National Institute of
Information and Communications Technology

NICT NEWS

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FEATURE

Toward ICT Innovation through Neuroscience

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Cover photo
7T-MRI located in the 2nd basement of the Center for Information and Neural Networks. It was the third such device in Japan when it was installed. Its 35 t superconducting coil generates an ultra-high magnetic field, 140,000 to 200,000 times that of the Earth's magnetic field, which is used to make measurements. The examination room is wrapped in a 271 t steal shield.

INTERVIEW

Neuroscience for ICT innovation

Toshio YANAGIDA

Director General of Center for Information and Neural Networks

After partially completing a doctoral program, He worked as a Professor at Osaka University, Distinguished Researcher at NICT, and then took his current position in 2013. He is also Director of the RIKEN Quantitative Biology Center. He researches "*Yuragi*" (fluctuation) as a basic mechanism of life. Awarded Person of Cultural Merit in 2013. Ph.D. (Engineering).

Society today is blanketed with giant networks exchanging huge amounts of information at high speed. They have rapidly increased comfort and convenience in our lives, but there are also major issues starting to appear, such as the increasing danger when cut off, as our dependence on networks increases, and the stress of being overloaded with information. There is hope that research on the information processing networks of living things, such as nerve cells and the human brain, will yield clues for solutions to these types of networking-related issues. We spoke with Dr. Toshio YANAGIDA, Director General of the Center for Information and Neural Networks (CiNet), which is operated jointly by NICT and Osaka University and is a base for such research.

A new research base, surpassing existing frameworks

— CiNet is located within the Suita Campus of Osaka University (Figure 1) near many other medical faculty research facilities. It is jointly operated by NICT and Osaka University, which is unusual. Could you describe the circumstances of how the research center came to be?

YANAGIDA Neuroscience has long been considered essential for innovation in information and communications, and actually, there has been activity in brain-related research at NICT for about 20 years already, (formerly the Kansai Advanced Research Center (KARC) in the Communications Research Laboratory (CRL), Ministry of Posts and Telecommunica-

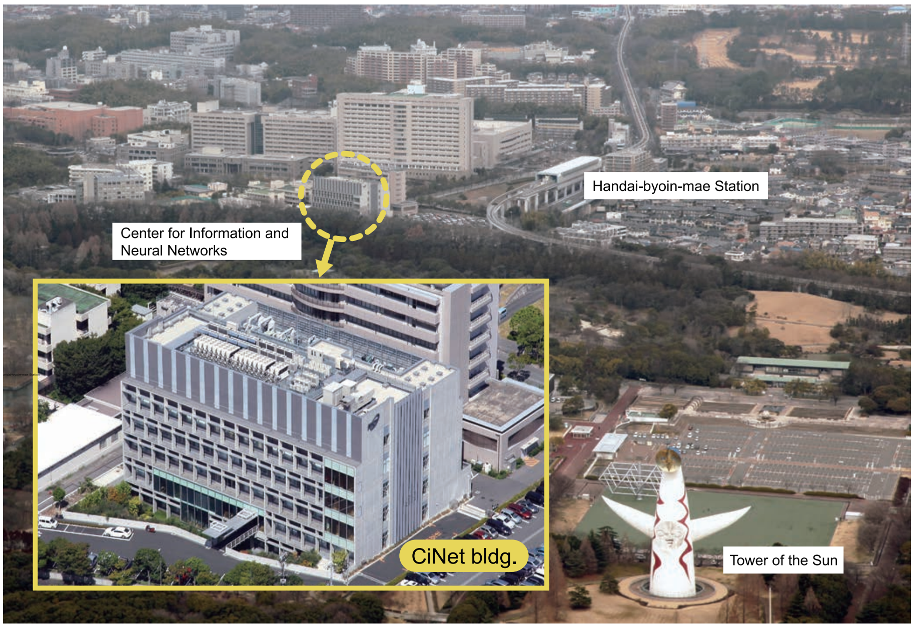


Figure 1 Center for Information and Neural Networks (CiNet)

Interview

Neuroscience for ICT innovation

tions). Collaborative research with universities has been essential in developing and expanding that research, which lead to the idea that a base on a university campus would also be good.

Osaka University is an excellent location for circulation of people, things and information, and there is a concentration of research facilities around the university, including companies related to ICT and bio-technology, so it is an excellent environment for collaboration with industry.

On another front, the Ministry of Internal Affairs and Communications (MIC) has also been backing neuroscience, with initiatives such as the Council on the Brain and ICT. These were all relevant in establishing the center.

I don't think there had ever been another case of NICT, which is operating under the jurisdiction of the MIC, establishing such a large base within a campus such as Osaka University, which is under the jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology (MEXT). I believe the above reasons contributed to achieving this organization, which surpasses all existing frameworks, but I also believe the basic, open-minded Osaka culture was also a factor, exemplified by the saying "if the big-picture is good, don't sweat the details".

Neuroscience brings an "evolution of quality" to information and communications

— What sort of connection is there between information and communications, which is basically a digital realm, and research on the brain—a living organism?

YANAGIDA A major objective of CiNet is to bring neuroscience into information and communications technology in the future, but this needs a little more explanation.

Till now, technologies for transmitting and receiving information using computers and radio waves have pursued all means of accurately processing and transmitting large volumes of data. As a result, we have achieved remarkable progress in technology that handles large volumes of data, but is that what people really want?... To what extent have we achieved a deeper understanding of where this information and communication really comes from?

If you think about it, it is human brains that ultimately send and receive this information. In all cases, "comfortably handling information to be sent or received," requires knowledge of the brain. That is the role of CiNet. It is a base for a paradigm shift in information and communications technology, from quantity to quality.

Various themes arising through cooperation and integration

— Here at CiNet, what sorts of research are you actually doing?

YANAGIDA We are conducting a variety of research, but visual recognition is one example. How is what people see processed within the brain? As this research advances, the quality of visual information in information and communication will improve, and we will better understand how to make it more comfortable for the brain.

