Research Institute of Electrical Communication
Tohoku University

2010/2011

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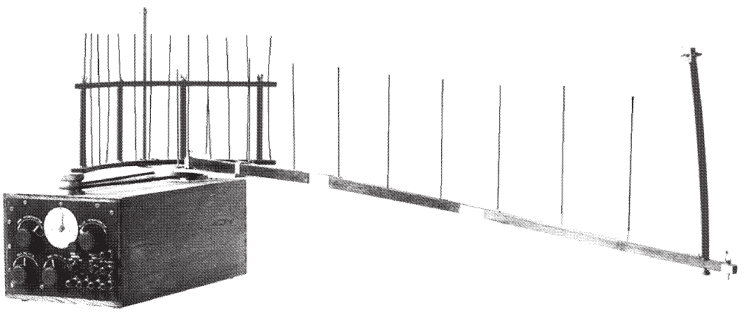
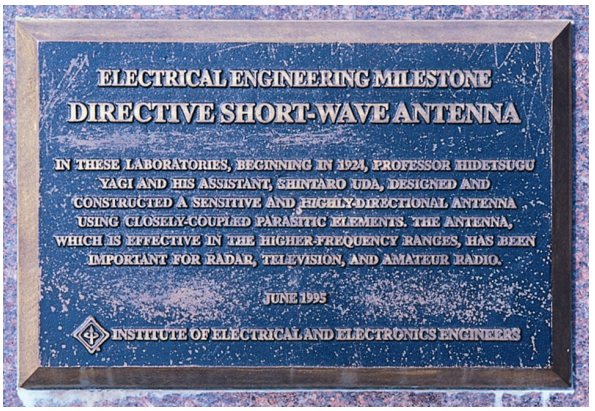
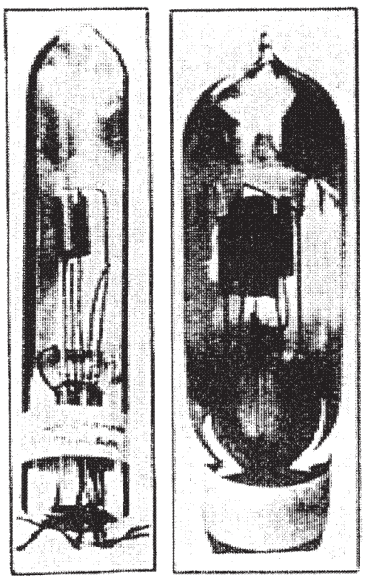


Experimental equipment for Yagi-Uda Antenna（1929）

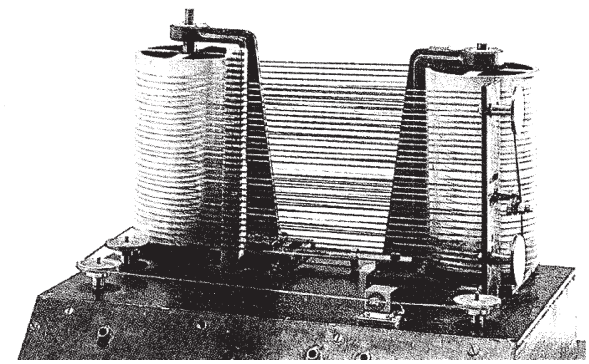


IEEE Electrical Engineering Milestone
for Yagi-Uda Antenna

IEEE Electrical Engineering Milestone
for Yagi-Uda Antenna（in Katahira Campus）



Experimental equipment for Split Anode Magnetron（1927）



Experimental equipment for AC-bias magnetic recording（1937）

Greeting from the Director

It would be no exaggeration to say that we owe the civilization created between the nineteenth and the twenty-first centuries, as represented by such technologies as the telephone, television, personal computer, mobile phone, and the Internet, to the information and communications industry and the electronics industry. Moreover, in terms of GDP, while most of Japan's industries have been showing little growth, the information and communications technology (ICT) sector has continued to expand at an annual rate of about 7 percent.

Tohoku University's Research Institute of Electrical Communication was established in 1935 in affiliation with the School of Engineering, where pioneering work on information and communications had already resulted in breakthroughs such as the Yagi-Uda antenna and the split-anode magnetron. Well known both by its Japanese abbreviation "Tsuken" and by the acronym RIEC, the Institute has contributed in no small measure to the progress that has been made on telecommunications technology over the past 75 years. From its early work with weak-current electricity, RIEC first became a leader in the field of electromagnetic and electronic devices. We have since added transmission, human interface, and software technologies, and today our integrated research covers everything from devices to software. Our organization consists of four major research divisions (Information Devices, Broadband Engineering, Human Information Systems, and Systems and Software), two experimental facilities (the Laboratory for Nanoelectronics and Spintronics, and the Laboratory for Brainware Systems), and the Research Center for 21st Century Information Technology, or IT21. As well as maintaining an active partnership with industry, we also cooperate closely with the six major courses at the Graduate Schools of Engineering, Information Sciences and Biomedical Engineering, in order to develop next-generation ICT with research and education working in tandem.

In today's global information society, smooth interpersonal communication is of ever-increasing importance. Furthermore, communications and broadcasting are becoming integrated, and the resulting paradigm shift toward a new society demands both greater information capacity and vastly more sophisticated ICT. By refining the originality and versatility that have long been a tradition at RIEC, we will contribute to the creation of this new society through the development of cutting-edge technologies designed to link people together.

Director Prof. Masataka NAKAZAWA

Since Tohoku University became a National University Corporation in 2004, its research institutes have also been undergoing a transformation. In April 2010, RIEC took a further step forward when it was promoted from a National Center for Cooperative Research to a Joint Usage/Research Center. This is an opportunity to demonstrate RIEC's important role in the society. At the same time, it represents a challenge as we question the value of our existence and invite society's evaluation. We are steadily constructing the basis of the next-generation information industry while remaining firmly rooted in the depth of knowledge that only a university can provide. We will also contribute to society by training international researchers and highly skilled engineers.

I look forward to your continuing support and encouragement as we at RIEC forge ahead toward achieving our goals, united in our renewed commitment and enthusiasm.

Chronology

1. Birth

Telecommunications research at Tohoku University began in 1919 with the establishment of the Department of Electrical Engineering in the university's School of Engineering. In that era, work was centered on strong-current electrical engineering, but upon the establishment of this department attention turned to weak-current electrical engineering.

In 1924, the Saito Foundation granted what in those days was a huge sum to fund research by three professors, Hidetsugu Yagi, Heiichi Nukiyama, and Shigetaro Chiba, into communication methods using electricity. As a result, telecommunications related research was conducted systematically for the first time in Japan. The department was subsequently strengthened by the addition of a succession of gifted young researchers such as Yasushi Watanabe, Masatoshi Matsudaira, Kinjiro Okabe, Shintaro Uda, Kenzo Nagai, and Katsuichiro Kobayashi. The fruits of their research were considerable, as reflected by the publication of numerous papers in journals both in Japan and overseas that attracted widespread attention.

Along with subsequent advances in telecommunications technologies and the spread of communications equipment, the importance of telecommunications related research became increasingly recognized, fueling a groundswell of opinion in favor of setting up a research establishment to undertake telecommunications research at the Tohoku Imperial University. The university's statutes were revised and an affiliated telecommunications research institute was established. Professor Heiichi Nukiyama was appointed as the first head of the new institute, and he had a full-time staff comprising three assistant professors, six assistants, and one secretary.

Given its intended evolution into an entity independent of the Department of Electrical Engineering, this research institute was designed to function in parallel with the School of Engineering, but shared premises with the Department of Electrical Engineering, and its research facilities were conventional. It maintained an arm's length relationship with the Department of Electrical Engineering and the number of people who functioned effectively as regular staff was far larger than the number of regular staff prescribed by its statutes. This strengthened both the organization and the content of its research, enabling it to produce noteworthy results.

2. Cradle and growth

In response to society’s need for telecommunications engineers, the Department of Electrical Communication was established within the School of Engineering in 1941. As part of a three-entity cooperative structure that included the Department of Electrical Engineering and the Department of Electrical Communication, the Research Institute of Electrical Communication (RIEC) achieved considerable success in a diverse range of research projects and produced a large number of skilled personnel through its research and education activities. In this way, it steadily built up a tradition of combined operations.

As a result of a statutory change, in 1944, RIEC, hitherto a telecommunications research institute affiliated with Tohoku University, was given the status of an integral research institute. It had an independent research institute structure comprising five divisions staffed by full-time professors, but firmly retained a system of close links with the Department of Electrical Engineering and with communications engineering.

During the difficult circumstances of the postwar period, work continued in the research facilities, which had narrowly escaped wartime destruction. As a result of the promulgation of the National School Establishment Act in 1949, Tohoku University was re-established with the status of a national university, and RIEC became one of its integral research institutes.

Owing to the subsequent rapid progress made in the field of electronics, there were successive increases in the number of research divisions with the addition of one in 1954 and 1957, four in 1961, three in 1962 and 1963, and one in each of 1965, 1969, and 1976. This saw RIEC develop into a major research institute with 20 research divisions and

some 100 teaching staff.

The year 1956 saw the completion of the institute's first independent building (currently part of the Institute of Multidisciplinary Research for Advanced Materials) on the Katahira Campus, formerly in the Sakurakoji district of Sendai. The end of March 1963 saw the completion of a new building (currently S Block No. 1 Building) that was double the size of its predecessor on the Katahira Campus formerly in the Minami Rokken-cho district, marking the beginning of a move from the Sakurakoji district to the Minami Rokken-cho district. When the School of Engineering transferred to Aobayama in 1966, the former Department of Electronic Engineering building (currently N Block, No. 1 Building) became an RIEC building, as did the building (currently No. 2 Building) of the Training School of Engineering Teachers upon its closure in 1969. This completed the transfer of all the divisions.

The Laboratory for Microelectronics (operating for a limited period until March 1994) was established in 1984, and the Super Clean Room block was completed in 1986. The Laboratory for Electronic Intelligent Systems was established in April 1994 as an advanced version of the Laboratory for Microelectronics.

In 1958 the electricity related departments of the School of Engineering, with which RIEC was closely associated, were supplemented by the addition of the Department of Electronic Engineering. Subsequent milestones included the establishment of the Research Center for Applied Information Science in 1972 and increases in the number of information engineering majors in the Graduate School of Engineering in 1973 and in the information engineering departments in the School of Engineering in 1984. With this as a basis, the Graduate School of Information Sciences was newly established in 1993.

With greater emphasis being placed on graduate schools, in 1994 the electrical, communication science, and electronic engineering majors in the Graduate School of Engineering became electrical and communication engineering and electronic engineering majors. With greater emphasis being placed on graduate schools, in 1994 the courses in electrical, communication science, and electronic engineering in the Graduate School of Engineering were replaced with courses in electrical and communication engineering and electronic engineering. A total of nine courses were instituted, including full-time courses. In addition, four electricity related departments and the Department of Applied Physics were amalgamated in 2007 to form the Department of Information and Intelligent Systems. In addition, 2008 saw the establishment of Japan's first Department of Biomedical Engineering, with the aim of fusing medicine and engineering with active input from the electrical field.

3. Development: From national collaborative research institute to joint usage/research center

In 1995 RIEC celebrated the 60th anniversary of its establishment. To mark the occasion it sought to meet the needs of the impending advanced information society by reorganizing itself as a national collaborative research institute. In June 1994, approval was given for RIEC to become a national collaborative research institute engaging in both theoretical and applied research relating to high-density and advanced information communications, whereupon it reorganized into three broad research divisions: Brain Computing, Materials Science and Devices, and Coherent Wave Engineering. In addition, to replace the Laboratory for Microelectronics, which had reached its specified duration, the Laboratory for Electronic Intelligent Systems was established across the three divisions.

The backdrop to this was the IT revolution, characterized by rapid progress in information and communication technologies, which made the information society a reality. To ensure that RIEC played a leading role in the information society, in 2001 its philosophy, objectives, and goals were reformulated.

RIEC has defined its philosophy as follows: "Close and smooth communication between people is fundamental to maintaining and developing a flourishing and humane society. We will contribute to the well-being not only of Japan but also of human society as a whole through the rapid development of science and technology related to communication." In addition, RIEC pledged that, based on the results of research conducted hitherto in relation to high-density and advanced information communications, it would play a pivotal role in undertaking comprehensive research into the

theory and application of science and technology that will provide communication approaches that benefit humankind.

Also, in April 2002, RIEC established the Research Center for 21st Century Information Technology in compliance with a ministerial ordinance. Straddling the three research divisions, the center's aim is to address, through collaborations between industry and academia, the changes that occur in the fabric of society, leading to the creation of new information and communication industries.

In 2009, major changes were made to the organization of university research institutes and centers; the national collaborative research institutes were abolished, and joint usage/research centers were established. A council for joint usage/research centers was set up in April 2010. These centers involve not only the joint use of facilities but also the conduct of joint research; something that is strongly desired by the research community.

At the time of the change to a collaborative research institute in 1994, RIEC's intention was to operate with its orientation towards joint research, gathering research scientists together from a broad range of backgrounds both within Japan and overseas, and pursuing joint research projects. In this regard, RIEC anticipated the main goal of these new centers. In recognition of its achievements, RIEC has been accredited as a joint usage/research center.

4. Leap forward: As a world center of excellence

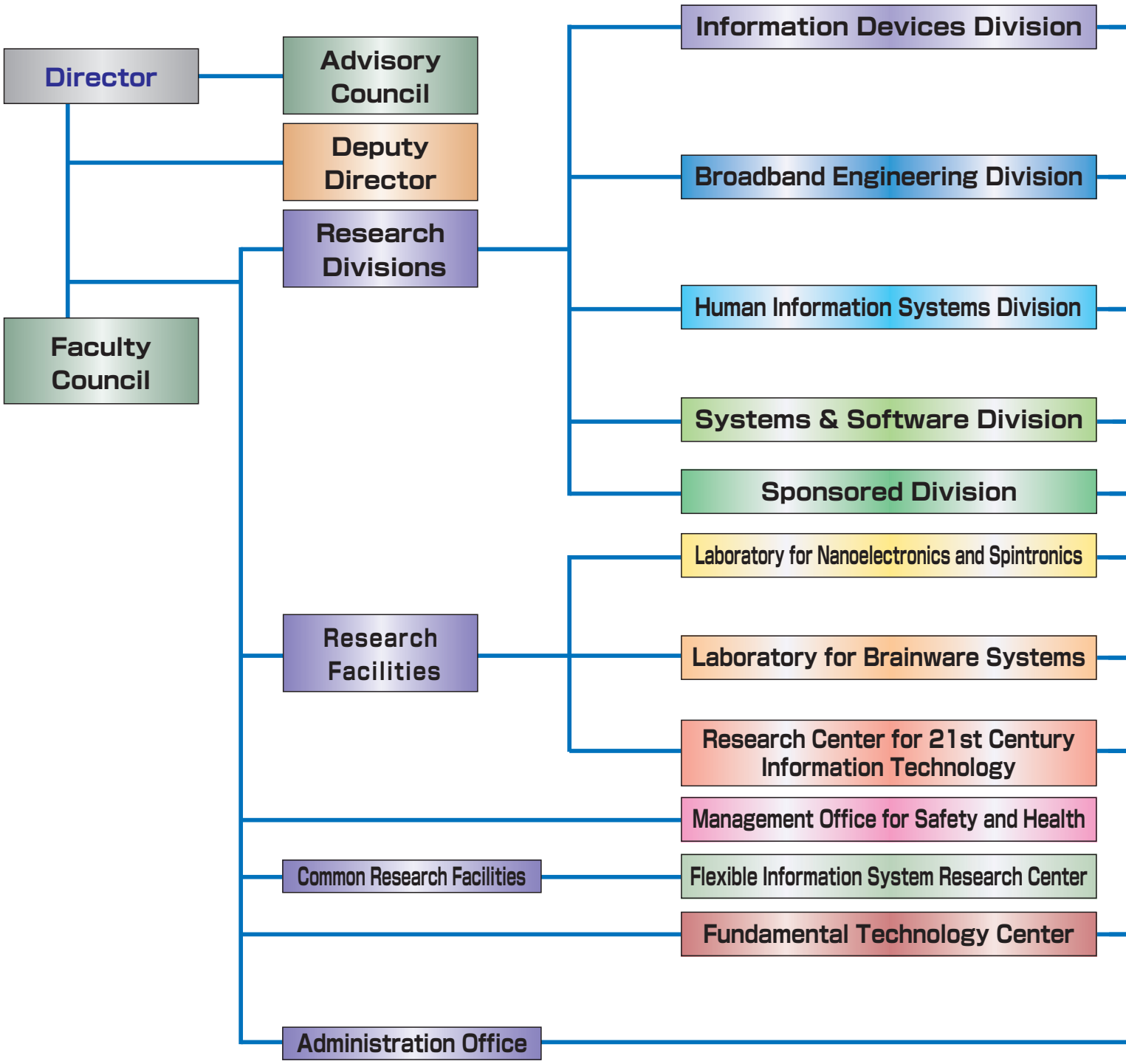
To realize RIEC's philosophy and goals in the coming era of next-generation global, ubiquitous information communication, an appropriate research system has been put in place. In fiscal 2004 a reorganization was undertaken that considered the research time scale, in addition to the research fields themselves. Research was divided broadly into short-, medium-, and long-term research, and we introduced flexibility to enable the organization to be changed fluidly according to the progress of the research. A major role in short-term research is played by the Research Center for 21st Century Information Technology, which facilitates the practical application of the excellent research results achieved by RIEC within approximately five years through collaboration between industry and academia. We have also set up a Laboratory for Nanoelectronics and Spintronics to engage in research over medium-term spans of approximately 10 years. It undertakes comprehensive and intensive research into material and device technologies based on nanotechnology. We have also established the Laboratory for Brainware Systems, whose aim is to build intelligent integrated systems that break down the barriers of present-day information technologies, conducting fundamental research with a view to practical applications. To promote research at the Laboratory for Nanoelectronics and Spintronics, in March 2004 we completed the Nanoelectronics and Spintronics integrated research block, which is equipped with the latest technology.

Long-term research has been reorganized into four major research divisions. The Materials Science and Devices Division and the Coherent Wave Engineering Division, which developed scientific techniques for transmitting large volumes of information accurately at high speed, are both in fields in which RIEC has traditionally been strong. These units have been reorganized into the Information Devices Division and the Broadband Engineering Division, respectively. Moreover, to build an advanced information society in which humankind and the environment are in harmony, we have established the Human Information Systems Division, which aims to elucidate the ways in which human beings process information, and the Systems and Software Division, whose goal is to develop software and systems to advance and enhance the information and communication systems that underpin the information society.

RIEC has structures for close cooperation in the spheres of research and education with the School of Engineering (Electrical and Communication Engineering, Electronic Engineering), the Graduate School of Information Sciences, and the Graduate School of Biomedical Engineering. At the same time it welcomes researchers from within Japan and from all over the world, and as a world center of excellence its duty is to engage vigorously in research activities in a wide range of fields related to telecommunications. Building on the proud record of achievement of our distinguished predecessors and colleagues, we are entering a new era in which we hope to make further leaps forward amid the rapid development of information and communication technologies and the rising tide of globalization.

Organization

1.Organization Chart



- Nano-Photoelectronics
- Quantum-Optical Information Technology
- Solid State Electronics
- Dielectric Nano-Devices
- Materials Functionality Design
- Magnetic Devices(Visitor Section)

- Ultrahigh-Speed Optical Communication
- Applied Quantum Optics
- Advanced Wireless Information Technology
- Information Storage Systems
- Ultra-Broadband Signal Processing
- Basic Technology for Broadband Communication(Visitor Section)

- Electromagnetic Bioinformation Engineering
- Advanced Acoustic Information Systems
- Visual Cognition and Systems
- Interdisciplinary Field for Informatics
- Ubiquitous Communications System
- Multimodal Computing (Visitor Section)

- Software Construction
- Computing Information Theory
- Communication Network
- Information Contents
- Information Social Structure(Visitor Section)

- Environmental-Adaptive Information and Communication Engineering

- Atomically Controlled Processing
- Semiconductor Spintronics
- Nano-Molecular Devices
- Nano-Spin Memory

- Real-World Computing
- Intelligent Nano-Integration System
- Microarchitecture
- New Paradigm VLSI System

- Project Planning Division
- Technology Development Division:
  - Mobile Wireless Technology Group
  - Storage Technology Group
  - Intelligence Archive Group(Visitor Section)

- Machine Shop Division
- Evaluation Division
- Process Division
- Software Technology Division

- General Affairs Section
- Cooperative Research Section
- Library Section
- Accounting Section
- Purchasing Section

2.Staff

(2010.7.1)

Classification	Division	Laboratory for Nanoelectronics and Spintronics	Laboratory for Brainware Systems	Research Center for 21st Century Information Technology	Fundamental Technology Center	Administration Office	Total
Professors	20	3	3	1			27
Associate Professors	13	5	1	1			20
Assistant Professors	19	3	5				27
Research Fellows	13	2	2				17
Technical Officials					16	2	18
Administrative Officials						14	14
Total	65	13	11	2	16	16	123

3.Land and Buildings

Site: Katahira 2-1-1, Aoba-ku, Sendai 980-8577, Japan

Total building area: 12,913m^2

Total floor area: 28,776m^2

(2010.7.1)

Name of Buildings	Structure	Year of Completion	Floor Area
Building No.1	Reinforced Concrete, 4 floors	Building-S:1962,1963 Building-N:1959,1960	7,772m^2
Building No.2	Reinforced Concrete, 4 floors	1962,1963	7,085m^2
Laboratory for Nanoelectronics and Spintronics	Steel-frame, 5 floors	2004	7,375m^2
Laboratory for Brainware Systems	Reinforced Concrete, 1 floor	1967,1968,1972	525m^2
	Reinforced Concrete(partly steel-frame), 2 floors	1986	1,553m^2
	Steel-frame 1 floor	1996	598m^2
	Light-weight steel-frame, 2 floors	1999	147m^2
Research Center for 21st Century Information Technology	Reinforced Concrete, 3 floors	1930	1,343m^2
	Steel-frame 1 floor	2002	435m^2
Evaluation and Analysis Center	Reinforced Concrete, 2 floors	1981	790m^2
Helium Sub-Center	Reinforced Concrete(partly light-weight steel-frame),1 floor	1972	166m^2
Machine Shop	Reinforced Concrete(partly light-weight steel-frame),1 floor	1965,1966,1978	479m^2
Others			508m^2
Total			28,776m^2

4.Budget

(Unit:1,000Yen)

Financial Year	Personnel Expenditure	Supplies Expenditure	Research Grant		Total
			Ministry of Education, Science and Culture	Partnership Between Universities and Industry	
2005	984,113	1,050,647	554,680	1,303,028	3,892,468
2006	971,482	927,090	599,040	937,441	3,435,053
2007	970,961	813,724	700,615	888,833	3,374,133
2008	879,481	953,000	694,883	1,069,832	3,597,196
2009	1,026,511	1,562,318	605,100	798,053	3,991,982

Nation-wide Cooperative Research Projects

The Institute has a long history of fundamental contributions in many fields of engineering and science that include the fields of semiconductor materials and devices, magnetic recording, optical communication, electromagnetic technology, applications of ultrasonics, acoustic communication, non-linear physics and engineering, and computer software. On the basis of this rich historical background the Institute was designated as National Center for Cooperative Research in 1994. Accompanying Tohoku University's transformation to " a national university juridical entity" in April, 2004, this institution plays a leading role on the world stage, as its researchers, both domestic and foreign, continue the task of "investigating the theory and application of universal science and technology to realize communication, to the enrichment of humanity."

In such background, the Institute organizes Nation-wide Cooperative Research Projects by coordinating its activities with research workers. The main themes for Cooperative Research are selected annually by the Committee for Cooperative Research. Then invitations for project proposals and participation are extended to university faculties and government laboratories as well as industrial research groups. Each project approved by the Faculty Council of the Institute is carried out by a team of researchers that include members of the Institute as well as outside participants.

The Advisory Council which includes members from other institutions has an advisory function to the Director in defining the general direction of the research at the Institute and its Nation-wide Cooperative Research Projects.

The Project Judging Committee that includes members from the outside of Tohoku University has a judging function for project proposals.The purpose of the Project Steering Committee is the proper operation of approved projects.

