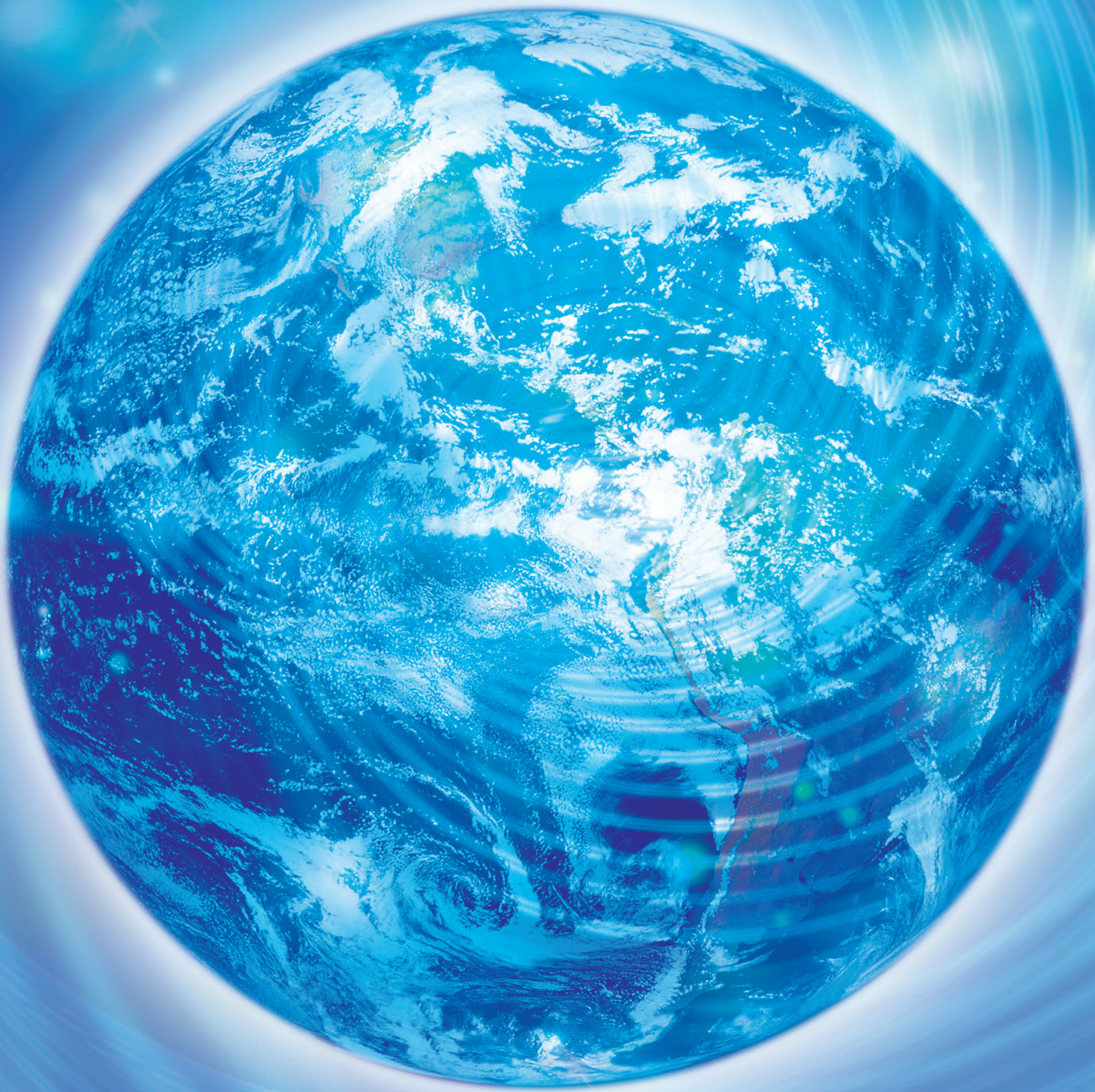
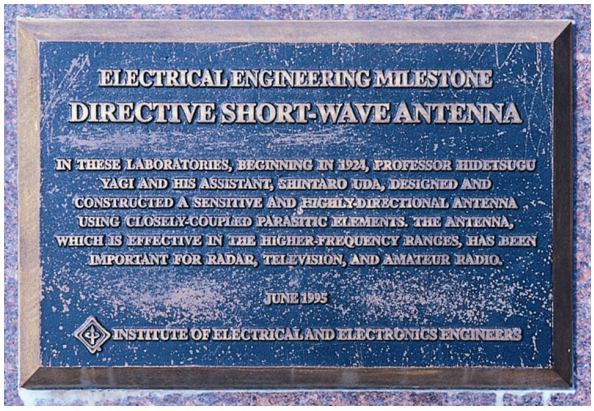
Research Institute of Electrical Communication Tohoku University

2012/2013



CONTENTS

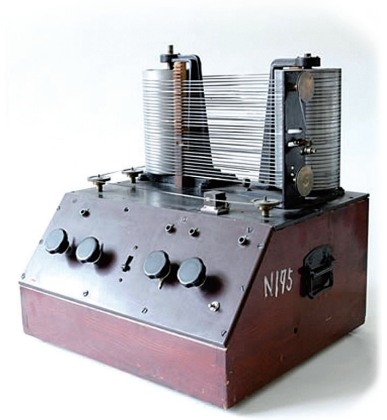


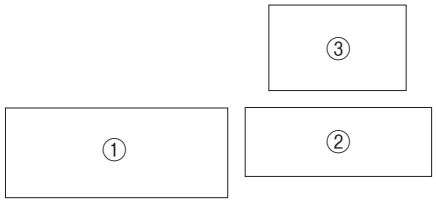
IEEE Electrical Engineering Milestone
for Yagi-Uda Antenna


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

Greeting from the Director

Director Prof.
Masataka NAKAZAWA





①Experimental equipment for Yagi-Uda Antenna（1929）
②Experimental equipment for Split Anode Magnetron（1927）
③Experimental equipment for AC-bias magnetic recording（1937）

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. The volume of information and communications in Japan today is growing at a rate of 40 percent annually, even as GDP remains level, and in twenty years' time the industry will be handling one thousand times its current capacity. The evolution of information and communications technologies is becoming ever more important as we draw closer to a highly advanced information society where accurate data can be exchanged with anyone, anywhere, at any time.

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.

These facilities pursue cutting-edge research and development centered on devices, networks, human interfaces, and software technology, with research interests that extend from materials to information services and even artificial hearts and the movements of living organisms.

The disaster that struck the Tohoku region on March 11 of last year brought to light many issues affecting the information and communications infrastructure. In particular, the task of building a disaster-resistant network falls naturally to our Tohoku University Group of Electrical Engineering, Communication Engineering, Electronic Engineering, and Information Engineering, with its nearly 80 laboratories, and we are committed to meet this challenge. To that end, a number of the university's institutions have collaborated in establishing a new organization, the Tohoku University [Research Organization of Electrical Communication]. We will work to identify real needs by asking people in the disaster-stricken areas what problems they faced, then bring our proposed solutions to the practical stage as quickly as possible in cooperation with local authorities in the affected areas, through a partnership among academia, industry, and government. The scale of this challenge will require a nationwide response, and I anticipate that many innovative technologies will emerge as a result of this concerted approach.

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. In 2012, the Department of Electrical and Communications Engineering of the Graduate School of Engineering was reorganized as the Department of Electrical Engineering and the Department of Communications Engineering.

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

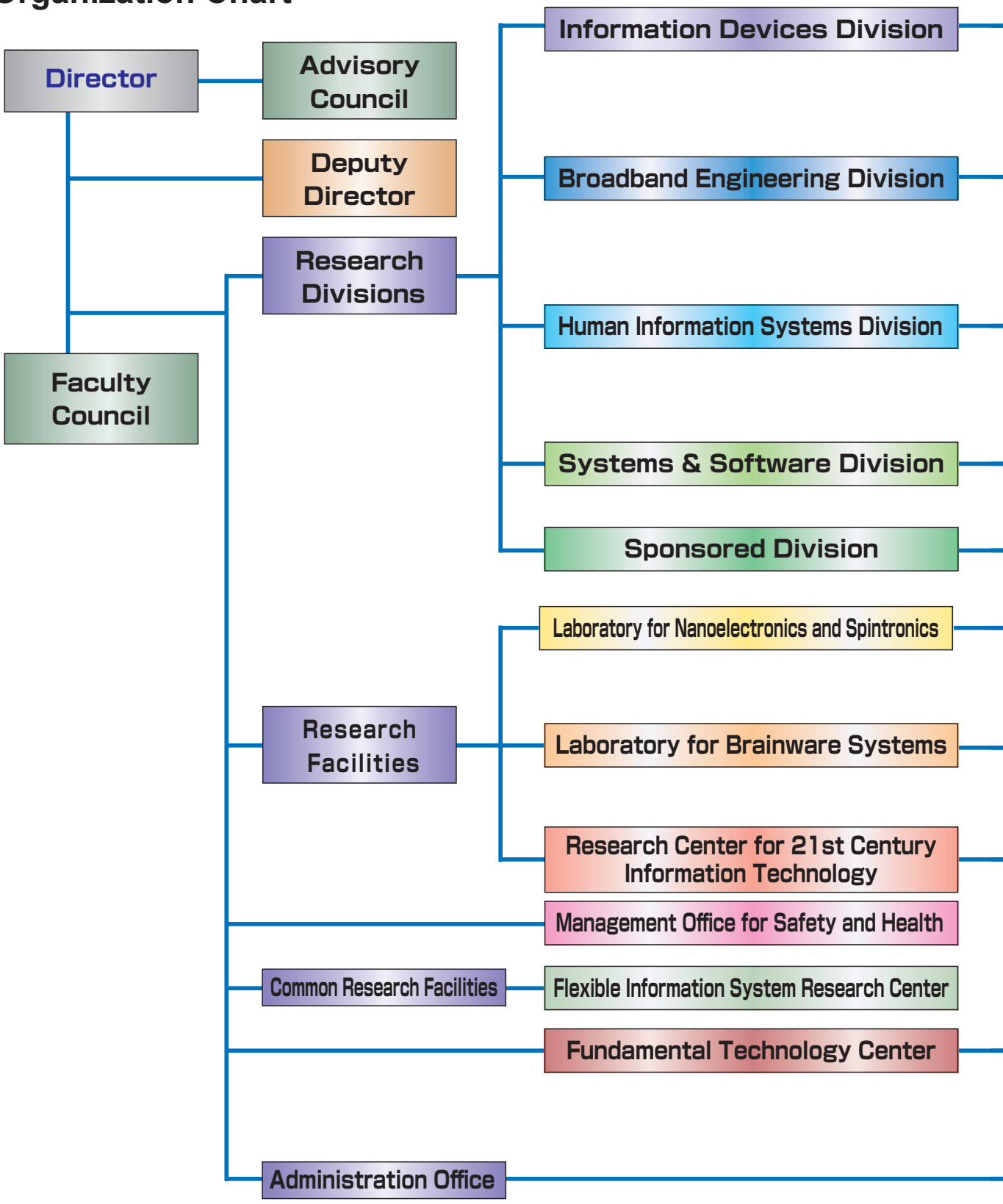
with the latest technology.

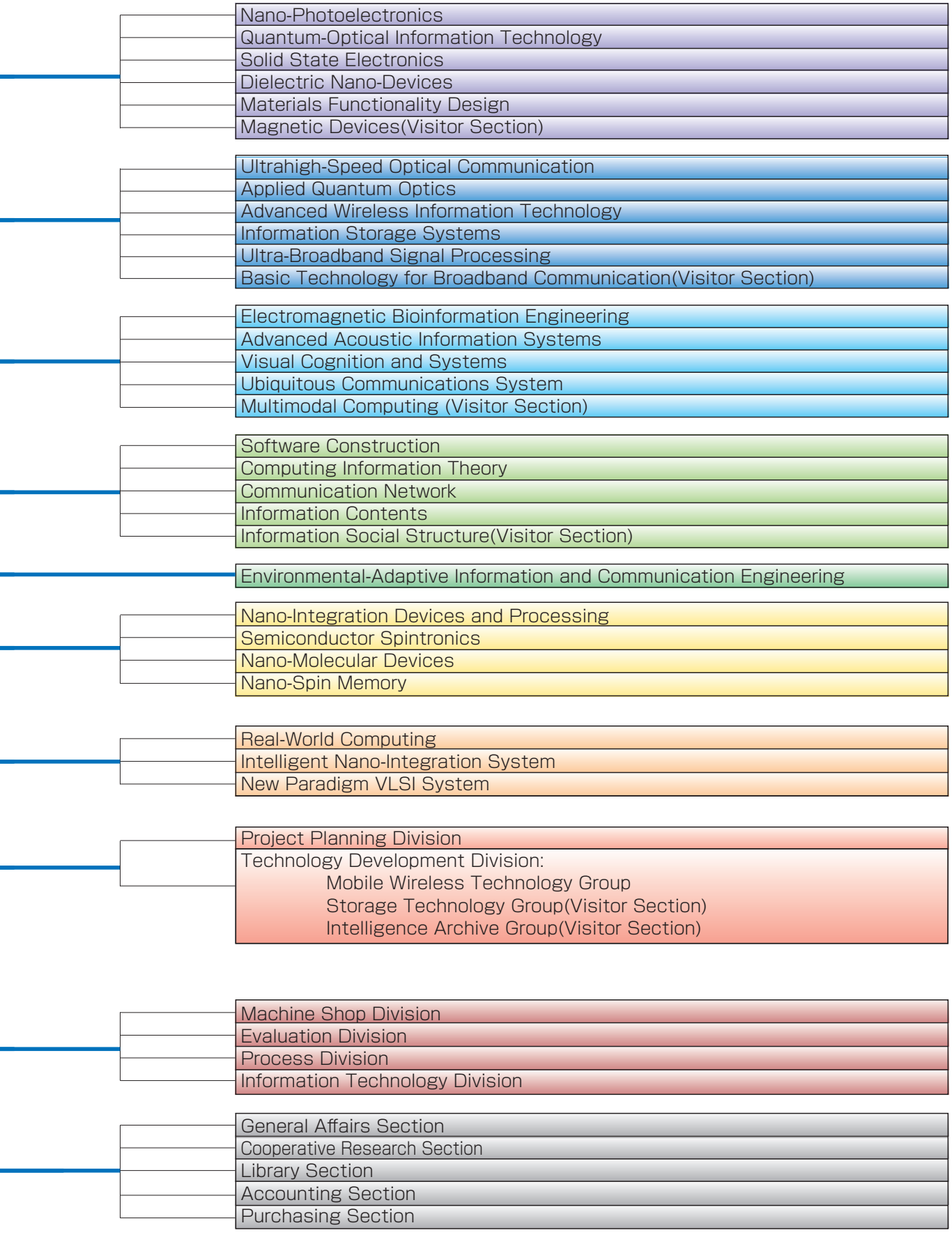
Long-term research has been reorganized into four major research divisions. The Materials Science and Devices Division and the Coherent Wave Engineering Division, which developed scientific techniques for transmitting large volumes of information accurately at high speed, are both in fields in which 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 Engineering, Communications Engineering and 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
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
Nano-Integration Devices and Processing
Semiconductor Spintronics
Nano-Molecular Devices
Nano-Spin Memory
Real-World Computing
Intelligent Nano-Integration System
New Paradigm VLSI System
Project Planning Division
Technology Development Division:
Mobile Wireless Technology Group
Storage Technology Group(Visitor Section)
Intelligence Archive Group(Visitor Section)
Machine Shop Division
Evaluation Division
Process Division
Information Technology Division
General Affairs Section
Cooperative Research Section
Library Section
Accounting Section
Purchasing Section

2.Staff

(2012.5.1)

Classification	Division	Laboratory for Nanoelectronics and Spintronics	Laboratory for Brainware Systems	Fundamental Technology Center	Administration Office	Total
Professors	19	3	3			25
Associate Professors	15	3				18
Assistant Professors	15	3	6			24
Research Fellows	19	2	1			22
Technical Officials				13	1	14
Administrative Officials					16	16
Total	68	11	10	13	17	119

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

(2012.5.1)