Conventionally, issues involving mood could only be understood vaguely, using methods such as questionnaires, but at CiNet, we aim to capture emotion precisely, using instruments to measure subconscious brain activity quantitatively.

Brain-machine-interface (BMI) research relates to possibilities such as controlling a robot arm through brain activity, or conversely, directly accessing a brain for rehabilitation purposes, to make it operate correctly.

Measuring brain activity precisely could also be useful in areas such as delaying age-related deterioration of brain function or controlling pain in the future, and we are also con-

Figure 2 Experiment using the 7T-MRI

Figure 3 Analyzing data in the 7T-MRI operations room

ducting research in these areas.

Incidentally, the brain is an extremely complex network of nerve cells, but in spite of that complexity, it hardly consumes any energy. If we could explain its mechanisms, we may be able to build networks that consume orders of magnitude less energy than current networks.

The goal of CiNet within NICT is to analyze the operation of the human brain and use the results in information and communications, but cooperation with academia and industry, namely Osaka University and the Advanced Telecommunications Research Institute International (ATR), has brought together many researchers for even broader research.

Gathering the "Great minds of Japan" as another role

── Having a full complement of leading-edge equipment and instrumentation is another big feature of CiNet, isn't it?

YANAGIDA Neuroscience reflects the mainstream in life sciences, with research on mouse genetics being done around the world. NICT is conducting research on the human brain for use in information and communications, which requires technical development measuring activity in the human brain. NICT has technology for analysis to carry out this research, with a full range of equipment including a 3T (three Tesla)- MRI and a 7T-MRI, which are large instruments for measuring brain activity (Figures 2 and 3). This is top-class in Japan, and only a few other facilities in the world that are similarly equipped.

We have a full range of equipment that is freely available, and the administrative organization is in good order. This is more than just a good environment for the researchers we have now. It also attracts researchers back to Japan, particularly excellent young researchers in their 30s and 40s who have spread throughout the world because they could not get access to the research environment they needed here. It has the ability to regain and retain "Japanese brains".

Of course, it's only been a few years since the organization began, so it is not yet particularly well known outside the community of Japanese researchers, but if the researchers at CiNet produce a succession of excellent papers in the future, our reputation will grow and we should be able to attract excellent researchers from around the world.

Aiming for still more "Omoroi research"

── I noticed there is a large calligraphy work with the words, "おもろい研究" ("*Omoroi* research") hanging in the hallway. I was told that it represents your approach as the Director of the Center.

YANAGIDA Research done at a university, for instance, is field oriented. That is because each professor is pursuing research in his or her own specific field. In contrast, research being done at CiNet is mission oriented, advancing toward a particular defined objective. Of course, I believe that all of our researchers understand this. But I also say that, as long as it doesn't stray from our overall objectives, any "omoroi" research is acceptable.

So what is "Omoroi research", then? In Tokyo, when they say "omoshiroi," it is very similar to "interesting" in English, but "omoroi", in the Osaka dialect is different. It has a visceral, exciting, feeling that cannot be expressed in one word. It encompasses words like attractive, cool, and sexy. Omoroi research is research that gives people those sorts of feelings.

Though we are mission oriented, we cannot just give researchers commands like "Do this!" or "Do that!" and expect them to follow. People that obediently follow someone else's commands are not really qualified to be researchers. My ideal for CiNet is that it becomes a place that produces successive "omoroi" research, which cannot be measured simply by the number of papers in "nature" or "Science".

The calligraphy work with the words "Omoroi research" and Director General YANAGIDA

The 5th CiNet Symposium in Tokyo

Introduction of CiNet Activities

Takahisa TAGUCHI
Associate Director General of Center for Information and Neural Networks
After completing his doctoral course, he conducted research projects on neural circuit dynamics and industrial applications of brain science at the Institut Pasteur, Osaka University, and the Osaka National Research Institute (currently the National Institute of Advanced Industrial Science and Technology, AIST). He entered his current position at NICT in 2013. Ph.D. (Engineering).

The Center for Information and Neural Networks (CiNet) holds the CiNet Symposium each year to introduce research results to the public. These alternate between Tokyo and Osaka, and several hundred people participate each year. This article reports on the Fifth CiNet Symposium, held on June 17 at the Tokyo International Forum.

Research at CiNet

CiNet is a research center with a mission to explain operating mechanisms of human brain functions and systems, using the latest instruments such as a 7T-MRI, and to use that knowledge in applications of information and communications technology and other technologies such as robot control and analysis of human social behaviors. It is located on the Suita Campus of Osaka University, which facilitates promotion of collaborative research with organizations like Osaka University and ATR. It also has four magnetic resonance imaging (MRI) devices, two magnetoencephalographs (MEG), and equipment developed in-house, such as brain-wave analyzers and near-infrared spectroscopy (NIRS). It is one of the big centers in the world for advancing basic research to elucidate human brain function.

Fifth CiNet Symposium

The CiNet Symposium is held in Tokyo and Osaka in alternating years. It was held in Tokyo in 2013, when a new CiNet building was completed and an enriched research system was started, so the program was created to promote awareness of research directions at CiNet. This year, two years later, the fifth symposium was held in Tokyo on June 17, to promote several original research results from CiNet.

From the planning stages, this symposium was organized in cooperation with the Organization for Center of Innovation (COI) Research at Osaka University, with the main theme of "The neuroscience for displaying personal potential talents," reporting on research results on the latest technologies to extend the strengths of the brain and compensate for its weaknesses. COI is an abbreviation of Center Of Innovation, which is a large project of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), to accelerate implementation of major research results from universities in society. The Osaka University COI aims to activate human power based on brain science. CiNet is also participating actively in this project. See the following URL for information regarding activities at the Osaka University COI.
http://www.coistream.osaka-u.ac.jp/en/

Program

The program included an invited lecture by Dr. Tetsuro MATSUZAWA, Professor of the Primate Research Institute, Kyoto University, introducing research results on the human brain and using that knowledge to activate the human and social power, as well as four lectures introducing the work of CiNet researchers and COI researchers from Osaka University. There was also a panel discussion on the main theme of the symposium. In parallel with this program, many researchers presented details of their research in poster displays in the lobby of the auditorium. 368 people attended the event, listening enthusiastically to the lectures and discussing them energetically. The poster displays were also impressive, with lively discussion between researchers and many participants till after closing time.