Research Fields

The Research Institute of Electrical Communication (RIEC) maintains a close cooperative relationship with the Graduate Schools of Engineering, Information Sciences and Biomedical Engineering in its research and educational activities, especially with the Departments of Electrical and Communication Engineering, Electronics, Computer and Mathematical Science, System Information Science and Applied Information Sciences. This cooperation enriches the research activities of RIEC as a "National Center for Cooperative Research." The research fields of four divisions are:

(1)Information Devices Division:Advanced Nano-Information Devices Utilizing Physical Phenomena
(2)Broadband Engineering Division:Next Generation Systems for Ultra-Broadband Communication
(3)Human Information Systems Division:Creation of Information Systems Harmonizing People and Environments
(4)Systems & Software Division:Advanced System and Software for Information Society

Information Devices Division

Materials Science and Device Science

- Solid State Electronics
- Dielectric Nano-Devices
- Materials Functionality Design
- Atomically Controlled Processing
- Physical Fluctuomatics *
- Intelligent Integrated Systems *
- Advanced Management of Integrated System Technology *
- Solid State Electronics *
- Physical Acoustics *

Electonic and Optical Quantum Science

- Nano-Photoelectronics
- Quantum-Optical Information Technology
- Image Science and Information Display *
- Biomodeling *

Plasma Science

- Electromagnetic Theory *
- Magneto-Plasma-Dynamic Engineering *

Visitor Section

- Magnetic Devices

Broadband Engineering Division

Information Technology

- Advanced Wireless Information Technology
- Technology Development Division Mobile Wireless Technology Group
- Ultrasonic Micro-Spectroscopy *

Ultrahigh-Frequency Engineering

- Ultra-Broadband Signal Processing
- Communication Engineering *

Optical Communication / Applied Quantum Electronics

- Ultrahigh-Speed Optical Communication
- Applied Quantum Optics
- Optical Physics Engineering *
- Neural Electronic Engineering *
- Information Measurement and processing *

Information Recording / Material Science

- Semiconductor Spintronics
- Information Storage Systems
- Technology Development Division Storage Technology Group
- Nano-Spin Memory
- Microelectronics *
- Electronic Physics Engineering *
- Algorithm Theory *
- Nanoscale Magnetism and devices *
- Medical Nanosystem Engineering *
- Spin Electronics *
- Magnetic Materials *
- Nano Intelligent System *

Visitor Section

- Basic Technology for Broadband Communication

Human Information Systems Division

Bioinformation

- Electromagnetic Bioinformation Engineering
- Electromagnetic Theory *
- Applied Power Systems Engineering *

Human Information Processing

- Advanced Acoustic Information Systems
- Visial Cognition and Systems
- Intelligent Communication Network *
- Electronic Control Systems *
- Advanced Information Technology *
- Electronic Control Engineering *

Communication Environment

- Ubiqutous Communication Systems
- Electromagnetic Wave Engineering *
- Firmware Science *

Bioelectronics

- Nano-Molecular Divices
- Interdisciplinary field for Informatics
- Basic Plasma Engineering *
- Biomedical Electronics *
- Nano-Biomedical Engineering *
- Systems Bioinformatics *

Real World Computing

- Real-World Computing
- Control Systems Engineering *
- Bio-electromagnetics *

Visitor Section

- Multimodal Computing

Systems & Software Division

Computer Science

- Software Construction
- Computing Information Theory
- Foundations of Software Science *
- Intelligent Systems Science *
- Information Security *
- Image Information Communications *

Internet Communication

- Communication Network
- Information Contents
- Information Network System *
- Information Technology *
- Electric Energy System Engineering *
- Applied Intelligence Software *

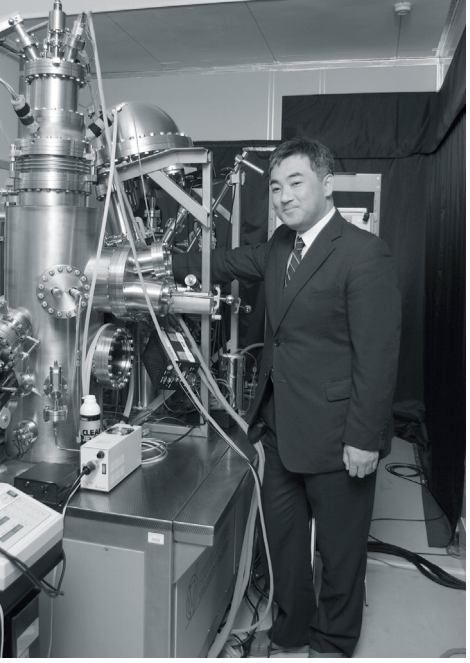
VLSI System

- Intelligent Nano-Integration System
- New Paradigm VLSI System
- Microarchitecture
- Intelligent Electronic Circuits *
- Power Electronics *
- Computer Structures *

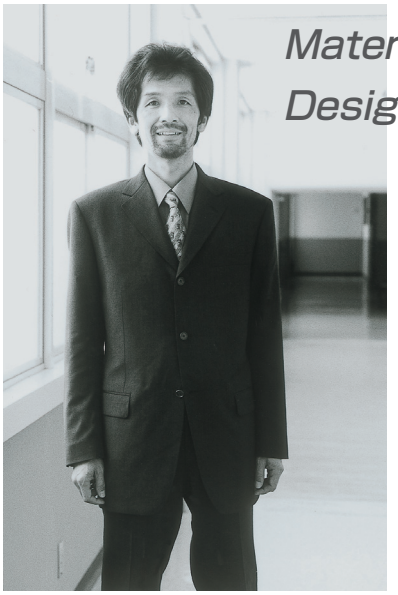
Visitor Section

- Information Social Structure

*Laboratories in Graduate Schools



Nano-Photoelectronics

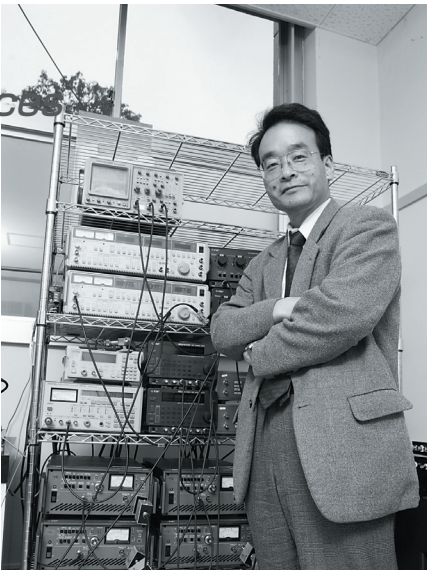


Materials Functionality Design

Information Devices Division

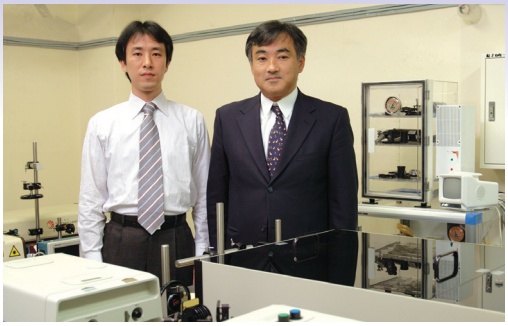
Quantum-Optical Information Technology

Dielectric Nano-Devices



Solid State Electronics

Nano-Photoelectronics



S. KATANO Y. UEHARA

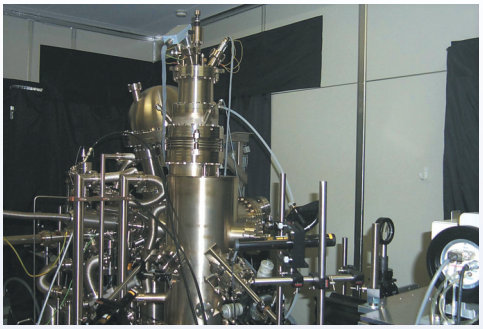
Staff:

Yoichi UEHARA, Professor
Satoshi KATANO, Assistant Professor

Research activities:

Our main interest lies in the studies of physical and chemical phenomena that take place in nanometer-scale regions as well as the applications of such phenomena in photo-electronic devices. We investigate materials properties of nano-structures through their optical response to local excitations that is generated by electrons from the tip of a scanning tunneling microscope (STM). The physical systems under study include adsorbed atoms and molecules on solid surfaces, metal and semiconductor nano-structures, and superconductive nano-structures.

We are also interested in developing novel probing methods for nano science. We are developing a STM light emission spectroscopy system that is capable of measuring the optical properties of nanometer scale objects with pico-second time resolution.

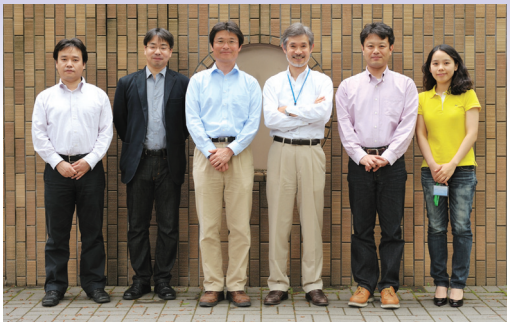


Integrated Surface Analysis System
with Low-temperature STM

Research topics:

1. Identification of individual surface adsorbates
2. Single molecule optical spectroscopy
3. STM light emission spectroscopy of normal and super conductive nano-structures
4. Light enhancement effect in nano-scale regions
5. Creation of novel nano-structures by STM

Quantum-Optical Information Technology



R. SHIMIZU T. KUTSUWA H. KOSAKA K. EDAMATSU Y. MITSUMORI S.-Y. BAEK

Staff:

Keiichi EDAMATSU, Professor
Yasuyoshi MITSUMORI, Assistant Professor
Takeshi KUTSUWA, Research Fellow
Hideo KOSAKA, Associate Professor
Ryosuke SHIMIZU, Research Fellow
So-Young BAEK, Research Fellow

Research activities:

Current information and communication technology utilizes macroscopic and classical physical quantities, such as voltage or frequency of electric fields. The classical technology will reach the limit of information density and speed in the near future. The quantum-mechanical counterpart, "quantum information processing and communication technology", in which information is carried by microscopic and quantum-mechanical quantities, is expected to overcome the difficulty. Our goal is to develop the quantum information devices utilizing quantum interaction between electrons and photons in semiconductor nanostructures, to obtain further understanding of their physics, and to apply them to practical quantum information technologies.

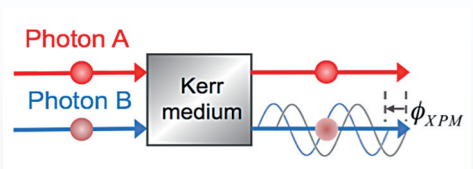


Fig. 1 Single-photon-level optical nonlinearity in optical fibers and waveguides.

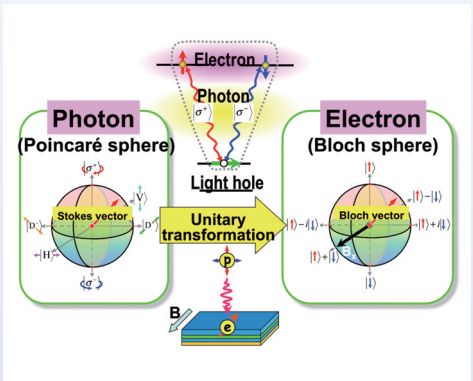


Fig. 2 Quantum media conversion from photon polarization to an electron spin.

Quantum-Optical Information Technology (Prof. EDAMATSU)

Development of fundamental devices of quantum info-communication technology (QICT) utilizing photons, novel materials and semiconductor nanostructures.

Research topics:

1. Novel techniques for the generation and detection of photon entanglement.
2. QICT devices using optical fibers and waveguides.
3. QICT using semiconductor quantum dots and nanostructures.

Quantum Solid State Physics (Assoc. Prof. KOSAKA)

Development of quantum interfaces essential for QICT based on particle-wave duality of a quantum through the deep understanding of interaction between electrons and photons.

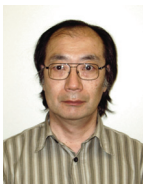
Research topics:

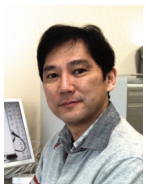
4. Quantum media conversion between a photon and an electron spin and its entanglement-based application.
5. Exploration of dynamic spin quantum correlation between photons and electrons and its QICT application.
6. Development of quantum repeaters with an electron spin and nuclear spins in quantum dots and diamonds.

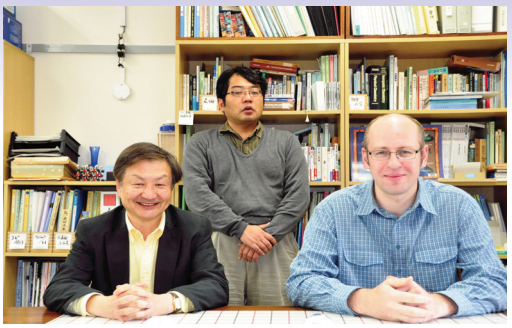
Solid State Electronics

Staff:

Maki SUEMITSU, Professor
Hirokazu FUKIDOME, Assistant Professor
Yasutake TOYOSHIMA, Visiting Professor
Jun TAKEDA, Visiting Professor
Sergey FILIMONOV, Visiting Associate Professor


Y. TOYOSHIMA


J. TAKEDA


H. FUKIDOME
M. SUEMITSU S. FILIMONOV

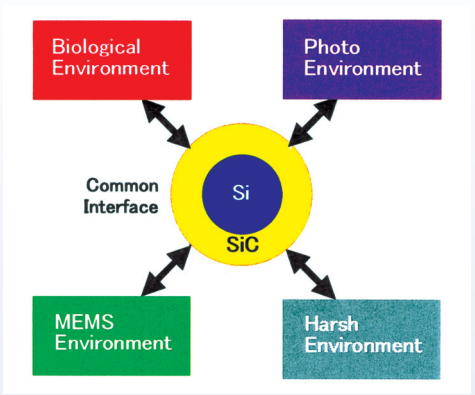
Research activities:

To realize the ubiquitous (or ambient intelligence) society, in which sensors and their networks are embedded in our ambience to support our daily life through a prompt warning of various environmental crises, a marriage between non-Si technologies suitable for environmental sensing and the Si technology suitable for signal processings is indispensable. To this goal, we investigate formation of ultrathin silicon-carbide (SiC) films on Si substrates, hoping to use them as a common interface between the two technologies. SiC is a group-IV compound that contains a pair of elements representative of both electronics (Si) and biology & nanoelectronics (ex. graphene) (C). It also bridges the gap between Si and other II-VI or III-V compounds. It is a widegap semiconductor that enables high-temperature operations. High enough strength and hardness of SiC make this material suitable for use in MEMS structures. We are developing gas-sensors, graphene-based ultrahigh-speed devices, LEDs, biosensors, MEMS structures, non-volatile memories, and photovoltaic cells based on the SiC/Si structures. What lies behind these applications is our original technology of SiC gas-source molecular-beam epitaxy (MBE) using organo-silane, which enables a high-quality, low-temperature SiC epitaxy on Si substrates.

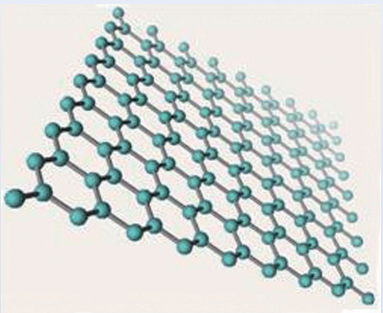
Our research covers the surface chemistry of Si-related surfaces, targeted to the control of nanostructure formation on Si and SiC surfaces. Fabrication of non-equilibrium Si structures such as amorphous-, microcrystalline-, and poly-Si thin films is also within our interests, and is being intensively investigated using atmospheric-pressure plasma-enhanced chemical vapor deposition (AP-PECVD).

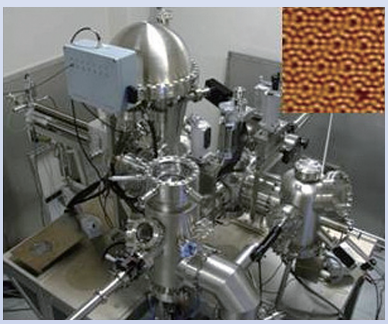
Research topics:

1. Surface chemistry during oxidation and film-deposition of Si-related surfaces and development of nanofabrication processes
2. Formation of SiC films on Si substrate and their applications to ubiquitous devices
3. Formation of graphene-on-Si structure and development of ultrahigh speed devices
4. Fabrication of Si-and C-related non-equilibrium structures using AP-PECVD and their applications to electronic devices.

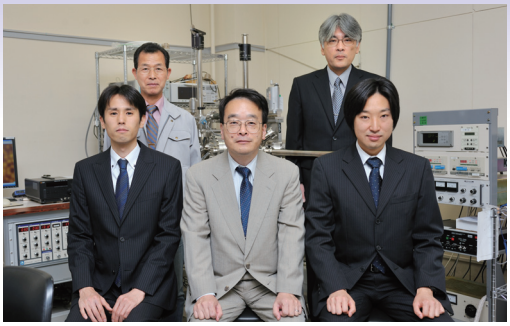


SiC expands the conventional Si technology


Graphene: A two-dimensional network of carbon atoms.


A UHV-compatible process/analyses system and the atomic image of a Si surface (inset).

Dielectric Nano-Devices



Y. WAGATSUMA N. OKAZAKI
K. YAMASUE Y. CHO Y. HIRANAGA

Staff:

Yasuo CHO, Professor
Yoshiomi HIRANAGA, Assistant Professor
Kohei YAMASUE, Assistant Professor
Yasuo WAGATSUMA, Technical Official
Noriaki OKAZAKI, Research Fellow

Research activities:

Our main area of interest is evaluation and development of dielectric materials, including ferroelectric and piezoelectric materials and their application to communication devices and ferroelectric data storage systems.

Our measure contributions to advancement in these fields are the invention and the development of "Scanning Nonlinear Dielectric Microscope" (SNDM) which is the first successful purely electrical method for observing the ferroelectric polarization distribution without the influence of the shielding effect by free charges and it has already been put into practical use. The resolution of the microscope has been improved up to atomic scale-order. Therefore, it has a great potential for realizing the ultra-high density ferroelectric recording system. Our recent research achieved to fabricate an ultra-small domain inversion dot, which has the diameter of 3 nm in case of single dot fabrication, and achieved the recording density of 4 Tbit/inch^2 in actual information storage, requiring an abundance of bits to be packed together.(Fig.3)

Moreover, we have started to make a measurement and an evaluation of flash-memory device and dopant profile in semiconductor devices using SNDM. Because SNDM can detect very small capacitance variation, it can be a very powerful evaluation tool for various materials. Now SNDM evolves into a new evaluation technique for insulator material and semiconductor materials besides ferroelectric materials.

Fig1:Commercially available scanning nonlinear dielectric microscope.

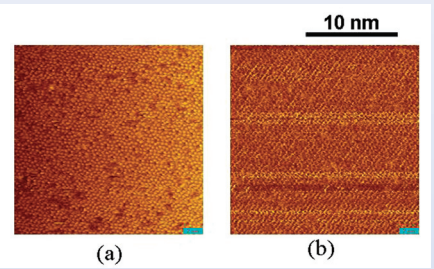


Fig2:S(111) 7X7 atomic structure taken by SNDM. (a)Topography (b) Electric dipole-moment.

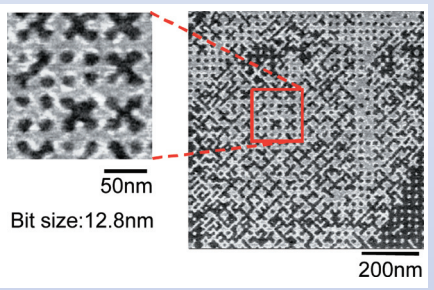
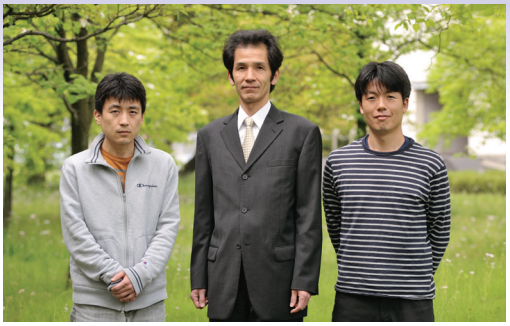


Fig3:Example of a ferroelectric actual information storage (4 Tbit/inch^2).

Research topics:

1. Development of scanning nonlinear dielectric microscope (SNDM) with super high (atomic-scale) resolution.
2. Ultra-high density ferroelectric recording system using SNDM.
3. Development of ferroelectric functional devices for electrical communications using nano-domain engineering based on SNDM.
4. Evaluation of ferroelectric material and piezoelectric material using SNDM.
5. Evaluation of flash-memory device and dopant profile in semiconductor devices using SNDM.

Materials Functionality Design



K. ABE M. SHIRAI Y. MIURA

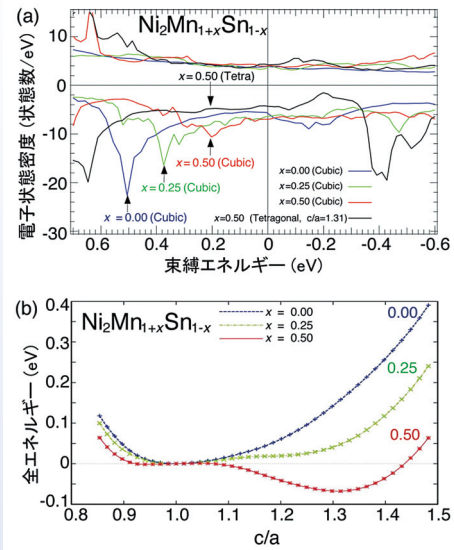
Staff:

Masafumi SHIRAI, Professor
Yoshio MIURA, Assistant Professor
Kazutaka ABE, Assistant Professor

Research activities:

Various kinds of materials, such as semiconductors, dielectrics, and magnets, are utilized for processing, communication, and storage of massive data in the modern information-oriented society. Our research objectives are as follows: (1) theoretical analyses of quantum phenomena which appear in materials and nanostructures for advanced information devices, (2) computational design of materials and nanostructures which possess new functionalities for improvement of device performance, and (3) development of epoch-making materials and functionality design procedures on the basis of large-scale computational simulation techniques.

Our research interest is focused on “spintronics”, an interdisciplinary research field emerging from materials science, physics, electronics, and magnetics, where both charge and spin degrees of freedom are exploited to realize new kinds of advanced information devices. The main research topics are computational design of new spin-related functionalities exhibited in the highly spin-polarized materials and device-structures utilized the materials. We undertake pioneering computational schemes for design of new functional materials and/or devices.



(a) Density of states (DOS) and (b) total energy as a function of tetragonal distortion calculated for ferromagnetic shape-memory alloys $Ni_2Mn_{1+x}Sn_{1-x}$ (x = 0, 0.25, 0.5).
A peak structure in the DOS shifts toward the Fermi level with increasing the Mn composition, and finally a tetragonal structure becomes stable for x = 0.5.
[modified from FIG. 3 in Phys. Rev. Lett. 104, 176401 (2010).]

Research topics:

1.Computational design of new spintronics materials from first-principles
2. Computational analysis of transport properties in spintronics devices
3. Computational simulation of nanostructure-growth process on surface
4. Development of new computational scheme for material/device design

Ultrahigh-Speed Optical Communication

Broadband Engineering Division

Applied Quantum Optics

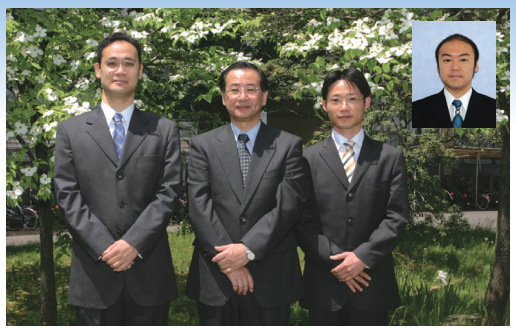
Wireless Info Tech

Information Storage Systems

Ultra-Broadband Signal Processing

Basic Technology for Broadband Communication(Visitor Section)

Ultrahigh-Speed Optical Communication



T. HIROOKA M. NAKAZAWA M. YOSHIDA K. KASAI

Staff:

Masataka NAKAZAWA, Professor
Toshihiko HIROOKA, Associate Professor
Masato YOSHIDA, Assistant Professor
Keisuke KASAI, Research Fellow

Research activities:

With the vast growth of traffic on the Internet from simple text data to high quality voice, image, and real-time video content, it has become increasingly important to realize an ultrafast, high-capacity network to support the daily needs of modern communications. Ultrahigh-speed optical communication is the key technology for building such an interconnected world. This laboratory aims to realize a global ultrahigh-speed optical network by engaging in research on ultrashort pulse generation and transmission. Our research areas include optical solitons, high-speed mode-locked lasers, optical signal processing, and the development of fibers with new functions.

