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National Institute of Information and Communications Technology

Special Feature Commemorating the 20th Anniversary of the Kobe Research Laboratories

NICT

Symposium Commemorating 20th Anniversary of the NICT Kobe Research Laboratories

Technology and Research Results Taking Flight from Kansai to the World

An anniversary symposium for the 20th Anniversary of the Kobe Advanced ICT Research Center (KARC), which was established with four laboratories as the Kansai Branch Office of NICT in 1989, was held at the Crown Plaza Kobe Hotel in Chuo-ku, Kobe on June 8 starting at 2:00 p.m. It introduced broadly the history of the laboratory's research results, its current activities, and plans for the future.

High-technology from the Kansai Center

The National Institute of Information and Communications Technology (NICT) is the sole research organization in Japan in the fields of information and communications. The Kobe Advanced ICT Research Center (KARC) is the Kansai branch of NICT, which aims to conduct basic research towards innovation in information and communications. It has produced many innovative results through its history.

In superconductivity research, which has progressed steadily since the beginning, world-leading successes have produced revolutionary technology in developing such as low-noise operation of niobium nitride SIS mixers and terahertz-band Josephson array oscillators. In information sciences based on biology, it was also discovered that an RNA-binding protein controls fission-yeast meiosis. Besides, simultaneous chemical and mechanical measurements of F1-ATPase, which is a rotary molecular motor, was achieved for the first time, along with many other world-class results.

At KARC, research on the five basic themes of superconductivity, molecular photonics, neuro-informatics, molecular communications and biological algorithms is carried out by Biological ICT Group and Nano ICT Group. A major feature of KARC is how it conducts a variety of research while actively pursuing collaboration with universities and international joint research. In January of this year, it entered a basic agreement with Osaka University for integrated research in the field of brain information and communication. It is hoped that this will aim at forming an international base for collaboration among industry, academia and government in this "Fin al Frontier", the area of brain information and communications research, and will continue to meet this bold challenge.

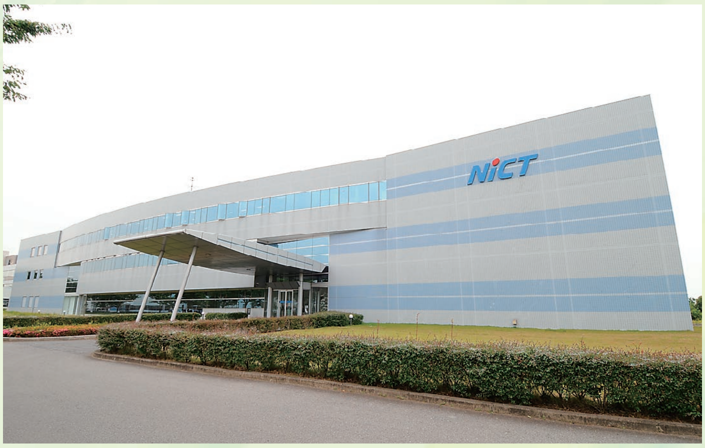
The Kobe Advanced ICT Research Center has now reached its 20th year, having accumulated many achievements such as these. To commemorate this, the "Kobe Laboratories 20th Anniversary Symposium" was held in Kobe, introducing the laboratory's past research results, its current research activities, and its plans for the future. The event was held at the Crown Plaza Kobe Hotel, with roughly 250 researchers attending from industry, academia, and government.

Speakers express hopes for KARC

Hideo Miyahara, President of NICT gave an opening address, followed by congratulatory addresses from Masataka Kawauchi, Director-General for International and Technology Policy Coordination of the Ministry of Internal Affairs and Communications (MIC), and Nobuaki Kumagai, President of Hyogo University and former President of Osaka University. Five lectures were given in two sections (ref. "Symposium Program"), presenting the hopes and prospects for future development for KARC, as well as other advanced research topics such as neuro-informatics.

In the leading address, a video tracing the 20-year history of the Kobe Research Laboratories set a calm and reflective mood, with nostalgic views of commemorative photos and the enthusiastic work of the early researchers. Then Shuichi Inada, Director of the MIC Kinki Regional Bureau of Telecommunications talked about how

A View of the Symposium Meeting Hall



Research Building 1 of the Kobe Advanced ICT Research Center

everyone's enthusiasm and enjoyment was a special characteristic of Kobe Research Laboratories, further contributing to the calm and reflective atmosphere. Kazuhiro Oiwa, KARC Director-General then spoke about how an appropriate blend of order and chaos can increase creative activities, eliciting nods of agreement from attendees.

In the second section, Professor Toshio Yanagida of Osaka University gave an outline of plans being undertaken at KARC for future research, uniting brain information and communications in an impressive lecture calling for the transition from data communications to true "information communications". Then Professor Shiro Usui of Riken Japan gave an introduction to current neuro-informatics research and development towards global sharing of neurological research results. The leader of the Bio-ICT Group, Hiroshi Imamizu then introduced brain-function research activities at KARC in an intellectually stimulating lecture that came to close after 5 p.m. The symposium closed amid feelings of congratulations and expectation, with words of thanks to each of the speakers and a closing saluation from Yuichi Matsushima, Vice President of NICT.