Lecture details

In the invitational lecture, Professor MATSUZAWA spoke clearly and interestingly of differences between chimpanzees and humans, which are both hominids, from his long years of research on chimpanzees. As suggested by his title, "The power of imagination: Learning of the Human Mind from Chimpanzees," it hinted strongly that the ability to conceive of the future is a strength of the human mind.

Next, two research results deciphering the human mind were presented. First, Dr. Mariko OSAKA, Professor of Osaka University, reported on the mechanisms of working memory within the brain, in a lecture titled, "The mind's notepad." This was followed

Photographs, from the upper-left: Opening greeting from Dr. Toshio YANAGIDA, Director General of Center for Information and Neural Networks, invitational lecture by Dr. Tetsuro MATSUZAWA, and lecture by Dr. Masahiko HARUNO, Senior Researcher
Photographs, from the lower-left: Panel discussion, lecture venue, poster presentations

by a lecture titled, "Prediction and control of social behavior based on brain activity," by Dr. Masahiko HARUNO, Senior Researcher at NICT. It introduced details of new discoveries about function of the amygdala and showing that it could have applications measuring depressive tendencies. Dr. HARUNO, who is also an Osaka University COI member, explained how it may be possible to activate human power through stimulation of the brain.

At the forefront of neuroscience, there is increasing need for research on dynamics (dynamic structure) and how connections are made in networks within the brain, in order to illuminate brain function. Two lectures introduced research from the "network" perspective. Dr. Takeshi YAGI, Professor of Osaka University and Osaka University COI member, showed that the complexity and specificity of networks created by nerve cells is determined by the diversity of proteins called protocadherins. Also, Dr. Hiroshi IMAMIZU, Computational Neuroscience Laboratories, Brain Information Communication Research Laboratory Group, ATR, who is also a CiNet member, reported on research results in neuroscience taking psychology into consideration, titled "Technologies to learn of and compensate for weaknesses in neural networks."

These lectures introduced some of the latest results in neuroscience research, and showed attendees how we are gaining a deeper understanding of the human brain and mind, based on scientific measurements, and how "activating human power" based on this knowledge is not an unreasonable prospect.

CiNet going forward

About two and a half years have passed since CiNet began full operation in 2013, and it has already produced many advanced and original results. Another mission of CiNet is to contribute to new lifestyles and to improve society by developing implementations of these results in society. This will also require work to develop new information processing technologies such as practical large-scale data storage and technology to extract new information quickly from that data. Starting in FY2016, NICT enters a new medium-term planning period. Within it, CiNet will continue to work actively on these and other issues, advancing R&D that can contribute to society soon.

Research and Development on Practical BMI Technology

Takafumi SUZUKI
Senior Researcher
Brain Networks and Communication Laboratory, Center for Information and Neural Networks

After completing his doctoral course, he became a Research Associate, Specially Appointed Assistant Professor and Assistant Professor at the University of Tokyo and then took his current position in 2012. He is engaged in Neuroengineering and BMI research. He is a Guest Associate Professor, Graduate School of Frontier Biosciences, Osaka University. (Doctor of Engineering).

Hiroshi ANDO
Senior Researcher
Brain Networks and Communication Laboratory, Center for Information and Neural Networks

After completing his doctoral course, he became a Researcher, Graduate School of Advanced Sciences of Matter, Hiroshima University, before taking his current position in 2012. He is engaged in research on development of fully-implantable wireless BMI. (Doctor of Engineering).

Brain-machine interfaces (BMI) and nerve interfaces are technologies for connecting external devices directly to nerves in a living organism to input and output information and realize a variety of applications. This type of technology has been imagined in various ways in the world of science fiction for a long time, but recently, there has been great progress in BMI research and development in the real world as well.

Introduction

BMI can be classified broadly according to the nervous system (motor, sensory, autonomic) to which it applies and the direction of information flow (whether to extract information from the organism nerves, or to input information to them). In this article, we introduce the type of BMI that measures signals from motor nerves to control devices such as artificial limbs (motor-output BMI). This type of system holds promise for people that have lost limbs due to illness or injury, and will enable them to move devices such as artificial limbs or wheel chairs as they like.

Our research group is doing R&D on this type of BMI system in collaboration with the Department of Neurosurgery, Osaka University Medical School, medical instrument manufacturers, electronic systems manufacturers and research groups at other universities. Below, we first describe the types of nerve signals used with motor-output BMI and then introduce a first-generation system that we hope to make practical (clinical research) in the next few years, and a second-generation system that we hope to implement about ten years after that.

The electrocorticogram

The signals used by the BMI system we are developing are called electrocorticograms (ECoG). These are brain waves measured by opening part of the cranium and placing a sheet of electrodes on the exposed brain surface. Placing the electrodes requires craniotomy surgery, but this procedure is commonly used for other purposes such as investigating brain areas that cause epilepsy. Compared with a scalp electroencephalogram (EEG), stronger signals can be measured because electrodes are closer to the brain, the source of the signals, by the thickness of the scalp and cranium. The ECoG is superior for reading motor signals in particular, because signals in the high-

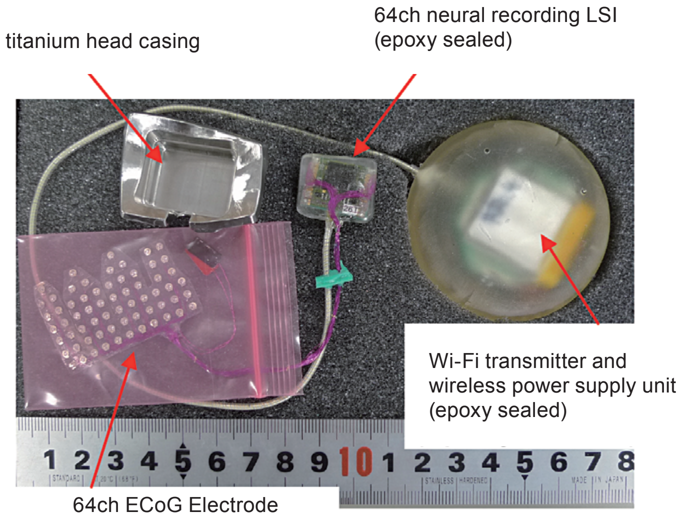


Figure 1 ECoG-BMI system for animal evaluation

gamma band (approx. 60–200 Hz), which are very active with motion, are left un-attenuated. BMI systems using spike signals, measured using needle array electrodes that penetrate the brain, have been reported in the USA but issues with safety are difficult to resolve. For our clinical applications, using ECoG provided an appropriate balance between invasiveness (damage to the body) and signal quality.