Optical Transmission (Prof. Masataka NAKAZAWA)

Ultrahigh-speed optical transmission is the driving force behind attempts to realize advanced high-speed networks that support ultrahigh-precision image transmission or ultra-realistic communication. At the same time, there is a strong need to realize spectrally efficient optical transmission to expand the transmission capacity for a given optical bandwidth. With a view to achieving an ultrahigh bit rate exceeding 1 Tbit/s/channel, we are actively engaged in realizing ultrafast optical time division multiplexed (OTDM) transmission using ultrashort pulse lasers. To expand the spectral density, we are working intensively on ultra-multi-level coherent QAM transmission technology in which the spectral efficiency is greatly improved by encoding the information in both the amplitude and phase of an optical beam. In addition, we are developing a new frequency standard by stabilizing a mode-locked laser so that it has a highly controlled longitudinal mode separation. This technique is also applicable to the microwave-photonics area. Another important aspect of our research relates to the development of photonic crystal fibers. These special fibers have many air holes in the fiber cross-section, and they have potential applications in new optical communication systems operating in the currently unused 500-1000 nm band.

Research topics:

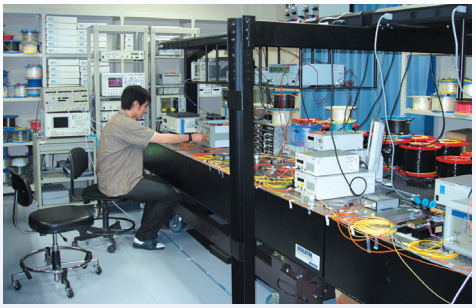
1. Terabit/s OTDM transmission using a femtosecond pulse train
2. Ultra-multi-level coherent optical transmission toward the Shannon limit
3. Ultrashort mode-locked lasers and their application to frequency standards and microwave-photonics
4. Photonic crystal fibers and optical fibers with new functionality

Optical Signal Processing (Assoc. Prof. Toshihiko HIROOKA)

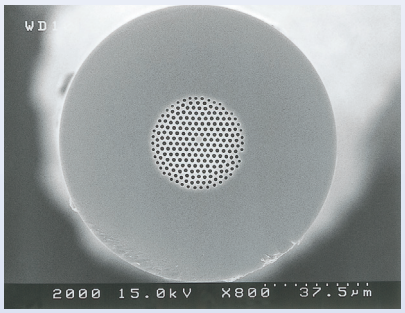
We are engaged in the development of ultrahigh-speed optical signal processing technologies that will support next-generation high-capacity optical networks. In particular, by taking advantage of ultrafast optical properties, we are actively working on all-optical technologies using nonlinear optical effects, where optical signals are processed without the need to convert them into the electrical domain. Specifically, we are developing femtosecond pulse compression, pulse shaping, optical demultiplexing, and distortion elimination techniques, which are indispensable for realizing ultrahigh-speed OTDM transmission exceeding terabit/s.

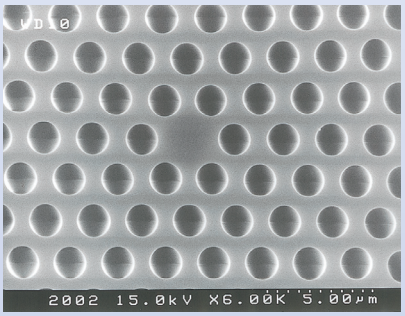
Research topics:

5. Distortion elimination technique using time-domain optical Fourier transformation
6. All-optical signal processing using nonlinear optical effects and their application to ultrahigh-speed OTDM transmission



Experiment on ultrahigh-speed optical transmission





Photonic crystal fiber
(Upper photo:cleaved end face of a PCF, lower photo:enlarged cross section)

Applied Quantum Optics

J. SHIKATA H. YASAKA

Staff:

Hiroshi YASAKA, Professor
Jun-ichi SHIKATA, Associate Professor

Research activities:

We are investigating novel, highly functional semiconductor photonic devices, which is indispensable to realize new generation information communication networks. We are also investigating novel, compact and widely tunable coherent light sources based on lasers and nonlinear-optical phenomena. Furthermore, our research interests cover ultrafast photonic devices, opto-electronic semiconductor devices and their applications to optical computing and signal processing areas.

Highly Functional Photonics (Prof. Hiroshi YASAKA)

We have been studying highly functional semiconductor photonic devices and semiconductor photonic integrated circuits based on semiconductor lasers and semiconductor optical modulators to create novel semiconductor photonic devices, which can control intensity, phase, frequency and polarization of optical signal freely.

Research topics:

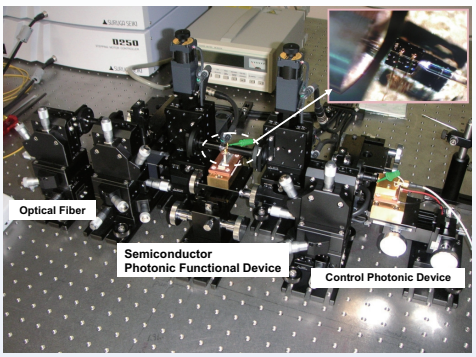
1. Highly functional semiconductor photonic devices
2. New function semiconductor photonic integration circuits

Broadband Photonics (Assoc. Prof. Jun-ichi SHIKATA)

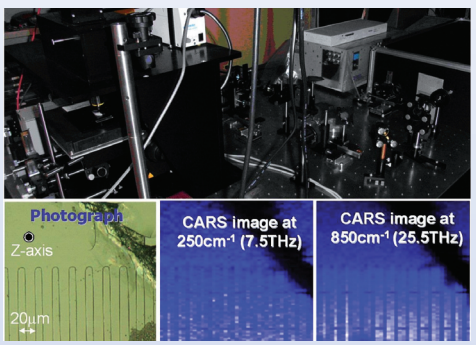
We have been studying ultra-broadband coherent terahertz (THz) wave radiation to explore novel science and technology fields, the band of which extends from ultra-violet to far-infrared region. Widely tunable, spatially and temporally coherent THz wave is generated for the first time, by using optical parametric effects. THz-frequency coherent anti-Stokes Raman (THz-CARS) microscope has been successfully applied for sensitive detection of THz resonances in biomolecules. Novel THz biosensors have been developed by using local-field enhancement via surface plasmon resonance, and successfully applied to near-field THz imaging with sub-wavelength resolution.

Research topics:

3. Ultra Broadband, coherent tunable light sources using nonlinear optics
4. Terahertz biophotonics

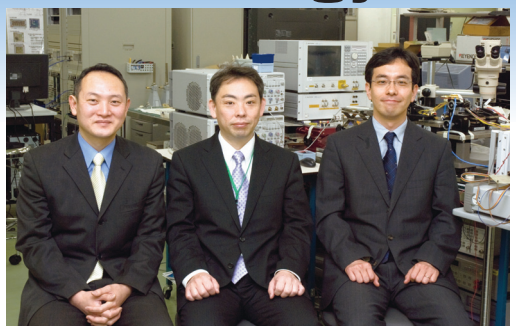


Experimental setup for high-speed operation of functional semiconductor photonic devices by external optical signal injection.



Terahertz CARS microscope and its imaging of periodically poled lithium niobate.

Advanced Wireless Information Technology



S. TANIFUJI N. SUEMATSU S. KAMEDA

Staff:

Noriharu SUEMATSU, Professor
Suguru KAMEDA, Assistant Professor
Shoichi TANIFUJI, Research Fellow

Research activities:

Since interchange of people and exchanges of information have been world wide, next generation wireless network for ubiquitousness and broadband is one of the most important technology. Especially, a signal processing circuit, device and packaging technologies and the modulation/demodulation and network technologies are the two wheels of realizing next generation wireless network.

For realizing the next generation wireless network, we are actively engaged in work on following technology for broadband, low-power consumption and small-size terminals; (1) RF power amplifier, synthesizer and mixer devices for millimeter wave and GHz-band wireless modems, (2) Ultra small antennas for mobile terminals. Moreover, digital assisted RF technology using digital signal processing has been investigated.

We are also interested in developing following wireless networks;
(1) next-generation mobile broadband wireless access (MBWA),
(2) dependable broadband wireless local area network (WLAN),
and (3) ultra-broadband wireless personal area network (WPAN). Currently, we are concentrating on the coherent work toward the next-generation "Dependable Wireless System" which is multi-band and multi-mode mobile terminal.

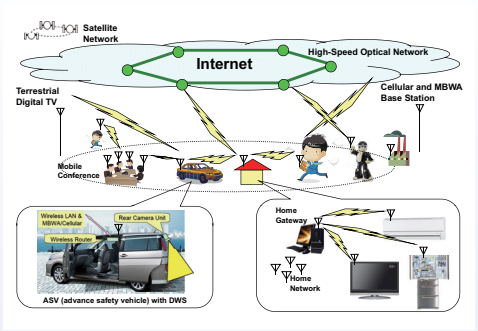


Fig.1 Evolutional network for ubiquitousness and broadband

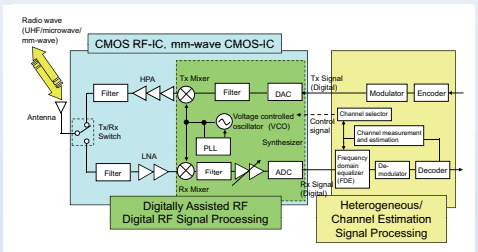


Fig.2 One-chip modem LSI for Broadband wireless communication

Research topics:

1. Mobile broadband wireless access network
2. Broadband wireless on-chip transceivers
3. Digitally assisted RF analog circuits
4. Millimeter-wave/submillimeter-wave IC's
5. Digital RF circuits
6. Heterogeneous mobile network
7. Digital signal processing for broadband wireless communication
8. Dependable wireless system

Information Storage Systems

K. MIURA H. MURAOKA S. J. GREAVES

Staff:

Hiroaki MURAOKA, Professor
Simon J. GREAVES, Associate Professor
Kenji MIURA, Assistant Professor

Research activities:

Our main interest lies in high-density information storage technology. The core technology is magnetic recording with fast data transfer and large storage capacity, which is applied for hard disk drives, magnetic tape storage, and flexible disk drives. Recently, multi-media information such as digital movie and music that requires very large storage capacity begins to be used in broad applications from consumer electronics to mobile communication. This trend accelerates the areal density increase of magnetic recording. Recording theories, devices, and systems based on perpendicular recording are being studied in order to attain ultra-high density information storage. Our target is the terabit storage (Over 5 Tbits/inch^2 areal density), in which the bit size corresponds to the area of 10 nm by 10 nm.

Information Storage Systems Research Division (Profs MURAOKA, MIURA)

A single-pole head and perpendicular disks are investigated through read/write experiments, as shown in Fig 1, to improve the recording performance. For extremely large capacity storage systems, the storage grid working on a network, as shown in Fig 2, is also explored.

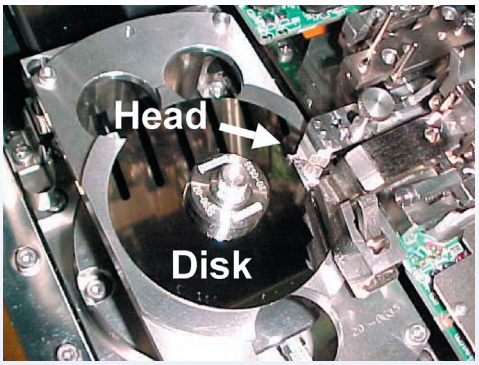


Fig 1 Read/write measurement by using a single-pole head and a perpendicular media.

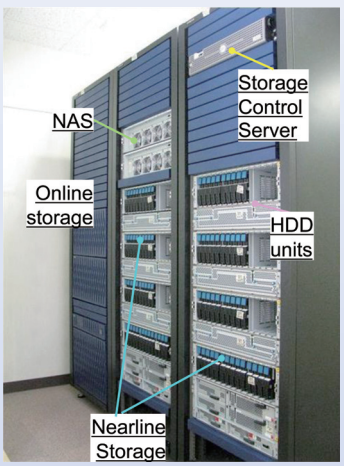


Fig 2 A large-scale storage system with parallel HDD operation.

Research topics:

1. High areal density hard disk drives
2. Head/disk devices for high density magnetic storage
3. Digital signal processing for high density storage
4. Network storage for large capacity file server

Recording Theory Computation Research Division (Prof. GREAVES)

A computer simulation utilizing micromagnetics is being carried out to obtain a guideline towards ultra-high density recording.

Research topics:

5. Micromagnetics simulation for high density read/write theory

Ultra-Broadband Signal Processing

S. A. BOUBANGA TOMBET S. TAKABAYASHI
A. SATOU T. OTSUJI T. SUEMITSU

Staff:

Taiichi OTSUJI, Professor
Tetsuya SUEMITSU, Associate Professor
Akira SATOU, Assistant Professor
Stephane Albon BOUBANGA TOMBET, Research Fellow
Susumu TAKABAYASHI, Research Fellow

Research activities:

Terahertz (sub-millimeter) coherent electromagnetic waves are expected to explore the potential application fields of future information and communications technologies. We are developing novel, ultra-broadband integrated signal-processing devices/systems operating in the millimeter and terahertz frequency regime.

Ultra-Broadband Devices and Systems (Prof. Taiichi OTSUJI)

We are developing novel, integrated electron devices and circuit systems operating in the millimeter-wave and terahertz regions. One example is the frequency-tunable plasmon-resonant terahertz emitters, detectors, and modulators. Another example is unique electromagnetic metamaterial circuit systems based on optoelectronic dispersion control of low-dimensional plasmons. We are also pursuing graphene-based new materials to creat new types of terahertz lasers and ultrafast transistors, breaking through the limit on conventional transistor/laser operation. By making full use of these world-leading device/circuit technologies, we are exploring future ultra-broadband wireless communication systems as well as spectroscopic/imaging systems for safety and security.

Research topics:

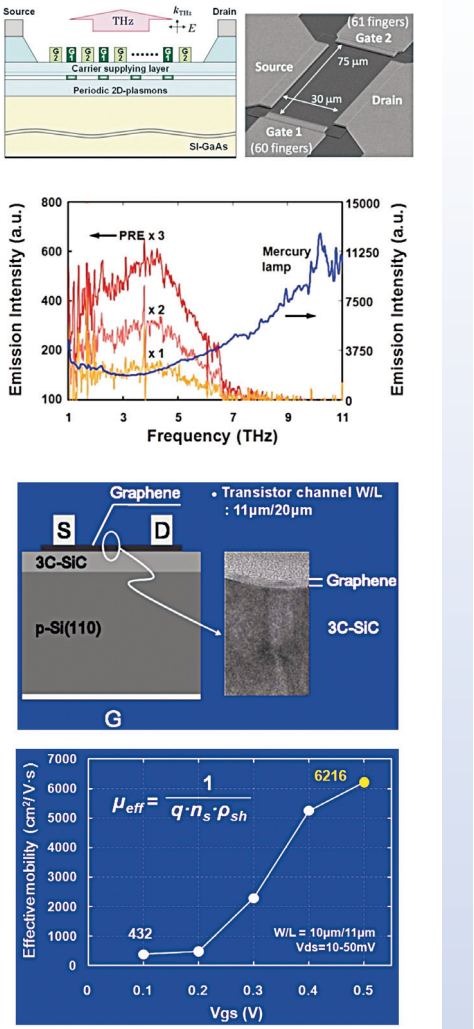
1. Plasmon-resonant terahertz emitters/detectors/modulators and their system applications
2. Terahertz metamaterial circuit systems based on dispersion control of low-dimensional plasmons
3. Graphene-based terahertz lasers and ultrafast transistors, and their system applications

Ultrafast Electron Devices (Assoc. Prof. Tetsuya SUEMITSU)

Transistors are important building blocks for integrated circuits used in a lot of systems for information and communication technologies. Particularly in optical fiber communication systems and (sub-) millimeter-wave frequency systems that requires ultimately high-speed operation, the channel materials of transistors should be chosen to realize high mobility and saturation velocity for carrier electrons (or holes). In our group, we are focusing on three important material systems for such high-speed devices: the indium gallium arsenide (InGaAs) material systems for ultimately high-frequency operation including sub-millimeter-wave regime, the gallium nitride (GaN) material systems for high-power millimeter-wave applications, and the graphene-based material systems as a new candidate for high-speed devices. Our activities include the design, process, and characterization of these devices and their integrated circuits.

Research topics:

4. InGaAs- and GaN-based heterostructure field effect transistors (FETs) for ultimately high frequencies in millimeter- and terahertz-wave regime
5. Graphene-based transistors for high-speed and high-frequency applications



Newly-proposed plasmon-resonant emitter (PRE) operating in the terahertz range. (Upper: cross-sectional view and SEM images of the device fabricated with GaAs-based heterostructure material systems, upper middle: FTIR-measured broadband emission spectra of single-chip and multichip PREs in the self-oscillation mode, lower middle: fabricated graphene-channel back-gate FET, lower: measured drift mobility)

Basic Technology for Broadband Communication

K. MIZUNO

Koji MIZUNO, Visiting Professor

Research activities:

Development of measurement methods using the millimeter- and terahertz-wave region of the electromagnetic spectrum is the research target of this section. Since the wavelength of this region is larger than that of the infrared and optical region, scattering by cloud, dust, flame, fabrics, skin, etc. is much smaller and since photon energy of this region is much smaller than thermal energy kTB at the room temperature, non-invasive measurement for objects is possible. Utilizing these characteristics this region can be applied in the areas such as security system under disaster such as earthquake followed by fire, fire in high-way tunnels, and also applied in security system for detection of weapons under clothes and in diagnostic of biomaterials including skin disease and agricultural produces. We are developing imaging systems mainly of passive mode.

We are developing a 77 GHz-band passive imaging system mainly for airport security check in cooperation with two companies. The flame rate of 2~4 f/s and the space resolution of ~20 mm have been obtained. The method of marking on visible pictures has been adopted to show positions of unidentified objects in consideration of privacy.

This laboratory is operated under the support of a project of MEXT (Ministry of Education, Culture, Sports, Science and Technology).

A prototype of 77 GHz PMMW imaging device was tested in-site at the Narita International Airport to demonstrate its usefulness for security applications in the fall of 2009.

M. INUTAKE Collaborators from other universities

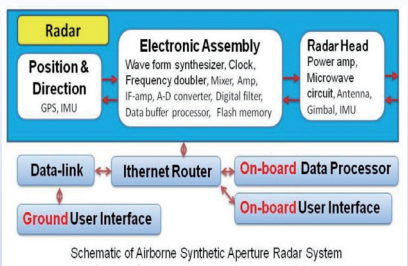
Masaaki INUTAKE, Visiting Professor

Research activities:

Our main interest is to develop an air-borne synthetic aperture radar (SAR) for the civilian applications. The SAR is very useful for all-weather surveillance and rescue in disastrous fires and smokes. Scientists and engineers from both universities and industries collaborate on this research project.

Development of a high resolution (10cm), small size and light weight (30kg) SAR at Ku-band has been started in 2009 under the contract of Ministry of Land, Infrastructure, Transport and Tourism.

Conceptual design of a real-time image-formation SAR system has been done, as shown in the figure. A waveform synthesizer circuit with capability of precisely setting delay time has been developed in 2009.This is prerequisite for a real-time image formation.

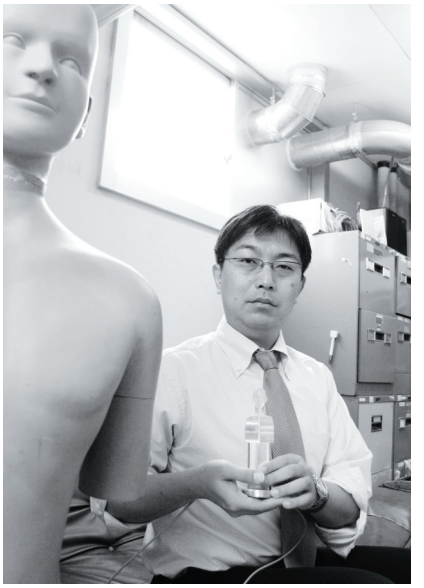


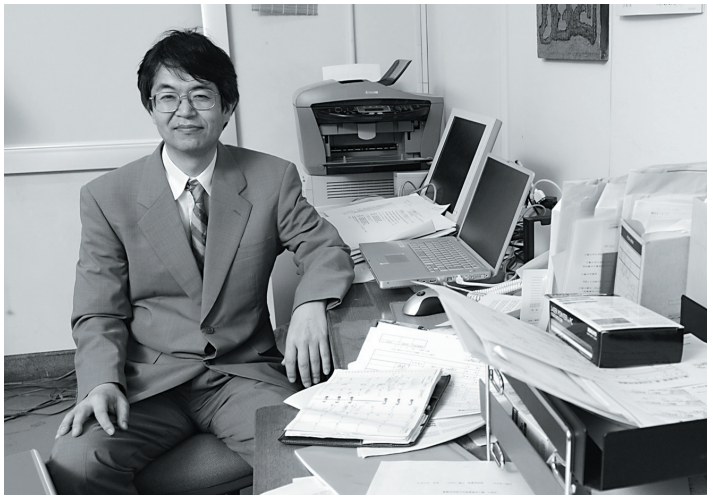
Schematic of Airborne Synthetic Aperture Radar System

Electromagnetic Bioinformation Engineering

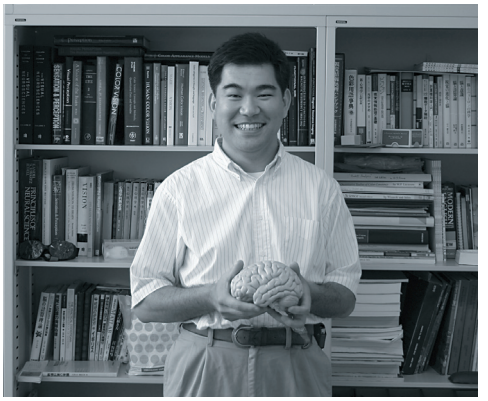
Human Information Systems Division

Advanced Acoustic Information Systems

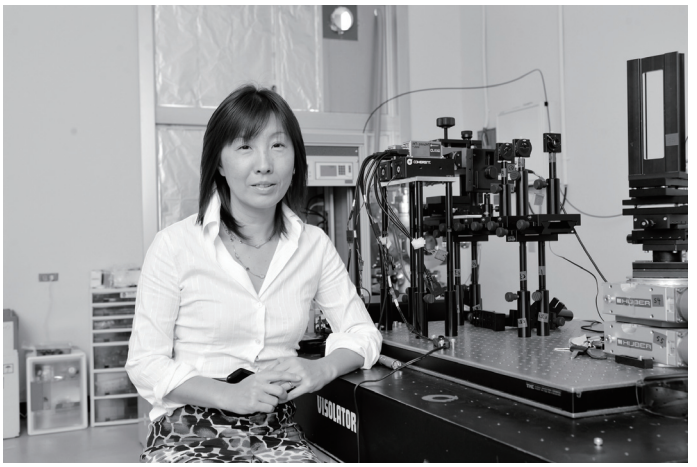




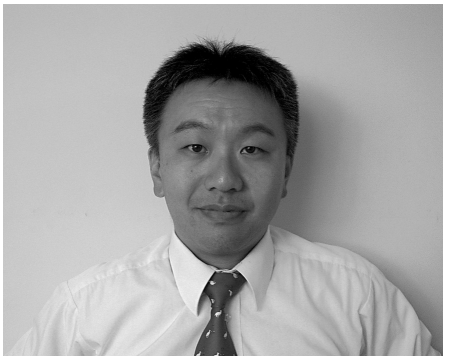
Visual Cognition and Systems



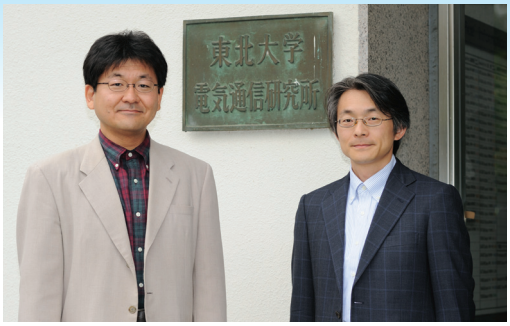
Interdisciplinary Field for Informatics



Ubiquitous Communications System



Electromagnetic Bioinformation Engineering



K. ISHIYAMA S. HASHI

Staff:

Kazushi ISHIYAMA, Professor
Shuichiro HASHI, Associate Professor

Research activities:

For realizing good communication with human body, and for realizing the properties of the human body as an information system, we have to realize the function of the human body as information in addition to catch the signals from the human body. Our research division works on the technology for sensing the information from the human body and for approaching action to the human body. We are focusing to realize the communication technology with human body and to contribute information and communication systems and medical-welfare spheres.