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	Ministry of Education, Science and Culture	Partnership Between Universities and Industry	Leading-edge Research Promotion Fund	Total
2007	970,961	813,724	700,615	888,833	0	3,374,133
2008	879,481	953,000	694,883	1,069,832	0	3,597,196
2009	1,026,511	1,562,318	605,100	798,053	400,440	4,392,422
2010	777,776	735,496	418,680	962,712	1,034,827	3,929,491
2011	835,898	1,174,027	469,840	1,122,944	813,777	4,416,486

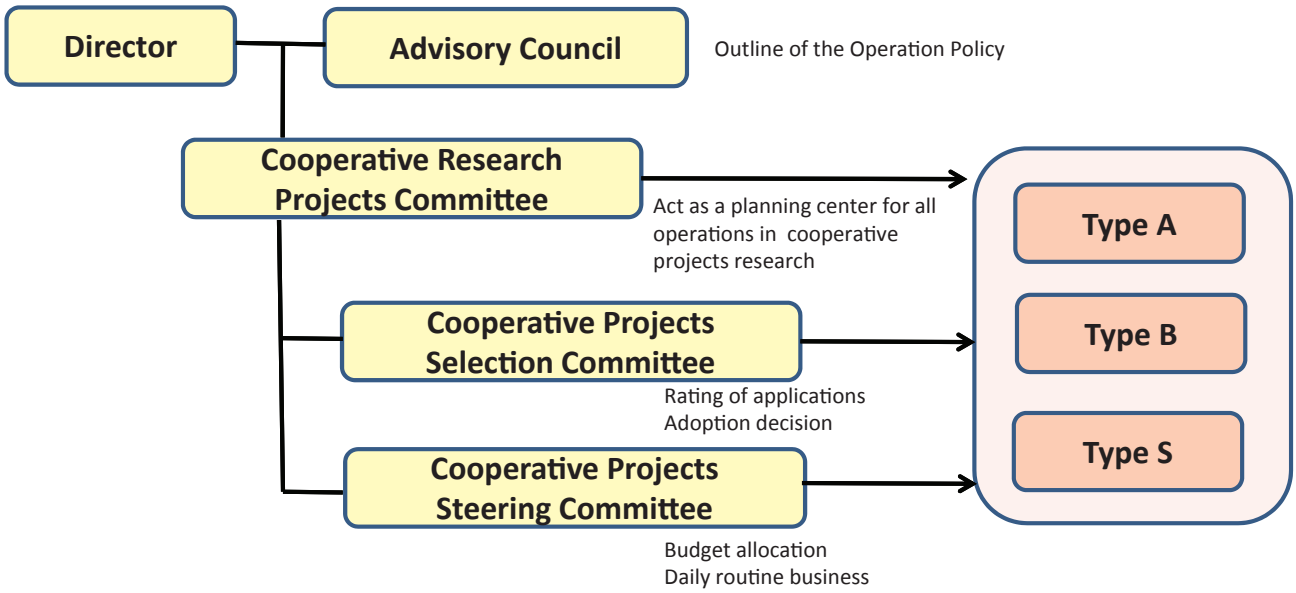
Nation-wide Cooperative Research Projects

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 Projects. 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 “Joint Usage / Research Center.” 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
- Nano-Integration Devices and Processing
- Physical Fluctuomatics *
- Solid State Electronics *
- Intelligent Integrated Systems *
- Advanced Management of Integrated System Technology *
- Acoustic Physics Engineering *

Electonic and Optical Quantum Science

- Nano-Photoelectronics
- Quantum-Optical Information Technology
- Biomodeling *

Plasma Science

- Applied Electromagnetic Energy *
- Energy Generation System *

Visitor Section

- Magnetic Devices

Broadband Engineering Division

Information Technology

- Advanced Wireless Information Technology
- Technology Development Division Mobile Wireless Technology Group

Ultrahigh-Frequency Engineering

- Ultra-Broadband Signal Processing
- Communication Engineering *

Optical Communication / Applied Quantum Electronics

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

Information Recording / Material Science

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

Visitor Section

- Basic Technology for Broadband Communication

Human Information Systems Division

Bioinformation

- Electromagnetic Bioinformation Engineering
- Micro Energy Device *
- Applied Electrical Energy System *

Human Information Processing

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

Ubiquitous Communications

- Ubiqutous Communication Systems
- Electromagnetic Wave Engineering *

Bioelectronics

- Nano-Molecular Divices
- Plasma science Engineering *
- Biomedical Electronics *
- Nano-Biomedical Engineering *
- Systems Bioinformatics *

Bio-inspired System

- Real-World Computing
- Ubiquitous Energy *

Visitor Section

- Multimodal Computing

Systems & Software Division

Computer Science

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

Internet Communication

- Communication Network
- Information Contents
- Electric Power Network System *
- Communication Science *
- Creation Understanding and Distribution Technology for Digital Content *
- Information Technology *
- Applied Intelligence Software *
- Information Network System *

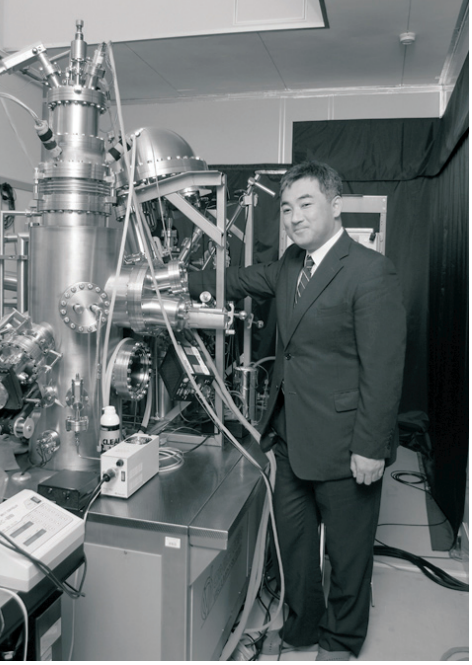
VLSI System

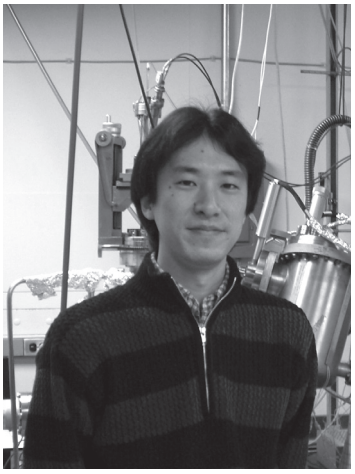
- Intelligent Nano-Integration System
- Microarchitecture
- New Paradigm VLSI System
- Intelligent Electronic Circuits *
- Energy Conversion System *
- Computer Structures *

Visitor Section

- Information Social Structure

*Laboratories in Graduate Schools

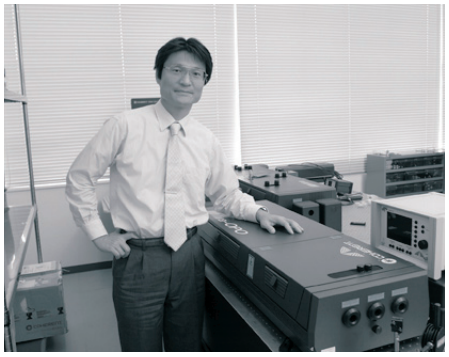


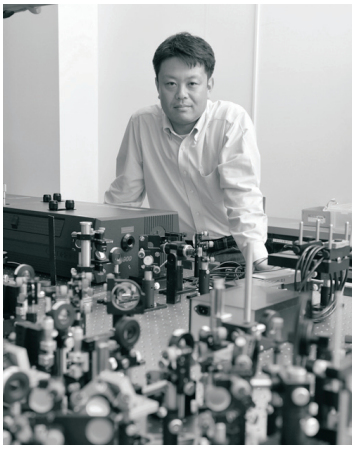


Nano-Photoelectronics

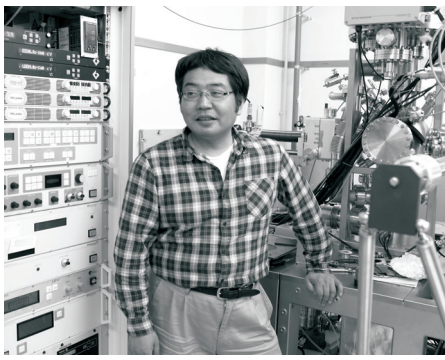
Information Devices Division

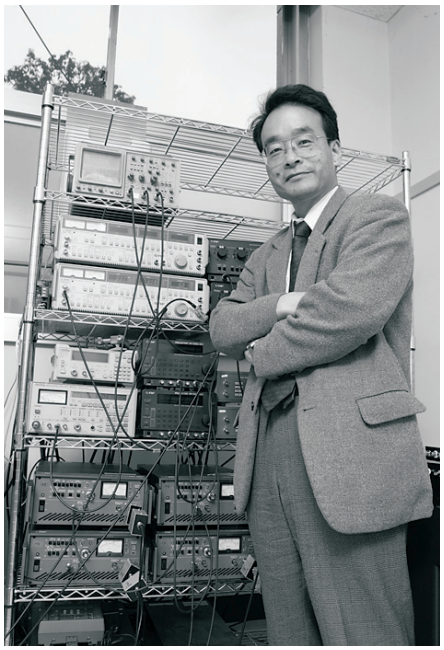
Quantum-Optical Information Technology





Solid State Electronics

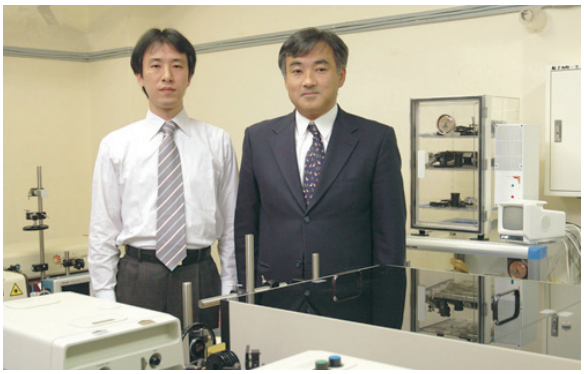




Dielectric
Nano-Devices

Materials Functionality
Design

Nano-Photoelectronics



S.Katano　　Y.Uehara

Staff:

Yoichi Uehara, Professor

Satoshi Katano, Associate Professor

Research activities:

Our main interest lies in studying the physical and chemical phenomena that take place in nanometer-scale regions and their applications in nanophotoelectronic devices. Development of novel probing methods is also targeted.

Nono-photoelectronics（Prof. Uehara）

The material properties of individual nanostructures are investigated through their optical responses to the local excitation induced by electron tunneling in a scanning tunneling microscope (STM). In this method, unlike conventional electric measurements, attainable temporal resolution is not limited by the signal levels. Hence, the material properties are explored with high spatial and temporal resolution. Efficient excitation of light confined in nanostructures is possible in the spectral range from THz to PHz by electron tunneling. This confined light is efficiently converted to free (i.e., propagating) light by the presence of the tip. By utilizing such properties, one can realize efficient and broad-band optical sources and detectors.

Research topics:

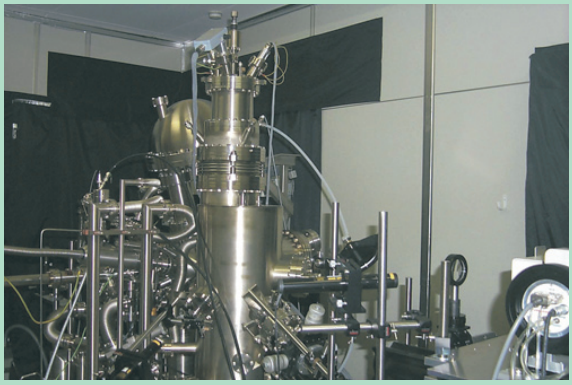
1. Exploration of material properties of individual solid-state nano-structures in spatial, energy, and time axes.
2. Development of STM light emission spectroscopy with ps time resolution.
3. Investigation of various electromagnetic phenomena in nanometer-scale spaces, and their engineering applications.
4. Development of efficient and broad-band light sources and detectors.

Nano-photomolecular electronics（Assoc. prof. S. Katano）

Process and operation principles of the next-generation molecule-based electronic devices are investigated to break through the limit of downsizing that the current Si technology will reach in the near future. By using electron tunneling in STM, one can control the locations of individual atomic and molecular species on a solid surface and even induce chemical reactions in them. The physical, chemical and electronic properties of the species processed in such a way are investigated by using abilities of STM itself. The optical properties are also analyzed by STM light emission spectroscopy. By combining these techniques, we explore novel molecule-based electronic devices.

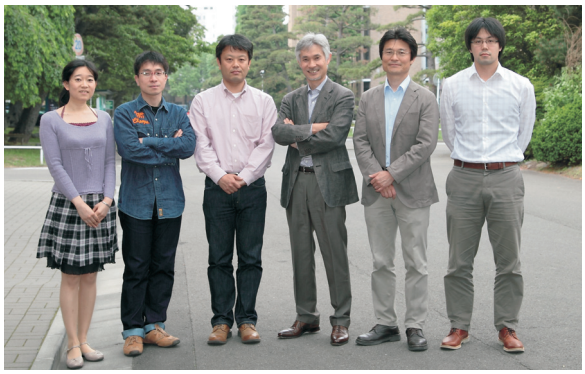
Research topics:

5. Optical excitation of a single atom and molecule.
6. Controlling of the chemical reaction and geometry of a single molecule.
7. Molecular electronics based on the nano molecular assembly



Integrated Surface Analysis System with Low-temperature STM

Quantum-Optical Information Technology



W.Ueno Y.Mitsumori H.Kosaka
M.Yabuno K.Edamatsu F.Kaneda

Staff:

Keiichi Edamatsu, Professor
Hideo Kosaka, Associate professor
Yasuyoshi Mitsumori, Associate professor
Wakana Ueno, Research Fellow
Fumihiro Kaneda, Research Fellow
Masahiro Yabuno, 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 technolo-gies.

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, waveguides, and semiconductor 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:

3. Quantum media conversion between a photon and an electron spin and its entanglement-based applica-tion.
4. Development of quantum repeaters with an electron spin and nuclear spins in quantum dots and dia-monds.

Quantum Laser Spectroscopy (Assoc. Prof. Mitsumori)

Development of optical manipulation technique of electron in semiconductor quantum structures for the realization of QICT.

Research topics:

5. Coherent optical control of electron in semiconductor quantum dot.
6. Quantum optics of semiconductor microcavities.

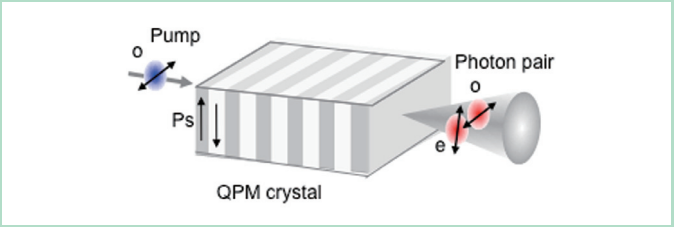


Fig. 1 Entangled photon generation using quasi-phase matching and extended phase matching.

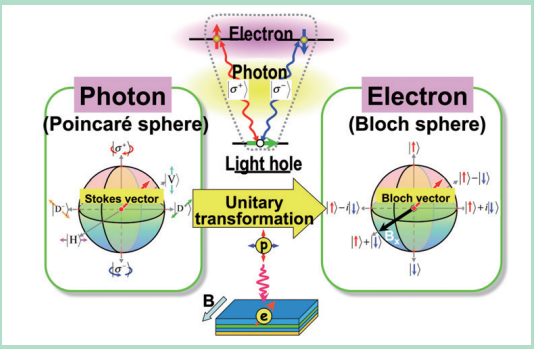
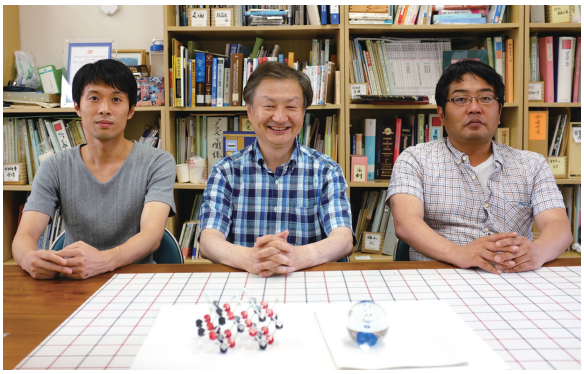


Fig. 2 Quantum media conversion from photon polarization to an electron spin.