A first-generation, 128-ch ECoG BMI system

To avoid risk of infection where cables penetrate the skin when used over long periods of time, a BMI system must be built consisting of a fully-implantable, compact and waterproof device which then transmits the measured signals wirelessly out of the body. To achieve this, we developed a 5 mm-square LSI that amplifies nerve signals from a 64-channel (ch) ECoG electrode and converts them to a digital signal. This was done in collaboration with a group including Osaka University and Hiroshima University. We prototyped an entire system using this LSI and also conducted successful behavior trials using animals for six months (Figure 1).

Initially, we used Bluetooth and low-power Wi-Fi to transmit signals to outside the body wirelessly, but later moved to a more practical format usable in medical applications. We aim to realize a 128-ch system for clinical applications in a few years.

To increase the accuracy of estimations of movement intentions in ECoG BMI, at the animal trial stage, we also simultaneously measured ECoG and internal brain (cortex) signals at multiple points and attempted to analyze the relationship between them. To do this we used a flexible, high-density mesh ECoG electrode we developed earlier using a 20 µm-thick Parylene C (polychloroparaxylylene) substrate, together with a penetrating multi-point electrode. This work was done in collaboration with Niigata University and the National Institute for Physiological Sciences, Inter-University Research Institute Corporation, National Institutes of Natural Sciences Group.

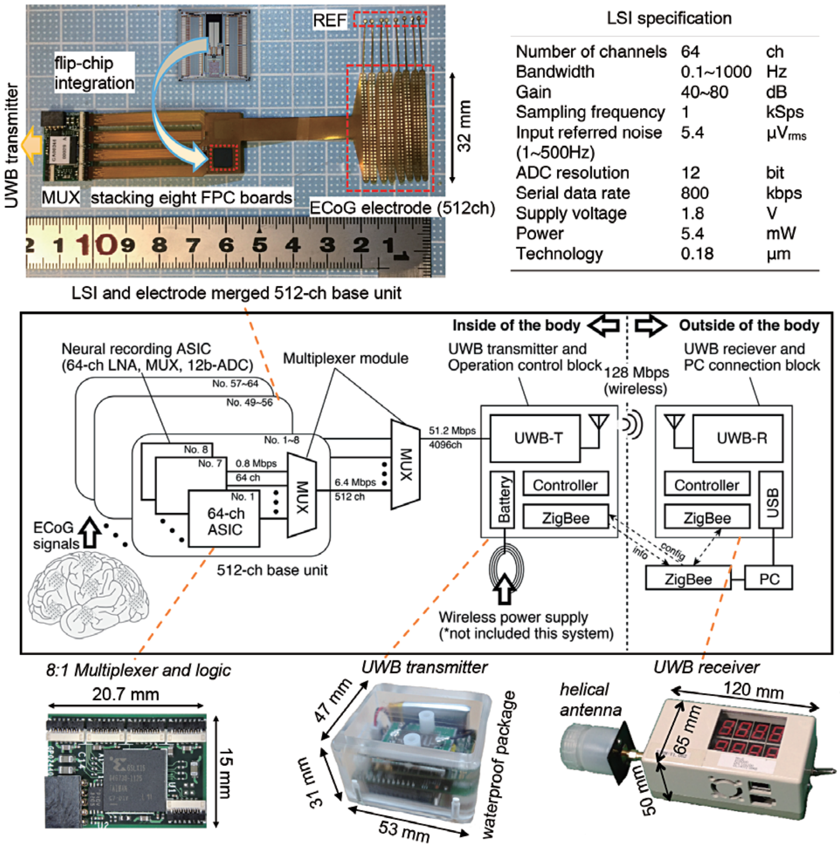


Figure 2 4096ch ECoG-BMI system

A second-generation, 4096-ch ECoG BMI system

To increase the accuracy of ECoG BMI still-further, we believe that it is necessary to increase the number of electrodes and thus, increase the amount of information obtained from the brain. With 100 electrodes in a 10×10 array at 3 mm spacing, information from a 30 mm-square area of the brain surface can be obtained. If we put 900 electrodes in a 30×30 array on the same area, information can be obtained at 1 mm-spacing, so it becomes closer to the size of the cortical column structure, which is a functional unit in the brain. Therefore, we are also developing a 4096-ch system to enable measurements in multiple regions including sulci (grooves) in the brain. To handle the additional complex interconnections between multiple electrodes and LSIs, we are also researching direct connections between electrodes and LSI, and have successfully prototyped a system using Ultra-Wide-Band (UWB) communication technology to advance the wireless communication component, which is becoming a bottleneck in the multi-channel system (Figure 2). The system functionality and effectiveness has been evaluated in 4096-ch wireless tests inside a liquid phantom simulating a human body, and also the response of somatosensory evoked potentials caused by stimulating lower limb nerve was successfully recorded in acute animal testing under anesthesia using a 512-ch base unit with UWB wireless system (in air).

Conclusion

As introduced above, our group is advancing R&D toward practical implementation, and researching technical elements that will realize revolutionary new systems. Other related research and our preliminary experiments are suggesting that living brains are so flexible (plastic) that they accommodate (adapt) to BMI systems rapidly, soon after they are connected to them. Simultaneously with this process, neurological research is also advancing on what is actually occurring within the brain.