Symposium Program

Part 1 Symposium Commemerating the 20th Anniversary of the Kobe Research Laboratories

"Strengthening R&D Capabilities and Expectations for KARC"
Shuichi Inada,
Director, MIC Kinki Regional Bureau of Telecommunications

"Present and Future of Kobe Research Laboratories — KARC's Vision for ICT in the Future —"
Kazuhiro Oiwa,
Director-General, Kobe Research Laboratories

Part 2 Kick-off Symposium for the Brain Information and Communications Integrated Research Project

"Future Plans for Brain Information and Communications Integrated Research"
Toshio Yanagida,
Professor, Graduate School of Frontier Biosciences and Medicine Osaka University
Program Coordinator, National Institute of Information and Communications Technology

"Towards a Systematic Understanding of the Brain—International Development of Neuroinformatics"
Shiro Usui,
Team Leader of Neuroinformatics Technology Development Team, Riken Brain Science Institute

"Brain Research Supporting the Brain Information and Communications Integrated Research Project at the Kobe Research Laboratories"
Hiroshi Imamizu,
Group Leader, Biological ICT Group, Kobe Advanced ICT Research Center

President Miyahara Giving the Opening Address

Chief Inada of MIC Kinki Regional Bureau of Telecommunications

Director-General Kazuhiro Oiwa of Kobe Research Laboratories

20 Years History of Kobe Research Laboratories

1989	•Established Kansai Branch Office (Communications Research Laboratory). •Established four new laboratories for perception mechanisms, knowledge processing, superconductivity, and coherence.
1990	•Established new laboratories for cognitive function and EM spectroscopy.
1991	•Established new laboratories for biological properties and bioinformatics research. •Completed Laboratory Building 1.
1992	•Succeeded in observation of an ion quantum jump.
1993	•Established a new laboratory for nano-mechanism research. •Succeeded in continuous oscillation of squeezed light.
1994	•Completed the second laboratory building (exchange building), a welfare building, a workshops building, etc. •Succeeded in fluorescent imaging of live human cells. •Discovered operation of telomeres.
1995	•Succeed in generating terahertz electromagnetic waves. •Developed high-speed 3D image-processing software.
1996	•Opened a graduate school linked to the Osaka University Graduate School of Science. •Succeeded in operation of the world's first low-noise niobium nitride SIS mixer (305 GHz band). •Developed a voice conversation system. •Began international joint research in natural language processing between Japan and Thailand.
1997	•Succeeded in the world's first control of a protein motor on a substrate. •Completed the APII building. •Discovered that an RNA-binding protein controls fission-yeast meiosis (reported in Nature).
1998	•Started the perception mechanisms laboratory and neuro-function research group. •Started international joint research on telomere structure. •Developed the world's first terahertz-band Josephson-array oscillator.
1999	•Started a graduate school linked to the Kobe University Graduate school of Natural Science (current Engineering).
2000	•Completed the first-generation library of flourescent proteins.
2001	•Completed Laboratory Building 4 (March). •Opened a graduate school linked to the Kyushu Industrial University Graduate school of Life Sciences and Systems Engineering. •Succeeded in control and visualization through STM of self-organizing molecular structures.
2002	•Succeeded in development of the world's first waveguide niobium nitride SIS receiver. •Succeeded in the world's first creation of a tunnel connection using MbB2 thin film.
2003	•Developed a network-element circuit using a superconducting single magnetic flux quantum circuit, and the world's fastest operation (45 GHz).
2004	•Succeeded in the world's first simultaneous chemical and mechanical measurements of F1ATPase, a rotating molecular motor.
2006	•Became the "Kobe Advanced ICT Research Center" (April).
2007	•Conducted field experiments in quantum encryption key distribution using a superconducting single-photon detector, achieving the world's longest distances and fastest speeds.
2008	•Succeeded in installing the world's first niobium nitride SIS receiver on a sub-millimeter wave radio telescope and putting it to practical use in collaboration with the Purple Mountain Observatory of the Chinese Academy of Sciences (CAS).
2009	•Completed the third-generation fluorescent protein library. •Concluded a basic agreement with Osaka University for integrated research related to the brain information and communications field. •Held a symposium for the 20th Anniversary of the Kobe Research Laboratories.

Brain Research in the Biological ICT Group, Kobe Research Laboratories Advanced ICT Research Center

The Present and Future of Research on Communication of Brain-derived Information

Profile

Hiroshi Imamizu

Group Leader
Biological ICT Group
Kobe Research Laboratories
Advanced ICT Research Center

After completing graduate school, served in a number of positions including promoted researcher at the ATR Human Information Processing Research Laboratory, group leader of computational psychology at the Japan Science and Technology Corporation Kawato Dynamic Brain Project, Chief Scientist at the ATR Human Information Science Laboratory, and Head of the Department of Cognitive Neuroscience at the ATR Brain Information Laboratories. In present post from 2008. Engaged in elucidating the mechanisms of human sensorimotor learning and research on applications to information and communications. Visiting Assistant Professor at Osaka University Graduate School of Frontier Biosciences, Head of the Department of Cognitive Neuroscience at the ATR Computational Neuroscience Laboratories. Doctor of philosophy (Psychology).

Research summary of the Biological ICT group

In the Biological ICT group at Kobe Research Laboratories, we aim to realize technologies that will lead to new concepts of information communication. We are engaged in the analysis of human brain function and biological functions of living organisms. We are studying and developing emergent elementary technologies such as those that utilize brain information, high-performance bio-type communication technologies which use molecules at super-low energy, and algorithms which are based on information from biological organisms, and which are capable of making autonomous judgments concerning changes in situation/environment and flexibly in communicating information. In this report, I will introduce some examples of research describing how brain-derived information is useful for communication, as well as future developments.