Electromagnetic Bioinformation Engineering (Prof. ISHIYAMA)

High-frequency carrier-type magnetic field sensor, which is developed in our laboratory, obtains the world-highest field sensitivity in room temperature under the works for materials, micro-fabrication techniques, controlling the magnetic properties. This sensor is studied for sensing system for bio-information. As one of the approaching system for human body, wireless actuators and manipulators are investigated. This technology is important for a basic study for robots working in the human body. A part of this technology is applied for a motion system for a capsule endoscope working in the colon tube.

Research topics:

1. Super high sensitivity magnetic field sensor
2. High-frequency electromagnetic measuring system
3. Micro magnetic actuator
4. New medical equipment using magnetic

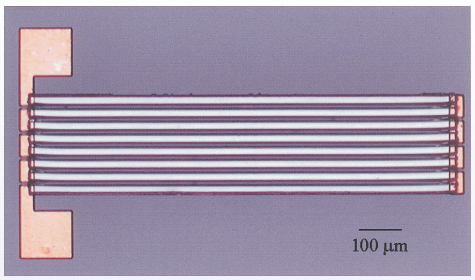
Electromagnetic Bioinformation Materials (Assoc. Prof. HASHI)

Stressless and painless acquisition technique for accurately capturing the motion or the information of a human body is strongly desired in the area of the medical treatment and/or rehabilitation therapy. In this research division, sensing systems for temperature and for hardness are studied as no contact sensing systems. In addition, wireless magnetic motion capture system is studied for the medical and welfare use.

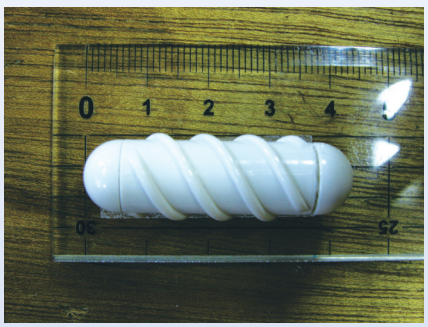
Development of functional magnetic materials and its fabrication process are also studied to progress these magnetic sensing systems.

Research topics:

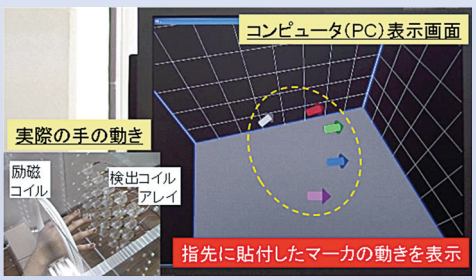
5. Wireless magnetic sensing system
6. Functional magnetic materials



High frequency carrior-type thin film magnetic field sensor



A prototype for motion of capsule-endoscope



Wireless magnetic motion capture system

Advanced Acoustic Information Systems

T. OKAMOTO W. TERAMOTO F. SAITO S. SAKAMOTO M. KOBAYASHI
D. KANG C. L. ZHENG Y. SUZUKI Y. IWAYA

Staff:

Yôiti SUZUKI, Professor
Shuichi SAKAMOTO, Assistant Professor
Takuma OKAMOTO, Research Fellow
Maori KOBAYASHI, Research Fellow
Wataru TERAMOTO, Research Fellow
Yukio IWAYA, Associate Professor
Fumitaka SAITO, Technical Official
Daegee KANG Research Fellow
Cui Lie ZHENG, Research Fellow

Research activities:

Our main interest is a study of the information processing in the human auditory system. We apply a psycho-acoustical approach to the study of fundamental characteristics of the human auditory system such as timbre perception, loudness perception, characteristics extraction, and sound localization. Moreover, in recent years, we are also investigating human multi-modal information processing including hearing.

Advanced Acoustic Information Systems (Prof. Y. SUZUKI)

With good knowledge of the human auditory system, we are, at the same time, aiming at the realization of a 'comfortable' sound environment exploiting digital signal processing techniques. Three-dimensional sound image control by simulating transfer functions of sound paths from sound sources to listeners' external ears, and a sound field simulator based on precise sound field analysis and control are two examples. These systems are expected to provide a high-quality virtual sound space, which is keenly required to realize in the multimedia communication, cyberspace systems and virtual auditory display systems. Furthermore, we have been devoting a lot of effort to the development of advanced digital hearing aids.

Research topics:

1. Auditory perception process and its modeling (including multi-modal perceptions).
2. Spatial hearing process and system theory of spatial information transmissions.
3. Development of new theories of acoustic digital signal processing.

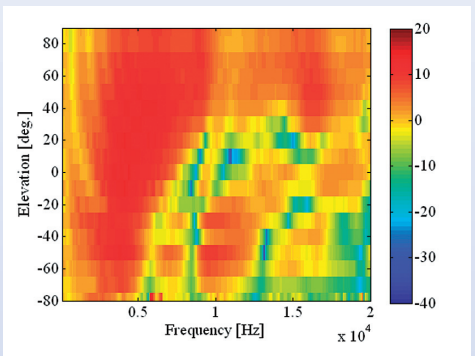
Acoustic Information Communications (Assoc. Prof. Y. IWAYA)

A lot of efforts are put to realize 3D sound space communication systems based on the system construction theory and knowledge of spatial hearing. Based on these systems, future principles for communications with a high sense of presence are keenly studied.

Research topics:

4. Spatial hearing communication systems.
5. Multi-modal sound space communications.

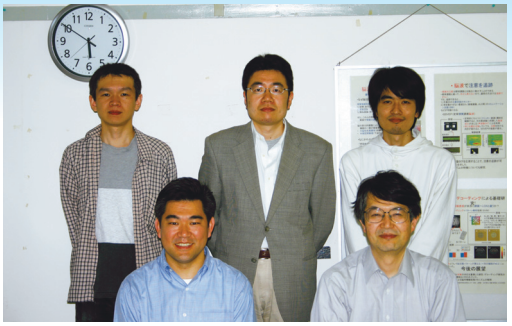
In this figure, speech intelligibility tests are performed to investigate the effect of asynchronization between talking-face movement and speech sound modified by speech-rate conversion technique.



Head related transfer functions as a fuction of elevetion. Poles and zeros change systematically with the rise of elevetion.

Visual Cognition and Systems

R. TOKUNAGA



M. OGIYA K. MATSUMIYA K. MATSUBARA
I. KURIKI S. SHIOIRI

Staff:

Satoshi SHIOIRI, Professor
Ichiro KURIKI, Associate Professor
Kazumichi MATSUMIYA, Assistant Professor
Rumi TOKUNAGA, Assistant Professor
Mitsuharu OGIYA, Research Fellow
Kazuya MATSUBARA, Research Fellow

Research activities:

Human brain is one of the most adaptable systems in the world. Understanding the brain functions is one of the most important issues for evaluating and designing things around us to improve the quality of life. We investigate the brain through visual functions to apply the knowledge to human engineering and image engineering. Our approaches include psychophysics, brain activity measurements, and computer simulations. Our research field covers visual spatial perception, 3D perception, color vision, visual attention and visual-haptic integration.

Visual Cognition and Systems (Prof. SHIOIRI)

Modeling the processes of human vision based on the findings of the strategies that the visual system uses, we plan to propose appropriate methods for evaluation of image qualities, efficient way of image presentation and evaluation of visual environments in general. We also investigate dynamic selection process in vision with or without attention to realize prediction system of human perception and action in the future.

Research topics:

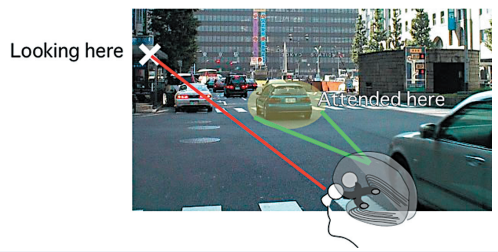
1. Measurements of spatial and temporal characteristics of visual attention.
2. Modeling control system of eye movements and visual attention
3. Investigation of early, middle and late vision of 3D perception.

Cognitive Brain Functions (Assoc. Prof. KURIKI)

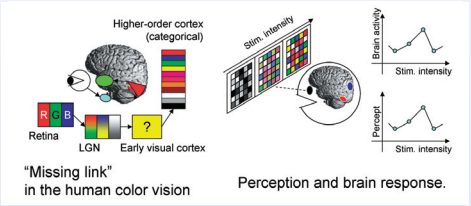
We investigate the brain functions of visual perception (mainly on color perception) using brain-activity measurement and analysis in relation to visual perception.

Research topics:

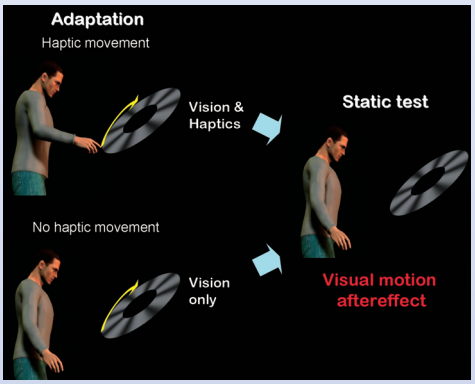
4. Representation of color information in human brain
5. Separation and integration of visual information in human brain



Independent measurements of attended and fixated points. An oversight and a mistake can cause a serious accident under the situation that you drive a car. For example, investigating the relationship between gaze and attention can provide a new insight into this problem.

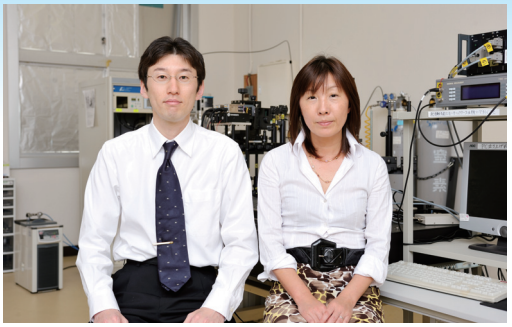


Representation of visual information in the early stage of human visual cortex is still unknown. The mechanisms of visual information processing will be investigated by using behavioral studies and functional brain-imaging studies. This study may reveal the "optimal coding method" of the visual information for human brain.



How does the perceptual system integrate visual and haptic information in motion processing? We compared the magnitude of visual motion aftereffect in the haptic movement condition with that in the no haptic movement condition. This study may reveal the mechanism underlying visual-haptic integration in motion processing.

Interdisciplinary Field for Informatics



A. YOSHIDA K. TAMADA

Staff:

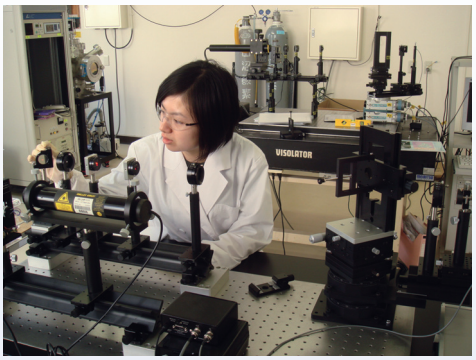
Kaoru TAMADA, Professor
Akihito YOSHIDA, Research Fellow

Research activities:

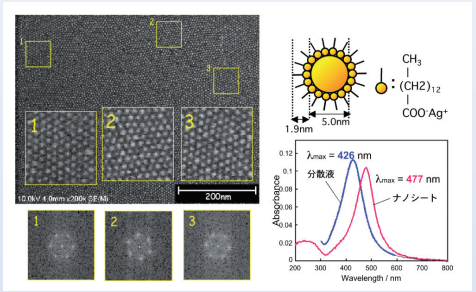
The interdisciplinary field of research combining nanobiotechnology and information technology attracts our exceeding interests. These studies stand on the development of new materials created by self-assembly of functional molecules and nanomaterials, leading to new classes of biosensing devices. The plasmons, especially the combination of surface plasmons propagating along the metal-organic interface and local surface plasmons on metal nanoparticles is crucial to control and manipulate localized light in nano-scale for nano-sensing as well as transportation of opto-chemical information in a nanospace. Our recent study demonstrates that two dimensional giant crystals composed of silver nanoparticles can efficiently trap and transport bulk light within nanosheet. This flexible, transferable nanosheet is the promising building block for various types of plasmonic devices. Future biosensing devices require particular designs for the multiple detection of dynamic molecular information. Massive data collected must be accumulated and analyzed comprehensively, to be referred quickly and flexibly --- The development of such advanced biosensing devices is highly desired on reflection of present sensing systems, in which nano-scaled local interactions and cooperative phenomena of molecules are omitted at the entrance (bio-interface). Plasmonic devices composed of nanostructured materials with enhanced electromagnetic field will be a solution for the detection of reaction dynamics with high spatiotemporal resolution and sensitivity.

Research topics:

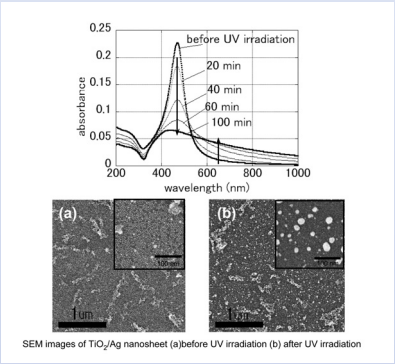
1. Propagating / local surface plasmons and waveguide modes
2. Plasmonic nanosheet composed of Ag nanoparticles
3. Design of devices based on nano-structured materials
4. Characterization of interfaces between various nanomaterials



Surface plasmon resonance (SPR) spectroscopy



Plasmonic nanosheet composed of Ag nanoparticles



Characterization of remote photocatalytic reaction of TiO_2 nanotube with Ag nanosheet

Ubiquitous Communications System

H. SAWADA S. KATO H. NAKASE

Staff:

Shuzo KATO, Professor
Hiroyuki NAKASE, Associate Professor
Hirokazu SAWADA, Assistant Professor

Research activities:

Wireless communications technologies have been providing various and indispensable communications means ranging from radio, TV, cell phones, wireless LANs and so on. However, there is big room to improve for more active wireless communications applications such as Super Broad Band Wireless Communications (Fig.1) which we have been proposing, remote wireless health check and so on.

In order to realize ubiquitous communications which enable communications possible without knowing communications means consciously, this Laboratory has been carrying out basic researches and developments on radio propagation, communications systems, equipment and so on with which one can communicate anywhere, anytime with anybody with the policy set by the individual interest.

More concretely, the Laboratory has been doing core / basic researches in the areas of Modulation/coding, Interference mitigation/equalization, 60 GHz CMOS RF, Antenna & propagation, and MAC (Medium Access Control) in addition to Practical wireless systems/equipment development including sensor systems.

Furthermore, the Laboratory has been contributing/leading IEEE standardization in millimeter wave communications systems.

Ubiquitous Communications Systems (Prof. KATO)

This year focus will be the millimeter beamforming antenna including “discrete phase control beamforming antenna, low loss phase shifter, high reliable communications channel creation” as core technologies for high reliable ultra high speed (3Gbps) transmission by portable terminals based on the global standardization which has been completed under the leadership of the COMPA Consortium led by Professor Kato (Fig. 2 and 3). Also the focus will be extended to low power consumption FEC, modems for portable terminals and wireless communications applications such as millimeter wave sensor systems, high reliable multi-point communications systems and so on.

Ubiquitous Communications Device (Assoc. Prof. NAKASE)

Research activities have been taken on high speed and efficient next generation CMOS RF devices. This year focus will be R&D on 60 GHz high efficient CMOS RF IC composed of a driver circuit and class B power amplifier (Fig.4).

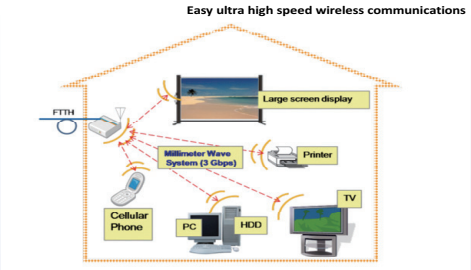


Fig. 1 Conceptual diagram of Super Digital Home

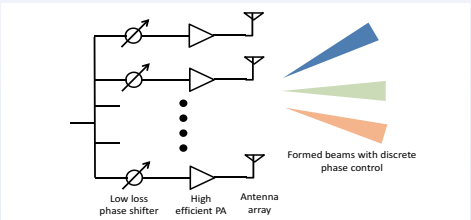


Fig. 2 Core technology of Super Digital Home- Beam forming antenna

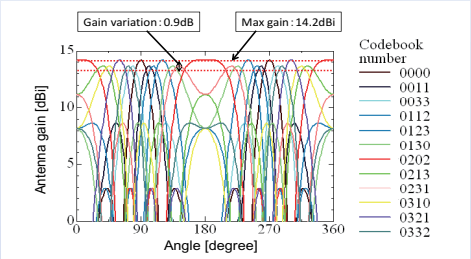


Fig.3 Performance of 4 element beam forming antenna Discrete phase (90 degree) control, 12 patterns for all coverage

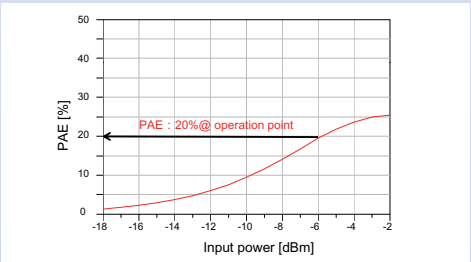
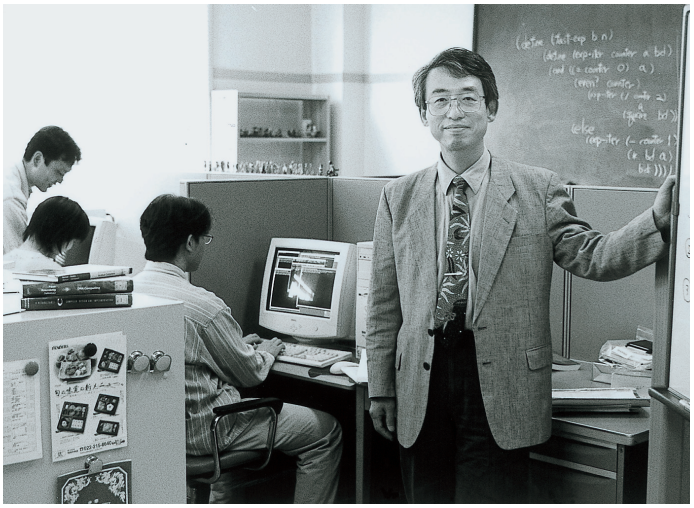


Fig. 4 Power added efficiency (PAE) of Class-B power amplifier 20 % PAE at operation point (Pout=3dBm)

Software Construction

Systems & Software Division

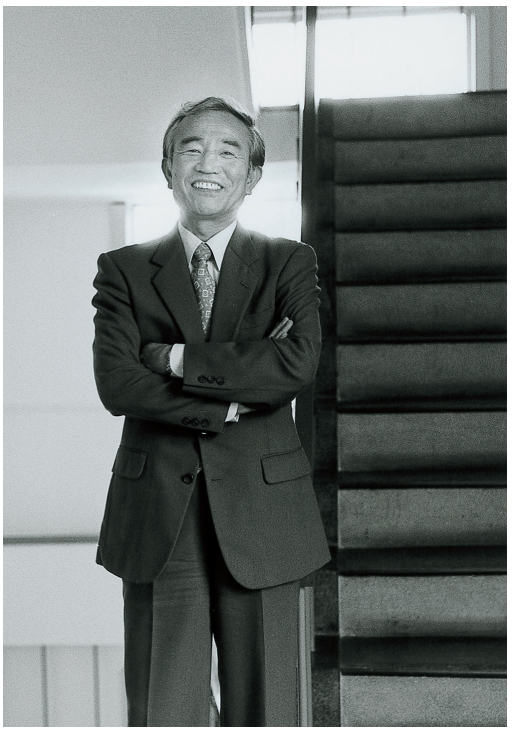


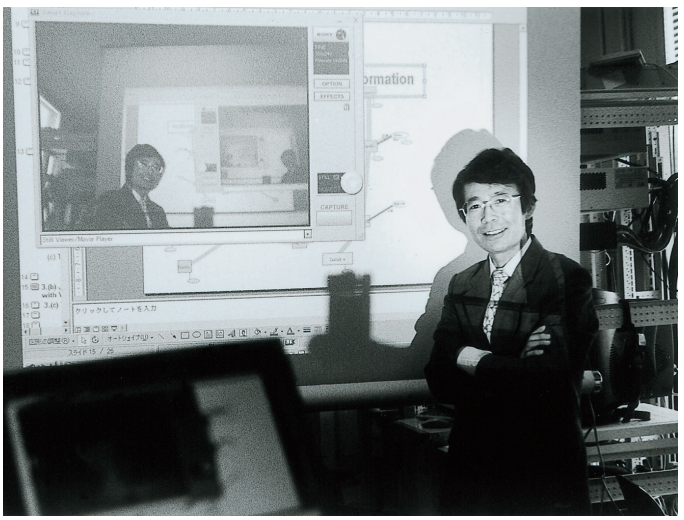
Computing Information Theory

Communication Network Systems

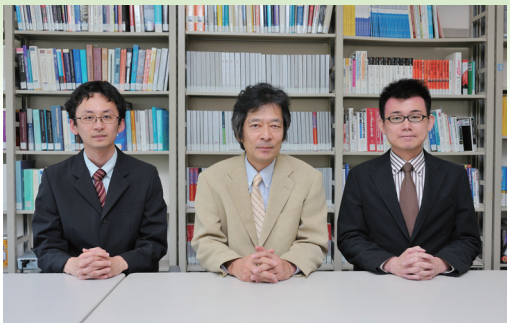
Information Contents

Information Social Structure (Visitor Section)





Software Construction



A. MORIHATA A. OHORI K. UENO

Staff:

Atsushi OHORI, Professor
Katsuhiro UENO, Assistant Professor
Akimasa MORIHATA, Assistant Professor

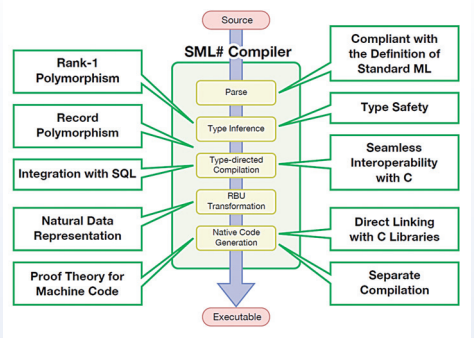
Research activities:

Today's software systems are becoming more and more complicated due to the need of integrating various computation resources available in the Internet. A key to control the complexity and to enhance the reliability of such a system is to develop a high-level programming language that can directly represent various resources and automatically detect potential inconsistencies among the components in a system.

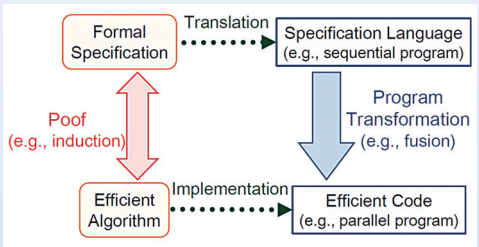
Based on this general observation, our research aims at establishing both firm theoretical basis and implementation method for flexible yet reliable programming languages for advanced Internet computation. One direction toward this goal is to establish logical foundations for compilation. We aim at establishing a proof-theoretical framework that accounts for the entire process of compilation -- including A-normalization and code generation -- as a series of proof-transformations. Another direction is to provide systematic methods of developing efficient programs by program transformations. Programs should correspond to their formal specifications. Our approach is to extract program-development processes by rephrasing the correspondence by program transformations. In addition to those foundational research, we are also developing a new practical ML-style programming language, SML#, that embodies some of our recent results such as record polymorphism, rank-1 polymorphism, and high-degree of interoperability with existing languages and databases.