Research and Development on Objective Medical Diagnosis through Network Science

Analyzing complex networks of diseased brains measured by fMRI

Tetsuya SHIMOKAWA
Senior Researcher
Brain Networks and Communication Laboratory, Center for Information and Neural Networks

After completing his doctoral course, serving as Research Associate and Specially Appointed Associate Professor at Osaka University, he joined NICT in 2010. Since then, he has been engaged in research on network analysis of the human brain. Ph.D. (Engineering).

An objective, data-based method for diagnosing schizophrenia does not yet exist, so psychiatrists currently establish their diagnoses based on patients' subjective reporting of symptoms. Our laboratory, in collaboration with the group of Dr. Ryota HASHIMOTO, Associate Professor, United Graduate School of Child Development, Osaka University, has developed a stable method for estimating characteristic brain area modules in both a schizophrenia patient group and healthy control group, by color coding (module extraction) according to the similarity of at-rest brain activity images.

Background

As neurological research has grown and accuracy of brain measurement technology has increased recently, it has become feasible to study methods for the diagnosis of psychiatric disorders through the use of functional Magnetic Resonance Imaging (fMRI), which can measure brain activity with high spatial resolution. Schizophrenia is a psychiatric disorder that occurs in approximately one in 100 people. It is diagnosed from symptoms by a doctor, but no effective tests or other objective diagnosis methods have been established yet.

In conventional analysis of brain-activity measured by fMRI, emphasis has been placed on identifying areas related to specific functions, such as areas involved in memory, but, as research has advanced, interactions between multiple brain areas have become apparent as possible origins of certain functionality or disorders.

Network science

Network science studies the overall pattern of interactions in a system rather than looking at individual parts. In analyzing schizophrenia data, we focus on what are called "modules" in network theory (Figure 1). The brain can be seen as a large-scale complex system in which a huge number of elements is combined in complex ways. To analyze and understand the brain, it must be divided into groups of intermediate sizes ("modules") and reduced into a simplified system composed of fewer elements. Especially in cases like schizophrenia, where it is difficult to identify specific areas that are the cause of the disorder, simplification of the system through the analysis of the module structure in this way may be effective for understanding and even treating disorders.

Issues with earlier research

In earlier brain research there are various studies in which module extraction is applied to the analysis of the brains of individuals, but the integrated analysis of groups of several tens of subjects has not yet been well-established. The greatest reason that there has been little progress in research so far is the large variation in module structure between individuals. This makes it difficult to estimate the module structure that characterizes a group. To distinguish between a healthy control group and a patient group, an appropriate index must be selected, so that there is little variation within the same group, but significant differences when comparing between groups. This has not yet been accomplished for group module structures.

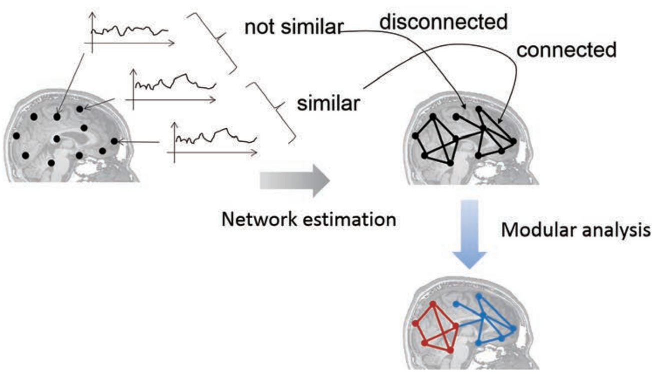


Figure 1 Brain function network module estimation
Brain networks are estimated by obtaining time-sequence data of neural activity in different parts of the brain, using MRI measurements. It is difficult to make observations directly inside the brain, so data obtained from any two locations in the brain are compared, and if they are similar, they are considered "connected", otherwise they are considered disconnected. The technique for constructing a network measured in this way, and subsequently grouping parts that are tightly connected is called modular analysis. The figure shows the case where two modules are estimated and shown with colors coded as red and blue.

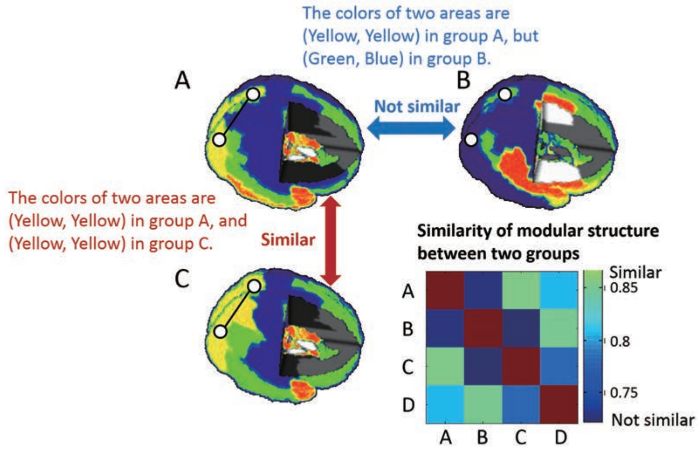


Figure 3 Similarity of module estimates (encoded by colors)

Results

In this research, our research group proposed a new method that attempts to perform module extraction (color coding), not according to individual subjects, as in the conventional way, but for all subjects of the same test group simultaneously, without averaging the data. At the same time, differences between subject groups of healthy control and schizophrenia patients are considered with respect to their resting brain activity measured by fMRI. Whereas, earlier research focused on modular analysis on an average brain, we have conducted modular analysis on the brains of all subjects together, thereby considering similarities among subjects in the same group, and subsequently averaging over all subjects together to filter out variations among individuals in the same group. In other words, we have reversed the order of averaging and modular analysis. Using this method reduces the variation in the results, allowing for stable module extraction that characterizes the subject group (Figure 2). Modular analysis was conducted on a patient group and a healthy control group, each of 37 subjects, and this resulted in our first data set. Five characteristic modules were found for each group. The colors themselves have no particular meaning and unlike in the usual case red does not necessarily indicate more activity. Rather, the importance lies in the color boundaries. To check the validity of the results, we created a second, completely different, data set using the same analysis on groups of patients and healthy control subjects with 36 subjects each. These produced similar extracted modules (as separated by color coding).