Communication of brain-derived information from the viewpoint of the receiver

We are surrounded by various information networks and terminals in modern society, and are constantly receiving and transmitting information (Fig.1). The development of communications equipment and networks has led to an enormous amount of information overflow; the time taken for considering and analyzing bits of information has gradually decreased and become limited, and there is a need for information expression that is intuitively understood by the receiver. In the Biological ICT group, we endeavor to elucidate the mechanisms of human "understanding" and "insight" and use this in technologies for evaluating information and interfaces.

In order to elucidate the mechanisms of visual "understanding" and "insight", the Murata group's sub-leaders are investigating the intracranial mechanisms at play as subjects suddenly recognize and identify a "hidden picture" as indicated in Fig. 2. Not only will the research simply describe the phenomenon, but methods have been proposed to quantitatively evaluate the power of insight in individuals by estimating individual differences in "intracranial cognitive temperature" based on the speed of insight and task difficulty. This method is likely to become a source of technologies for evaluating whether information is "difficult" or "easy" to understand.

Language serves an important role in communication, but investigator Ihara and principal investigator Fujimaki are engaged in elucidating the mechanisms of "understanding" in language. They discovered that it is possible to estimate from brain activity whether humans continue to recognize an ambiguous word as ambiguous or recognize it as non-

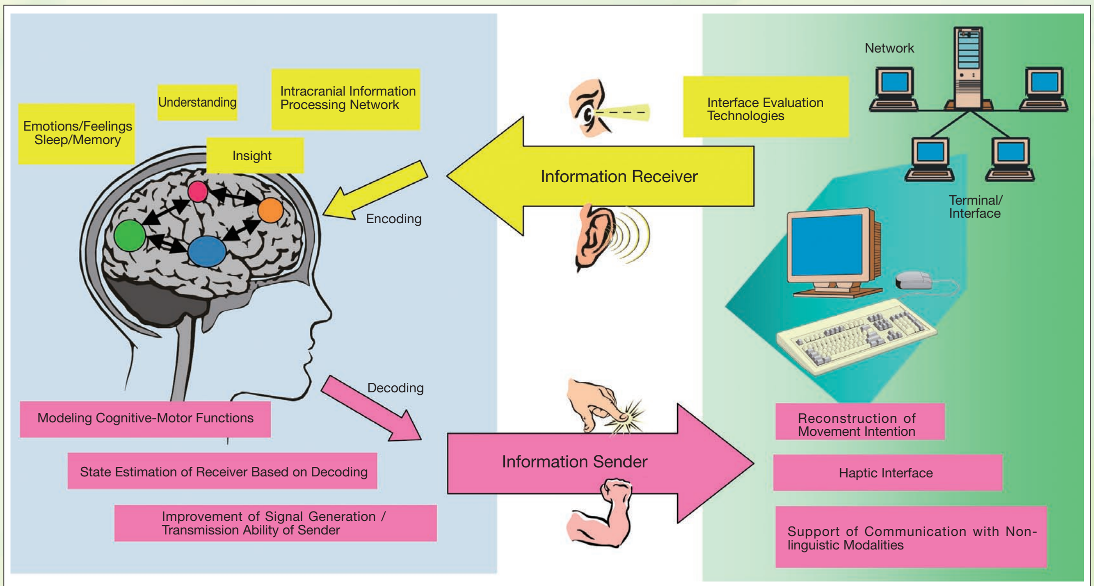


Figure 1: Schematic of Main Research Themes Studied by the Brain Research of Biological ICT Groups

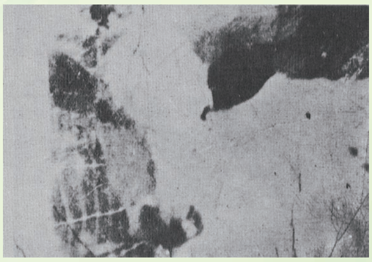


Figure 2: "Hidden Pictures" with which visual "understanding" and "insight" can be experienced (Answer is at the end of the article.)

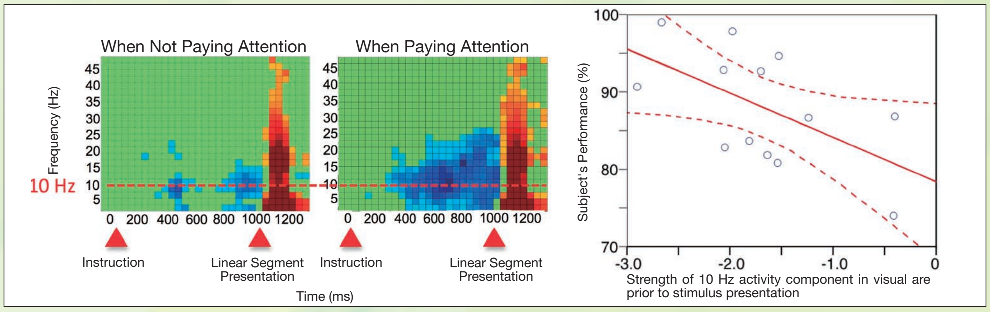


Figure 3: Estimating Human Attention/Preparedness from Brain Activity (Red indicates that the frequency component is high, blue indicates it is low.)

ambiguous by using contextual information. For example, the word "KO-EN" by itself is ambiguous and has multiple meanings, but after presenting the word for "a stroll," its meaning is singularly determined. In this way, the brain network that serves an important role when resolving ambiguity based on contextual information was successfully identified. In communication, what meaning is received from sensory data, and how it is understood by that person, are critical. We have found that by measuring the activity of an identified network, it is possible to evaluate whether a particular word latently possesses multiple meanings for that person.

