENTS OF THE WINNING PRIZE :
Great contribution to the activity and development of the technical study group in IEICE Technical Committee on Electromagnetic Compatibility (EMCJ) as (assistant) secretary during 2 years while planning and managing 20 meetings of the technical study group, 4 workshops of the second-class technical study group, the national convention, the society meeting and the 30th anniversary project after creating the technical study group.
◎NAME OF GROUP :
Communications Society, The Institute of Electronics, Information and Communication Engineers

◎Comment by the winner:

I was an assistant secretary for two years, but I had to spend the last six months of the two years in a hospital due to an accident. So, I'm not sure of my contributions as an assistant secretary. Mr. Shinobu Ishigami (EMC Group), who was the secretary then, helped me greatly.

USB Memory Stick Distributed as a 30-Year Anniversary Token

Report

ATR/NICT Open House 2008

[D a t e] : Thursday, Nov. 6 - Saturday, Nov. 8, 2008 (Hands-on Demonstration Mainly on 8th)
[Venue] : Advanced Telecommunications Research Institute International (ATR) (Kansai Science City)

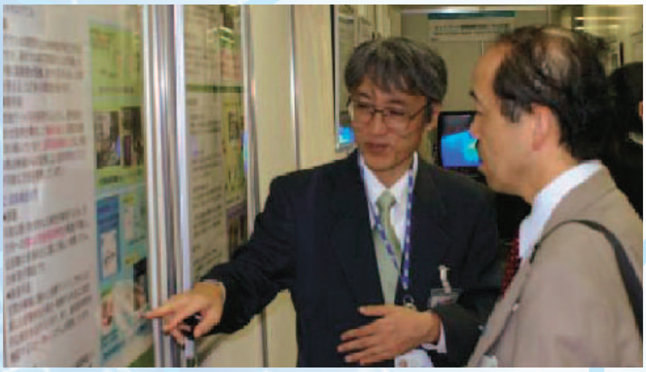
Keihanna Research Laboratories and Kobe Research Center, in collaboration with Advanced Telecommunications Research Institute International (ATR), have hosted an Open House 2008 (Joint Meeting for Research Presentation). Knowledge Creating Communication Research Center, Universal Media Research Center, and Kobe Research Center Biological ICT Group collaboratively held a research in order that each research group could introduce their researchresults and future R&D evolution, presentation conference with exhibitions and lectures, etc. where each research group could introduce their research results as well as talk about the future R&D prospects.

"Lecture Presentation by NICT" (10:00 - 13:00, November 7)

Keynote Speech by Director of Keihanna Research Laboratories

NICT Exhibition Panels & Hands-on Demonstration: 22 Themes including 4 Hands-on Demonstrations

A total number of visitors during 3 days: Approximately 2,200



Panel Exhibit
The visitor is intently listening to the explanation.

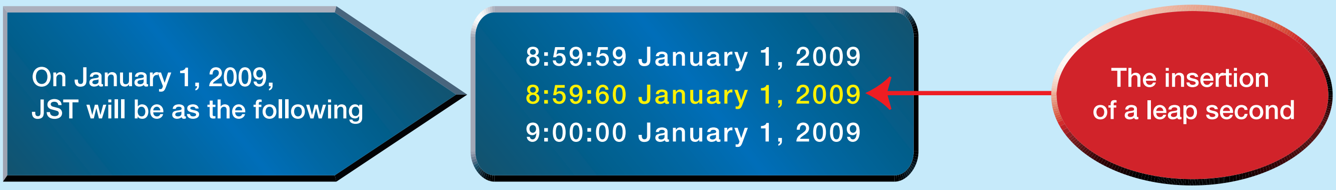
It was the first time for us to hold an open house on Saturday, setting up the spots of hands-on demonstrations for the local residents including the el-hi students, while preparing the spots where visitors could closely experience the information communication technology by participating in the demonstrations such a system technology which brings full of realistic sensation, etc. Despite a rainy day, many family-visitors came to our open house especially on Saturday and besides, the questionnaire contents were favorable.

From the next year onward, we hope to furthermore strengthen the collaboration with research institutes located in the vicinity of the Kansai Science City

Demonstration Exhibit (Autostereoscopic Display System)
3D images can be viewed without using special glasses.

Demonstration Exhibit (Multi-Sensory Interaction System)
We can have the experience of seeing, touching and hearing the 3D virtual object as if it were in our 3 dimentional world, although actually there is nothing at all.

A leap second will be inserted between 8:59:59 a.m. and 9:00:00 a.m. at Japan Standard Time (JST) on January 1, 2009 after three years. This leap second insertion will be the 24th after the adjustment by its insertion started in 1972.



Information on the leap second

A leap second is one-second adjustment which keeps the difference between the astronomical time the universal time based on the rotation and revolution of the heavenly body such as the earth and the atomic time kept by atomic clock within ±0.9 second. All the leap second adjustments have been done so far by inserting one second because the universal time has gotten slower in comparison with the atomic time.

NICT is carefully preparing for the leap second adjustment while engaging in the service of disseminating Japan Standard Time through transmitting the standard radio wave, etc.

Astronomical Time and Atomic Time

In our daily lives, we had been using time called the astronomical time, which is based on the earth's rotation on its axis and revolution around the sun. However, astronomical time changes in irregular manner when examined in terms of a millisecond, so that it has not been suitable for today's leading edjed scientific technology in high precision.

Therefore, about 50 years ago, the second was defined in terms of the time supplied by the atomic clock, which uses an accurate electromagnetic wave emitted by an atom (the quantum theory). The time we use today is based on the atomic clock with a high degree of accuracy.

Information for Readers:

In the next issue, we will have an interview on the Strategy Headquarters of New Generation Network R&D aiming for the new generation network configuration.

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