We use the expression, "similar," but similarity of color coding could be defined in various ways. We introduce one such way below. We prepared a patient group and a healthy control group for each of the two data sets, then performed module extraction on a total of four groups, and finally compared them for similarity. Similarities are shown in Figure 3, with A indicating the patient group and B the healthy control group of the 1st data set, and C indicating the patient group and D the healthy control group of the 2nd data set. Similarities were determined according to the following procedure.

1. Select two brain areas (two are needed to compare boundaries) and compare colors in both groups.
2. If two areas have the same color in both groups, then the two brain areas are considered similar.
   (e.g.: A (yellow, yellow), C (yellow, yellow))
3. If two areas have different colors in both groups, then the two brain areas are considered similar as well.
   (e.g.: A (blue, green), C (yellow, green))
4. If two brain areas have the same color in one group and different colors in another group, then the two brain areas are considered dissimilar.
   (e.g.: A (yellow, yellow), B (green, blue))
5. Select two different brain areas, and repeat procedures 2 to 4. Study all pairs of brain areas, calculate the ratio of similarity, and use it as the level of similarity.

We expected that the patient groups (A and C) and the healthy control groups (B and D) would be similar, and conversely that A and B, A and D, C and B, and C and D, would all be dissimilar. Figure 3 shows that the results were as expected.

So, what can be learned from this method to extract modules? In the healthy control group, there is one large module ranging from the occipital (back) to the parietal (front) areas. These experiments were done at rest (i.e., no task being performed by the subjects), and the so-called "default mode" can be seen as a broad active area in the healthy group. However, when looking at the same area in the patient group, it is generally divided into three modules. This suggests that the area that is normally active at rest in a healthy person is not operating properly.

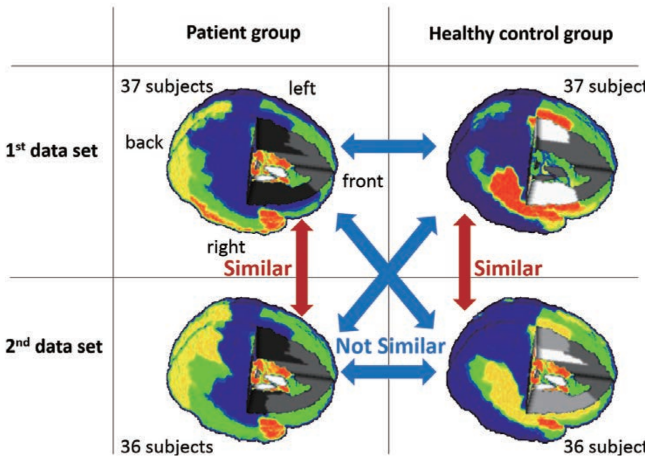


Figure 2 Module estimation based on the similarities of internal brain activity (encoded by colors)

Future prospects

At this time, there is no objective, data-based method for diagnosing schizophrenia, and psychiatrists establish a diagnosis based on a patient's subjective reporting of symptoms. As such, the method we have developed and its use as an objective diagnosis method based on merely brain image data, not affected by patients' subjective opinions, has attracted attention in the field of psychiatry. Because of this, there are strong prospects for the development of an automatic diagnosis system for use in clinical settings, which will complement doctors' diagnoses.

Report on the NICT Special Summer Open House for Children

The NICT Special Summer Open House for Children was held at NICT headquarters on July 23 and 24 (Thu.& Fri.), and was attended by 962 visitors.

This year we had hands-on classes for upper grades of elementary students, a lecture on South-pole and North-pole, and various guided tours (Japan Standard Time, Space Weather Forecasting, the airborne Polarimetric and Interferometric Synthetic Aperture Radar (Pi-SAR2) system, the Space Communications Exhibition Room, and the Space Optical Ground Station Center). There were also many activities in the participatory exhibits, including 3D images of space debris, different types of encryption, the principles of how clouds form, and the mysteries of light using polarizing plates and diffraction gratings.

Hands-on class

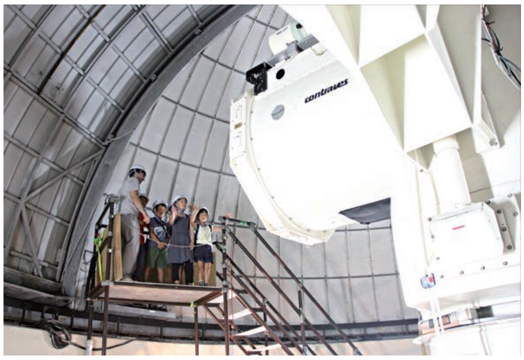
Build an animation projector while learning about motion video mechanisms

Lecture on South-pole and North-pole

Lecture from NICT employee who conducted observations and research on location

Guided tours

Space Weather Forecast



Space Optical Ground Station Center

Participatory exhibits

Experiencing the wonders of light with a polarizing plate box

Experiment demonstrating the principles of how clouds form

Try to decipher various encryption types

Experience the sound of South-pole ice melting (in cooperation with the National Institute of Polar Research)

Report on Open House 2015 at the Advanced ICT Research Institute

Experience the Future of Information and Communications Technology!!

Open House 2015 at the Advanced ICT Research Institute (in Kobe) was held on July 25 (Sat.). The day was blessed with fine weather, and the event had 503 visitors. Most of the visitors participated in the quiz rally, which has been very popular in the past years, visiting each exhibit booth in the order of the quiz, while enjoying experiential exhibits of the researchers' work and interacting with them.

Public lectures were held for the 8th time this year. Lecturers explained their latest research using familiar examples. Nearly all seats were filled in the event.