Communication of brain information from the viewpoint of the sender

When viewed from the perspective of the sender as well, present-day information communication is beset with various problems. First, in communication that does not involve an encounter through a communications terminal, one problem is that it is extremely difficult to infer whether one's counterpart is in a state receptive to listening to one's conversation. In addition, the operation of information terminals is becoming more complex as their functions increase, and for those that cannot keep pace, the information gap is widening whereby reception and transmission of necessary information is becoming increasingly difficult. Even for those capable of performing the operations, there is a constant desire of wanting to convey imagined images and intentions without performing cumbersome operations. In order to solve such problems, in the Biological ICT group we are engaged in the development of technologies for estimating a receiver's attention/preparedness from his/her brain activity, as well as extracting intentions from brain-derived information.

Research manager Yamagishi and colleagues have shown that it is possible to estimate whether a person is truly paying attention by measuring brain activity in a place called the primary visual cortex, where visual information first arrives in the brain (Fig.3). They have shown that when the person is paying attention, the 10 Hz activity component of the primary visual cortex decreases, and moreover that the degree of this decline correlates with how well the subsequent task is performed as well as how often it is performed correctly. We think that this phenomenon may be used to develop an interface that estimates the target of interest and preparedness of the user based on his/her brain activity, and presents crucial information at the right place and time.

Researcher Shimizu and I are presently engaged in the development of technologies to estimate where a person's fingers are located based on brain activity when moving their fingers. By combining the brain activity measured from magnetoencephalograms and that from functional magnetic resonance images using a statistical technique known as the hierarchical variational Bayesian method, we have investigated the time courses of activity at accurate intracranial positions, and from their patterns we have succeeded in predicting the movement of approximately 10 cm of the fingers from the fingertips within a mean error of 1.5 cm. In the future, by increasing accuracy and conducting estimation in real time, we hope to parlay the results into the development of technologies that enable the precision operation of equipment without the need for cumbersome operations.

Future developments

Currently at NICT, a plan for a Brain Information Communication Fusion Project in collaboration with Osaka University is in the works. Brain research at NICT, including the Kobe Research Laboratories, as a forerunner of non-invasive technologies for measuring brain activity in Japan, has amassed many achievements. This accumulation of knowledge will be of direct use as a foundation for the fusion project. Furthermore, it is expected that by linking up with cutting-edge measurement technologies in the fusion project, the technologies introduced in this article–including those for evaluating interfaces with brain activity as indices, and those for extracting attention/preparedness or movement intentions from brain activity–will elucidate physiological foundations and increase in speed and accuracy at the same time. Thus, it is expected that the technologies will make great advances toward practical applications. In addition, by coordinating with a comprehensive University such as Osaka University, we think that avenues will open up for these technologies to be used widely in daily social life through the fusion of sciences in the humanities such as sociology, economics, philosophy and psychology (The answer for Fig 2 is cow).

Development of Atomic Force Microscope Functioned in Liquid with Atomic Resolution

A Technology to Visualize Atoms/Molecules on Surfaces in Liquid with Sub Nanometer Precision

Profile

Shukichi Tanaka

Group Leader
Biological ICT Group
Kobe Research Laboratories
Advanced ICT Research Center

After completing a doctoral degree at Nagoya University Graduate School, engaged as research assistant and later associate professor in the Department of Physics, Faculty of Science and Engineering, Saga University, and after an engagement as a research fellow in the Department of Solid State Physics, the University of Geneva in Switzerland, joined the Communications Research Laboratory (current NICT) in 2002. Engaged in research on the development of ultra-fine measurement, nano-process, and molecular nano-device technologies. Specializes in nanostructure properties, physics of substance development, and biomaterials applications. PhD. in Physics

Future ICT depicted by molecular nanotechnology

With the drastic development of Information and Communication Technology (ICT) , various kinds of obstacles–such as the difficulties to miniaturize electronic device components, and the explosive increase in energy required for information processing –are emerging. In the Nano-ICT research group, we are trying to find clues to overcome these difficulties from the view point of molecular nanotechnology. The molecules focused in our research are organic molecules that are chemically synthesized in mass-productive style by chemical reactions through liquid from elements such as hydrogen, carbon, oxygen. The typical size of each molecule should be only a few nanometers. We utilize these small nano-scale molecules and their unique functions towards the innovation of device and sensor functions for a high-performance and high-efficiency ICT system in next generation. This is the technological concept of molecular nanotechnology proceeded in our research project.

A technology that visualizes nanoscale molecular structures (FM-AFM)

In order to utilize organic molecules for device elements, it is necessary to have certain experimental methods of handling these nanometer sized molecule units at the appropriate spatial resolution. For this purpose, the Scanning Probe Microscope (Scanning Tunneling Microscope; STM) or the Atomic Force Microscope (AFM) are generally used. While non-contact and non-destructive observations at excellent spatial resolution are possible with STM, this technique can only be applied to measure electrically conductive samples and is not suited for observing device structures. Using conventional AFM, it is easy to observe even non-conductive materials, however, the spatial resolution of AFM is not as high as that of STM.