Solid State Electronics



M.Jung M.Suemitsu H.Fukidome

Staff:

Maki Suemitsu, Professor

Hirokazu Fukidome, Associate Professor

Myung-Ho Jung, Research Fellow

Research activities:

The strategy of Si technology, in which betterment of the device performance, large scale integration, and reduction of the fabrication cost are all achieved simultaneously by scaling, is now facing several severe challenges. The challenges include that from the intrinsic physical properties of Si, difficulties in nano-fabrication of devices, and the saturating bit cost by scaling. Clearly, novel materials need to be introduced in Si technology to break the barriers. Graphene, a two-dimensional honeycomb network of carbon atoms, provides excellent carrier mobilities that are 100 times higher than those in Si, and is thus a strongest candidate for such next-generation semiconducting materials. To introduce graphene into Si technology, we are studying various aspects of graphene, from materials to devices.

Solid State Electronics (Prof. Suemitsu)

By using our original technology of organosilane-based gas-source molecular beam epitaxy, we have succeeded in the formation of qualified SiC thin films on Si substrates at low temperatures (~1000°C). Using this SiC/Si heterostructure, we have further succeeded for the first time in the epitaxial formation of graphene on Si substrates (GOS). We are now studying the betterment of the GOS film as well as fabrication of graphene-based field-effect transistors working in the THz regime.

Research topics:

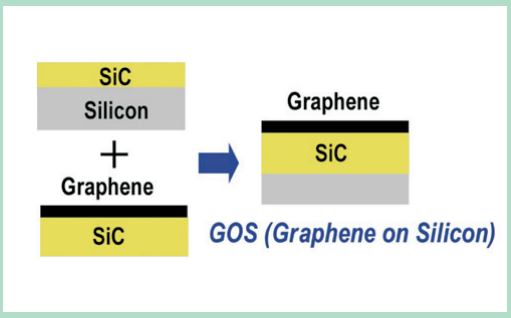
1. Surface chemistry during formation of SiC films on Si substrates
2. High-speed devices based on graphene-on-silicon structures
3. Material processing using normal-pressure plasma-enhanced chemical vapor deposition

Solid State Physics for Electronics (Assoc.Prof. Fukidome)

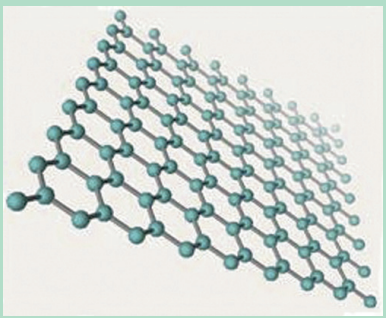
By use of nano-scale characterization methods centered on synchrotron-radiation-based analyses, we are investigating in detail the surface-physical properties of SiC as well as of graphene (Dirac electrons). We found a method to control the surface structural and electronic properties of graphene in terms of the crystallographic orientation of the Si substrate, which paves a way to industrialization of graphene. Use of nano-fabrication is also investigated to realize further control of graphene properties.

Research topics:

4. Surface chemistry during graphene-on-Si process
5. Development of novel functionalities of Dirac electrons by use of nanofabrication of the substrates and its application to devices



The world-first graphene-on-silicon technology



Graphene: A two-dimensional network of carbon atoms

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

Dielectric Nano-Devices

Y.Wagatsuma K.Honda
Y.Hiranaga Y.Cho K.Yamasue

Staff:

Yasuo Cho, Professor
Yoshiomi Hiranaga, Assistant Professor
Kohei Yamasue, Assistant Professor
Koichiro Honda,Research Fellow(Assistant Professor)
Yasuo Wagatsuma, Technical Official

Research activities:

The aim and target of the dielectric nano-devices laboratory are developing the research on the dielectric measurement of electronic materials using nano-technologies and applying its fruits to high-performance next generation electronic devices. It is also very important aim of our laboratory to bring up leaders of the next generation by cultivating young researchers and students through the research activities.

Dielectric Nano-Devices (Prof. Cho)

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/inch2 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.

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.

Fig.1 Commercially available scanning nonlinear dielectric microscope.

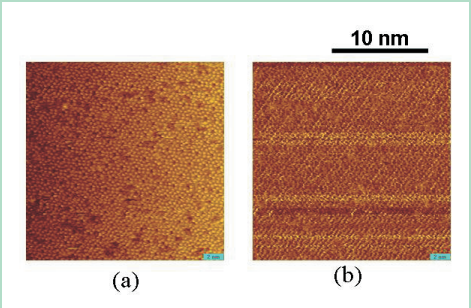


Fig.2 S(111) 7X7 atomic structure taken by SNDM. (a)Topography (b) Electric dipole-moment.

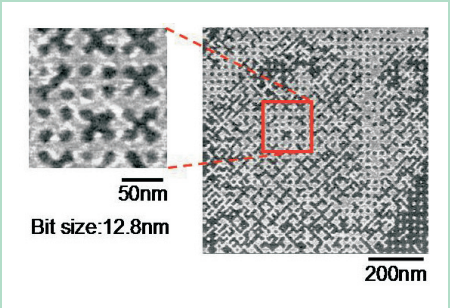
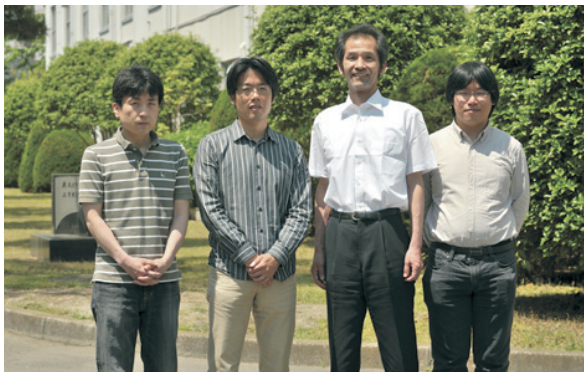


Fig.3 Example of a ferroelectric actual information storage (4 Tbit/inch^2).

Materials Functionality Design



K.Abe Y.Miura M.Shirai M.Tsujikawa

Staff:

Masafumi Shirai, Professor
Yoshio Miura, Assistant Professor
Kazutaka Abe, Assistant Professor
Masahito Tsujikawa, Research Fellow

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.

Materials Functionality Design (Prof. Shirai)

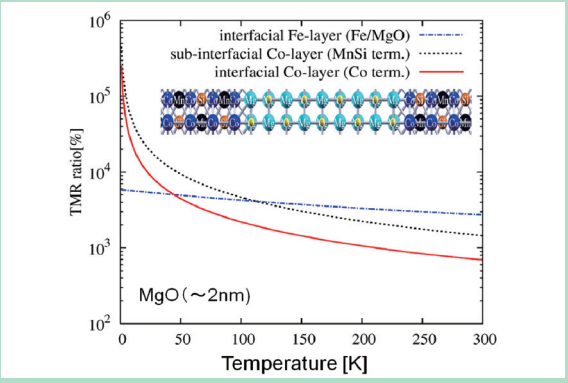
Our research interest is focused on "spintronics", an interdisciplinary research field emerging from materials science, physics, electronics, and magnetics, where both charge and spin degrees of freedom are exploited to realize new kinds of advanced information devices. The main research topics are theoretical analysis of spin-dependent transport properties in highly spin-polarized materials and device-structures utilized the materials. Recently, we extend our theoretical research to electric-field effect on magnetic anisotropy in ferromagnetic thin films for realizing new devices with ultra-low power consumption, such as non-volatile spin memories.

We investigated the temperature dependence of tunneling magnetoresistance (TMR) in $Co_2MnSi/MgO/Co_2MnSi$ junctions on the basis of first-principles calculations. We found that the tilting of interfacial Co spin moments resulting from the thermal fluctuations causes spin-flip scattering and reduces the TMR ratio significantly (see Figure). We proposed that the insertion of ultrathin Fe or FeCo layers into the interface enhances magnetic coupling and thus the TMR ratio at room temperature [Y. Miura, *et al.*, Phys. Rev. B **83**, 214411 (2011)].

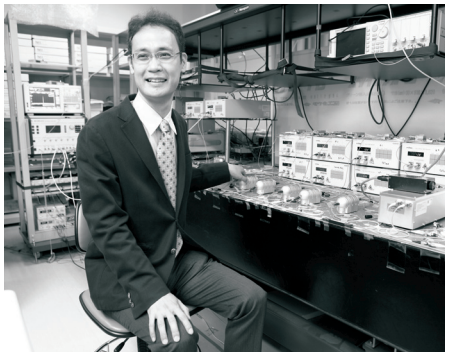
We also investigated the spin-dependent transport properties of $Co_2MnSi/X/Co_2MnSi$ (X = Ag, Au, Al, V, Cr) trilayers. We found that the matching of the Fermi surface predominantly determines the spacer dependence of the interfacial resistance. In particular, MnSi-terminated interfaces with Ag, Au, and Al spacers are promising for realizing larger magnetoresistance ratios [Y. Miura, *et al.*, Phys. Rev. B **84**, 134432 (2011)].

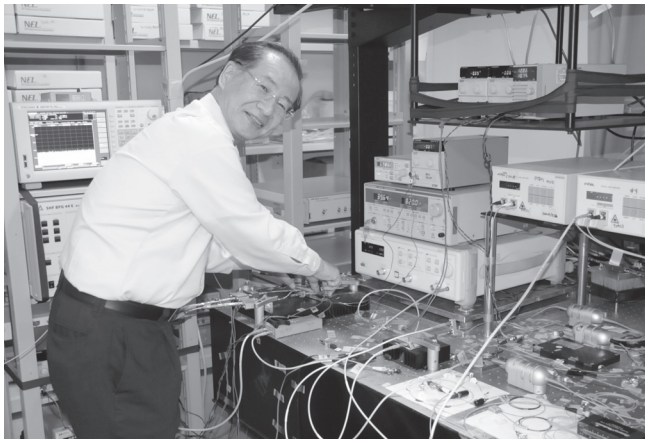
Research topics:

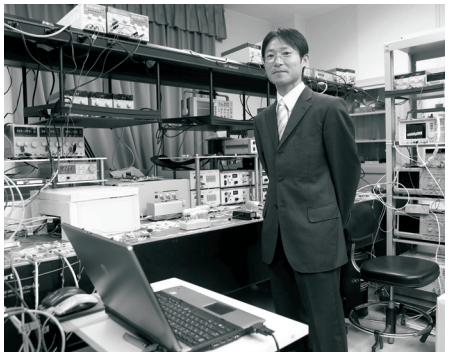
1. Computational design of new spintronics materials from first-principles
2. Computational analysis of transport properties in spintronics devices
3. Computational simulation of nanostructure-growth process on surface
4. Development of computational scheme for material/device design



The temperature dependence of tunneling magnetoresistance (TMR) ratio evaluated for Fe/MgO/Fe and Co- and MnSi-terminated $Co_2MnSi/MgO/Co_2MnSi$ junctions.





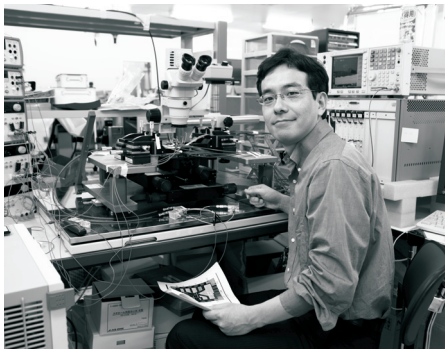


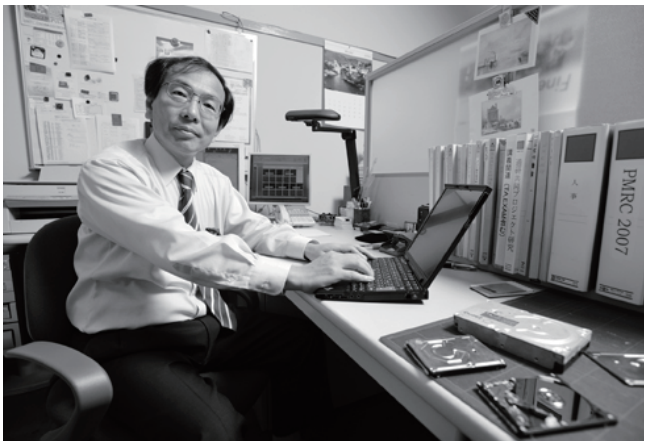
Ultrahigh-Speed Optical Communication

Applied Quantum Optics

Broadband Engineering Division

Advanced Wireless Information Technology





Information Storage Systems

Ultra-Broadband Signal Processing

Basic Technology for Broadband Communication(Visitor Section)

Ultrahigh-Speed Optical Communication

T.Hirooka L.Chen P.Guan
M.Nakazawa M.Yoshida K.Kasai

Staff:

Masataka Nakazawa, Professor
Masato Yoshida, Associate Professor
Pengyu Guan,Research Fellow
Toshihiko Hirooka, Associate Professor
Keisuke Kasai, Research Fellow
Lei Chen,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. 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. 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. Photonic crystal fibers and optical fibers with new functionality

Optical Signal Processing (Assoc. Prof. Hirooka)

We are engaged in the development of all-optical technologies using nonlinear optical effects by taking advantage of ultrafast optical properties, 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:

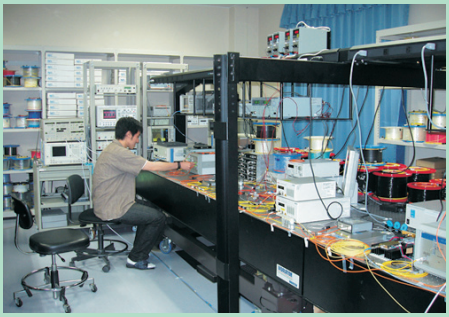
4. Distortion elimination technique using time-domain optical Fourier transformation
5. All-optical signal processing using nonlinear optical effects and their application to ultrahigh-speed OTDM transmission

High Accuracy Measurements using Optical Fibers (Assoc. Prof. Yoshida)

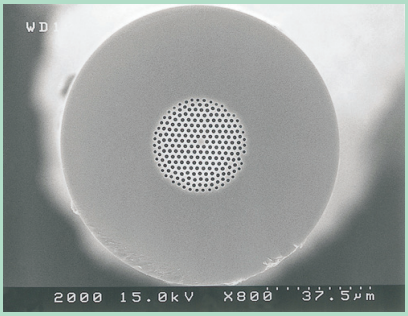
We are engaged in the development of frequency stabilized laser operated at 1.55 μm and its application to high accuracy measurements using optical fibers. Furthermore, we are developing ultra-short pulse lasers.

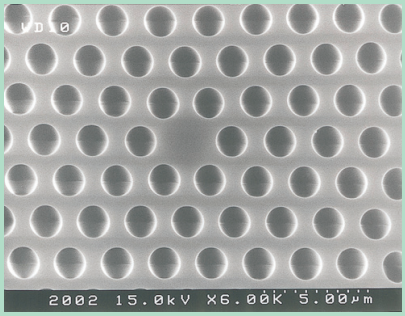
Research topics:

6. Frequency stabilized lasers and their application to high accuracy measurements using optical fibers
7. Ultrashort mode-locked lasers and their application to frequency standards and microwave-photonics



Experiment on ultrahigh-speed optical transmission





Photonic crystal fiber
(Left photo:cleaved end face of a PCF) (Right photo:enlarged cross section)

Applied Quantum Optics

Staff:

Hiroshi Yasaka, Professor

H.Yasaka

Research activities:

Internet traffic has been increasing explosively and the amount of information which should be processed has been increasing. The capacity of information processing in optical communication systems should be increased drastically to cope with the explosive increase in the information traffic. It is necessary to realize ultra-high speed and highly functional semiconductor photonic devices and semiconductor photonic integrated circuits to construct next generation highly functional optical information communication network systems.