Research topics:

1. Development of SML#, a new ML-style polymorphic programming language
2. Logical foundations for compilation
3. Integration of databases and programming languages
4. Program transformations for developing/optimizing algorithms
5. Reliable scripting languages for Web programming

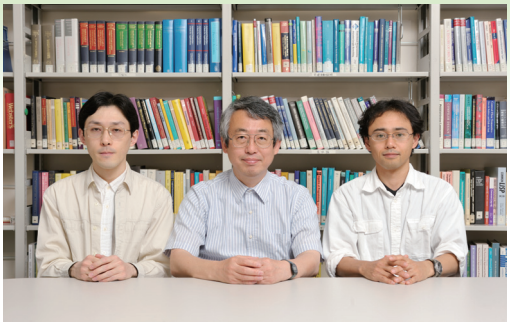


SML#, a state of the art compiler



A framework for deriving algorithms by program transformations

Computing Information Theory



K. KIKUCHI Y. TOYAMA T. AOTO

Staff:

Yoshihito TOYAMA, Professor
Takahito AOTO, Associate Professor
Kentaro KIKUCHI, Assistant Professor

Research activities:

Equational reasoning is ubiquitous in many areas of computer science such as automated theorem proving, formula manipulating systems, algebraic specifications, and functional and logic programming languages. Rewriting is a mathematical formalism which can offer both flexible computing and effective reasoning with equations. We aim at developing a unified theory of computational-logical-algebraic systems based on the theory of rewriting systems combining computations and proofs.

Computing Information Theory （Prof. TOYAMA）

Our research focuses on important theoretical features of the rewriting paradigm, such as the Church-Rosser property, the termination property, and the modular property. We are also interested in design and analysis of automated deduction systems which can offer both effective computation of functional (or logic) programming languages and flexible reasoning of automated theorem provers. We are investigating program verification and transformation systems based on automated theorem proving techniques.

Research topics:

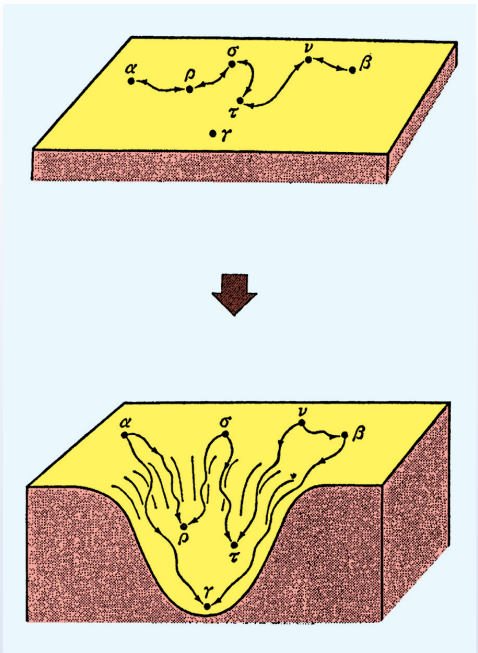
1. Rewriting Theory
2. Foundations of Softwares
3. Automated Deduction

Computing Logical Systems （Assoc.Prof. AOTO）

We are developing techniques for verifying important properties of rewriting systems such as the Church-Rosser property and the termination property. We are also interested in proving inductive properties of rewrite systems and lemma generation methods for this. We are trying to extend these techniques to higher-order rewriting systems which are amenable for modeling more practical functional programs.

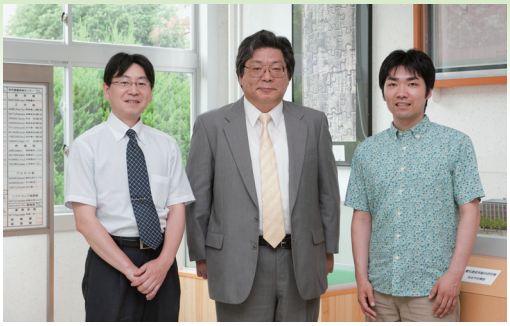
Research topics:

4. Rewrite Systems
5. Automated Theroem Proving



Proof by Equational Reasoning
→ Computation by Rewriting Systems

Communication Network Systems



T. SUGANUMA T. KINOSHITA S. UTSUMI

Staff:

Tetsuo KINOSHITA, Professor
Takuo SUGANUMA, Associate Professor
Satoshi UTSUMI, Research Fellow

Research activities:

People expect that various networks exist everywhere in the society and information systems over such networked environment support everyday life and social activities of people and create new life styles as well as information society. This laboratory aims at research and development of advanced network-based intelligent systems.

Intelligent Communication (Prof. KINOSHITA)

It becomes an important problem to develop intelligent systems, which can cooperate with various people as the human-friendly, easy-to-use, intelligent partners, in order to support various creative activities of people in an active and autonomic way. To realize such an intelligent system, we propose a concept called Cyberware as an infrastructure of cybersociety that provides people a new information environment in which people and intelligent systems can work together cooperatively. We aim at studying advanced information technologies to realize a new infrastructure of cybersociety based on cooperation and coordination of both people and intelligent systems over the networked environment, using the agent based computing technologies.

Research topics:

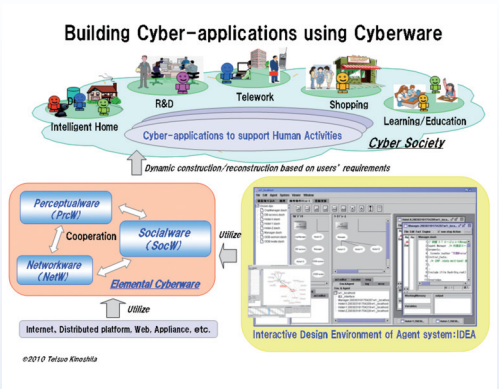
1. Software Infrastructure of Cyber society (Cyberware)
2. Multiagent framework/Design methodology
3. Knowledge-based communication service infrastructure/ User-oriented networking
4. Agent-based/Knowledge-based/Network-based systems

Symbiotic Communication System (Assoc. Prof. SUGANUMA)

We investigate basic technologies and applications towards next-generation information communication environment called "Symbiotic Communication System," where diverse entities in real world collaborate with each other harmonically, based on the advanced technologies of ubiquitous computing, agents and multimedia communications.

Research topics:

5. Basic theory, model and architecture for Symbiotic Communication System
6. Symbiotic care-support system, 3D symbiotic space
7. Next generation ubiquitous network management



Cyberware and its applications based on agent based computing

Information Contents

Y. KITAMURA T. AOKI

Staff:

Yoshifumi KITAMURA, Professor
Terumasa AOKI, Associate Professor

Research activities:

Good media content has the power to enrich our lives. The effectiveness of content delivery is becoming more and more important in a wide variety of fields, such as industry, education, culture, entertainment, and so on. Expectations of its use in the general public are also increasing.

We are conducting comprehensive research on a variety of content areas to create new value by uniting information and communications technologies. We focus on non-traditional content areas other than movies, music, and games.

Interactive Content Design (Yoshifumi KITAMURA)

We are conducting research on technologies related to interactive content which creates new value through interactions with humans.

Research topics:

1. Displays and Interactive Techniques
   Original display systems to show visual information accurately and comfortably, and interaction techniques to use the display systems effectively (Fig. 1).
2. Dynamic, Interactive, and Autonomous Multimedia Content
   Real-time creation of multimedia content which satisfies a variety of user interactions and environmental changes.
3. Interactive Video Content
   New types of interactive content which effectively use real movies taken by cameras and computer animations (Fig. 2).

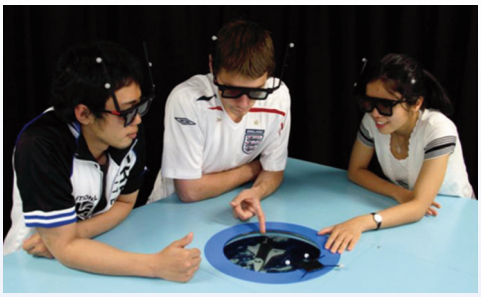


Fig.1

Fig.2

Creation, Comprehension & Distribution of Digital Content (Terumasa AOKI)

We are developing new technologies about intelligent processes through lifecycles of digital content (creation, archiving, distribution, protection and consumption).

Research topics:

4. Digital Content Creation Technologies
   Simple content creation technologies for all kinds of people such as automatic 3DCG animation creation system only by scenario input (Fig.3) and digital cloth fitting room (Fig.4) etc.
5. Digital Content Comprehension Technologies
   High-level content comprehension technologies such as automatic metadata generation for video retrieval, 3D model reconstruction and objectionable content detection etc.
6. Digital Content Distribution Technologies
   Secure/safe or other kinds value-added content distribution technologies such as high-efficient video coding, content protection, cyclic broadcasting for content distribution etc.

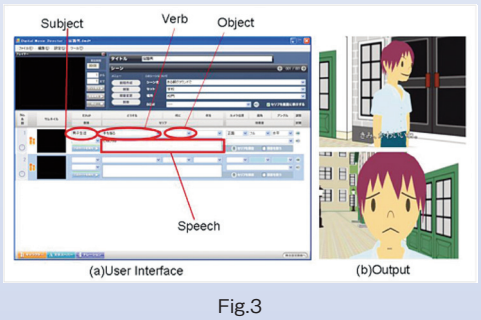


Fig.3

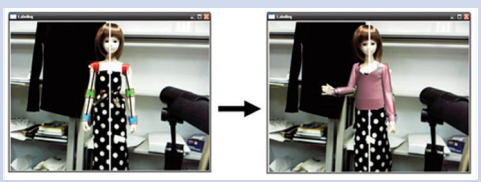


Fig.4

Information Social Structure

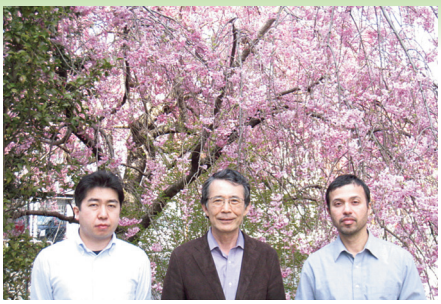
M. YANO

Masafumi YANO, Visiting Professor

Research activities:

There are close relationship between the way of communication and the behavior of human beings The communication technology has so rapidly developed and brought about great social change including globalization of communication and physical distribution Even this sophisticated technology, however, does not still work in harmony with human nature Because the today information systems can only process learned information and requires all necessary information in advance It means that the present information system cannot adapt to changing environment In contrast, biological systems such as human beings can create information necessary to interpret external stimuli and to control actuators in real-time, by appropriately recognizing and judging unpredictably changing environment.

We will try to understand how living organisms create information, and to realize a new system for flexible information processing.



N. SHIRATORI
H. TAKAHASHI D. CHAKARABORTY

Norio SHIRATORI, Visiting Professor
Debasish CHAKARABORTY, Visiting Associate Professor
Hideyuki TAKAHASHI, Research Fellow

Research activities:

Science and technology in the 21st century demands us to deal with the changes in the global environment, social structure, and aging society. In our laboratory, we propose the philosophy of Symbiosis that can absorb and sublate these changes. The focus of our research is the preservation of Earth from its present crisis and plays a role towards humanity and sociality.

More concretely, we are promoting the theory of Symbiotic Computing and Green Computing and developing application based on the concept of symbiosis.

Research topics:

1. Symbiotic Computing: Symbiosis between Human and Information Environment
2. Green Computing and Network Management
3. Net Media / Smart Home / Supervisory Support System
4. Symbiotic Information Social Structure

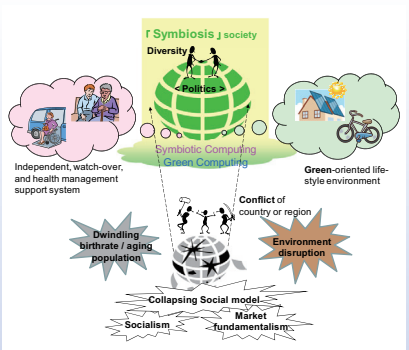


Fig. Symbiotic computing and Information Social Structure

Sponsored Division

Environmental-Adaptive Information and Communication Engineering

Environmental-Adaptive Information and Communication Engineering

E. ADACHI

Staff:

Eiki ADACHI, Professor

Research activities:

To embody a humanity-rich-communication by innovating information-and-communication technology (ICT) in the sustainable global society, we have to create human-friendly low-environmental-impact ICT devices and systems by using electronic materials and device-technology in the research fields of Nanotechnology, Spintronics and Information technology.

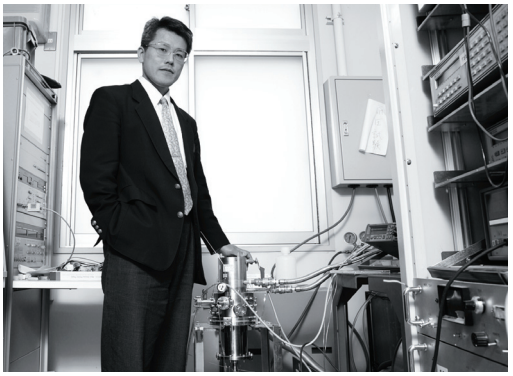
Our aim is that the embodiment of low-environmental-impact information devices and electronic equipments based on fundamental theory of spin and electron; these are designed by systematic survey of the rapidly-changing industry needs and R&D trends.

By analyzing the innovation trend in the fields of environmental and energy technologies, we embody innovative ICT devices and equipments. Further we would like to lead a related ICT researcher's community to the desirable trend.

Research topics:

1. Manufacturing technology research for environmental-load-reducing ICT devices and equipments
2. Fundamental research for ICT devices and equipments reducing environmental destruction by human activities
3. Survey research for industry needs and R&D trend induced by moving to an environmentally sound society

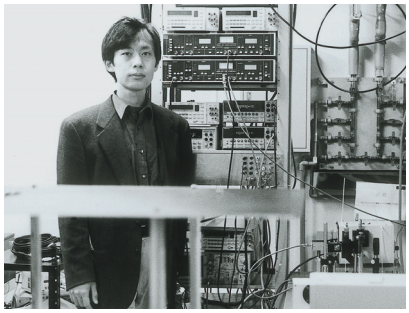
A smart city balanced between human society and natural environment

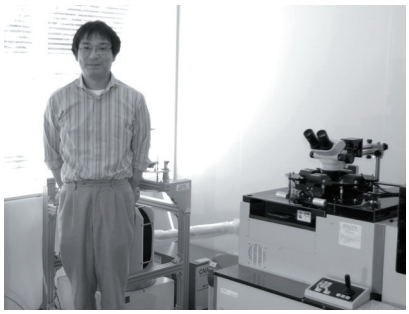


Atomically Controlled Processing

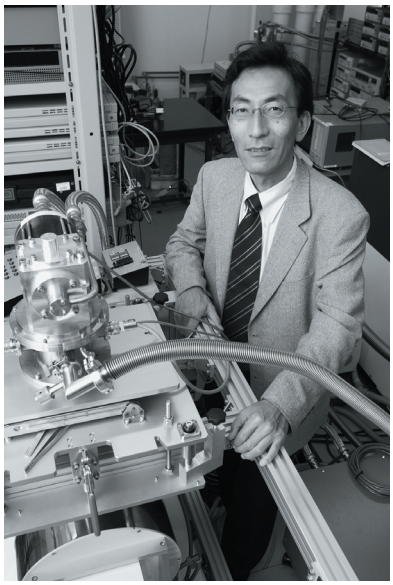
Nano-Spin Memory

Laboratory for Nanoelectronics and Spintronics

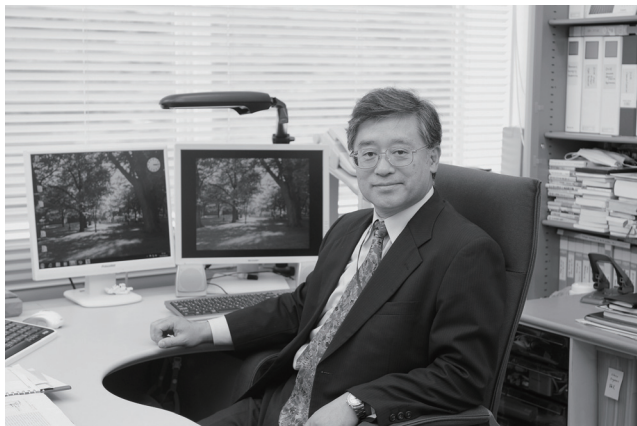




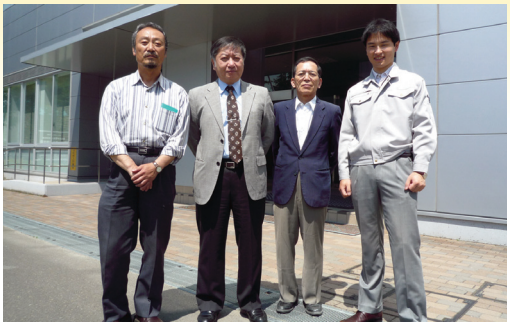
Semiconductor Spintronics



Nano-Molecular Devices



Laboratory for Nanoelectronics and Spintronics



S. TSUCHIDA J. MUROTA T. MEGURO R. SASAKI

Staff:

Director: Junichi MUROTA, Professor

Cooperation Section

Ryutaro SASAKI, Technical Official

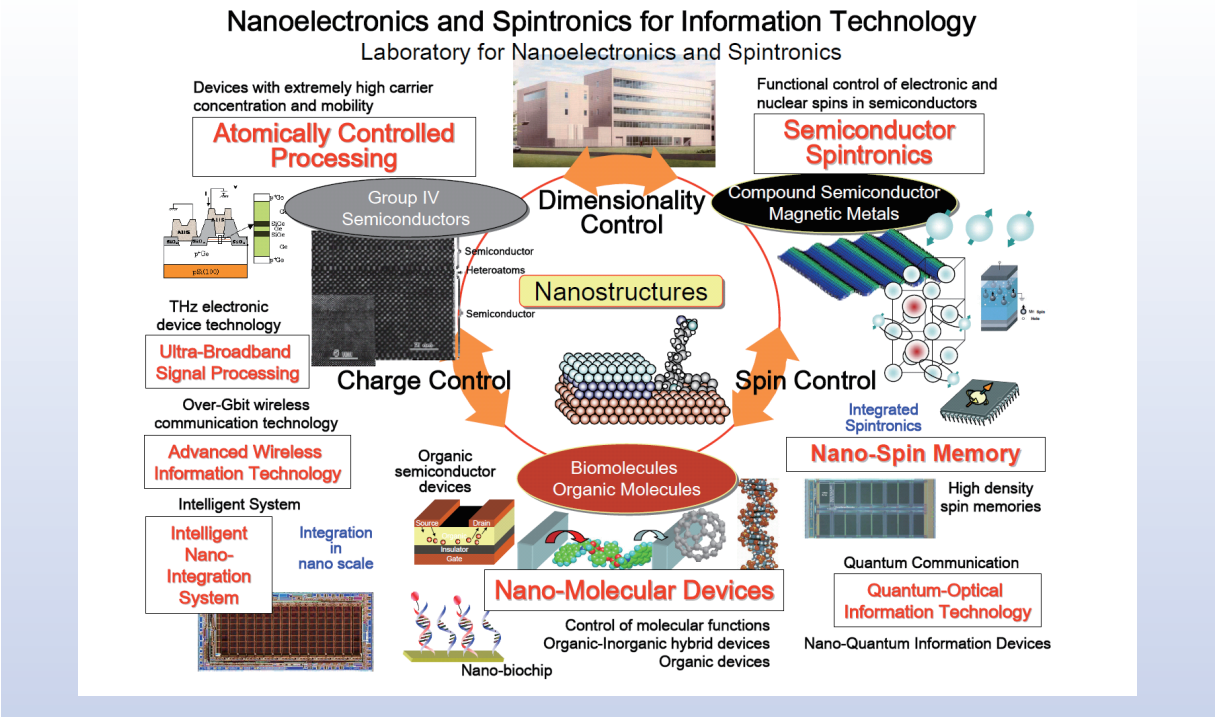
Sadao TSUCHIDA, Technical Official

Toshiyasu MEGURO, Research Fellow

Research activities:

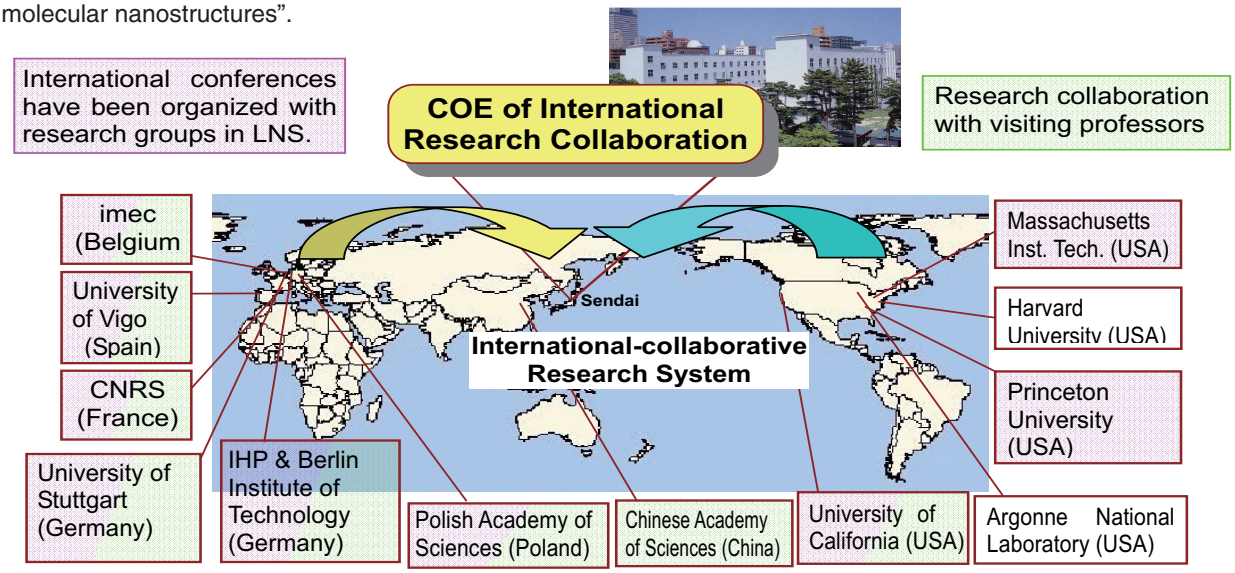
The Laboratory for Nanoelectronics and Spintronics of the Research Institute of Electrical Communication was established on April of 2004. Its purpose is to develop and establish the science and technology of nanoelectronics and spintronics for information technology. Utilizing the facilities installed in the Nanoelectronics-and-Spintronics building and under collaboration between the RIEC and electro-related laboratories of the Graduate Schools of Engineering, Information Sciences, Biomedical Engineering, Tohoku University, R&D of nanotechnologies of materials and devices in Nanoelectronics and Spintronics will be continued extensively. Furthermore, nation-wide and world-wide collaboration research projects will be conducted to build a systematic database in the electrical communication research area.

The Laboratory for Nanoelectronics and Spintronics mainly consists of research groups which promote following sections: Atomically Controlled Processing, Semiconductor Spintronics and Nano-Molecular Devices; together with the groups of Intelligent Nano-Integration System, Quantum-Optical Information Technology, and Ultra-Broadband Signal Processing. These groups cooperatively carry out the research aimed at establishing a world-wide COE in the research area of nanoelectronics and spintronics.



COE of International Research Collaboration

Based on the program(FY2005-2009) to build a system for international research collaboration by Special Funds for Education and Research (Ministry of Education, Culture, Sports, Science and Technology, Japan), we aim to establish COE in research fields of “Fabrication and application of semiconductor 3D-nanostructures”, “Establishment and application of spin-control technologies in semiconductors”, and “Realization and application of information processing using molecular nanostructures”.



Academic Exchange Programs

IHP-Innovations for High Performance microelectronics, Germany
Berlin Institute of Technology, Germany
Interdisciplinary Center on Nanoscience of Marseille (CINaM)-CNRS/University of Mediterranean, France
Institute of Semiconductors, Chinese Academy of Sciences, China
Institute of Physics, Polish Academy of Sciences, Poland
University of California, Santa Barbara (UCSB), USA
Harvard University, USA

International Symposium held in LNS, RIEC

International Workshop on New Group IV Semiconductor Nanoelectronics (RIEC Symp.)