An Atomic Force Microscope operated by frequency modulation mode (Frequency Modulation-AFM; FM-AFM) has been receiving attention as an experimental method that possesses both the high spatial resolution of STM and the wide applicability of AFM. In this method, a cantilever with a probe formed at one end is oscillated with a piezoelectric actuator placed on the pedestal region. This oscillation is read out with a displacement sensor using a laser beam, and is then positively feed-backed to the piezoelectric actuator after appropriate processing of the signal. This is just like bringing a microphone close to a speaker, which are connected to the same amplifier. And by adjusting signal processing conditions the cantilever spontaneously starts self-induced oscillations (howling) at its resonance frequency (~300 kHz) with extremely high quality factor. In this condition, when the apex of cantilever probe is approached to the observational target within a few Å (just before contact), its oscillation frequency changes slightly in response to the relative distance between these two. This information is used to regulate the distance between the probe apex and the observed surface in

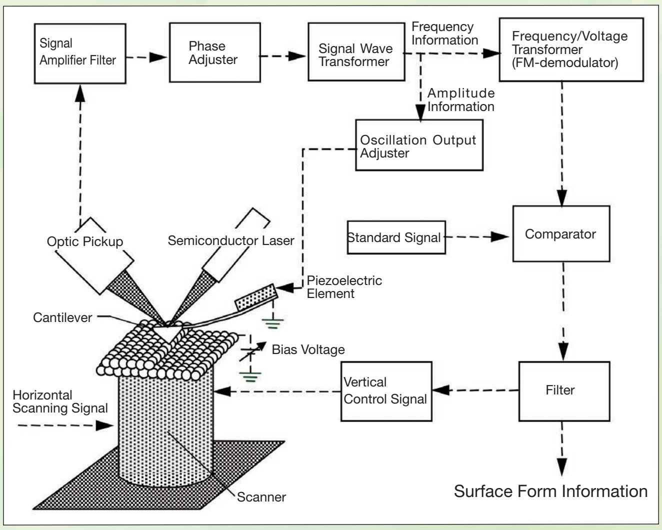


Figure 1: Operational Diagram of FM-AFM

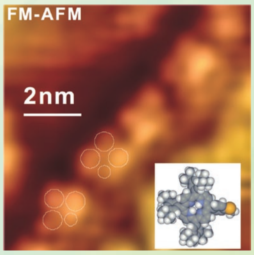


Figure 2: A High Resolution Image of Porphyrin Molecule Arrangement Obtained in Vacuum by FM-AFM
The insert shows molecular 3-dimensional form obtained by theoretical calculations.

order to trace the surface by probe apex without touching the surface, so that topographical information of the surface can be obtained from the motion of the probe. Because the signals of frequency shift detected by this method respond sensitively to the distance between the probe and the observed surface, the spatial resolution becomes theoretically comparable to that of STM. This method is indeed the only one reliable method to observe organic molecules on the surface with the single molecule scale regardless of their electrical conductivity.

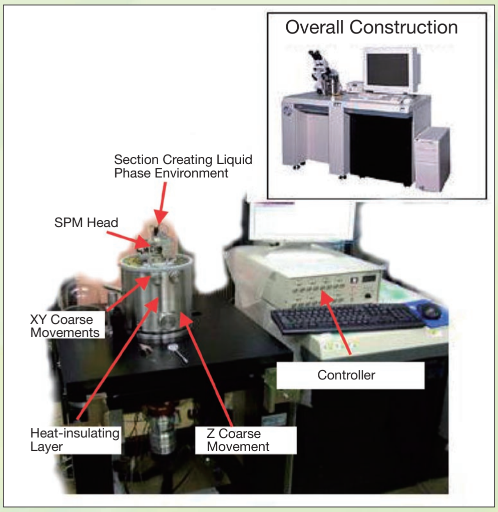


Figure 3: Test-constructed and Developed, Solution FM-AFM Device

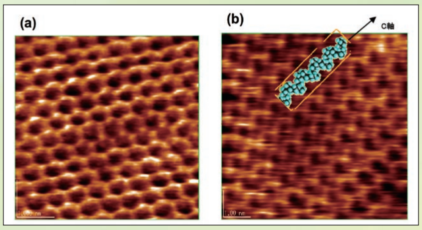


Figure 4: Image of Atomic Arrangement Observed at a Surface in Solution
(a) Mica Surface, (b) Polypropylene Surface
Both (a) and (b) are 50 Å a side. The insert in (b) shows the correspondence between the atoms comprising polypropylene and the surface arrangement pattern.

Developing a solution-operated type of FM-AFM

The operation of FM-AFM requires precise feedback loop control. For this reason, this method was commonly used in vacuum environments where external noise is very little. While a clean and stable vacuum environment is favorable for adjustable observation process in nano-meter scale, it is difficult to combine these processes to other kinds of process, such as the chemical reaction in solutions, which are necessary for utilizing the specific chemical reactivity and functionality of organic molecules. While in principle it is not impossible to operate FM-AFM in a solution, various technical obstacles should be solved to achieve a performance level comparable to that seen when using a vacuum condition. For example, in order to obtain a stable self-induced oscillation, a greater energy input is necessary in a solution than in a vacuum due to the presence of the viscosity or fluidity in the vicinity of the oscillating cantilever. On the other hand, strong input energy should spoil the sensitivity of AFM detection. Furthermore, the cantilever oscillation may cause another oscillations of the surrounding solution and of other parts via this medium, which are then deflected back to the cantilever resulting in a confusing state of affairs. The thermal Brownian motion (random motion phenomena) of solution molecules will also have adverse effects on measurements. In order to actualize FM-AFM measurements in this inferior environment that are comparable to those in a vacuum, it is essential not only to improve the noise tolerance of the device itself, but also to develop such items as sophisticated excitation circuits that self-oscillate stably even with low input energies, and displacement sensors capable of detecting with high precision even miniscule changes in oscillation amplitude or frequency.