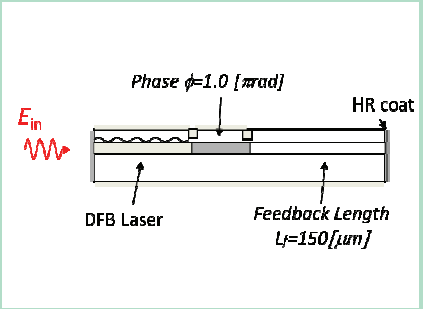
We are investigating novel, highly functional semiconductor photonic devices, which is indispensable to realize new generation optical information communication network systems. Furthermore, our research interests cover ultrafast photonic devices, opto-electronic semiconductor devices and their applications to optical computing and signal processing areas.

Highly Functional Photonics（Prof. Hiroshi Yasaka）

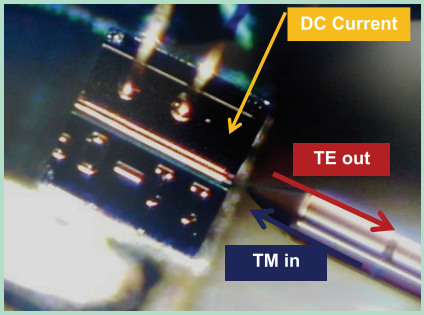
It is indispensable to establish highly functional light source and photonic device technologies and novel functional semiconductor photonic integrated circuit technology for realizing highly functional optical communication systems and novel functional optical signal processing systems. We have been 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. Furthermore we research novel semiconductor photonic functional devices based on novel principle to realize innovative photonic information communication network systems.

Research topics:

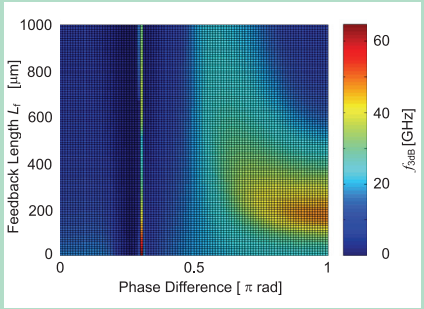
1. Ultra-high speed control of semiconductor photonic devices by signal light injection
2. Highly functional semiconductor light sources
3. Highly functional semiconductor optical modulators
4. Novel functional semiconductor photonic integrated circuits



Schematic device structure of a functional semiconductor photonic device.



Magnified photo of the functional semiconductor photonic device.



Calculated 3 dB bandwidth of the functional semiconductor photonic device.

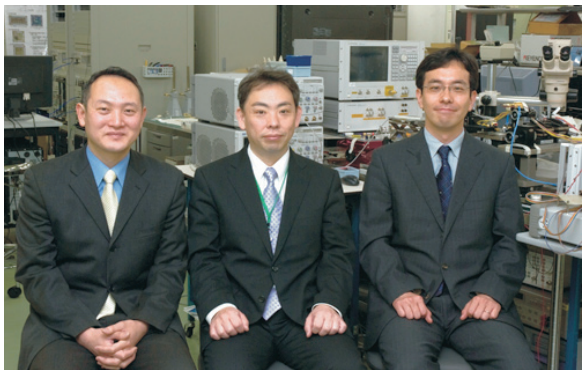
Advanced Wireless Information Technology

Staff:

Noriharu Suematsu, Professor

Suguru Kameda, Associate Professor

Shoichi Tanifuji, Research Fellow



S.Tanifuji N.Suematsu S.Kameda

Research activities:

Wireless communication systems, such as cellular phones, have offered mobile voice/mail services to us. Nowadays, they begin to offer mobile internet services which handle high capacity photo/motion data. In order to enjoy freedom from wired lines, small size, light weight, long battery life terminals have been required. For the next generation wireless systems which include terrestrial / satellite communications, dependable connectivity and green wireless information technologies (IT) will be the key issues.

Advanced Wireless Information Technology (Prof. Suematsu)

Toward the realization of a ubiquitous and broad-band wireless network, we are actively engaged in the research work on dependable and low power consumption advanced wireless IT. We cover the whole technical fields from the lower to higher layers, i.e., signal processing, RF/Mixed signal device, antenna, MODEM and network technologies.

As the studies on signal processing, RF/Mixed signal device and antenna technologies, we are developing RF/Millimeter-wave RF CMOS IC's, antenna integrated 3-dimensional system in package (SiP) transceiver modules, and digital/RF mixed signal IC's.

As the studies on MODEM and network technologies, we are focusing on next generation mobile broadband wireless access (MBWA: mobile broadband wireless access), dependable broadband wireless local area network (WLAN) and ultra-broadband wireless personal area network (WPAN).

We are also working for the next generation wireless communication systems/devices which include a location / short message communication system via quasi-zenith satellites (QZS) and a fusion of various wireless communication systems "dependable wireless system."

Research topics:

1. Broadband wireless on-chip transceivers
2. Digitally assisted RF analog circuits
3. Millimeter-wave/submillimeter-wave IC's
4. Low power digital signal processing for multi-mode wireless / satellite communications
5. Location and short message communication system via QZSS

Advanced Wireless Network Technology (Assoc. Prof. Kameda)

We are engaged in the development of wireless access technology for heterogeneous wireless network include satellite communications. Specifically, we are developing seamless roaming technologies among heterogeneous networks and large-capacity wireless access method for large disaster relief.

Research topics:

6. Joint terrestrial and satellite communication network
7. Digital signal processing for broadband wireless communication

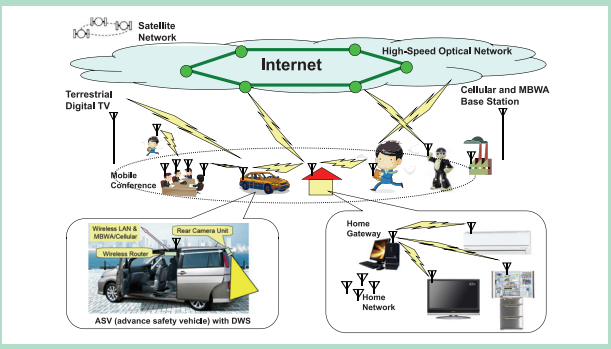


Fig.1 Evolutional network for ubiquitousness and broadband

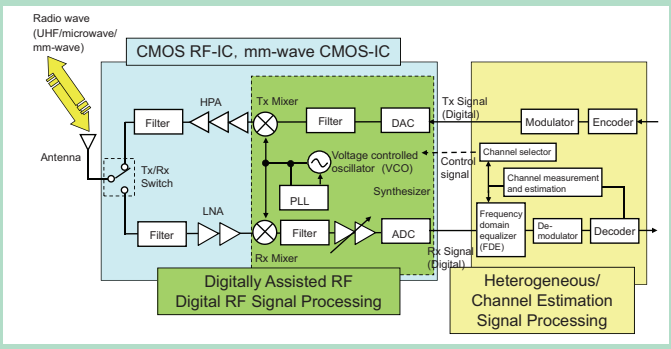


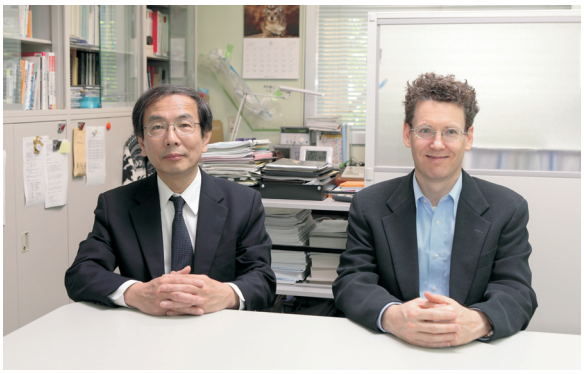
Fig.2 One-chip modem LSI for Broadband wireless communication

Information Storage Systems

Staff:

Hiroaki Muraoka, Professor

Simon J. Greaves, Associate professor



H.Muraoka S.J.Greaves

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/inch2 areal density), in which the bit size corresponds to the area of 10 nm by 10 nm.

Information Storage Systems Research Division（Profs Muraoka）

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.

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:

1. Micromagnetics simulation for high density read/write theory

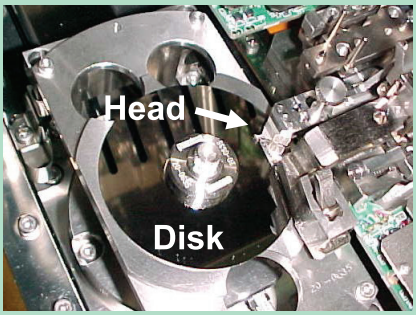


Fig 1 Read/write measurement by using a single-pole head and a perpendicular media.

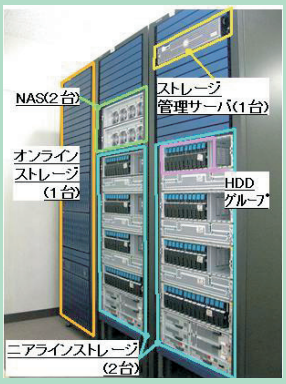
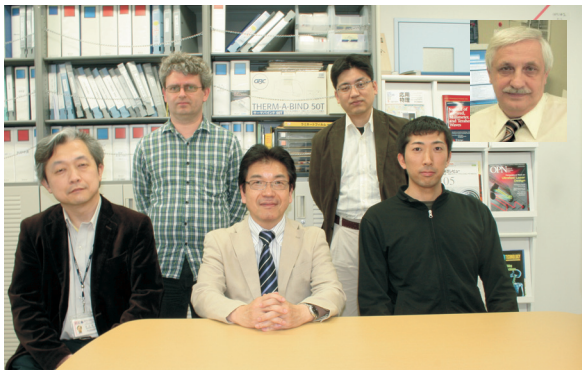


Fig 2 A large-scale storage system with parallel HDD operation.

Ultra-Broadband Signal Processing



A.Dobroiu S.Takabayashi V.Ryzhii
T.Suemitsu T.Otsuji A.Satou

Staff:

Taiichi Otsuji, Professor
Tetsuya Suemitsu, Associate Professor
Susumu Takabayashi, Assistant Professor
Victor Ryzhii, Visiting Professor
Akira Satou, Assistant Professor
Adrian Dobroiu, 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. 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 create 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:

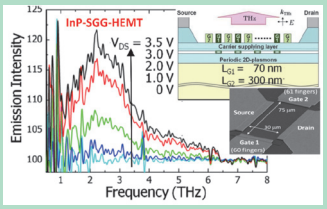
1. Plasmon-resonant terahertz emitters/detectors/modulators and their system applications
2. Terahertz metamaterial circuit systems based on dispersion control of low-dimensional plasmons
3. Graphene-based terahertz lasers and ultrafast transistors, and their system applications

Ultrafast Electron Devices (Assoc. Prof. Suemitsu)

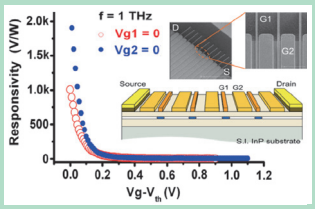
Transistors are important building blocks for integrated circuits used in a lot of systems for information and communication technologies. Particularly in optical fiber communication systems and (sub-) millimeter-wave frequency systems that requires ultimately high-speed operation, the channel materials 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:

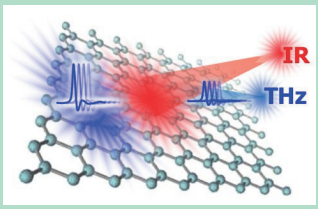
4. InGaAs-based field effect transistors (FETs) for ultimately high frequencies in millimeter- and terahertz-wave regime and their application to integrated circuits
5. GaN-based FETs for high-power and high-frequency regime and their application to integrated circuits
6. Graphene-based transistors for high-speed and high-frequency applications



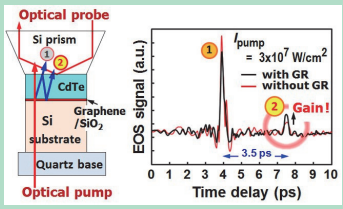
Cross-sectional view, SEM images, and FTIR-measured broadband emission spectra of newly-proposed plasmon-resonant emitter (PRE) fabricated with InP-based heterostructure material systems operating in the terahertz range.



Cross-sectional view, SEM images, and measured responsivity of plasmon detector operating in the terahertz range.



Schematic view of terahertz-wave amplification by stimulated emission utilizing population inversion in optically pumped graphene.



Time response of terahertz-wave amplification utilizing optically pumped graphene measured by electrooptic sampling.

Basic Technology for Broadband Communication

Staff:

Masaaki Inutake, Visiting Professor

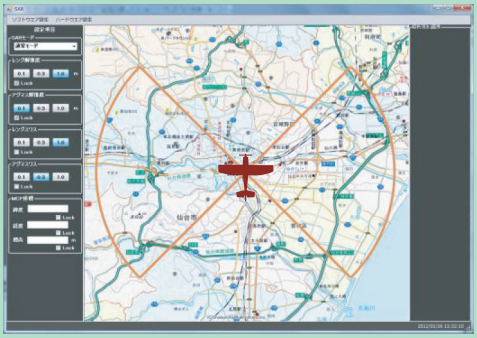
Sakai (SakuraTec) Inutake Mase (Kyushu Univ.) Kogi (Fukuoka Inst.Tech.) Yamashika (Fuji HI)

Research activities:

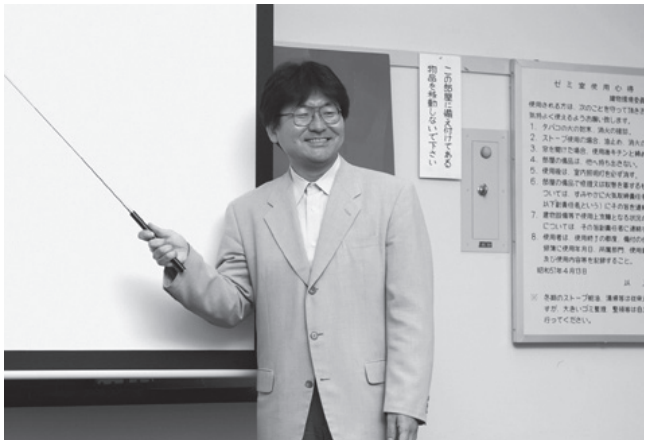
Our main interest is to develop an air-borne synthetic aperture radar (SAR) for civilian applications. The SAR is very useful for all-weather surveillance and rescue in disastrous fires and smokes. Scientists and engineers from both universities and industries collaborate on this research project.

Development of a high resolution (10cm), small size and light weight (25kg) SAR at Ku-band has been started in 2009 under the contract of Ministry of Land, Infrastructure, Transport and Tourism.

Hard wares of a real-time image-formation SAR “Live SAR” have been successfully completed in 2010. The antenna/ gimbal assembly weighs 10kg, while the radar electronics assembly weighs 15kg . Soft wares “SAR Tools” for the “Live SAR” has been developed in 2011. Graphical user interface is shown in the figure. Air-borne test is scheduled in 2012.



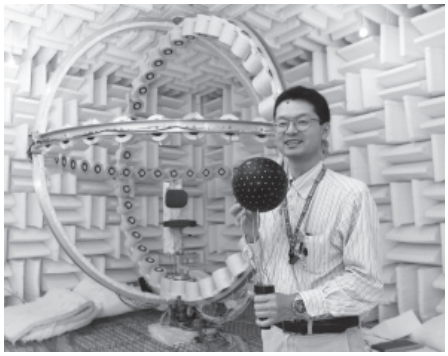
Graphical user interface for an imaging radar "LiveSAR". Images can be taken in fan-shaped area.