(1st: May 27-28, 2005; 2nd: October 2-3, 2006;
3rd: November 8-9, 2007, 4th: September 25-27, 2008 ;
5th: January 29-30, 2010)

3rd Int. Workshop on New Group IV Semiconductor Nanoelectronics

RIEC Symposium on Spintronics

(1st: February 8-9, 2005; 2nd: February 15-16, 2006;
3rd: October 31-November 1, 2007, 4th: October 9-10, 2008;
5th: February 5-6, 2010)

International Workshop on Nanostructure & Nanoelectronics

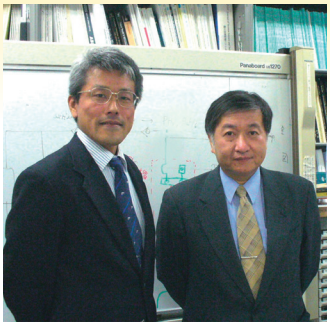
(1st: November 21-22, 2007; 2nd: March 11-12, 2010)

2nd RIEC Symposium on Spintronics-MgO-based Magnetic Tunnel Junction- Left: Albert Fert (received 2007 Nobel Prize in Physics); Right: Russel Cowburn

RIEC-CNSI Workshop on Nano & Nanoelectronics, Spintronics and Photonics

(1st: October 22-23, 2009)

Atomically Controlled Processing



M. SAKURABA J. MUROTA

Staff:

Junichi MUROTA, Professor
Masao SAKURABA, Associate Professor

Research activities:

For highly functional semiconductor devices with ultrahigh speed and ultralow power for the Si LSIs, our atomically controlled processing technology by control of reaction in low-temperature CVD (Chemical Vapor Deposition) becomes important increasingly. Utilizing the technology, we aim to create non-equilibrium strain-controlled Si-Ge-C group IV semiconductors with high carrier concentration and high carrier mobility by advancing atomically controlled heteroepitaxial growth of Si, Ge, SiGe, SiGeC and impurity (B, P, C, N and so on) to the extremity. Moreover, we also aim to establish a technological basis for highly controlled nanometer-order three-dimensional structure formation.

By the above researches, highly strained nanometer-order three-dimensional structures and room temperature resonant tunneling structures with higher performance which exceeds the limit of physical properties in use of existing Si, SiGe alloy and Ge materials will be created. Simultaneously, by applying them to device fabrication, creation of group IV semiconductor quantum-effect nanodevice applicable to the large scale integration will be expected.

Atomically Controlled Processing (Prof. MUROTA)

The following researches are being advanced: (1) Control of extremely high carrier concentration due to non-equilibrium atomically controlled heteroepitaxial growth, (2) Modulation of energy band structure and carrier mobility due to introduction of atomically controlled strain into Si and Ge, (3) Formation of the nanometer-order three-dimensional structure with nanometer-order thickness utilizing CVD heteroepitaxial growth of unstrained Si/strained SiGe/Si heterostructures and selective etching with atomic layer control to form highly strained Si and SiGe layers and to achieve extremely high carrier mobility in Si-Ge materials.

Research topics:

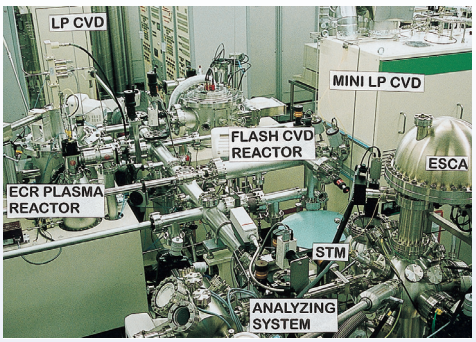
1. Atomically controlled heteroepitaxial growth of Si-Ge-C group IV semiconductors
2. Atomic layer doping into nanometer-order heterostructures of group IV semiconductors
3. Three-dimensional nanometer-order fabrication of group IV semiconductor heterostructures
4. Fabrication process of Si-based highly strained nanometer-order heterostructure devices

Group IV Quantum Heterointegration (Assoc. Prof. SAKURABA)

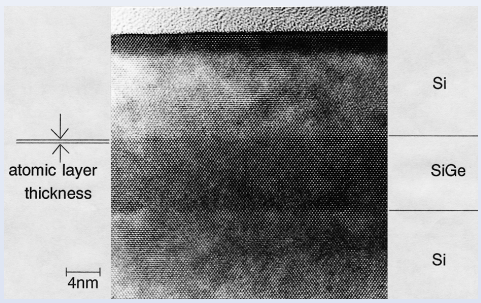
The following researches are being advanced: (1) Atomic-order control of highly strained group IV semiconductor heterostructure formation in a nanometer-order ultrathin region which utilizing plasma CVD reaction at low temperatures without substrate heating, (2) Systematic investigation and control of charge transport phenomena including quantum phenomena in the highly strained group IV semiconductor heterostructures to find out novel electronic properties, (3) Heterointegration of the group IV semiconductor quantum heterostructures and high-performance nanodevices into the Si large-scale integrated circuits.

Research topics:

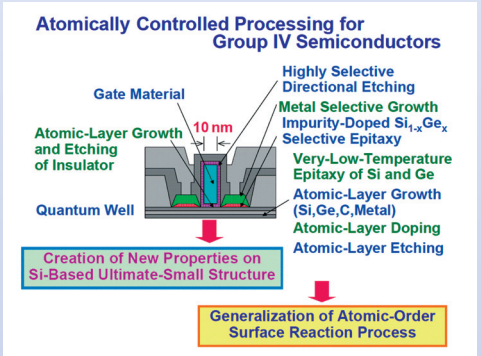
5. Low-damage plasma CVD process without substrate heating for epitaxial growth of highly strained group IV semiconductors
6. Large-scale integration process of group IV semiconductor quantum heterostructures
7. Fabrication of high-performance nanodevices utilizing group IV semiconductor quantum heterostructures



Atomically controlled processing systems for group IV semiconductors



Atomic lattice image of a SiGe heterostructure grown by CVD at 500℃.



Atomically controlled processing for group IV semiconductors.

Semiconductor Spintronics

(Nano-Spin Memory)

K. OHTANI K. MIURA F. MATSUKURA S. MATSUZAKA M. GHALI
S. IKEDA H. OHNO Y. OHNO

Staff:

Hideo OHNO, Professor
Fumihiro MATSUKURA, Associate Professor
Keita OHTANI, Assistant Professor
Mohsen GHALI, Research Fellow
Yuzo OHNO, Associate Professor
Shoji IKEDA, Associate Professor
Shunichiro MATSUZAKA, Research Fellow
Katsuya MIURA, Research Fellow

Research activities:

In order to realize new functional spintronic and high-speed devices, our research activities cover the areas of preparation, characterization, and application of new classes of solid state materials as well as their quantum structures, in which electronic and spin states can be controlled.

Functional Spintronics (Prof. Hideo OHNO)

We are working on the preparation of quantum structures based on semiconductor and metal materials as well as their characterization by electrical, optical, and magnetic means, in order to realize new functional devices with low power consumption, high-speed operation, and high density.

Research topics:

1. Semiconductor spintronics
2. Quantum cascade structures and their application to THz optical devices
3. Growth and characterization of semiconductor quantum nanostructures
4. Magnetic metal devices and their application

Functional Spin Photonics (Associate Prof. Yuzo OHNO)

We are studying the properties and coherent dynamics of electron and nuclear spins in semiconductor quantum structures by using such as high-sensitivity and high-time resolution optical characterization technique to establish novel spintronic devices technology.

Research topics:

5. Growth and characterization of electrical, optical, and spin properties of semiconductor quantum nanostructures
6. Spin coherence in semiconductor nanostructures and its application to quantum information technology and low power consumption technology

Functional Spintronics Materials (Associate Prof. Fumihiro MATSUKURA)

We are working on the fabrication and characterization of spintronics materials and their based structures, in order to demonstrate new principle of spintronic device operation.

Research topics:

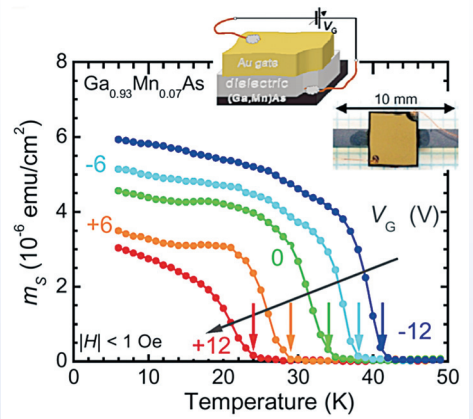
7. Properties and application of magnetic semiconductors and their quantum structures

Nano-Spin Memory (Associate Prof. Shoji IKEDA)

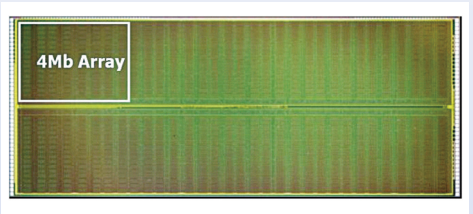
We are developing technologies to realize high-performance low-power consumption spin memory and logic devices using magnetic tunnel junctions (MTJs) consisting of ferromagnetic metal electrodes with in-plane or perpendicular magnetic anisotropy and insulating barrier.

Research topics:

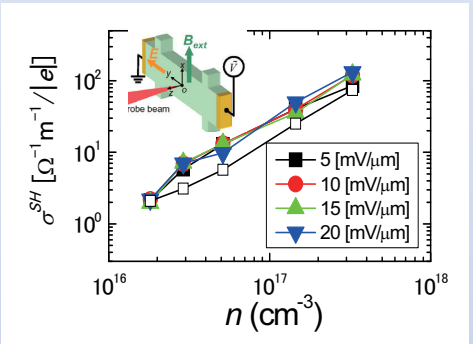
8. Magnetic tunnel junctions with high output voltage
9. Metal-based spintronics devices
10. Spin transfer torque memory and logic devices



Direct magnetometry of electric-field effect on magnetic semiconductors.



A prototype of 32 Mbit SPRAM with access time of 32 ns and writing time of 40 ns.



Spin-Hall conducitvity in n-type semiconductor GaAs vs carrier concentration has been measured by optical means.

Nano-Molecular Devices

Y. KIMURA M. NIWANO Y. AONUMA

Staff:

Michio NIWANO, Professor
Yasuo KIMURA, Associate Professor
Yuki AONUMA, Assistant Professor

Research activities:

Miniaturization and performance improvement of various devices has been being sustained by the tremendous progress of the semiconductor fine processing technology. On the other hand, nanotechnology or biotechnology to prepare and manipulate biomolecules, supramolecules, and nanostructures with unique electric and optical properties that are hardly obtained from other materials are advancing. Our aim is the realization of molecule-sized electronic devices that can process various more sophisticated tasks by application of these unique materials based on the Si technology.

Nano-Molecular Devices（Prof. NIWANO）

Sensing systems for analysis of biological materials such as DNA and protein molecules at the Si semiconductor surfaces that manufactured and controlled by Si technology are developed. Observation equipments for biological materials and cultured cells such as nerve cells are developed to elucidate the mechanism of communication and signal processing between the cells.

Research topics:

1. Analysis of biological functions at semiconductor surfaces (Surface-Biotronics)
2. Development of bio-sensing systems
3. Investigation of the signal processing of the nerve cell network

Nano-Electronic Device（Assoc. Prof. KIMURA）

The mechanism of formation processes of nanostructures is investigated. Based on the elucidated mechanism, the nanostructure formation process is controlled by the semiconductor fine processing technology. The novel processes will be able to generate functions of nanostructures simultaneously with control of the position of them to fabricate nano electronic devices.

Research topics:

4. Fabrication of nano electronic devices through electrochemical process.
5. Fabrication of dye-sensitized solar cells using anodic TiO2 nanotubes.
6. Development of high-power organic electronic devices using supramolecules or organic molecules

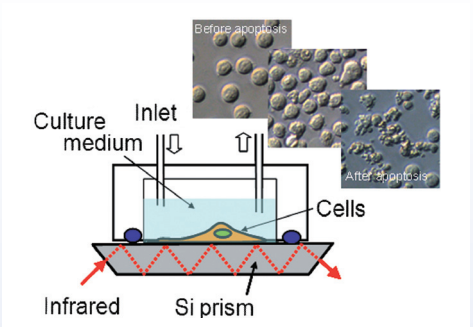


Fig.1: Apoptosis (Programmed cell death) of cells and infrared spectroscopy for the analysis of cell functions

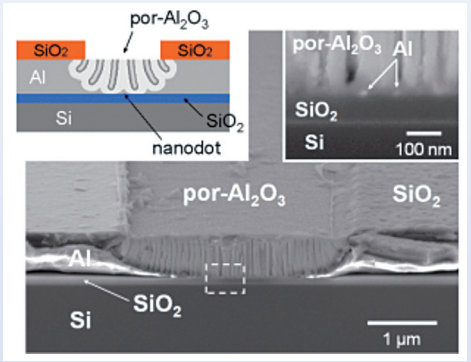


Fig.2: The structure of a single electron transistor (SET) fabricated through anodization

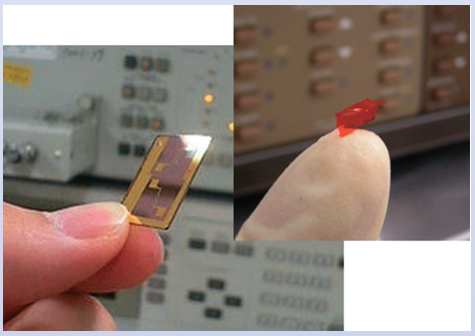
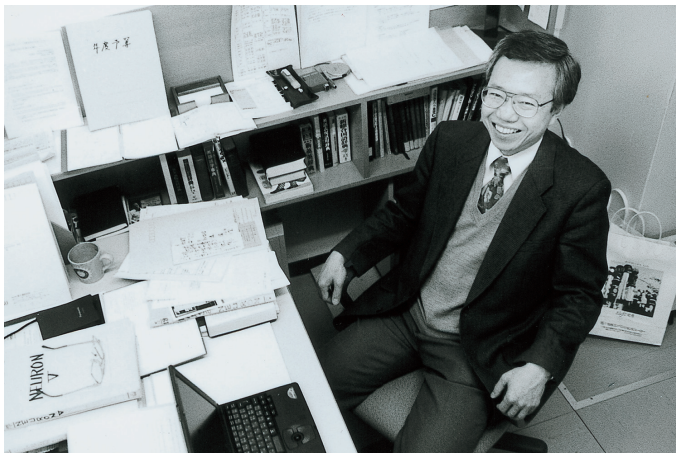


Fig.3: An organic field-effect transistor and a rubrene single crystal

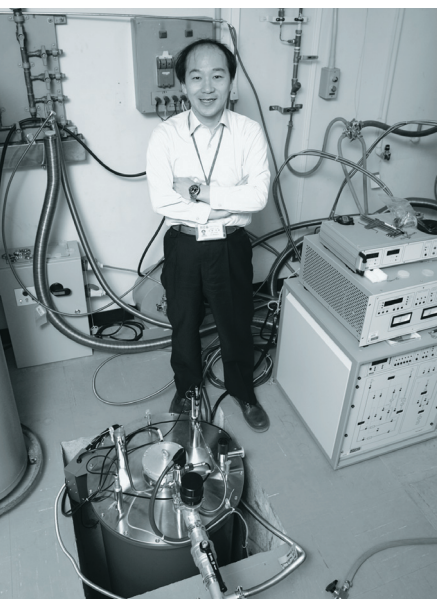
New Paradigm VLSI System

Real-World Computing

Laboratory for Brainware Systems



Intelligent Nano-Integration System



Microarchitecture

Laboratory for Brainware Systems

K. NAKAJIMA

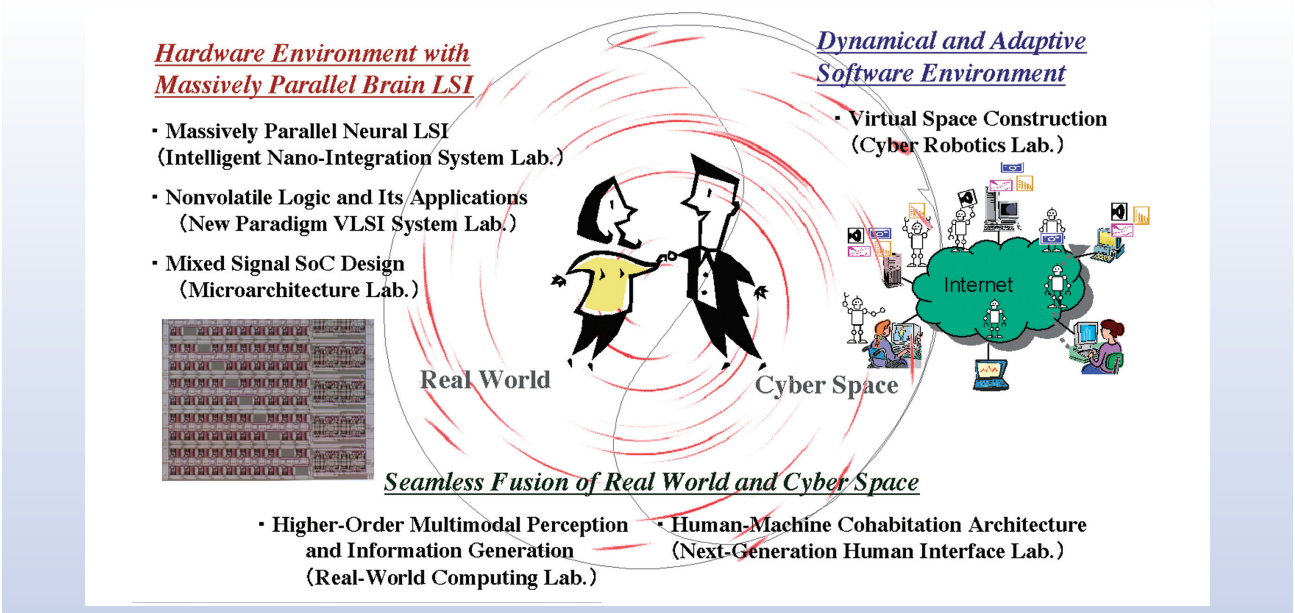
Staff:

Director: Koji NAKAJIMA, Professor

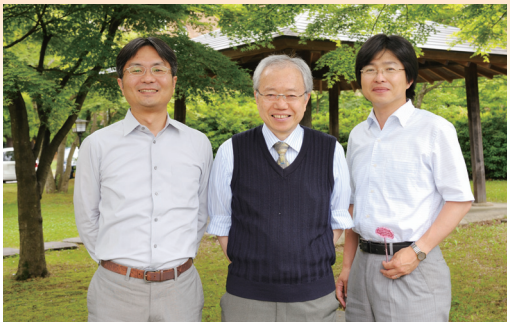
The Laboratory for Brainware Systems of the Research Institute of Electrical Communication was established in 2004. Its purpose is to contribute to the research and development of advanced information science and technology for Brainware systems which realize a seamless fusion of the changeable and complex real world and the cyber space.

We aim at establishing scientific and technological foundations for Real-World Computing (section), New Paradigm VLSI System (section),Microarchitecture (section), Cyber Robotics (planning section), and Next-Generation Human Interface (planned section). The Laboratory for Brainware Systems consists of the above six sections which cooperatively carry out the research. At the same time they serve as a laboratory for nation-wide cooperative research in the field of Brainware systems.

The technology developed in the Laboratory is expected to enhance the research carried out in the four Divisions of the Institute, and the research conducted in the Divisions, in turn, is expected to provide scientific basis for the information technology developed in the Laboratory.



Real-World Computing



Y. MAKINO K. NAKAJIMA K. SAKAMOTO

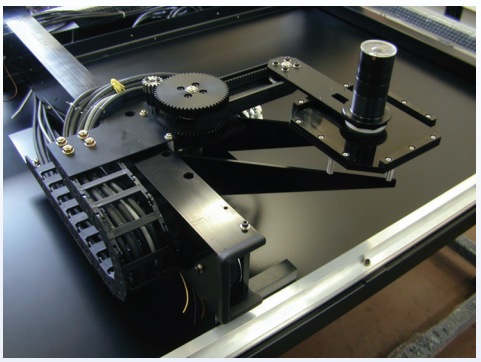
Staff:

Koji NAKAJIMA, Professor *
Yoshinari MAKINO, Assistant Professor
Kazuhiro SAKAMOTO, Assistant Professor

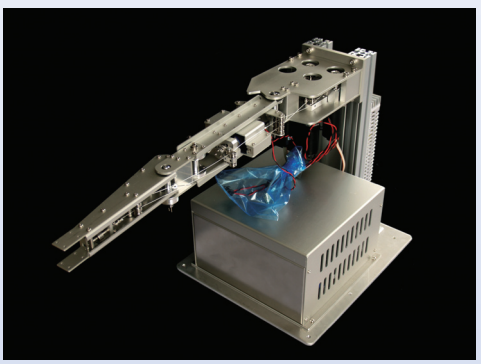
Research activities:

Our main aim is to understand highly harmonic and autonomous biological-information systems in order to propose new designing principles for building innovative systems. Today, state-of-the-art robots display a high level of performance in a predictable and regulated environment. However, they display very poor performance in real-world: an unpredictable and unregulated environment. Why? Because the controller of today's robots can only process learned information, it requires all the necessary information in advance, and without that it will fail to control its own body. Therefore, when the robots encounter new information in an unknown environment they don't have the ability to process it and consequently cannot adapt to a changing environment. In contrast, biological systems such as human beings can create information necessary to interpret external stimuli and to control actuators in real-time, by appropriately recognizing and judging unpredictable changes in the real-world.

To understand how living organisms create information, we study biological mechanisms of object recognition, speech recognition, learning and memory, and voluntary-movement control, with various methods such as psychophysics, neurophysiology, computational simulation, developing robot control system.



Manipulandum system for arm reaching movements. Control mechanisms for voluntary movements can be clarified by measuring motions under various environmental conditions.

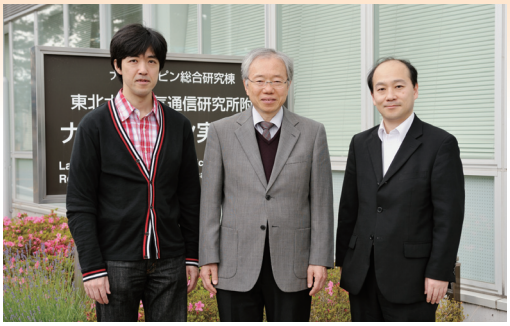


2-joint-6-muscle arm robot. By using the redundant actuators and the sensory information about the joints and the actuators, the controller can create movements appropriate to unpredictable environments.

Research topics:

1. Mechanisms of learning and memory in olfaction
2. Visual recognition by integrating motion vision and form vision
3. Real-time control mechanisms for voluntary movements

Intelligent Nano-Integration System



T. ONOMI K. NAKAJIMA S. SATO

Staff:

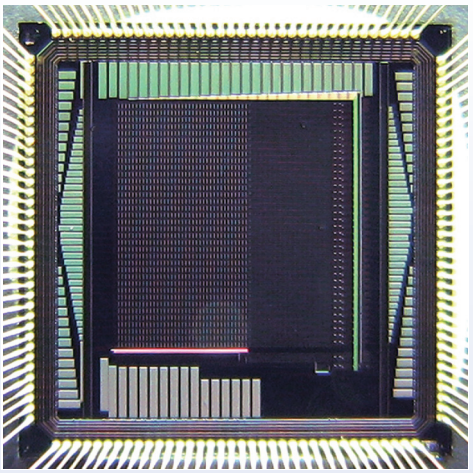
Koji NAKAJIMA, Professor
Shigeo SATO, Associate Professor
Takeshi ONOMI, Assistant Professor

Research activities:

Our research activities cover the fields of architectures of Brain computing systems, characterization and application of artificial neural networks, and fabrications of intelligent integrated circuits, and exploitation of new devices for neural circuits.

Intelligent Nano-Integration System (Prof. Koji NAKAJIMA)

We have constructed a stochastic artificial neural network with one million synaptic units, analyzed the dynamic behaviour of neural networks aiming at a time-dependent data processing, succeeded to propose a system where we are able to get off successfully from any local minima fallen into on the way of data processing in neural networks, and fabricated its prototype hardware system on the silicon microchip for brain computing systems. We have also presented an FFT and a neural system operated by using a flux quantum logic in superconducting integrated circuits.