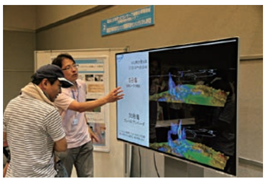
Exhibit booths

Experiencing "polarization" by creating a sparkling kaleidoscope

Extracting broccoli DNA

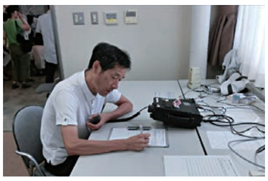
Introducing the latest research using quantum mechanical properties, such as quantum cryptography, quantum communications, and quantum clocks

Experiencing brainwave measurements using an electroencephalograph developed by NICT



Introducing rain observations using phased-array weather radar

Explaining the generation and distribution of Japan Standard Time



Public operation of 8N100ICT, a limited-term special amateur radio station, commemorating the 100th anniversary of Hiraiso Radio Laboratory

Introducing the proper use of electromagnetic waves (Kinki Bureau of Telecommunications, Ministry of Internal Affairs and Communications)

Lecture

8th public lectures

New-generation superconducting device
—Toward ultimate information and communications—
Dr. Taro YAMASHITA
Senior Researcher, Nano ICT Laboratory

Observation of a moment of memory formation on the feeding command neuron
Dr. Motojiro YOSHIHARA
Senior Researcher, Bio ICT Laboratory

Development of a conceptually new weather radar
—Aiming at early detection of localized heavy rainfall—
Dr. Minoru KUBOTA
Director of Radiowave Remote Sensing Laboratory,
Applied Electromagnetic Research Institute

Awards

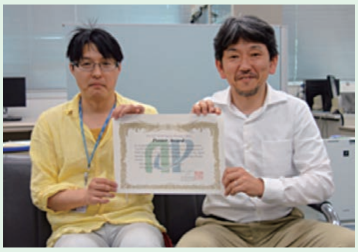
Kazumasa MAKISE / Research Promotion Expert, Nano ICT Laboratory, Advanced ICT Research Institute
Hirotaka TERAI / Research Manager, Nano ICT Laboratory, Advanced ICT Research Institute

The Japan Society of Applied Physics

Poster Award (**April 1, 2015**)

Manufacture and evaluation of NbN tunnel junctions on a TiN buffer layer

We are very happy to have received this award recently, for research our group has been working on for many years on niobium nitride thin film device applications. We would like to express deep gratitude to the many people supporting this research and leading to this award. This technology is a first step toward our goal of the ultimate superconducting device, and we will continue to work even harder toward this goal.



From the left: Kazumasa MAKISE, Hirotaka TERAI

Yasuyuki ICHIHASHI / Planning Manager, Strategic Planning Office, Strategic Planning Department (temporarily transferred to Cabinet Office, Government of Japan)
Kenji YAMAMOTO / Director of Ultra-realistic Video Systems Laboratory, Universal Communication Research Institute

SPIE-the international society for optics and photonics

The Fumio Okano Best 3D Paper Award (**April 21, 2015**)

Integral photography capture and electronic holography display

This award was created by SPIE in memory of Fumio Okano, who made great contributions to the development of 3D imaging technology. The award ceremony was held in the USA, with the SPIE President and members of Prof. Okano's family participating.

The paper receiving the award discusses a method that takes 3D information based on ray theory and reproduces it based on wavefront theory using holography, so the approach follows a different line of inquiry than earlier methods such as stereo viewing. On this point it was evaluated highly and received the award. I would like to express deep thanks to all who provided support for receiving this award.

Kenji YAMAMOTO

Jyunpei UEMOTO / Senior Researcher, Radiowave Remote Sensing Laboratory, Applied Electromagnetic Research Institute
Tatsuharu KOBAYASHI / Senior Researcher, Radiowave Remote Sensing Laboratory, Applied Electromagnetic Research Institute
Makoto SATAKE / Senior Researcher, Radiowave Remote Sensing Laboratory, Applied Electromagnetic Research Institute
Shoichiro KOJIMA / Senior Researcher, Radiowave Remote Sensing Laboratory, Applied Electromagnetic Research Institute
Toshihiko UMEHARA / Research Manager, Radiowave Remote Sensing Laboratory, Applied Electromagnetic Research Institute
Takeshi MATSUOKA / Senior Researcher, Radiowave Remote Sensing Laboratory, Applied Electromagnetic Research Institute
Seiho URATSUKA / Managing Director, Applied Electromagnetic Research Institute

The Remote Sensing Society of Japan

Best Presentation Award (**June 2, 2015**)

Improvement of the automatic vertical structure extraction method on SAR interferogram

In this research, we proposed a method for automatically extracting vertical structures such as buildings from data obtained with airborne Synthetic Aperture Radar (Pi-SAR2), which is being developed in the Radiowave Remote Sensing laboratory. We are very happy and honored that it has been recognized with this Best Presentation Award. We will push this research forward to create a practical implementation of this method through further refinements. We would like to express deep gratitude to all who lent their support and cooperation in advancing this research.

From the back left: Takeshi MATSUOKA, Tatsuharu KOBAYASHI, Jyunpei UEMOTO, Makoto SATAKE, Seiho URATSUKA
From the front left: Toshihiko UMEHARA, Shoichiro KOJIMA

Akihiro TAMURA / Researcher, Multilingual Translation Laboratory, Universal Communication Research Institute
Eiichiro SUMITA / Associate Director General of Universal Communication Research Institute

Taro WATANABE (Google Inc.), Hiroya TAKAMURA, Manabu OKUMURA (Tokyo Institute of Technology)

Information Processing Society of Japan

IPSJ Best Paper Award (**June 3, 2015**)

Unsupervised Learning of Part-of-Speech in Dependency Trees for Machine Translation

In this paper, we proposed an unsupervised method to infer bilingual parts-of-speech automatically from a parallel corpus. Our experiments showed that use of these inferred parts-of-speech improves the performance of machine translation. We are very happy that this paper was selected for the 2014 IPSJ Best Paper Award. Encouraged by this award, we will continue to work, contributing to improving the quality of machine translation further in the future.