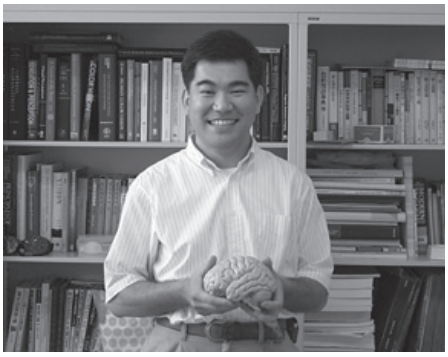


Electromagnetic Bioinformation Engineering

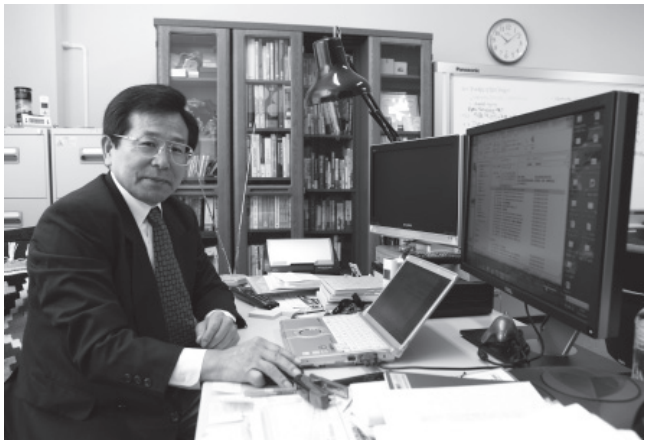
Human Information Systems Division

Advanced Acoustic Information Systems

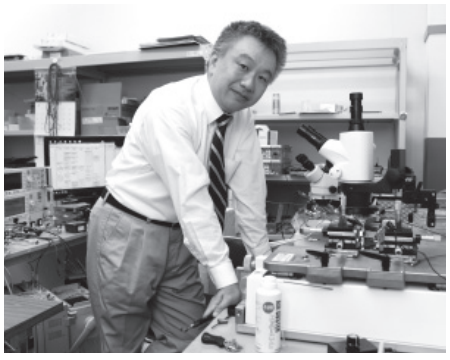




Visual Cognition and Systems



Ubiquitous Communications System



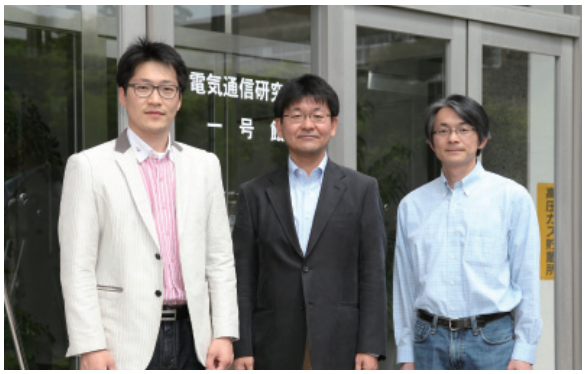
Electromagnetic Bioinformation Engineering

Staff:

Kazushi Ishiyama, Professor

Shuichiro Hashi, Associate Professor

Sung Hoon Kim, Assistant Professor



S.H.Kim K.Ishiyama S.Hashi

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 wireless driving technology is applied for a development of completely embedding artificial heart assist blood pump and 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

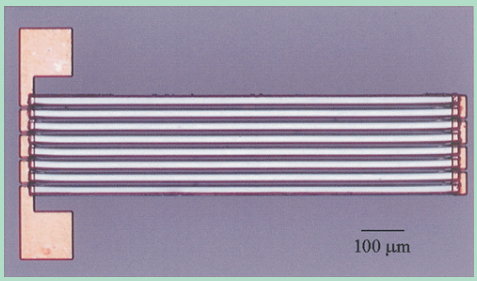
Electromagnetic Bioinformation Materials（Assoc. Prof. Hashi）

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.

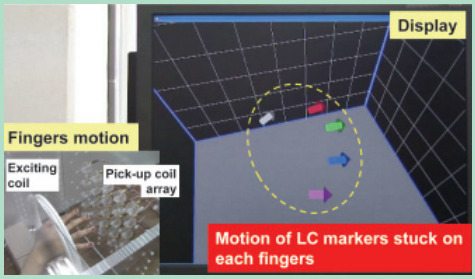
Research topics:

5. Wireless magnetic sensing system
6. Functional magnetic materials



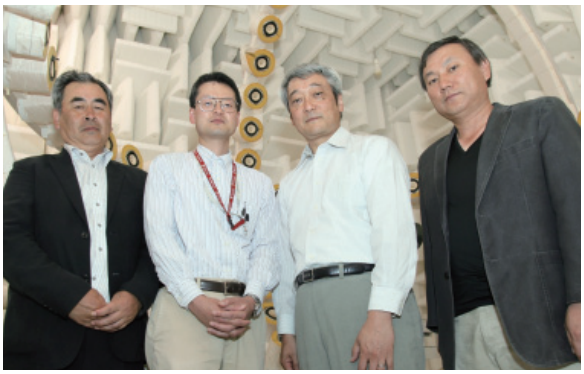
High frequency carrior-type thin film magnetic field sensor

A prototype of wireless artificial heart assist blood pump



Wireless magnetic motion capture system

Advanced Acoustic Information Systems



F.Saito S.Sakamoto Y.Suzuki C.Zheng

Staff:

Yôiti Suzuki, Professor
Shuichi Sakamoto, Associate Professor
Fumitaka Saito, Technical Official
Cui Lie Zheng, Research Fellow

Research activities:

We are aiming at developing advanced and comfortable acoustic communications systems exploiting digital signal processing techniques. Moreover, to realize this, we are also keenly studying the information processing in the human auditory system and multimodal information processing including hearing. We mainly apply psycho-acoustical approaches to study human auditory and multimodal perception.

Advanced Acoustic Information Systems (Prof. Y. Suzuki)

With good knowledge of the human auditory and other perceptual systems, we are aiming at the realization of a 'comfortable' sound environment; development of three-dimensional auditory displays is a typical example. These systems are keenly required to realize the multimedia universal communications.

Research topics:

1. Spatial hearing process as a multimodal perception.
2. System theory and development of 3D high-definition auditory displays based on the notion of “active listening.”
3. Development of new theories of acoustic digital signal processing.
4. High level cognition process of the sense of presence and verisimilitude

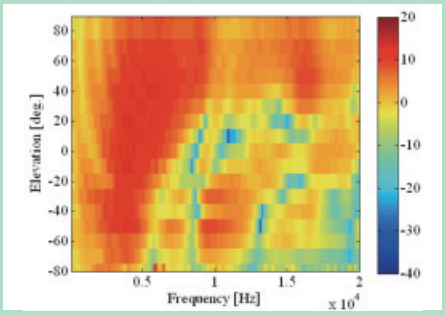
Auditory and Multisensory Information Systems (Assoc. Prof. S. Sakamoto)

We are studying the mechanism of human multimodal processing including hearing because such knowledge is crucial to develop advanced communications and information systems. Based on the knowledge, we are developing future auditory information systems.

Research topics:

5. Mechanism of multisensory information processing including hearing.
6. Development of high-definition 3D sound space acquisition systems
7. Auditory information systems based on multisensory information processing.

Accurate sound space communication system based on higher order Ambisonics by using 157ch speaker array



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

Visual Cognition and Systems

K.Matsubara R.Nakashima R.Tokunaga
I.Kuriki S.Shioiri K.Matsumiya

Staff:

Satoshi Shioiri, Professor
Kazumichi Matsumiya, Assistant Professor
Kazuya Matsubara, Research Fellow
Ichiro Kuriki, Associate Professor
Rumi Tokunaga, Assistant Professor
Ryoichi Nakashima, 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:

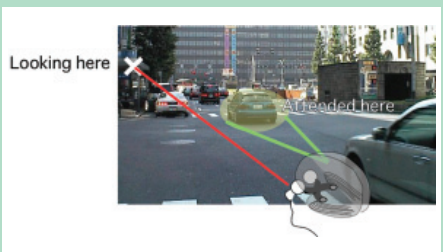
1. Measurements of spatial and temporal characteristics of visual attention.
2. Modeling control system of eye movements and visual attention
3. Investigation of early, middle and late vision of 3D perception.

Cognitive Brain Functions (Assoc. Prof. Kuriki)

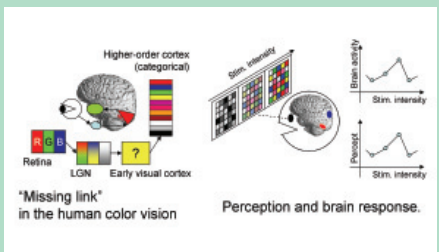
Our perceptual experience arises from neural activities in the brain. Studies of these neural activities are critical for understanding the mechanisms of visual perception. Moreover, presenting visual information in order that the visual information is suitably represented in the brain can provide the way to display proper visual information in information and communication technology. Here 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:

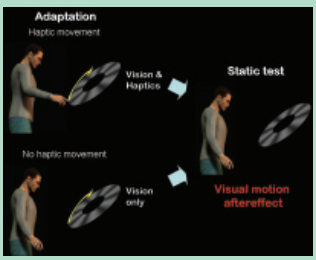
4. Representation of color information in human brain
5. Separation and integration of visual information in human brain



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.

Ubiquitous Communications System

Staff:

Shuzo Kato, Professor

Hiroyuki Nakase, Associate professor

Hirokazu Sawada, Assistant professor

H.Nakase S.Kato H.Sawada

Research activities:

To realize the communications environments in which everybody can communicate without paying much attention to the tools, the laboratory has been focusing on the core technologies and applications of 60GHz Super Broad Band Wireless Communications in which people can communicate at the speed of multi-Gbps freely. These include propagation, antennas, RF devices, modems, FEC, MAC, up to system design. One of the systems the Laboratory has been working on is a wide area sensor network that can be deployed for many applications including a disaster-relief application. Also, the laboratory has been promoting Japanese technologies to be standardized at IEEE802 standardization, IEEE802 15.4k (Low Energy CriticalInfrastructure Monitoring) now.

Ubiquitous Communications System (Prof. Kato)

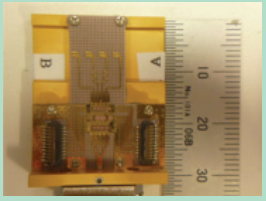
To solve the key issue of millimeter wave communication systems that is reliability, the laboratory has carried out researches on (1) beam-forming antenna with discrete phase shifter (90 degree resolution) and has successfully developed close-to-commercial level beam-forming receiver modules (Fig.1), and (2) high reliability communications systems deploying artificially installed reflectors to reduce the disconnection probability to1/4 (with one artificial reflector) and to1/18 (with two reflectors).

Furthermore, researches have been carried out on low power consumption FEC and modems as well as applications of millimeter wave communications such as wireless harness communications systems (Fig.2) that deploy metalized hoses to reduce weight of automobile harness and increase the reliability.

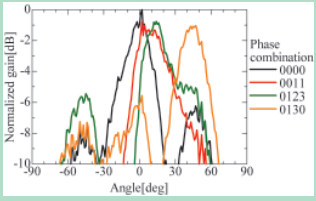
From this year, the laboratory starts to research two new topics of "Wireless power transmission with high gain / beam-forming antennas" and "ISWAN (Integrated Services Wide Area Wireless Networks)(Fig.3) for anti-disaster low rate wide area wireless networks".

Ubiquitous Communications Device (Prof. Nakase)

High speed and low power consumption RF devices are researched and developed for new generation millimeter wave Multi-Gbps communications. The goal of this year is to realize the high resolution sensor systems with ultra high speed (1.5-3Gbps) modulated signals. In addition, Silicon-on-chip antennas will be studied for small and positive gain antenna.



(a)



(b)

Fig.1 Beam-forming antenna module : (a)Rx module and (b) directivity

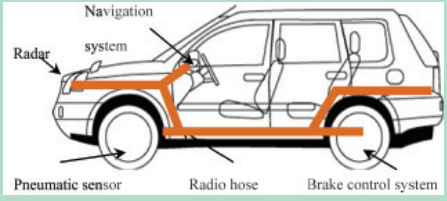


Fig.2 Wireless harness system

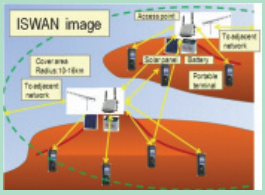
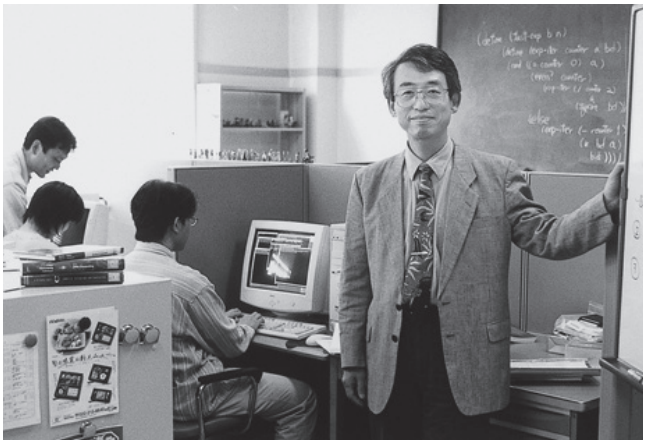


Fig.3 ISWAN (Integrated Services Wide Area Wireless Networks) for anti-disaster low rate wide area wireless networks

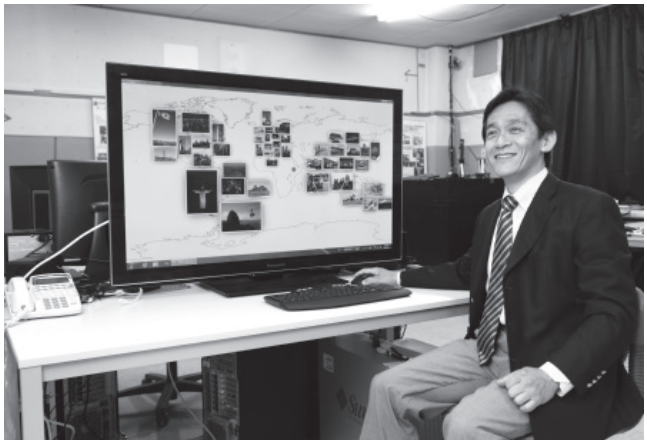
Software Construction

Systems & Software Division

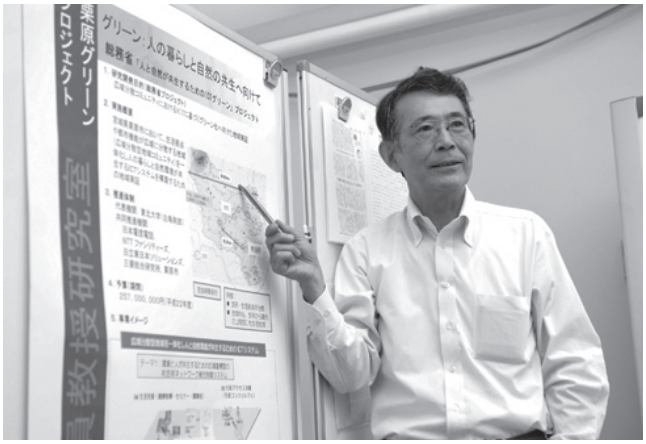
Computing Information Theory



Communication Network Systems



Information Content



Information Social Structure

Software Construction

Staff:

Atsushi Ohori, Professor

Katsuhiro Ueno, Assistant Professor

Akimasa Morihata, Assistant Professor

A.Morihata A.Ohori K.Ueno

Research activities:

Nowadays, a variety of software systems manage everything in the world. Therefore, firm foundations for developing high performance and highly reliable software are essential for continuous advance of our societies.

We are studying foundation of software. We mainly focus on programming languages and database systems, which provide bases of software developments and data managements, respectively. The major research issues include fundamental theories for reliable software, design of productive and reliable programming languages, implementation techniques for high performance software, and software development frameworks that enable seamless integration of a variety of resources, such as programming languages, databases and distributed computational environments.

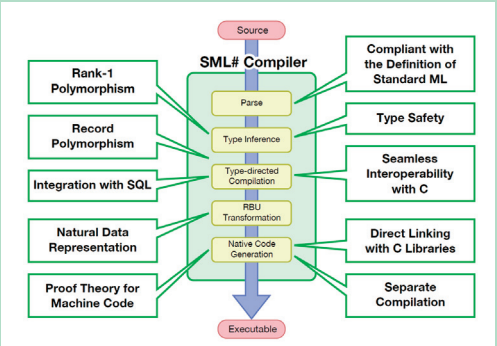
Software Construction (Prof. Ohori)

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.