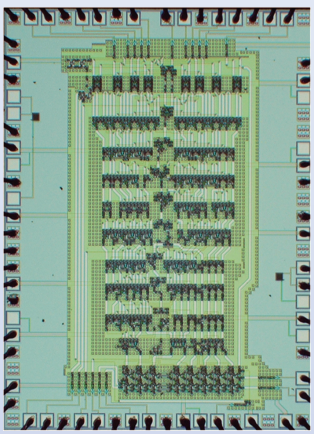
Microchip of a neural network

Research topics:

1. Basic architecture for integrated active Brain computers
2. Dynamic intelligent associative memory system
3. Superconducting single flux-quantum data-processor

Integrated Superconducting Quantum System (Assoc. Prof. Shigeo SATO)

We study on implementation of high-Tc superconductor multi qubits using intrinsic Josephson junctions and neuromorphic adiabatic quantum computation algorithms for practical solid-state quantum computer and its application to brain computing systems.



Microchip of a single flux-quantum circuit

Research topics:

4. High-Tc Superconductor Qubit
5. Adiabatic Quantum Computation Algorithm

Microarchitecture

T. KAHO S. MASUI I. M. NAWI

Staff:

Shoichi MASUI, Professor
Takana KAHO, Visiting Associate Professor
Illani Mohd NAWI, Reseach Fellow

Research activities:

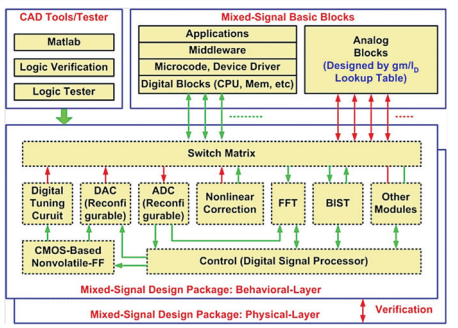
Ubiquitous society has been established by the deployment of various wireless systems ICs, and it demands advances in mixed-signal (analog and digital) design technique as well as higher integration through SoC (System on a Chip). Our research activities include architecture and circuit design of mixed-signal SoC applicable to sensor network systems for the investigation of brain activities researches along with mixed-signal topdown design methodologies. Since a mixed-signal SoC combines RF/analog and digital blocks to minimize cost and power consumption, scaled CMOS technology must be used to minimize the digital block area. However, the associated process variations and mismatch due to the scaling restrict performance of RF/analog circuits; moreover, increasing mixed-signal design complexity tends to result in the design time elongation and the increase of NRE.

Our approaches to solve these problems are to expand digital-assisted analog circuit enhancement techniques to realize mixed-signal platform, and to develop automatic design optimization flows for RF/analog circuit. The mixed-signal platform includes the software-definable RF/analog circuit and the integration of CMOS-based nonvolatile memory for the control of digital-based analog circuit calibration. We focus on the development and deployment of gm/ID lookup table design methodology to minimize the power consumption of RF/analog circuits in scaled CMOS technologies.

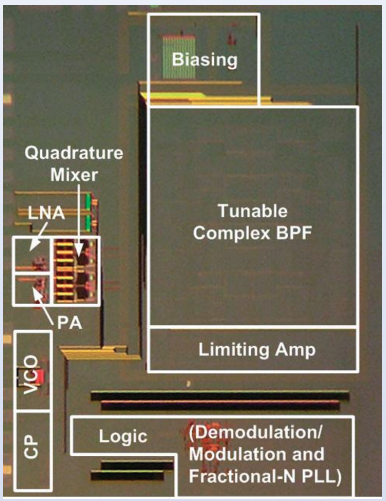
The planned research project will take advantage of collaborations with semiconductor industries and EDA (Electronic Design Automation) vendors and relationships with oversea universities and startup companies.

Research topics:

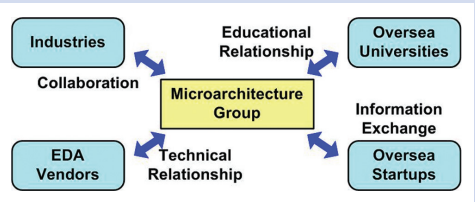
1. Mixed-signal SoC architecture and circuit design for wireless sensor network systems
2. Design automation and associated topdown design methodologies for RF/analog circuits.
3. Design and applications of software-definable mixed-signal circuits
4. Design and applications of nonvolatile memory



Mixed Signal Platform



Transceiver IC for Sensor Network Systems



Vision of Collaboration

New Paradigm VLSI System

N. ONIZAWA T. HANYU M. NATSUI A. MATSUMOTO

Staff:

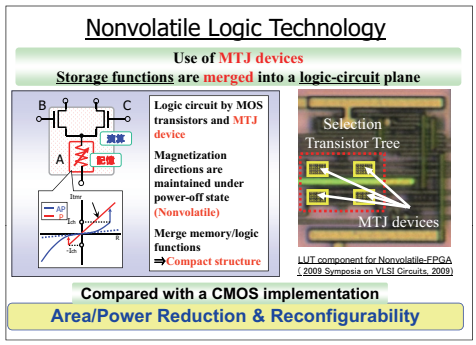
Takahiro HANYU, Professor
Masanori NATSUI, Assistant Professor
Atsushi MATSUMOTO, Assistant Professor
Naoya ONIZAWA, Research Fellow

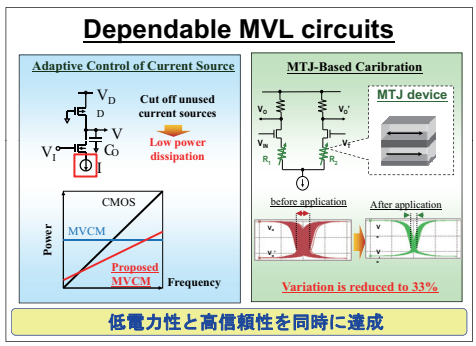
Research activities:

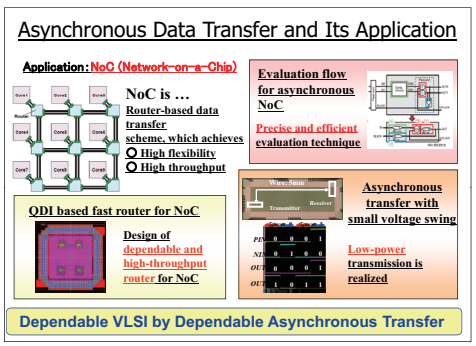
Rapid progress in recent deep submicron regime has led to the capability to realize giga-scaled embedded systems on a chip, while the communication bottleneck between memory and logic modules has increasingly become a serious problem. In addition, power dissipation and device-characteristic variation have been also the emerging problems in the recent VLSI chip. In order to solve such the recent VLSI problems causing performance and reliability degradation, we focus on a "new-paradigm VLSI computing" concept that investigates the optimal design through all the VLSI design layers such as a device/material design level, a circuit-architecture level, a logic-synthesis level, a system-architecture level, and an application-oriented algorithm level. The use of "logic-in-memory VLSI architecture," where storage elements are distributed over a logic-circuit plane, makes global wires reduced greatly. To implement a logic-in-memory VLSI compactly, we utilize multi-functional and nonvolatile devices such as ferroelectric devices, TMR (MTJ) devices and phase-change devices. We are also focusing on other challenging research subjects concerning with a new-paradigm VLSI computing system. Preliminary research subjects in our laboratory are listed below:

Research topics:

1. Logic-in-memory VLSI architecture and its applications
2. Self-controllable VLSI processor and its applications
3. Information-communication super chips based on new-paradigm VLSI architecture
4. Device-model-based new-paradigm VLSI computing architecture
5. Asynchronous-control/multiple-valued data representation-based circuit for a high-performance Network-on-Chip



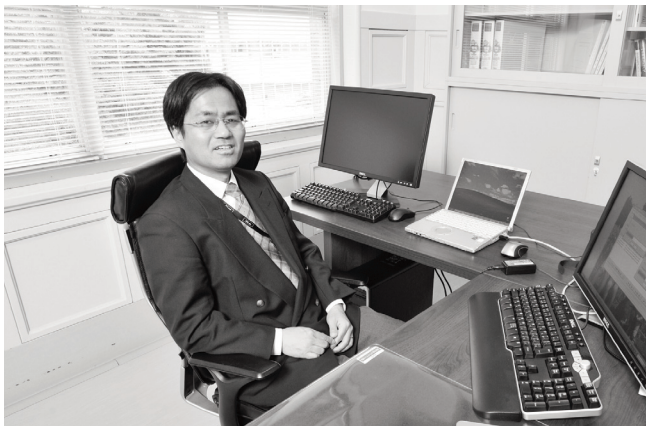




Technology Development Division

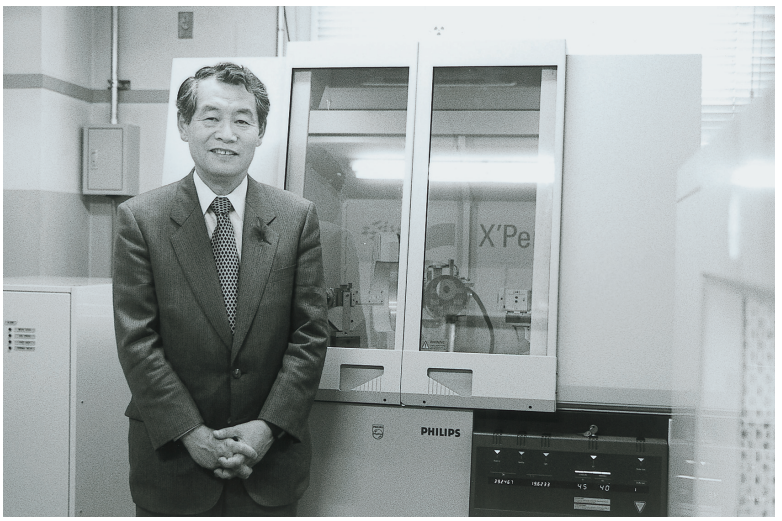
Mobile Wireless Technology Group

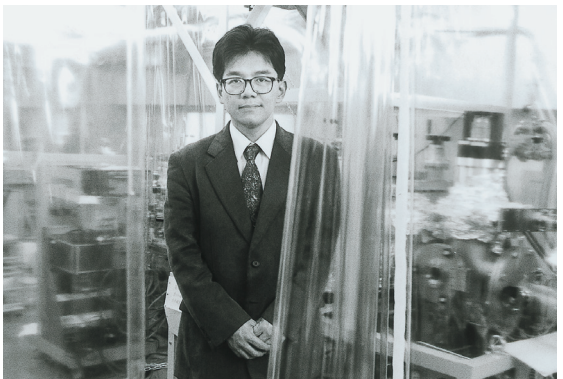
Research Center for 21st Century Information Technology



Technology Development Division

Storage Technology Group





Research Center for 21st Century Information Technology (IT-21 Center)

H. MURAOKA

Director: Hiroaki MURAOKA, Professor

Project Planning Division

Makoto FURUNISHI, Visiting Professor

Technology Development Division

Development of Dependable Wireless System and Device

Project Leader : Kazuo TSUBOUCHI, Visiting Professor

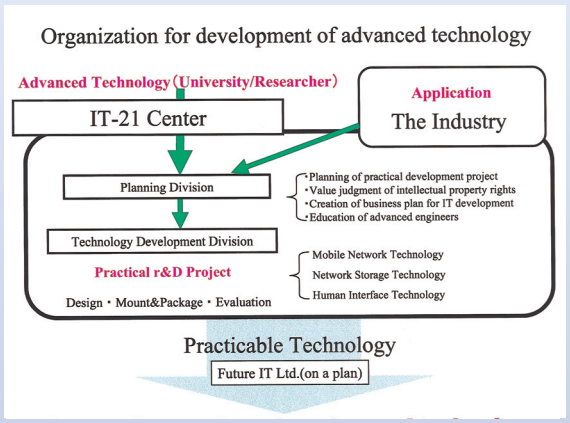
Tadashi TAKAGI, Visiting Professor

Development of Super High-Speed Mass Storage HDD Systems

Project Leader : Hiroaki MURAOKA, Professor *

Hajime AOI, Visiting Professor
Takehito SHIMATSU, Associate Professor
Kiyoshi YAMAKAWA, Visiting Associate Professor

IT-21 Center



The purpose of the IT-21 center is development of practical technologies for IT based on the advanced technologies of RIEC with the partnership among Industry, Government and University. The term of development is limited less than 5 years. The projects are planed on matching with both basic technologies in the University and application in the Industry. Combination of the technologies of the University and Industry makes practical technologies with availability for the commercial products. The center actively accelerates to obtain the intellectual properties generated from the development of practical technology to the Industry.

Technology Development Division

Mobile Wireless Technology Group

K. TSUBOUCHI

T. TAKAGI

Staff:

Kazuo TSUBOUCHI, Visiting Professor
Tadashi TAKAGI, Visiting Professor

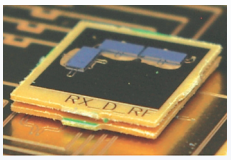
Research activities:

Mobile wireless communication technology is one of the significant communication technologies that support the IT society, connected with the high-speed backbone network using optical fiber. Evolution of the mobile wireless communication technology in Japan is indispensable to keep the leadership in this technology area in the world.

With the partnership of Japanese major mobile wireless manufacturers and Japanese Type I carrier, the mobile wireless technology group of IT-21 center has been developing ultra-high-speed wireless communication technology and an ultra-small wireless terminal by using three-dementional (3D) system-chip and using high density packaging for next generation mobile wireless communication. As a result, so far, (1) 5GHz-band 324Mbit/s wireless LAN terminal, (2) ultra-small size 3D system-in-package (SiP) millimeter wave wireless terminal for uncompressed high definition television (HDTV) transmission have been successfully developed, and (3) seamless handover technology for wide area broadband mobile wireless access (MBWA) and seamless roaming technology between MBWA and wireless LAN have been successfully demonstrated by field tests.

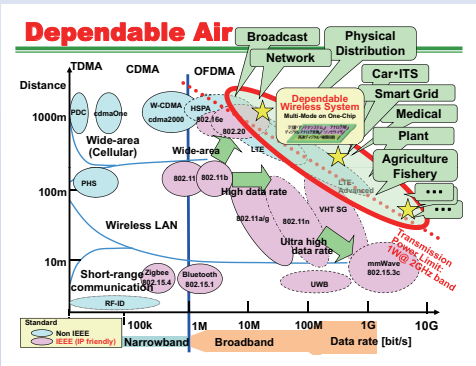
From 2007, the mobile wireless technology group will make a progress toward development of advanced practical technologies for new concept "Dependable Air" which integrates all wireless systems. In addition, our group has a will for contributing to the industry in Sendai area such as build up venture companies based on the developed practical technologies.

5GHz-Band 324Mbit/s Wireless LAN terminal



Ultra-small-size 3D SiP millimeter wave wireless terminal for uncompressed HDTV

MBWA field test (Base station)



Dependable Air

Research topics:

1. Broadband wireless communication technologies for Dependable Air
2. High-speed and high frequency mixed signal Si system chip for Dependable Wireless System

Technology Development Division

Storage Technology Group

K. YAMAKAWA M. YAMADA H. AKAIKE D. INOUE H. KATAOKA H. SAGA Y. OSAWA
S. OGAWA T. SHIMATSU K. FUJIMOTO H. AOI

Staff:

Kazuhisa FUJIMOTO, Professor
Takehito SHIMATSU, Associate Professor
Susumu OGAWA, Research Fellow
Masaki YAMADA, Research Fellow
Yuichi OSAWA, Research Fellow
Daisuke INOUE, Research Fellow
Hajime AOI, Visiting Professor
Kiyoshi YAMAKAWA, Visiting Associate Professor
Hideki SAGA, Research Fellow
Hirotoshi AKAIKE, Research Fellow
Hiroyasu KATAOKA, Research Fellow

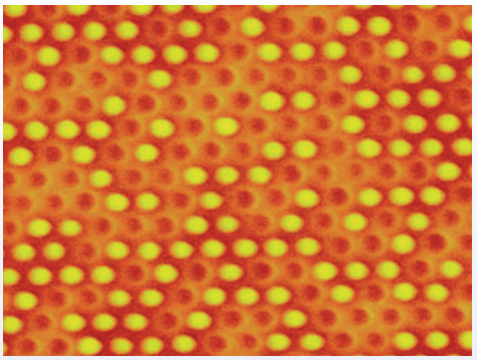
Research activities:

High density and high data-rate hard disk drive (HDD) information storage technologies are core technologies for IT infrastructure. In Japanese universities, only the Research Institute of Electrical Communication (RIEC) has maintained a comprehensive progress of research into information storage technology, including materials, devices and theory.

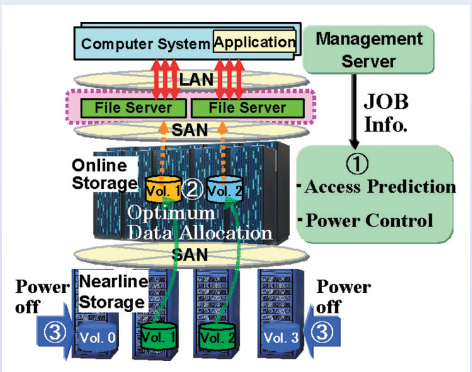
In March 2007, the IT21 cooperative research project between industry, academia and government was successfully finished. An ultra-high small perpendicular magnetic recording prototype HDD and basic technologies for densities of 0.5 to 1 Tbits/inch^2 were developed during the project.

A new project ;Development of super high-speed mass storage HDD systems started in August 2007 under the collaborations between RIEC including IT21 storage technology group, major Japanese HDD manufacturers and other laboratories researching related technologies within Tohoku University.

The goals of this project are to develop the perpendicular recording technologies required for higher than 2 Tbits/inch^2 recording density and, based on these technologies, to develop the system architecture for realizing large capacity, high performance and low power consumption storage systems.



MFM images of a $L1_1$-CoPt patterned films (One of fundamental technologies to realize densities of over 2 Tbits/in^2.



2-dimension data allocation method with an access prediction

Research topics:

1. Development of fundamental technologies for the recording densities over 2 Tb/inch^2; high sensitivity sensors, high recording resolution SPT writers and high-density media including patterned media.
2. Development of a system architecture for high performance and low power consumption storage systems.

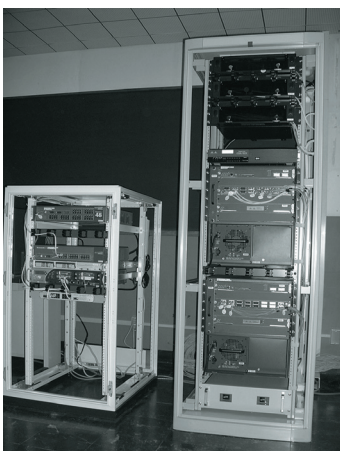
Fundamental Technology Center

Flexible Information System Research Center

Fundamental Technology Center

Management Office for Safety and Health

Flexible Information System Research Center



Flexible Information System Research Center

T. OSADA G. KITAGATA Y. SUZUKI K. SASAI

Staff:

Director: Yôiti SUZUKI, Professor

Yoshihito TOYAMA, Professor*
Gen KITAGATA, Associate Professor
Toshiaki OSADA, Research Fellow

Tetsuo KINOSHITA, Professor*
Kazuto SASAI, Assistant Professor

Research activities:

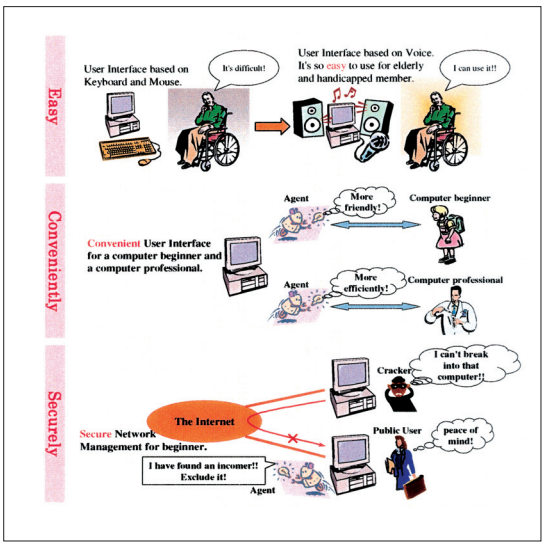
The present information systems represented by computers are inflexible systems, because their uses are predefined and they provide only the fixed processing and functions. The flexible information system on the other hand, is a system which can perform the flexible information processing adopted to the human intention and situation of its environment, and this can correspond to the flexible human thinking using multi-dimension perceptional information such as the visual and auditory senses fully, beyond the limitations of the principles of the inflexible information processing. The aims of this research are the exploration of principles of the flexible information processing through the theories and experiments, and the establishment of their system construction methodology.

Moreover, we also study the flexible distributed systems for advanced organization, utilization, administration, operation and dispatching of science information, and are aiming at the establishment of construction methodology of them confirming the effectiveness of the system with practical applications to the scientific information of RIEC on the network.


Network room

Research topics:

1. Information collection, organization, dispatching, utilization and research support environment.
2. Advanced maintenance, management and operation of network.
3. Relation between technology and ethics.
4. Perceptual information processing of living bodies and intelligent UI and OA.



Flexible Global Network

Fundamental Technology Center

N. SATO H. WATANABE T. SUENAGA Y. KONNO
K. ABE K. SAGAE K. SATO R. YONEZAWA M. ABE C. TAKYU
S. AGATSUMA K. SHOJI F. SAITO Y. UEHARA M. SUGAWARA

Staff:

Director: Yoichi UEHARA, Professor

Nobuyuki SATO, Assistant Professor
Katsumi SAGAE, Technical Official
Tamotsu SUENAGA, Technical Official
Keisuke SATO, Technical Official
Hiroshi WATANABE, Technical Official
Yuji KONNO, Technical Official
Choichi TAKYU, Technical Official
Fumitaka SAITO, Technical Official
Koichi SHOJI, Technical Official
Maho ABE, Technical Official
Kento ABE, Technical Official
Munetomo SUGAWARA, Technical Official
Ryuji YONEZAWA, Technical Official
Shigeto AGATSUMA, Technical Official

Pioneering research and development (R&D) in a wide range of disciplines ranging from basic sciences to applied communication technologies has been carried out in the institute. The technical officials have traditionally contributed to R&D through their well-established skills and considerable experience. To sustain and increase such contributions in the future, the institute established the fundamental technology center in 2007. The technical support commonly required in the institute was reorganized and is now being provided by four technical divisions: machine shop, evaluation, processing, and software. These divisions are in charge of the following services.

The machine shop division develops advanced machining techniques and offers them for the development and manufacture of experimental apparatuses (e.g., Fig. 1). This division also provides machining instructions to students and faculty members who perform machining by themselves. The evaluation division offers various evaluation and measurement techniques such as focused ion beam system (Fig. 2) and electron probe X-ray micro-analyzer (Fig. 3). Glass machining and supply of liquid helium and nitrogen are also covered by this division. The processing division is, in cooperation with the evaluation division, responsible for operating and maintaining the project clean room (PCR), one of the commonly used clean rooms in the institute. Nanometer-scale electron beam lithographic techniques and customized optical filters for the visible and infrared spectral range can be provided by this division. The software technology division operates and maintains the computer networks in the institute.

Figure 1 Visual display system using a half-mirror

Figure 2 Focused ion beam system (FIB)

Figure 3 Electron Probe X-ray Micro Analyzer (EPMA)

Management Office for Safety and Health

Staff:

Manager: Michio NIWANO, Professor
Deputy Manager: Yoichi UEHARA, Professor
Nobuyuki SATO, Assistant Professor

The Management Office for Safety and Health is an organization with the objective of maintaining the health and safety of staff and students working at the institute. The use of chemicals, high-pressure gas and radiation in research activities at the institute entails many risks. The Management Office for Safety and Health provides support for safety and health management in facilities such as research laboratories, experimental facilities, and machine shops through various activities to ensure that research activities within the institute are conducted safely and smoothly.

With respect to safety and health management, the Safety and Health Committee, comprising the Director, staff at the institute and industrial physicians, discusses various matters related to safety and health and the maintenance of the safety and health management system at the institute, and submits recommendations to the Director and Faculty Council. The Director and Faculty Council then finalize guidelines as advised by the contents of these recommendations. The guidelines are then implemented into actual safety and health management operations at each of the facilities such as research laboratories.

Under collaboration with these organizations, the Management Office for Safety and Health takes charge of practices related to safety and health, and operates to ensure safety and convenience in research activities at the institute.

Safety and health seminar

High-pressure gas seminar

Activity contents:

1. Inspection of and assistance in improving the safety and health management system and working environment within the institute.
2. Investigation of laws related to safety and health and collection of information regarding safety and health management.
3. Provision of advice and information to safety and health personnel in each department.
4. Implementation of various types of safety education targeted at staff and students.
5. Liaison and coordination with the supervisory authority and other departments on campus.