The solution FM-AFM device which I test-constructed is shown in Figure 3. This is the specially designed SPM system which uses the conventional scanning probe microscope (JSPM-5200) manufactured by JEOL Ltd. as the base, to which improvements necessary for operation in solution have been added. At present, the development has reached the technical level with which it has become possible to visualize the atomic corrugation image of mica substrate, a typical insulating material as substrates, and of polypropylene, a polymer compound, extremely stably and at high spatial resolutions even in liquid. This research and development is just one step away from realizing performance levels comparable to those of FM-AFM in a vacuum.

A single molecule scale solution process linking nano and bio

For the information and communications technology in future, interfacing technologies that seamlessly connect humans, environments and information, will become important. In order to respond to this need, new technologies founded on novel concepts should be explored such as creating devices from biophilic materials, or detecting and processing target signals using methods with biological mechanisms of information usage. The various biological activities performed in living cells always involve solutions and solvents, and within these, nanometer size microstructures are constantly exchanging substances and information. These are very similar to the technological scheme of "handling functions and structures of nanometer size organic molecular bodies at the single molecule level" to which we are aspiring, and there is considerable promising potential for the in-liquid FM-AFM technology itself to develop into a nano/bio applied fundamental technology in the future. With this technology as a stepping stone, I hope to bring nano and bio closer together, and to develop it towards breakthroughs in advanced ICT technology.

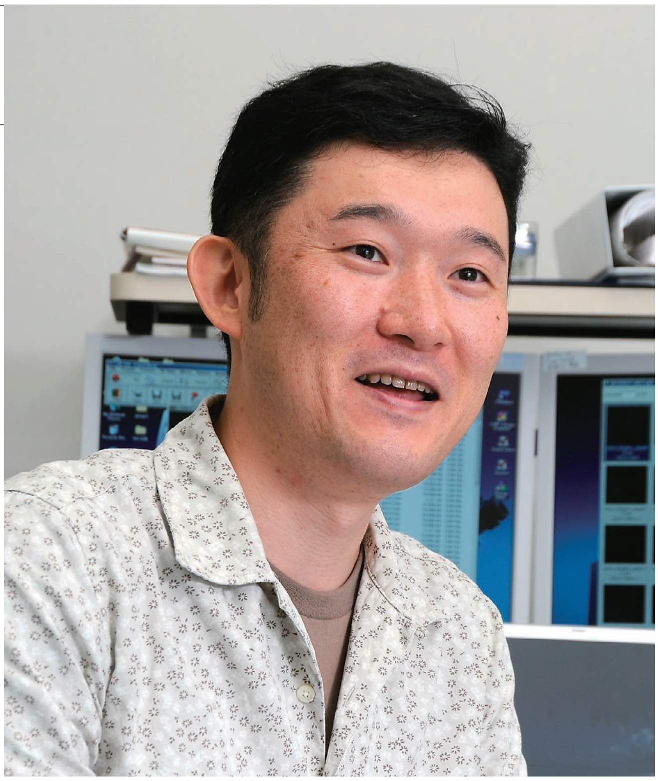
Acknowledgements

For the research results introduced here, I received a great deal of technological cooperation from JEOL Ltd. I herein express my gratitude.

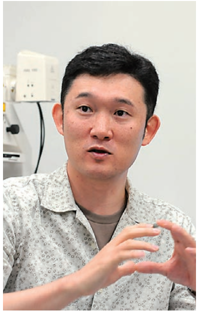
Explanation of units
1 nanometer (nm) is a thousandth of a thousandth of 1 mm.
1 angstrom (Å) is 0.1 nanometers.

Growing Expectations for Applications to Nanodevice Elements

Discovery of a Mechanism for Differential Transport of Nuclear Proteins to Two Types of Cell Nuclei in Tetrahymena



Profile



Masaaki Iwamoto

Biological ICT Group
Advanced ICT Research Center

After completing the graduate school, following stints as a doctoral research fellow at the University of Hawaii and as a special investigator at the Science and Technology Promotion Program CREST (Core Research of Evolutional Science and Technology), joined the National Institute of Information and Communications Technology in 2007. Engaged in research on elucidating mechanisms that regulate intracellular genetic information, as well as research aiming towards applications to the development of information and communications technologies. Doctor of Science

An idea from college years brought to fruition at NICT

As the latest result from the Biological ICT Group, which shoulders one wing of the Kobe Research Laboratories Advanced ICT Research Center, the discovery of a mechanism for differential transport of nuclear proteins to the two types of cell nuclei (macronuclei and micronuclei) in the ciliated protozoan Tetrahymena has been receiving much attention. Masaaki Iwamoto, Expert investigator is one of the researchers involved in the revolutionary discovery.

"It had been known since long time ago that Tetrahymena was an unusual organism that possesses two types of cell nuclei. Normally the organism retrieves and uses genetic information from the macronucleus only, but when it comes down to creating the next generation of offspring, it passes the information in the micronucleus on to its offspring and disposes of the information in the macronucleus it had been using for living. Everyone had been wondering how this was functionally regulated and what were the mechanisms involved."

While Iwamoto, Research Fellow, had long held the idea that would lead to this discovery, it was only after being able to use NICT's complete facilities that his research vision was finally realized. He says that the technology which he specifically used was the visualization of target proteins using the green fluorescent protein, for which Dr. Osamu Shimomura received the Nobel Prize in Chemistry last year.