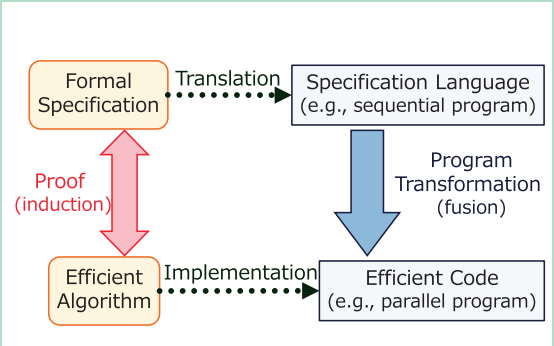
Based on this general observation, our research aims at establishing both firm theoretical basis and implementation method for flexible yet reliable programming languages for advanced Internet computation. One direction toward this goal is to establish logical foundations for compilation. We aim at establishing 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 transformation. 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 researches, 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. Reliable and practical Web programming framework
3. Logical foundation for compilation
4. Integration of databases and programming languages
5. Program transformations for developing/optimizing algorithms



SML#, a state of the art compiler



A framework for deriving algorithms by program transformations

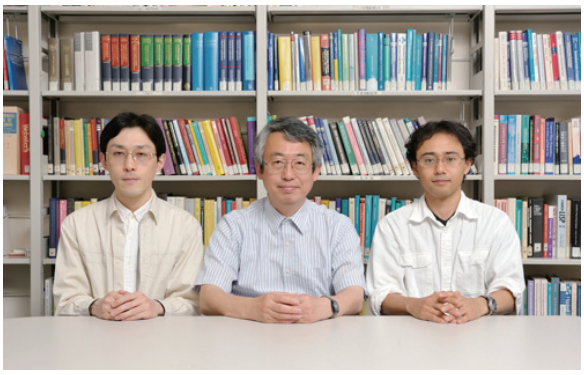
Computing Information Theory

Staff:

Yoshihito Toyama, Professor

Takahito Aoto, Associate Professor

Kentaro Kikuchi, Assistant Professor



K.Kikuchi Y.Toyama T.Aoto

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:

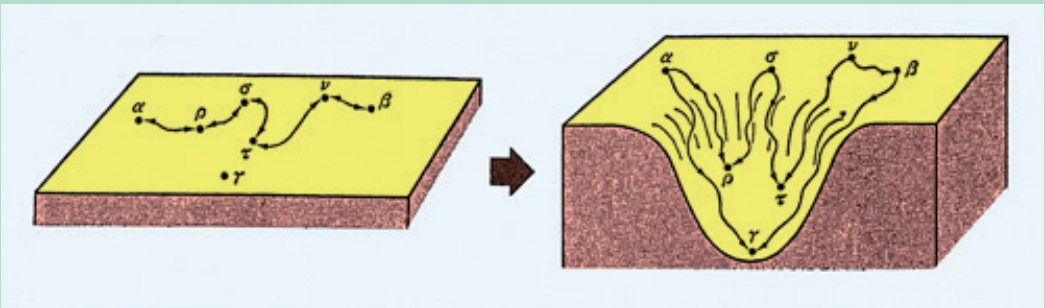
1. Rewriting Theory
2. Foundations of Softwares
3. Automated Deduction

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.

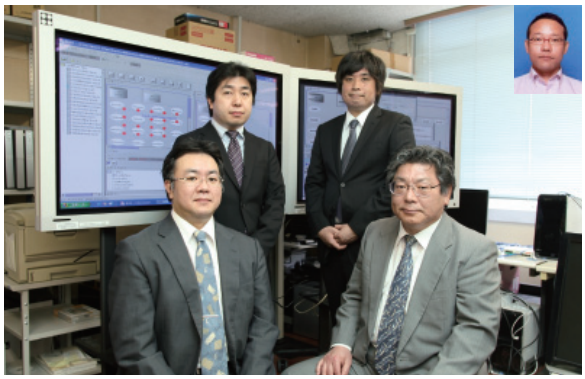
Research topics:

4. Rewrite Systems
5. Automated Theroem Proving



Proof by Equational Reasoning → Computation by Rewriting Systems

Communication Network Systems



H.Takahashi K.Sasai Y.Hayashi
G.Kitagata T.Kinoshita

Staff:

Tetsuo Kinoshita, Professor
Gen Kitagata, Associate Professor
Kazuto Sasai, Assistant Professor
Hideyuki Takahashi, Assistant Professor
Yuichi Hayashi, 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:

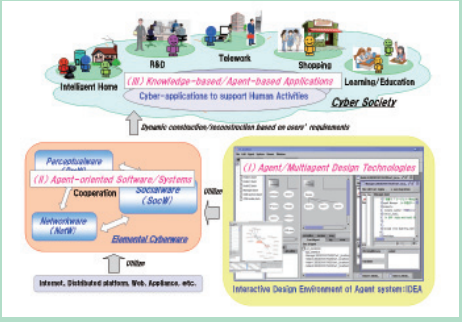
1. Software Infrastructure of Cyber society (Cyberware)
2. Multiagent framework/Design methodology
3. Knowledge-based communication service / User-oriented networking
4. Agent-based/Knowledge-based/Network-based systems

Intelligent Network (Assoc. Prof. Kitagata)

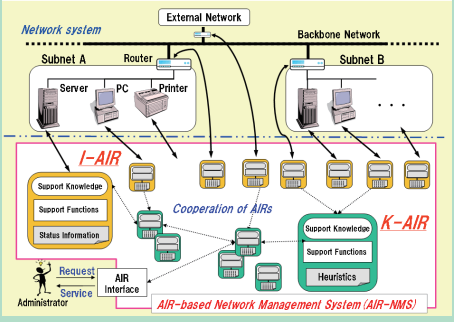
With Intelligent Network, networks and services must have the ability to autonomously construct/reconstruct themselves, according to change of user demands or changes in the environment. To realize such a system, we investigate network software, based on agent and multi-agent technology, networking technology and service infrastructure.

Research topics:

5. Knowledge based network middle-ware / Application software
6. High tolerability networking / Intelligent networking
7. Next generation ubiquitous service infrastructure



Knowledge-based System and its applications based on agent/multiagent technologies



Network Management System based on Active Information Resources

Information Content

H.Yokoyama Y.Kitamura K.Takashima

Staff:

Yoshifumi Kitamura, Professor
Kazuki Takashima, Assistant Professor
Hitomi Yokoyama, Research Fellow

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.

Interactive Content Design (Prof. Kitamura)

We focus on non-traditional content areas other than movies, music, and games, conducting comprehensive research on a variety of interactive content which creates new value through interactions with humans.

Research topics:

1. Displays and 3D Interaction Technologies
   We design original display systems to show visual information accurately and effectively, and interaction techniques to make better use of these display systems (Fig. 1).
2. Interactive Video Content
   This research deals with effectively creating new interactive content from real video taken by video cameras or computer-generated animations. (Fig. 2)
3. Relation between Interpersonal Communication and Information Content
   Aiming to design new interactive content, we are exploring relation between interpersonal communication and information content in the space (Fig. 3)
4. Design and Evaluation of Novel Interaction Techniques
   This research focuses on designing and evaluating novel interaction techniques on target selection for variety types of displays including large and touch displays.
5. Entertainment Computing for Creative Rejuvenation
   We are conducting research of novel entertainment computing technologies that empower people and industry in disaster-stricken areas with interdisciplinary collaborations.

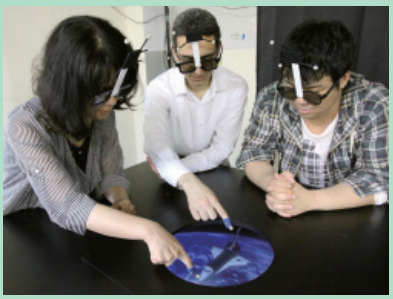


Fig.1

Fig.2

Fig.3

Information Social Structure

N.Shiratori S.Izumi

Staff:

Norio Shiratori, Visiting Professor
Satoru Izumi, Research Fellow

Research activities:

In 21st century, we are facing with "global environmental changes" including global warming and "social structural changes" such as aging of the population. For absorbing and sublating these changes, we proposed a new computation paradigm, the concept of "Symbiotic computing", in 1992. This idea places on values on harmony between "Agents" (e.g. human, computer, internet, robot, nature, country, culture and etc.). From the engineering point of view, we have been pursuing researches on the "Symbiotic computing" which are its model, design and applications (Fig1).

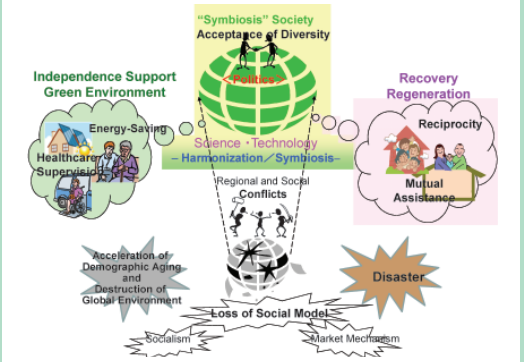


Fig.1: Model of Symbiotic Information Society towards Recovery and Regeneration

Research topics:

1. Symbiotic Computing: Symbiotic between Human and Information System
2. Disaster-oriented Network・Green Computing
3. Net Media / Smart Home / Supervisory and Health Support System
4. Model of Symbiotic Information Society

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.

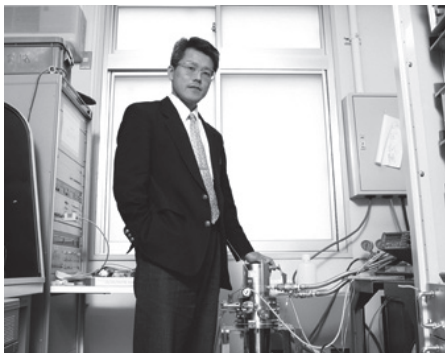
Environmental-adaptive information and communication engineering（Prof. Adachi）

A passive sensor using surface-active nano-materials and its sensor-network application are the current research targets. Especially color stability of silver nanoparticles adhered on metal oxide powders under gamma ray irradiation are of importance for its chemical-sensor application. This material will be applied to a sensor device with ICT system for realizing product traceability.

Research topics:

1. High-sensitivity chemical-gamma-ray-sensor and its application for product traceability
2. Passive sensor technology development for recording of environmental change as changes in nanostructure
3. Fundamental research for ICT devices and equipments reducing environmental destruction by human activities

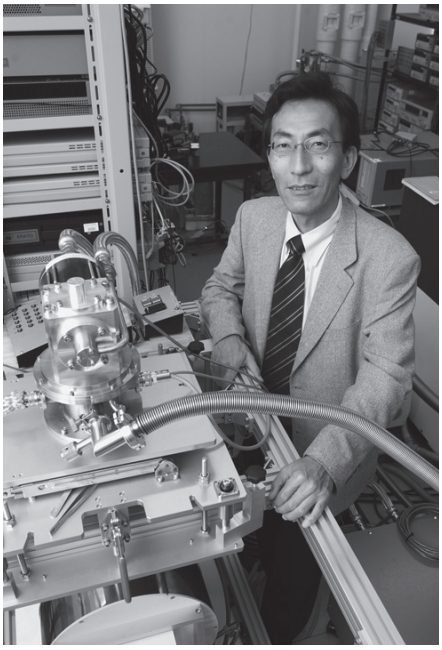
We rebuild our society balanced with nature and industrial environments.

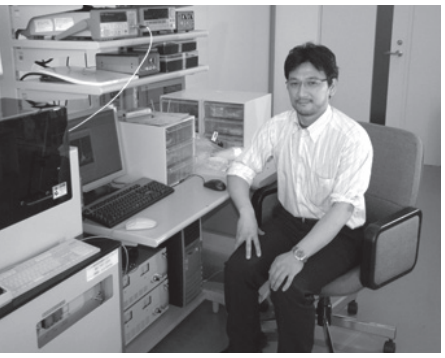


Nano-Integration Devices and Processing

Laboratory for Nanoelectronics and Spintronics

Semiconductor Spintronics





Nano-SpinMemory

Nano Molecular Devices

Laboratory for Nanoelectronics and Spintronics

Y.Iwami H.Ohno T.Meguro Y.Nishimura

Staff:

Director Hideo Ohno, Professor

Cooperation Section

Yurika Iwami, Technical Official

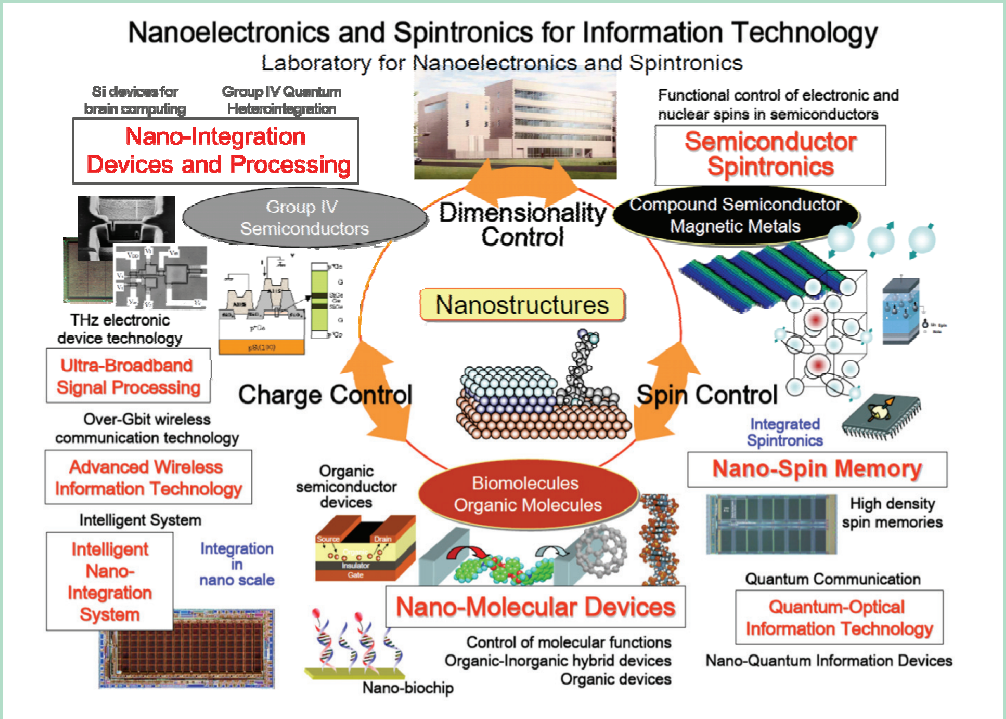
Toshiyasu Meguro, Research Fellow

Youtaro Nishimura, Research Fellow

Research activities:

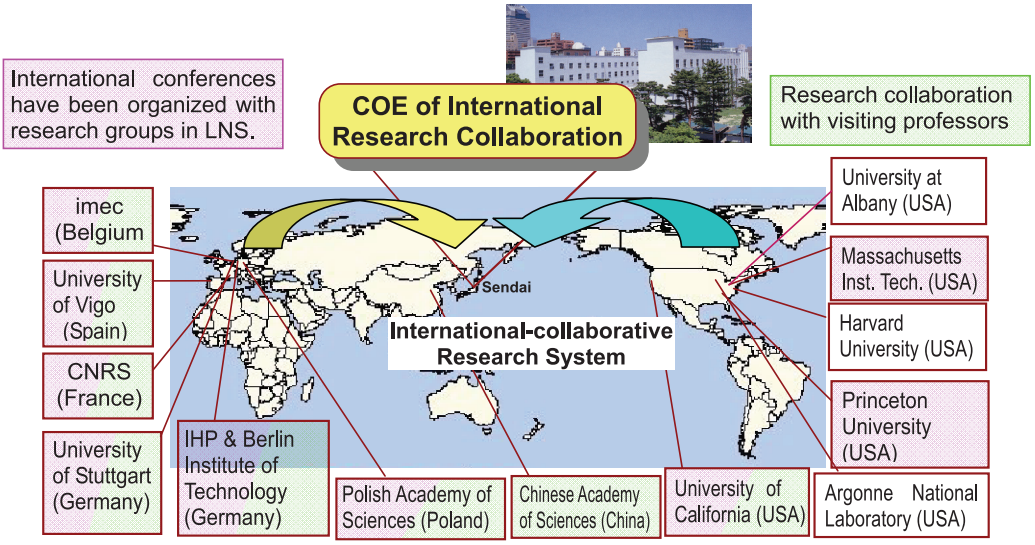
The Laboratory for Nanoelectronics and Spintronics of the Research Institute of Electrical Communication was established on April of 2004. Its purpose is to develop and establish the science and technology of nanoelectronics and spintronics for information technology. Utilizing the facilities installed 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: Nano-Integration Devices and 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

We aim at establishing a Center of Excellence in three research areas, “Nano-integration technologies and their evolution”, “Spin-control physics and technologies and their applications”, 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
University of Vigo, Spain
State University of New York at Albany,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)

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: October 22-23, 2009; 6th: February 5-6, 2010;
7th: February 2-3, 2011; 8th：February2-3, 2012)

International Workshop on Nanostructures & Nanoelectronics

(1st: November 21-22, 2007; 2nd: March 11-12, 2010;
3rd:March21-22, 2012)

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

(1st: October 22-23, 2009)

3rd Int. Workshop on New Group IV Semiconductor Nanoelectronics

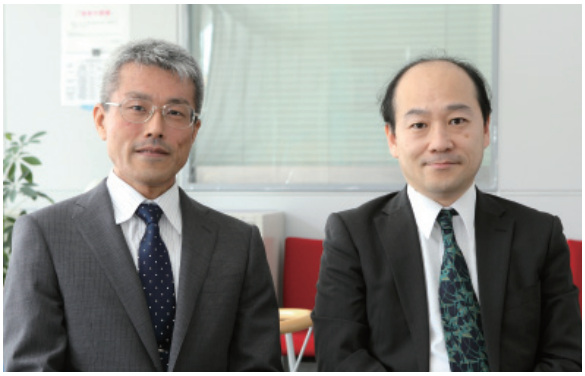
2nd RIEC Symposium on Spintronics-MgO-based Magnetic Tunnel Junction-Left: Albert Fert (received 2007 Nobel Prize in Physics); Right: Russel Cowburn

Nano-Integration Devices and Processing

Staff:

Shigeo Sato, Professor

Masao Sakuraba, Associate Professor



M.Sakuraba S.Sato

Research activities:

In addition to the conventional demands such as faster operation and larger throughput, low power operation for low-carbon emission and robust operation not damaged even in a disaster are required for the development of the next generation information technology. To meet these demands, studies on high functional and high performance Si-based semiconductor devices realized by 3-D nano-processing and large scale integration of such devices are important research subjects. We study the subjects such as new transistors and memories using new materials, new devices based on new principles like quantum effects, and required 3-D processing. Moreover, we develop advanced technologies related to 3-D nano-integration, dependable mixed signal LSI, and non von Neumann architecture.