Research Activities

Study Groups on Electrical Communication

Study Groups on Electrical Communication are organized to solve scientific and technological problems and to promote research and development through the collaboration of the Research Institute of Electrical Communication, Group of ECEI (Electrical Engineering, Communication Engineering, Electronic Engineering, and Information Engineering)in Graduate Schools of Engineering, Information Sciences, Biomedical Engineering, related scientists and engineers inside and outside Tohoku University. The Study Groups on Electrical Communication consist of 14 Sub-Groups as listed, to deal with specific subjects. Each Sub-Group holds workshops and the abstracts of the workshops are published annually in *The Record of Electrical and Communication Engineering Conversazione Tohoku University*.

Many scientists and engineers not only from universities but also from government laboratories and industries attend the workshops, present papers, and discuss issues very actively. We are pleased to provide information on these activities upon request. Please contact the General Chairman or each Sub-Group Chairman for general information or more specific questions.

Title of Sub-Group

Electromagnetic and Optical Waves Engineering	New Paradigm Computing
Acoustic Engineering	Ultrasonic Electronics
Sendai "Plasma Forum"	Brainware
Sendai Seminar on EMC	Mathematical Physics and its Application
Computer Science	to Information Sciences
Systems Control	Biocybernetics and Bioinformatics
Information-biotronics	Nanoelectronics and Spintronics
Spinics	

The 7th International Symposium

Symposiums Organized by the Institute

This Symposium is planned to exchange relevant information on current important topics concerning Electrical Eng., Electrical Communications, Electronic Eng., and Information Eng. Many related researchers inside and outside Tohoku University participate the Symposium and stimulate discussion.

Past Symposium

	Title	Date
1	Quantum Electronics of Light Waves and Micro Waves	Feb. 6- 8, 1964
	Magnetic Recording	Feb.14-15, 1964
2	Ultra-High Frequency Acoustelectronics	Feb.11-12, 1965
3	Artificial Intelligence	Mar. 8- 9, 1966
4	Thin Film Electronics	Jan.26-27, 1967
5	Crystal Growth	Dec.19-20, 1967
6	1968 Sendai Symposium on Acoustelectronics	Aug.19-20, 1968
7	Current Status and Future Trends of Superconductivity	Jan.22-24, 1970
8	Speech Information Processing	Feb.24-26, 1971
9	Surface Acoustic Wave Technology	May.25-26, 1972
10	Liquid Crystals • Their Molecular Orientations and Application to Display Devices	Dec.13-14, 1974
11	Computer Network	Mar.17-18, 1975
12	The Memorial Symposium on the 40th Anniversary of the Foundation of RIEC	Sep.25-26, 1975
13	Application of Amorphous Ferromagnetic Materials	Mar.10-11, 1977
14	Stoichiometry of Compound Crystals	Nov.24-25, 1977
15	Submillimeter Waves	Nov.16-17, 1978
16	Solid State Chemical Sensors	Feb. 1- 2, 1980
17	Graph Theory and Algorithms	Oct.24-25, 1980
18	Perpendicular Magnetic Recording	Mar.11-12, 1982
19	Approach to Optical Computer	Mar.10-11, 1983
20	Plasma Non-Linear Phenomena - Basic Problems for Fusion Plasmas	Mar. 8- 9, 1984
21	New Computer Architecture	Jul.25-26, 1985
22	Guided Wave Technology and Its Application at Mid-Infrared	Mar.13-14, 1986
23	Physics and Applications of Tunnelling Phenomena	Mar.12-14, 1987
24	Biomagnetics and Bioelectronics	Feb.26-27, 1988
25	Ultrasonic Electronics - New Applications of Piezoelectricity	Feb. 2- 3, 1989
26	Boundaries between Light and Electromagnetic Wave	Feb. 1- 2, 1990
27	Issues and Realization of Pattern Recognition and Understanding	Feb.28-Mar.1, 1991
28	Discrete Algorithms	Oct.17-18, 1991
29	Perspective for New Computing Paradigm	Feb. 4- 5, 1993
	Current Status and Future Prospects of System Control	Mar. 3- 4, 1993
30	Future Prospects of Electron Beam Devices	Nov. 1- 2, 1993
31	Discharge and EMC	Dec.20-21, 1994
32	Statistical Physics and Information Science	Mar.22-23, 1995
33	Photo-and Plasma-Excited Processes on Surfaces	Nov.30-Dec.1, 1995
34	Nano Spinics and Power Electronics	Feb.15-16, 1996
35	Potential Formation and Related Nonlinear Phenomena in Plasmas	Sep.17-19, 1996
36	New Trend in Ultrasonic Measurements	Feb. 3- 4, 1997
37	Toward the Realization of the High-Definition Multi-Media Communication	Nov. 4- 6, 1997

International Symposium organized by the Institute

	Title	Date
1	Intrinsic Josephson Effect and THz Plasma Oscillation in High T_c Superconductors	Feb.23-25, 1997
2	Design and Architecture of Information Processing Systems Based on The Brain Information Principle	Mar.16-18, 1998
3	Novel Techniques and Applications of Millimeter-Waves	Dec.14-16, 1998
4	The International Joint Conference on Silicon Epitaxy and Heterostructures	Sep.13-17, 1999
5	International Workshop on Photonic and Electromagnetic Crystal Structures	Mar.8-10, 2000
6	Physics and Application Spin Related Phenomena in Semiconductors	Sep.13-15, 2000
7	Rewriting in Proof and Computation	Oct.25-27, 2001
8	Nonlinear Theory and its Applications	Oct.28-Nov.1, 2001
9	New Paradigm VLSI Computing	Dec.12-14, 2002
10	Ultra High Density Spinic Storage System	Oct.23-24, 2003
11	3rd International Workshop on New Group IV (Si-Ge-C) Semiconductors	Oct.12-13, 2004
12	3rd International Workshop on High Frequency Micromagnetic Devices and Materials (MMDM3)	Apr.11-12, 2005
13	4th International Conference on Silicon Epitaxy and Heterostructures (ICSI-4)	May.23-26, 2005
14	1st International WorkShop on New Group IV Semiconductor Nanoelectronics	May.27-28, 2005
15	GSIS International Symposium on Information Sciences of New Era: Brain, Mind and Society	Sep.26-27, 2005
16	The 1st RIEC International Workshop on Spintronics -Spin Transfer Phenomena-	Feb.8-9, 2006
17	4th International Workshopn on High Frequency Micromagnetic Devices and Materials (MMDM4)	May 8,2006
18	4th International Conference on Physics and Applications of Spin-Related Phenomena in Semiconductors (PASPS-IV)	Aug.15-18,2006
19	2nd International Workshop on New Group IV Semiconductor Nanoelectronics	Oct.2-3,2006
20	2nd RIEC International Workshop on Spintronics	Feb.15-16,2007
21	Japan-China Joint Conference on acoustics, JCA2007	Jun.4-6,2007
22	International Conference on Discovery Science / International Conference on Algorithmic Learning Theory	Oct.1-4,2007
23	The 3rd RIEC International Workshop on Spintronics	Oct. 31-Nov.1,2007
24	3rd International Workshop on New Group IV Semiconductor Nanoelectronics	Nov.8-9,2007
25	International Workshop on Nanostructures & Nanoelectronics	Nov.21-22,2007
26	The 18th International Symposium on Algorithms and Computation (ISAAC2007)	Dec.17-19,2007
27	International Interdisciplinary-Symposium on Gaseous and Liquid Plasmas (ISGLP 2008)	Sep.5-6,2008
28	4th International Workshop on New Group IV Semiconductor Nanoelectronics	Sep.25-27,2008
29	The 4rth RIEC International Workshop on Spintronics	Oct.9-10,2008
30	GSMM 2009 (Global Symposium on Millimeter Waves 2009)	Apr.20-22,2009
31	Mini R.I.E.C. workshop on multimodal perception	Apr.24-25,2009
32	The 4th International Symposium on Ultrafast Photonic Technologies	Aug.4-5,2009
33	PIMRC2009 (Personal Indoor and Mobile Radio Communications Symposium 2009)	Sep.13-16,2009
34	2nd RIEC-CNSI Workshop on Nanoelectronics,Spintronics and Photonics (5th RIEC Symposium on Spintronics)	Oct.22-23,2009
35	International workshop on the principles and applications of spatial hearing 2009 (IWPASH2009)	Nov.11-13,2009
36	5th International Workshop on New Group IV Semiconductor Nanoelectronics	Jan.29-30,2010
37	6th RIEC International workshop on Spintronics	Feb.5-6,2010
38	2nd International Workshop on Nanostructure & Nanoelectronics	Mar.11-12,2010

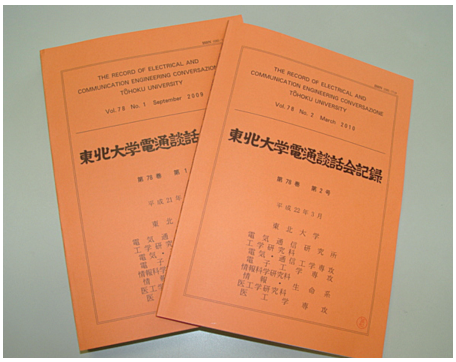
Periodicals Published by the Institute

The Institute publishes the following two periodicals to inform readers on recent research results of the Institute.

1. The Record of Electrical and Communication Engineering Conversazione Tohoku University

This journal aims at providing an opportunity to publish research results of the Institute as well as the result of the Graduate Schools of Engineering, Information Sciences, Biomedical Engineering. Since the journal also aims at publishing general research activities of the Institute and of the Graduate Schools such as records of the final lectures of retiring professors, records of the Institute Symposium, and reviews.

The name of the Journal 'Conversazione' is attributable to the 'Tuesday Conversazione' at the Department of Electrical Engineering, which had been held once a week on Tuesday since around 1920. Minutes of the meetings had been distributed to researchers outside of the University via various routes and therefore some of them had been referred to as 'Records of Tuesday Electrical Engineering Conversazione Tôhoku University' with the result that they came to be treated as official publications.

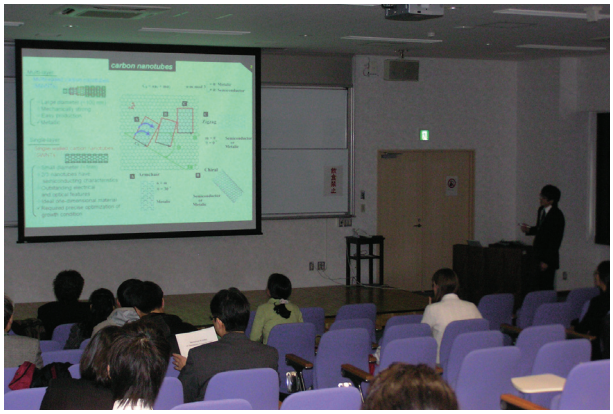


Though the meeting was once interrupted by World War Two, it was restarted in 1947. In 1952, the publication of the records was succeeded by the Institute and the records have been published as periodicals, two times a year recently, since No. 1 Vol. 21 was published in July, 1952.

2. The Annual Report of Research Activity at the Research Institute of Electrical Communication, Tohoku University

Published annually since 1995. This report details the activities of each research division and research facility. Also included are reports on nation-wide co-operative research projects, international symposium and seminars organized by members of RIEC, and the reports and evaluation on the RIEC advisory board members. English version is also avairable since 2007.

Educational Activities



Presentation scene at a workshop


Seminar scene at a laboratory

The Institute is keeping close contact with the Graduate Schools of Engineering, Information Sciences and Biomedical Engineering, not only in research activities but also in educational activities. For example, all the members of the faculties of the Institute also hold positions with the faculties of the four Departments and give lectures there. Moreover, undergraduate and graduate school students related to the Departments belong to the laboratories of the Institute for their theses. In 2010, there are 40 undergraduate students, 145 masters course students, and 56 doctors course students belonged to the Institute.

Other than the students, Institute's research students, Research Fellow of JSPS, and JSPS Postdoctral Foreign Researchers also engage in research activities in cooperation with the staff of the Institute.


Marathon relay race


Weed out-the-garden-and-Drink-beer-there Meeting

International Activities

Many of the staff in RIEC contribute to the development of technology and science in the world by serving as editors of referees of international journals or by chairing or programming international conferences. In some fields in electronics, electrical communications, or information engineering RIEC serves as a Center of Excellence(COE), which attracts many visiting researchers and students from all over the world every year. Several academic exchange programs with foreign colleges or institutes are in operation.

International academic exchange programs:

The Institute of Physics, Polish Academy of Sciences (Poland)

Reesarch Center of Condensed Materials and Nanosciences, National Center for Scientific Research (France)

IHP-Innovations for High Performance microelectronics (Germany)

Institute of Semiconductors Chinese Academy of Sciences (China)

WINLAB, Rutgers University (U.S.A)

University of California, Santa Barbara (U.S.A.)

King Mongkut's Institute of Technology Ladkrabang (Thailand)

The University of York (U.K.)

The Dresden University of Technology (Germany)

Berlin Institute of Technology (Germany)

National Tsing Hua University (Taiwan)

Universite de Technologie de Compiegne (France)

Harvard University (U.S.A.)

International journals in which a staff in RIEC participates as an editor:

1. Applied Physics Express (APEX)
2. Applied Acoustics
3. Acoustical Science and Technology
4. Higher-Order and Symbolic Computation
5. IEICE Electronics Express
6. IEICE Transactions on Electronics
7. Institution of Engineering and Technology (IET)
8. International journal of Artificial Intelligence, Neural Networks, and Complex Problem Solving Technologies
9. International Journal of Computer Science and Network Seculity
10. International Journal of Information Sciences and Computer Engineering (IJSCE)
11. Journal of Infrared, Millimeter and Terahertz Waves
12. Journal of Ambient Intelligence and Humanized Computing
13. Journal of Communications and Networks
14. Japanese Journal of Applied Physics
15. Japanese Journal of Applied Physics (JJAP)
16. NPG Asia Materials
17. Nonlinear Theory and Its Applications, IEICE
18. Optical Fiber Technology
19. Optics Communications
20. The Journal of Computer Animation and Virtual Worlds
21. Virtual Journal of Nanoscale Science and Technology

International conferences programmed by a staff in RIEC:

1. European Solid-State Device Research Coference (ESDERC)
2. Asia-Pacific Radio Science Conference (AP-RASC)
3. Asia-Pacific Microwave Conference (APMC)
4. Asia-Pacific Workshop on Fundamentals and Applications of Advanced Semiconductor Devices (AWAD)
5. International Conference on Infrared, Millimeter, and Terahertz Waves
6. International Conference on Magnetics (ICM)
7. IEEE International Magnetic Conference (INTERMAG)
8. Conference on Magnnetism & Magnetic Materials (MMM)
9. International Symposium on Advanced Magnetic and Applications (ISAMMA)
10. International Symposium on Surface Science (ISSS-6)
11. 6th International Conference on Molecalar Electronics and Bioelectronics (M&BE5)
12. Europian Conference on optical Communication (ECOC)
13. ACM Symposium on Virtual Reality Software and Technology
14. IEEE Symposium on 3D User Interfaces
15. International Symposium on Graphene Devices : technology, Physics and Modeling (ISGD)
16. SPIE International Conference on Defence, Security, and Sensing
17. International Symposium on Compound Semiconductors (ISCS)
18. The 7th International Conference on Ubiquitous Intelligence and Computing
19. Topical Workshop on Heterostructure Microelectronics (TWHM)
20. 4th SiGe, Ge, and Related Compounds: Materials, Processing, and Devices Symposium (The Electrochemical Society)
21. International Symposium on Technology Evolution for Silicon Nano-Electronics (ISTESNE)
22. 4th International Workshop on spin Currents and 2nd International Workshop on Spin caloritronics
23. 6th RIEC International Workshop on Spintronics
24. 5th RIEC International Workshop on Spintronics, RIEC-CNSI Workshop on Nanoelectronics, Spintronics, and Photonics
25. Engineering Conference International (ECI)

26. International Conference of Magnetism (ICM)
27. The 14th International Conference on Modulated Semiconductor Structures (MSS14)
28. 20th International Colloquium on Magnetic Films and Surfaces (ICMFS)
29. 5th International School and Conference on Spintronics and Quantum Information Technology (SPINTECH V)
30. 38th International School & Conference on the Physics of Semiconductors (Jaszowiec)
31. The 6th International Conference on the Physics and Applications of Spin Related Phenomena in Semiconductors (PASPS-VI)
32. The 37th International Symposium on Compound Semiconductors
33. ISMVL Technical Committee
34. International Workshop on the Principles and the Applications of Spatial Hearing 2009
35. The 10th western pacific acoustics conference (WESPAC) 2009
36. The 3rd International Universal Communication Symposium (IUCS2009)
37. The Fifth International Conference on Intelligent Information Hiding and Mutimedia Signal Processing (IIHMSP2009)
38. International Conference on Functional Programming 2009
39. ACE 2009: 5th Advances in Computer Entertainment Technology Conference
40. 2009 International Advisory Board, Korean Magnetic Society
41. ISMVL (International Symposium of Multiple-Valued Logic) 2009
42. VRST 2009: 16th ACM Symposium on Virtual Reality Software and Technology
43. 22nd International Conference on Indium Phosphide and Related Material (IPRM2010)
44. The 22nd IEEE International Semiconductor Laser Conference (ISLC2010)
45. Asia-Pacific microwave Conference (APMC) 2010
46. Joint MMM-Intermag Conference 2010
47. The 9th Perpendicular Magnetic Recording Conference (PMRC 2010)
48. The 3rd International Symposium on Organic and Inorganic Electronic Materials and Related Nanotechnologies (EM-NANO2010)
49. The 9th International Conference on Auditory-Visual Speech Processing (AVSP2010)
50. International Multisensory Research Forum (IMRF) 2010
51. The Sixth International Conference on Intelligent Information Hiding and Mutimedia Signal Processing (IIHMSP2010)
52. The 4th International Universal Communication Symposium (IUCS2010)
53. Asia Pacific Vision Conference 2010
54. International Conference Nanoscopio Colloidand Surface Science (NCSS2010)
55. ACM SIGPLAN-SIGACT Symposium on Principles of Programming Language 2010
56. ACM SIGPLAN Workshop on pertial Eualation and Program Manipulation 2010
57. The 5th International Conference on broadband, Wireless Computing, Communication and Applications (BWCCA-2010)
58. The 25th International Conference on Advanced Information Networking and Applications (AINA-2010)
59. The 1st International Workshop on Symbiotic and Multiagent Systems (SCMAS-2010)
60. IEEE Virtual Reality Conference 2010
61. ACE 2010: 6th Advances in Computer Entertainment Technology Conference
62. 3DUI 2010: 5th IEEE Symposium on 3D User Interfaces
63. 2nd International Symposium on Aware Computing (ISAC2010)
64. 5th International SiGe Technology and Device Meeting (ISTDM2010)
65. 2010 International Symposium on Nonlinear Theory and Its Applications (NOLTA 2010)
66. International Workshop on Human and Information Space Symbiosis (IWHISS2010)
67. First International Workshop on Symbiotic Computing and Multiagent Systems (SCMAS2010)
68. The 9th perpendicular Magnetic Recording Conference (PMRC 2010)
69. International Multisensory Research Forum (IMRF) 2011

RIEC Open Day

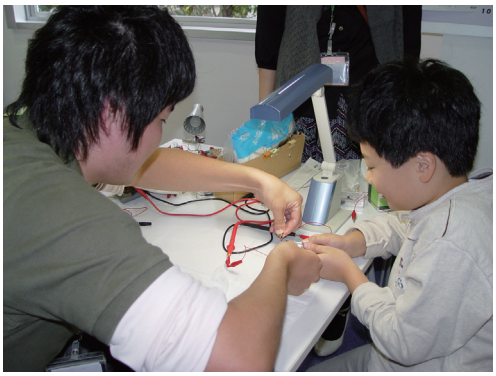
The Research Institute of Electrical Communication holds an open day every year, in order to present our research and educational activities to the public, university staff, students and alumni as well as representatives from the industrial sector.

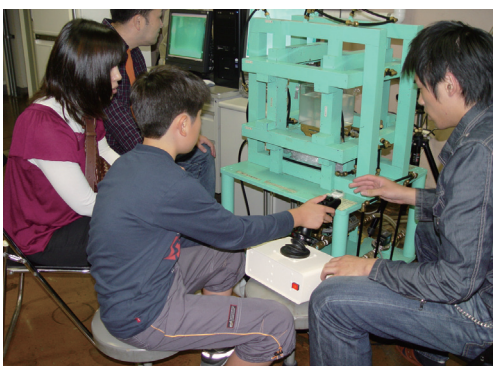
On Oct. 10(Sat)-11(Sun), 2009, all the research laboratories, research centers and machine shops of RIEC exhibited various types of demonstration focused on their respective research field and activities.

Concerning with groundbreaking accomplishments of the RIEC, historical devices and instruments developed in the RIEC were operated, such as magnetron tubes and steel recorders. Experiments on recent research were also demonstrated, such as ultra-high speed data transmission using photonic fiber, experience of symbiozone, fabrication of graphene, and operation of micromachines. Furthermore, handicrafts were conducted, such as producing simple anime movies, play by vision, and making of germanium radios and spectrometers.

We sincerely hope your participation in our open day. The open day 2010 will be held on Oct.9(Sat) and 10(Sun) this year. Brief and easy explanations of our research labs are also available from the following web pages at any time. Please feel free to access and enjoy our virtual RIEC open day.

http://www.riec.tohoku.ac.jp/koukai/index.html
(Available in Japanese only)





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Eiki ADACHI, Professor

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Sadao TSUCHIDA, Technical Official
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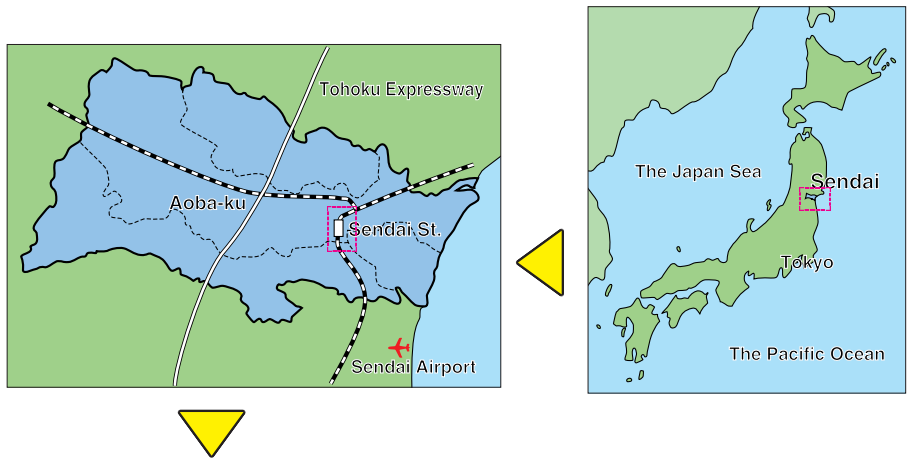
Ryutaro SASAKI, Technical Official
Choichi TAKYU, Technical Official

• Software Technology Division

Fumitaka SAITO, Technical Official

*Joint Appointment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The Japan Sea
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Tokyo
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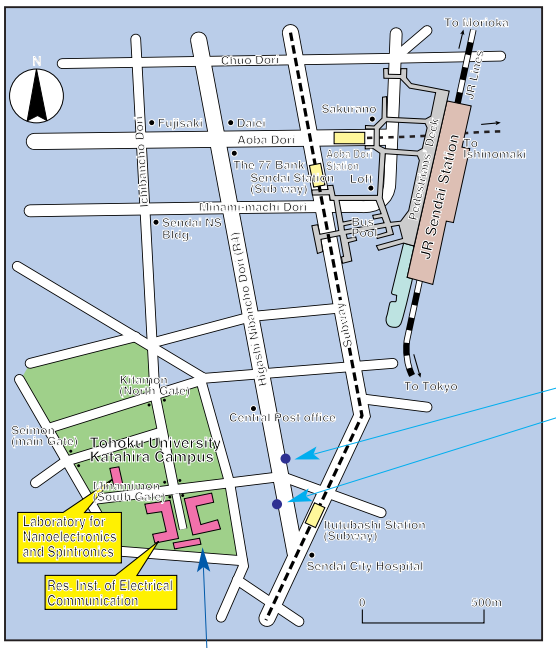
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Printed by TOHOKUDO INSATSU Co.Ltd.