"By placing a green label on a protein, you can find out where that protein is located within the cell. However, there were aspects which were rather difficult in Tetrahymena. I became adept at using the green label exactly the way I wanted to, searched for differences by expressing the green label in many nuclear proteins, and studied their localization."

An "art" that cannot be understood from sentences

However, for a while the fluorescent proteins refused to light up even when using the established methods reported in other studies, and Dr. Iwamoto explains that it took nearly a year to make the first type of protein glow. What broke open the bottleneck was somewhat of an "art" that cannot be understood simply from the sentences of methodology written in the other articles. He feels that such an art, which is difficult to explain in words, is very important, particularly in biological research.

It was about 1 year ago that Dr. Iwamoto submitted the manuscript for publication describing the discovery of the protein Nup98, which comprises the nuclear membrane pores connecting the cytosol with the inside of the nucleus, and exists in macronucleus specific and micronucleus specific forms. After having gone through revisions, the research was published in the May edition (April for the electronic version) of the journal Current Biology, which has a 20% acceptance rate.

Dr. Iwamoto is expanding his dreams: "This time, we found differences in proteins at the entrance, or in other words, in the passages to the nucleus. By using these proteins as the elements for nanodevices, might it be possible to create selective filters? I am hoping that this discovery will lead to the creation of new structural foundations which can be applied to future information and communication systems."

Approaching 20 Years since Establishment of the Kobe Research Laboratories

Cultivating the Terahertz Range

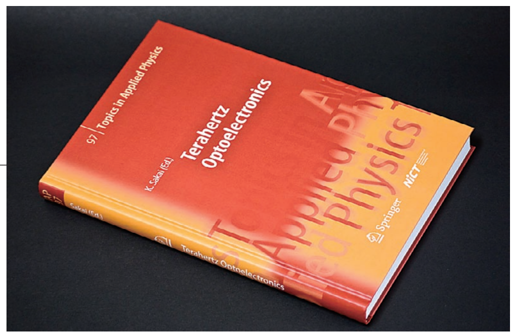
Kiyomi Sakai

The frequency range on the border between lightand radio waves has been called the last un-tapped range, and is now receiving much attention under the label "Terahertz". By current definitions, this indicates frequencies in the range of 100 GHz to 10 THz. I began my life as a researcher in a laboratory in the Faculty of Engineering of Osaka University, which pioneered in this area, so you could say that research in this area is my life's work. Since becoming a member of the newly established KARC in 1990, I began research in the field of new quantum electronics. In 1984 Prof. Auston from the USA had opened the field with his method for transmitting and receiving terahertz (THz) waves by excitation with ultra-short optical pulses using a photoconductive switch. At the beginning of the 1990's, femtosecond lasers came onto the market and his method rapidly spread around the world. I also quickly adopted it as one of the research themes of the laboratory. Non-linear optics and THz quantum cascade lasers, which were successfully achieved for the first time in 2002, have recently become the core of innovative electromagnetic technology, and conferences related to these are now very active. I'd like to add that NICT also took the initiative in Japan for both photoconductive switches and quantum cascade lasers.

Solid body and molecular research, space science, and plasma diagnostics, were some of the applications of electromagnetic waves in this range before 1990, and the 2006 Nobel prize in physics, "Measurement of Cosmic Background Radiation," further motivated mastery of technology in this area. Since 1990, applications of these technologies have spanned many fields, including active use in spectroscopy and imaging, security, analysis of nanomaterials, biological and medical applications, agricultural products and food and remote environmental sensing, but I believe in the future the focus will be on communications, new materials and biological applications. In communications, the difference in speed between wired and wireless communication has been closing rapidly, and there is a new trend towards near-field wireless communication. Study of THz wireless communication has already begun around the world.

In 2003, the "Terahertz Technology Forum" made up of industry, government and academia was established to lead the other organizations in rapidly applying terahertz technology in industry. NICT, Aisin Seiki Ltd. and Technova Inc. have contributed to it greatly in many areas.

Finally, I would like to offer heartfelt thanks to the Kobe Research laboratories for its constant support for my research. I am also very thankful for the opportunity and privilege of publishing the results of that work in collaboration with the German publisher, Springer in K. Sakai (Ed.), "Terahertz Optoelectronics," (Springer, Berlin, 2005) (photo).



Profile

Kiyomi Sakai

Joined the Communications Research Laboratory (current NICT) in 1990 from a position as Assistant Professor in the Engineering Faculty of Osaka University. Director of the Second Special Research Laboratory. Engaged in research related to terahertz technology. Retired in 2000. Participant in SCAT. Chairman of the Terahertz Technology Forum. Guest Professor at the Fukui University Research Center for Development of Far-Infrared Region. Currently also engaged as a short-term research expert for NICT at the Kobe Research Laboratories. Doctor of Engineering.

Receiving the NAB Technology Innovation Award

— Exhibition Report from the NAB Show 2009 —

Kazuhiro Kimura,
Director of Project Promotion Office,
Universal Media Research Center

Award Ceremony

NICT Booth

- Date: April 20 (Mon) to 23 (Thu), 2009
- Venue: Las Vegas Convention Center (Nevada, USA)
- Participants: Approx. 84,000

NICT received an invitation to exhibit at the NAB Show 2009, which is the largest exhibition of equipment for the broadcasting industry in the world, held each April by the National Association of Broadcasters (NAB), an association unifying all regional radio and public broadcasting stations in the USA. We exhibited technology related to ultra-realistic communications, focusing on research activities of the Universal Media Research Center at the Keihanna Research Laboratories. A point that deserves special mention is the first-ever showing of a system able to display images photographed under natural light and then converted to holographic imagery in real time and full color, although small sized, using a technology called "electronic holography", which has been called, "the ultimate 3D video system."