Akihiro TAMURA

Teruaki HAYASHI / Researcher, Advanced Speech Technology Laboratory, Advanced Speech Translation Research and Development Promotion Center
Yutaka ASHIKARI / Director of System Development Office, Advanced Speech Translation Research and Development Promotion Center
Yoshinori SHIGA / Senior Researcher, Spoken Language Communication Laboratory, Universal Communication Research Institute
Hideki KASHIOKA / Managing Director, Center for Information and Neural Network
Masao UTIYAMA / Senior Researcher, Multilingual Translation Laboratory, Universal Communication Research Institute
Eiichiro SUMITA / Associate Director General of Universal Communication Research Institute
Hisashi KAWAI / Director of Spoken Language Communication Laboratory, Universal Communication Research Institute
Shigeki MATSUDA (ATR-Trek Co., Ltd.), Keiji YASUDA (KDDI R&D Laboratories), Hideo OKUMA (FEAT Limited), Satoshi NAKAMURA (Nara Institute of Science and Technology)

The Institute of Electronics, Information and Communication Engineers

Best Paper Award (**June 4, 2015**)

Development of "VoiceTra" Multi-Lingual Speech Translation System for Practical Use

We would not have been able to develop this system without the cooperation of many who are not noted as authors. We also discussed with and received advice from many people. We would like to take this opportunity to thank them all. We hope the knowledge gained in this paper contributes to developing more accurate automatic speech translation systems and new services with speech input in the future.

From the left: Shigeki MATSUDA, Masao UTIYAMA

Yoshiaki NEMOTO / Director General of Resilient ICT Research Center

Cabinet Office, Government of Japan

13th Award for Meritorious Services on Cooperation among Industry, Academia and Government

Minister for Internal Affairs and Communications Award

(**August 28, 2015**)

For advancement of disaster resilient ICT research and initiatives towards its practical deployment, through research consortium activities in cooperation among industry, academia and government

As the chairman of the Resilient ICT Forum, I have promoted various activities under the auspices of the forum, which aims to promote disaster resilient ICT research and early practical deployment of the research results to give root to disaster resilient ICT networks, based on the experience obtained from damage to ICT networks caused by the Great East Japan Earthquake.

This award was granted as the result of efforts made by all forum members, including initiatives to lead industry-academia-government cooperation for the forum's activities such as disaster resilient ICT research, promoting field tests based on disaster resilient ICT research in cooperation with local governments, and development of the "Guidelines for the Introduction of Disaster-Resilient Information and Communications Networks". I hope disaster resilient ICT will be deployed further in the future as well, through industry-academia-government cooperation.

Yoshiaki NEMOTO (left)

On July 1, 2015, a leap second was inserted

Between 8:59:59 a.m. and 9:00:00 a.m. on July 1, 2015 (Wed.), NICT, which maintains and distributes Japan Standard Time, inserted a leap second designated 8:59:60 a.m. It was a weekday morning, and unfortunately raining, but still approximately 1,000 people came to NICT headquarters (Koganei City) to see this unusual moment.

At NICT, four talks were given by Dr. Toshio IGUCHI, NICT Fellow, explaining leap seconds. There was also a talk given by Dr. Mizuhiko HOSOKAWA, Senior Executive Director, for local elementary school students.

A video of the event is available in the "Video Library" on the NICT Web site.

http://www.nict.go.jp/video/leap-second.html

The moment the leap second was inserted

Visitors looking up at the moment of the 60th second

Talk for visitors

Talk for elementary students

Keihana Information and Communications Fair 2015

NICT Open House 2015 in Keihanna

Date/Time
October 29 (Thu.), 13:00–17:00
October 30 (Fri.), 10:00–17:00
October 31 (Sat.), 10:00–16:30

Location Keihanna Plaza (1-7 Hikaridai, Seika-cho, Soraku-gun, Kyoto)
NICT Bldg. (3-5 Hikaridai, Seika-cho, Soraku-gun, Kyoto)

Details See: http://khn-fair.nict.go.jp/ (Japanese only)

Main Exhibits

- Multilingual speech translation "VoiceTra4U"
- Information analysis system "WISDOM X" and "DISAANA"
- Technology for Ultra-realistic Communications
- Sensory evaluation technology
- Glasses-free tabletop 3D display "fVisiOn"

Main NICT Lectures

- "Finding knowledge in textual big data"
  —The WISDOM X and DISAANA large-scale information analysis systems
- Special Lecture: "Learning from Neymar: Brain mechanisms that move the body"
  —Training Japanese who are competitive on the world stage by training the central nervous system


DISAANA

NICT Open House 2015 in Umekita

Keihanna Information and Communications Fair 2015 @ The Knowledge Capital

Date/Time Nov. 21–23 (Sat.-Mon.), 10:00–18:00

Location Grand Front Osaka, North Bldg., The Knowledge Capital
(3-1 Ofuka-cho, Kita-ku, Osaka)

Special exhibition of content from the Hannyaji-temple using a 200-inch multiview, glasses-free 3D display system


The standing statue of Amida Nyorai (normally withheld from public view)

NICT Open House 2015 in Kashima

Kashima Space Technology Center
—Experience radio waves and artificial satellites close-up!—

Date/Time Nov. 21 (Sat.)10:00–16:00
(No admittance after 15:00)

Location 893-1 Hirai, Kashima City, Ibaraki

Contents

- Touch the 34 m antenna for space observations!
- Trying to catch a satellite!
- Learning how artificial satellites work!
- Opening of the 8N100ICT, amateur radio station commemorating the 100th anniversary of Hiraiso Radio Laboratory
- Crafts class (Capacity: 120)

NICT Open House 2015 in Okinawa

Okinawa Electromagnetic Technology Center

Date/Time Nov. 21 (Sat.)10:00–16:30
(No admittance after 16:00)

Location 4484, Onna, Onna-son, Kunigami-gun, Okinawa

Contents

- Radio-wave and light experiment and participatory exhibits
- Facility tours, exhibit room
- Introduction of the Okinawa Office of Telecommunications, Ministry of Internal Affairs and Communications
- Radio-wave monitoring car exhibit

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