Nano-Integration Devices (Prof. Sato)

Our short-term research subjects are the development of a synapse device having non-volatile storage and multiplication functionalities, the design and implementation of a high-functional neuron circuit having self-excitation functionality, the development of a 3-D neural network having adjustable topology functionality, and the realization of a prototype brain computer. Also, we make efforts to realize nano-processing and nano-devices required for the accomplishment of our purposes.

Research topics:

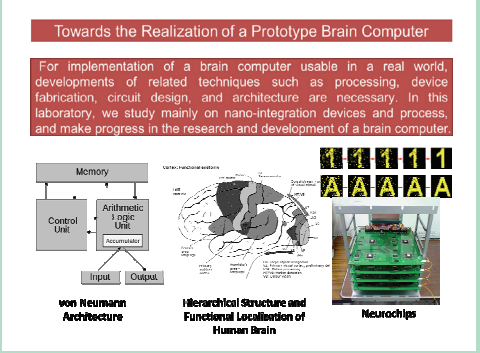
1. New structure non-volatile memory device
2. New structure product-sum operation device
3. High-density implementation of devices for brain computing
4. Intelligent quantum device for brain computing

Group IV Quantum Heterointegration (Assoc. Prof. Sakuraba)

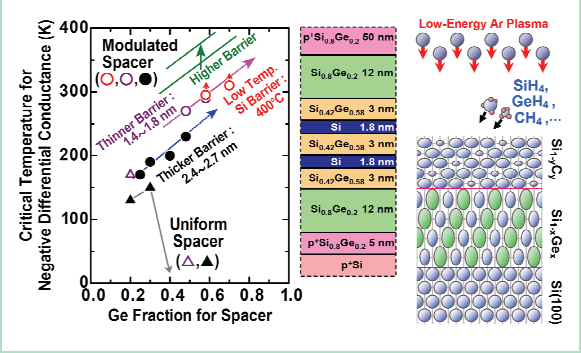
The following researches are being advanced: (1) Atomic-order control of highly strained group IV semiconductor heterostructure formation in a nanometer-order ultrathin region which utilizing plasma CVD reaction at low temperatures without substrate heating, (2) Systematic investigation and control of 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



Towards the Realization of a Prototype Brain Computer

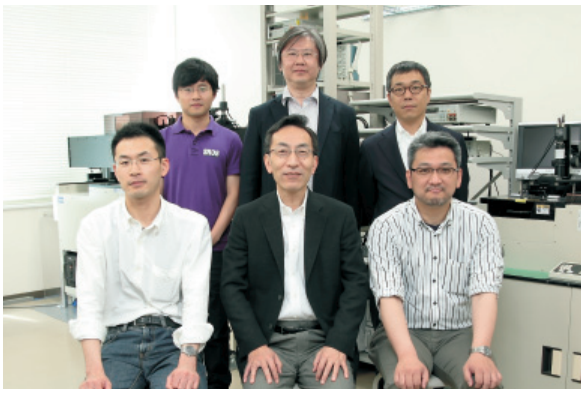


Towards Establishment of Process for Group IV Quantum Heterointegration

Semiconductor Spintronics

Staff:

Hideo Ohno, Professor
Shoji Ikeda, Associate Professor
Michihiko Yamanouchi, Assistant Professor
Lin Chen, Research Fellow
Tadashi Yamamoto, Research Fellow
Norikazu, Ohshima, Research Fellow



L.Chen N.Ohshima T.Yamamoto
M.Yamanouchi H.Ohno S.Ikeda

Research activities:

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, including applications of our findings to realize new spintronic devices as well as functional devices.

Functional Spintronics（Prof. Hideo Ohno）

We are working on spin-related phenomena in semiconductors, magnetic semiconductors, and magnetic metals as well as novel functional spin materials and devices, in order to realize low-power functional spintronics devices.

Research topics:

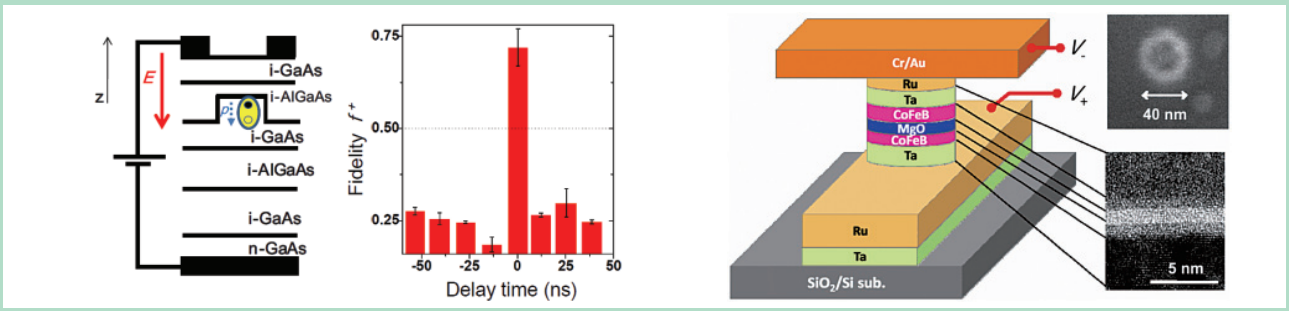
1. Spintronics
2. Magnetic metal functional devices and their application
3. Properties and application of magnetic semiconductors and their quantum structures
4. Characterization of electrical, optical, and spin properties of semiconductor quantum nanostructures and their applications

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:

5. Magnetic tunnel junctions with high output voltage
6. Metal-based spintronics devices
7. Spin transfer torque memory and logic devices



(Left) Schematic of single GaAs dot based on GaAs/AlGaAs quantum well and the second-order cross-photon correlation histogram of polarization-entangled photons. Polarization-entangled photons with a high fidelity $f^+ = 0.72 \pm 0.05$ are generated from the single GaAs quantum dots by an electric field. (Nature Comm. 2012) (Right) Development of the world's first high performance 40 nmϕ magnetic tunnel junctions (MTJs) with CoFeB/MgO perpendicular anisotropy. (Nature Mater. 2010)

Nano Molecular Devices

Staff:

Michio Niwano, Professor

Yasuo Kimura, Associate Professor

Yuki Aonuma, Assistant Professor

Y.Aonuma Y.Kimura

M.Niwano

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 culture cells such as nerve cells are developed to elucidate the mechanism of intercellular communication and signal processing.

Research topics:

1. Development of bio-sensing systems at semiconductor surfaces (Surface-Biotronics)
2. Function analysis of dynamics of cells based on the semiconductor technology
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.

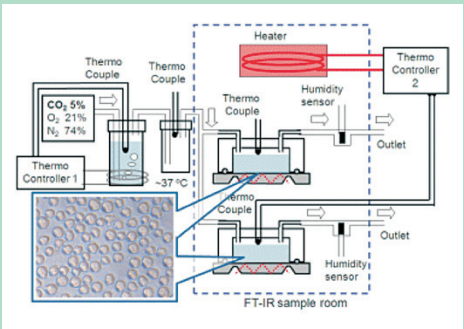


Fig.1: System for the analysis of biological functions of living cells using infrared spectroscopy.

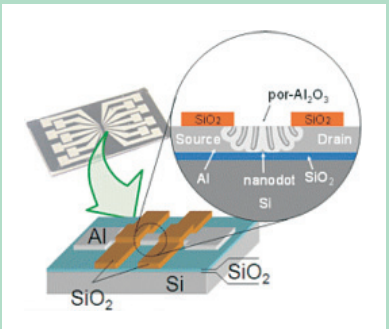


Fig.2: Single electron transistor (SET) fabricated by anodization.

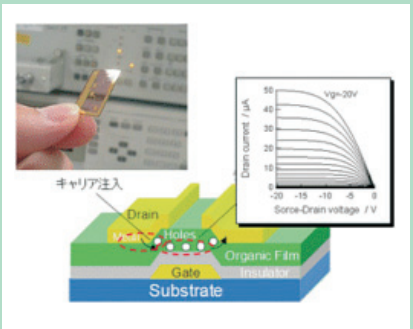


Fig.3: Organic field-effect transistor.

Real-World Computing

Intelligent Nano-Integration System

Laboratory for Brainware Systems

New Paradigm VLSI System

Laboratory for Brainware Systems

K.Nakajima

Staff:

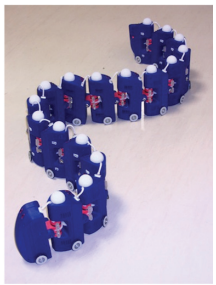
Director: Koji Nakajima, Professor

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 that 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), Intelligent Nano-Integration System (section), Cyber Robotics (planned section), Next-Generation Human Interface (planned section), and Multi-Modal Computing (planned section). The Laboratory for Brainware Systems consists of the above six sections that 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.

Physical and Adaptive Hardware Environment

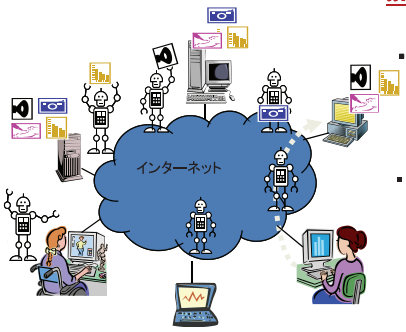


- **Real-World Dynamical Intelligence**

(Real-World Computing)

- **Virtual Space Construction**

(Cyber Robotics)



Seamless Fusion of Real World and Multi-Modal Computing

- **Human-Machine Cohabitation Architecture**

(Next-Generation Human Interface)

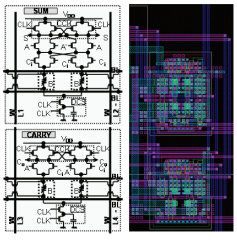
- **Higher-Order Multimodal Perception and Information Generation**

(Multi-Modal Computing)

Hardware Environment with Massively Parallel Brain LSI

- **Massively Parallel Neural LSI**

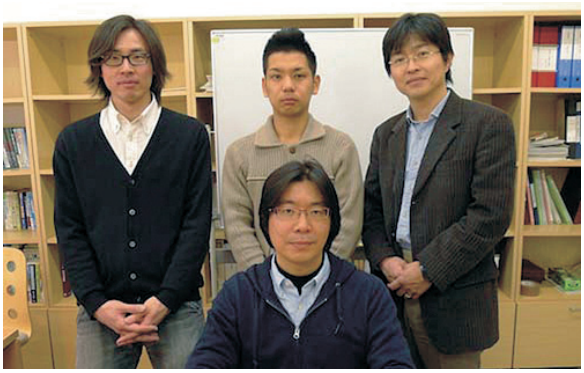
(Intelligent Nano-Integration System)



- **Nonvolatile Logic and Its Applications**

(New Paradigm VLSI System)

Real-World Computing



D.Owaki T.Kano K.Sakamoto
A.Ishiguro

Staff:

Akio Ishiguro, Professor
Dai Owaki, Assistant Professor
Takeshi Kano, Assistant Professor
Kazuhiro Sakamoto, Assistant Professor

Real-World Computing (Prof. Ishiguro)

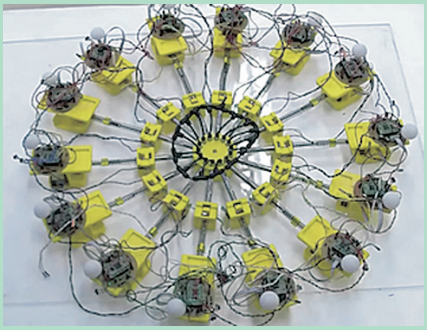
Living organisms exhibit surprisingly adaptive and versatile behaviors in real time under unpredictable and unstructured real world constraints. Such behaviors are achieved via spatiotemporal coordination of a significantly large number of bodily degrees of freedom. Clarifying these remarkable abilities enable us to understand life-like complex adaptive systems as well as to construct truly intelligent artificial systems. A prominent concept for addressing this issue is “autonomous decentralized control”, in which non-trivial macroscopic functionalities are emerged via spatiotemporal coordination among vast amount of autonomous components that cannot be explained solely in terms of individual functionality.

We study the design principles of autonomous decentralized systems that exhibit life-like resilient behaviors from the viewpoints of robotics, biology, mathematics, nonlinear science, and physics.

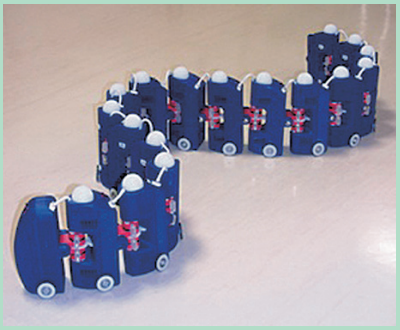
Research topics:

1. Control of soft-bodied robots with large degrees of bodily freedom
2. Autonomous decentralized control for various types of locomotion, e.g., slithering, swimming, flying, walking, running.
3. Dynamical system approach to understand versatility behavioral and its application to robotics.

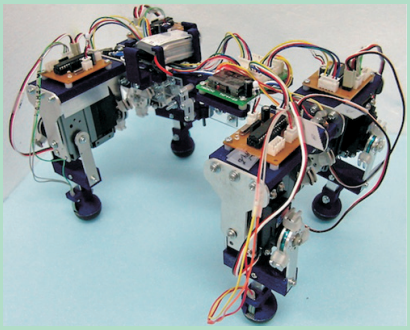
True slime mold as a good living organism for studying autonomous decentralized control



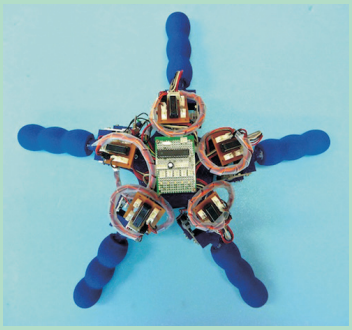
Soft-bodied amoeboid robot driven by a fully decentralized control scheme extracted from true slime mold.