Other systems were also introduced, such as a naked-eye 3D display system equipped with the 70-inch large-screen, an audio system able to correctly reproduce the audio anisotropy of each instrument using three sphere-shaped speakers, the gCubik hand-held 3D display, and a multi-sensory interaction system which, by reproducing tactile, audio, and 3D representations, is able to present the cultural treasure called Kaiju-budo-kyo, an ancient copper mirror, as though it were actually there. These were picked up and reported by various media, including Web news and YouTube.

NICT, together with NHK, received this NAB Technology Innovation Award, which was newly established at the exhibition this year. The award is presented to the organization contributing the most exhibits in advanced broadcast or communications technology R&D results and the demonstration that receives the most attention from the media at the NAB Show. We will continue to proactively announce research results through such an exhibitory activity in the future.

Opening Ceremony Held for the Sarobetsu Radio Observatory

Wakkanai radio observatory moves to Sarobetsu

Mamoru Ishii,
Director, Project Promotions Office,
Applied Electromagnetic Research Center

An opening ceremony for the Sarobetsu radio observatory was held on May 29.

The ceremony began at 15:00, with a greeting by President Miyahara from NICT, followed by congratulatory words from Eimitsu Kudo, Town Mayor of Toyotomi, where the facility is located. Then, Town Mayor Kudo, Shuichi Komuro of the Toyotomi town council chairman, President Miyahara, and NICT Vice President Hiroshi Ikegawa performed a tape cutting ceremony. President Miyahara then thanked them for their generous cooperation during the construction and presented Mayor Kudo with a certificate of appreciation. After a commemorative photo, guests were invited on a tour of inspection of the new facility, and the ceremony ended at 15:45. After the opening ceremony, starting at 16:30, a commemorative lecture was held in the Toyotomi community center hall. After a greeting by NICT Vice President Kumagai, the following three presentations were given.

"Is there absolute vaccuum high above the sky?"
Takashi Maruyama,
Applied Electromagnetic Research Center

"Aurora: A Gift from Space, and Nature in Antarctica"
Norio Nagahama,
Applied Electromagnetic Research Center

"Getting the Exact Time"
Mizuhiko Hosokawa,
New Generation Network Research Center


Certificate of Appreciation Presentation Ceremony


Presentation of the Certificate of Appreciation to Koichi Yokota, Mayor of Wakkanai (Left)

The presentations were very well received by the local attendees, who commented that they were very easy to understand, making the event a good start for active interaction with the local government.

On the previous day, May 28, a closing ceremony was also held for the Wakkanai Radio Observatory at its facility, which had been used since 1946 to make observations of the ionosphere and other phenomena.

Starting at 17:00, NICT Vice President Kumagai and Senior Researcher Takeshi Maruyama of the former Director gave greetings in the former Director office of the facility, and after that, a reception was held in the former observatory. The reception was a great success, sharing stories and memories among several tens of former co-workers, staff and others who had worked at the Wakkanai observatory.

Before the closing ceremony, Vice President Kumagai, Center Director Iguchi, and project promotion office Director Ishii paid a visit to the Mayor of Wakkanai, Koichi Yokota, presenting him with a certificate of appreciation for the town's cooperation over the many years in operating the observatory.

Scene of Tape Cutting
(From the left: Shuichi Komuro of the Toyotomi town council chairman, Town Mayor Kudo, NICT President Miyahara, NICT Vice President Ikegawa)

Announcement of NICT's Facilities Opened to the Public in Fiscal 2009

Each year, the National Institute of Information and Communications Technology (NICT) opens its facilities to the surrounding communities and the general public, introducing the research and other activities being done at each of its facilities.

In an effort to bring science closer to young people, this year we are also planning to our facilities with an experiential event for elementary, junior high school boys and girls, and family members.

For details such as the access to each facility, please refer to maps and instructions which can be found on their respective Web pages.

A View of NICT Headquarters Facility Opening to the Public in Fiscal 2008

NICT Headquarters (Koganei City, Tokyo)
http://www.nict.go.jp/
Date/Time: 10:00 to 16:00, Fri. July 24 - Sat. July 25;

Kashima Space Research Center (Kashima City, Ibaraki Prefecture)
http://www2.nict.go.jp/w/w122/ka/index-j.html
Date/Time: 10:00 to 16:00, Sat. Aug. 1

Keihanna Research Laboratories (Seika-cho, Soraku-gun, Kyoto)
Facilities are being planned to open in Novermber, during the Open House 2009.
Details will be announced in NICT NEWS and on the NICT Web page when they are finalized.
http://kccc.nict.go.jp/keihanna-lab/

Kobe Research Laboratories (Kobe City, Hyogo Prefecture)
http://www2.nict.go.jp/w/w103/
Date/Time: 10:00 to 16:00, Sat. July 25

Okinawa Subtropical Environment Remote-Sensing Center (Onnason, Okinawa)
http://www2.nict.go.jp/y/y222/okinawa/
Date/Time: 10:00 to 17:00, Sun. Aug. 23

※ Please finish the admittance to all of these facilities one hour before their closing time

Information for Readers

In the next issue, we will feature the New Generation Wireless Communications Research Center, where research for the ubiquitous-network society is being done.

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