Autonomous decentralized control of a snake-like robot that exhibits highly adaptive and resilient properties.



Quadruped robot driven by a fully decentralized control



Ophiuroid robot that enables omnidirectional locomotion

Intelligent Nano-Integration System

T.Onomi K.Nakajima

Staff:

Koji Nakajima, Professor

Takeshi Onomi, Assistant Professor

Research activities:

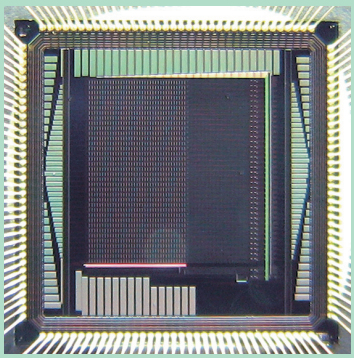
Our research activities cover the fields of architectures of Brain computing systems, characterization and application of artificial neural networks, and fabrications of intelligent integrated circuits, and exploitation of new devices for neural circuits.

Intelligent Nano-Integration System（Prof. Koji Nakajima）

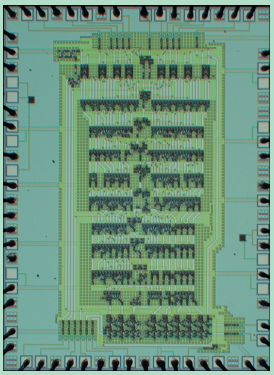
We have constructed a stochastic artificial neural network with one million synaptic units, analyzed the dynamic behaviour of neural networks aiming at a time-dependent data processing, succeeded to propose a system where we are able to get off successfully from any local minima fallen into on the way 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. Meanwhile, we have studied 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.

Research topics:

1. Basic architecture for integrated active Brain computers
2. Dynamic intelligent associative memory system
3. Superconducting single flux-quantum data-processor
4. High-Tc Superconductor Qubit
5. Adiabatic Quantum Computation Algorithm



Microchip of a neural network



Microchip of a single flux-quantum circuit

New Paradigm VLSI System

T.Hanyu M.Natsui A.Matsumoto

Staff:

Takahiro Hanyu, Professor
Masanori Natsui, Assistant Professor
Atsushi Matsumoto, Assistant Professor

Research activities:

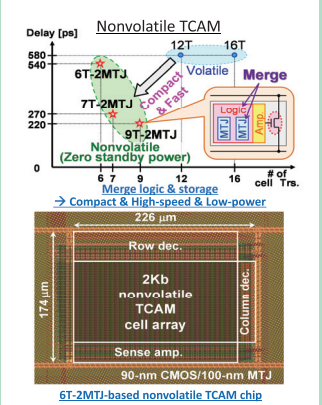
Very Large-scaled Integrated (VLSI) processors and their applications to electronics systems, where VLSI processors are used as a "brain" for intelligent control like human beings, are the key components in the recent information-communication-technology (ICT) society, while the demands for improving power-efficiency and system-reliability with maintaining their higher performances are still getting increased in the recent nano-scaled era. In this research division, we design and implement a low-power and highly reliable VLSI processor using novel device technologies and new-paradigm circuit architecture such as logic-in-memory architecture.

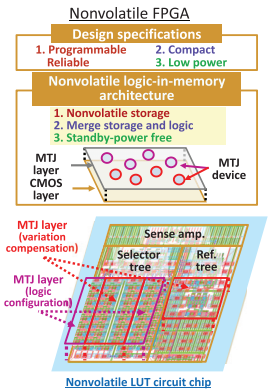
New Paradigm VLSI System (Prof. Hanyu)

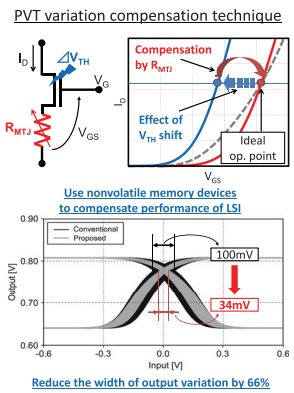
Rapid progress in recent deep submicron regime has led to the capability to realize giga-scaled embedded systems on a chip, while the communication bottleneck between memory and logic modules has increasingly become a serious problem. In addition, power dissipation and device-characteristic variation 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, magnetic tunnel junction (MTJ) devices and phase-change devices. We are also focusing on other challenging research subjects concerning with a new-paradigm VLSI computing system, such as asynchronous network-on-chip (NoC) and process-voltage-temperature (PVT) variation-aware VLSI architecture. Preliminary research subjects in our laboratory are listed below:

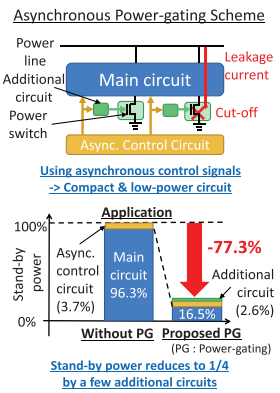
Research topics:

1. Logic-in-memory VLSI architecture and its applications
2. Nonvolatile logic and its application to ultra-low-power VLSI processors
3. PVT-variation-aware VLSI architecture and its applications
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









Research Center for 21st Century Information Technology

Technology Development Division
Mobile Wireless 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

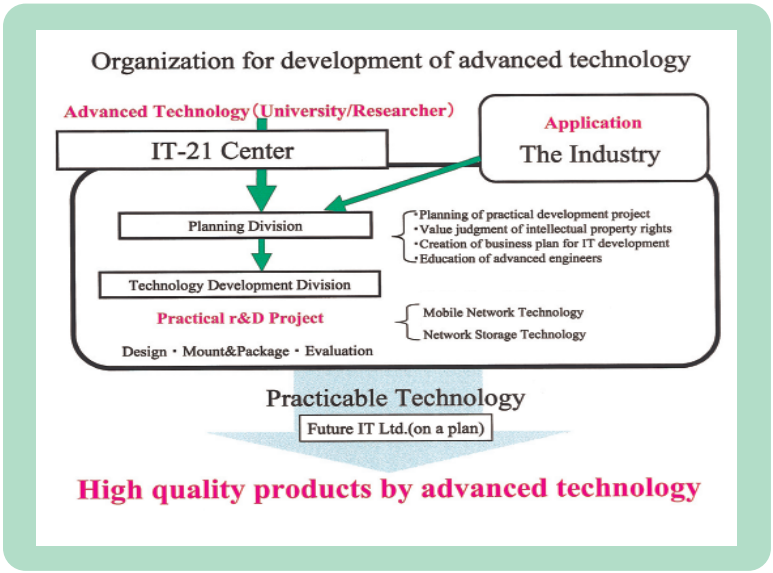
Development of Dependable Wireless System and Device

Project Leader : Kazuo Tsubouchi, Visiting Professor

Tadashi Takagi, Visiting Professor

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 Universities. 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

Kazuo Tsubouchi

Tadashi 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 progress toward development of advanced practical technologies for a 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.

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

Fig.1 5GHz-Band 324Mbit/s Wireless LAN terminal

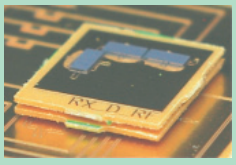


Fig.2 Ultra-small-size 3D SiP millimeter wave wireless terminal for uncompressed HDTV

Fig.3 MBWA field test (Base station)

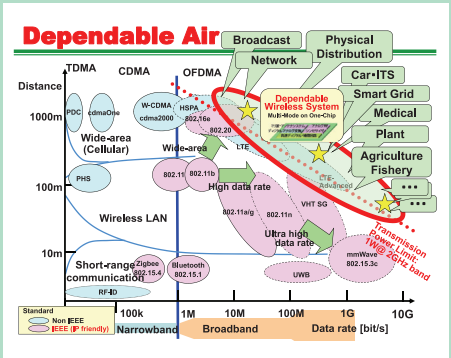


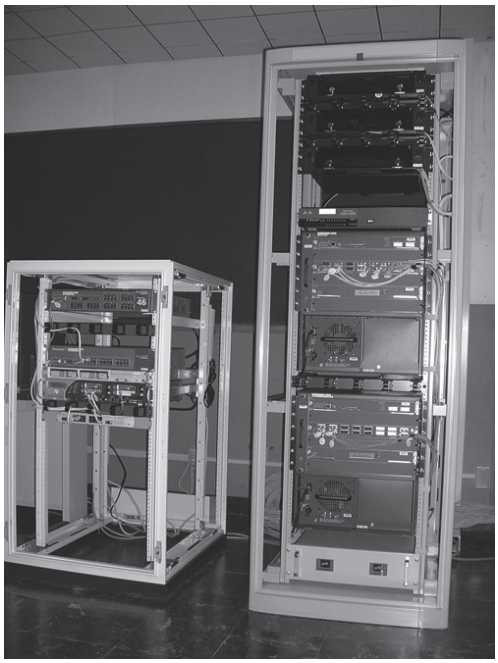
Fig.4 Dependable Air

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.Kinoshita G.Kitagata K.Sasai
J.Sveholm M.Sato

Staff:

Tetsuo Kinoshita, Professor
Yoshihito Toyama, Professor*
Takuo Suganuma, Professor*
Gen Kitagata, Associate Professor*
Kazuto Sasai, Assistant Professor*
Masahiko Sato, Technical Official
Johan Sveholm, Research Fellow

Research activities:

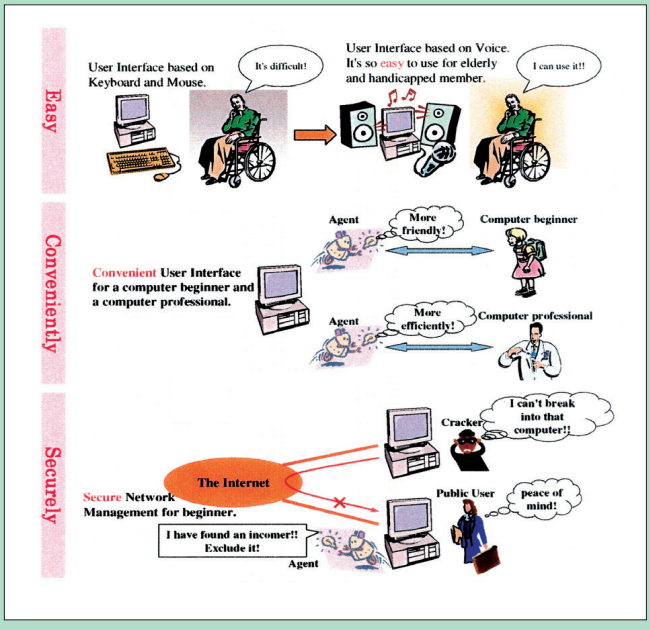
The present information systems represented by computers are inflexible systems, because their uses are predefined and they provide only the fixed processing and functions. The flexible information system on the other hand, is a system which can perform the flexible information processing adopted to 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 information 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.

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.

Network room



Flexible Global Network

Fundamental Technology Center

F.Saito
K.Sato K.Abe T.Suenaga K.Sagae N.Sato K.Shoji
M.Abe S.Agatsuma Y.Uehara Y.Maruyama C.Takyu

Staff:

Director: Yoichi Uehara, Professor

Nobuyuki Sato, Assistant Professor
Fumitaka Saito, Technical Official
Katsumi Sagae, Technical Official
Koichi Shoji, Technical Official
Tamotsu Suenaga, Technical Official
Yuko Maruyama, Technical Official
Keisuke Sato, Technical Official
Choichi Takyu, Technical Official
Maho Abe, Technical Official
Kento Abe, Technical Official
Shigeto Agatsuma, Technical Official

Pioneering researches and developments (R&D) in the wide range of disciplines spreading from basic sciences to applied communication technologies have been carried out in the institute. Technical officials have traditionally contributed these though their well established skills and experienced knowledge. In order to maintain and develop such contributions towards the future, the institute established the fundamental technology center in 2007. The technical supports required commonly in the institute were rearranged in four technical divisions, i.e., machine, evaluation, processing, and software technical divisions. These divisions take charge of the following services.

The machine shop division develops advanced machining techniques, and offers them for developing and manufacturing experimental apparatuses (e.g., see Fig. 1). This division also provides machining instructions to the students and faculty members who carry out machining by themselves. The evaluation division offers various evaluation and measurement techniques such as focused ion beam system (see Fig. 2) and electron probe X-ray micro analyzer (see Fig. 3). The glass machining and the 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 common-use clean rooms in the institute. Nanometer-scale electron beam lithographic techniques and customized optical filters in the visible and infrared spectral range can be provided by this division. The information technology division operates and maintains the computer networks in the institute. In addition, this division gathers and provides the information for researchers.

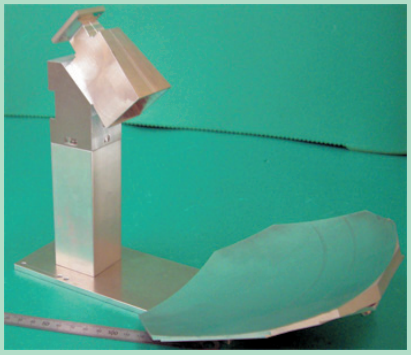


Figure 1 Offset parabola reflector and feedhorn for a Ku-band synthetic aperture radar(SAR)

Figure 2 Focused ion beam system (FIB)

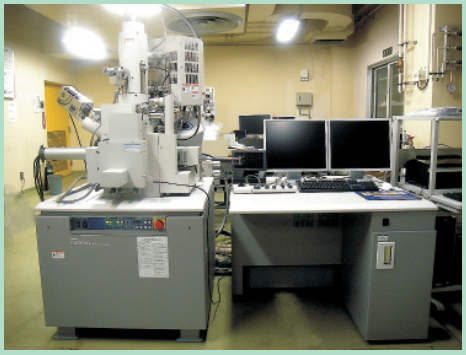


Figure 3 Electron Probe X-ray Micro Analyzer (EPMA)

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.

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.

Safety and health seminar

High-pressure gas seminar

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 15 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	Advanced Information Communication Engineering

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.

The 7th International Symposium

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
39	2nd RIEC International Symposium on Graphene Devices (ISGD2010)	Oct.27-29,2010
40	9th Japan-Korea Symposium on Surface Nanostructures (JKSSN9)	Nov.15-16,2010
41	The 7th RIEC International Workshop on Spintronics	Feb.3-4,2011
42	12th International Multisensory Research Forum (IMRF 2011)	Oct.17-20,2011
43	8th RIEC International Workshop on Spintronics	Feb.2-3,2012
44	6th International Symposium on Medical, Bio-and Nano-Electronics	Mar.8,2012
45	3rd International Workshop on Nanostructures and Nanoelectronics	Mar.21-22,2012

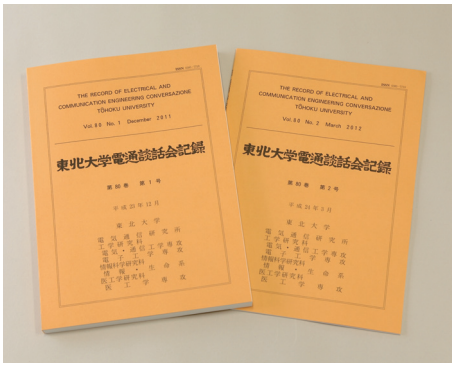
Periodicals Published by the Institute

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

RIEC is keeping close contact with the School of Engineering, Graduate School of Information Sciences, and Graduate School of Biomedical Engineering. All faculty members of RIEC hold positions in these schools and have courses for graduate and undergraduate students. Students also have chances to join the research groups in RIEC. In 2012, 50 undergraduate students, 135 master couse students, and 41 doctor course students are studying at RIEC.

RIEC also receives many visiting professors, visiting scholars, visiting students, and postdoc researchers from all over the world.

Presentation scene at a workshop

Seminar scene at a laboratory

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)
The Interdisciplinary Center on Nanoscience of Marseille, National Center of 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.)
University of Vigo (Spain)
State University of New York at Albany (U.S.A)
Technische Universität Kaiserslautern (Germany)
Johannes Gutenberg University (Germany)

International Journals in which a staff in RIEC participates as an editor

1. Acoustical Science and Technology
2. Applied Acoustics
3. Higher-order and symbolic computation
4. IEICE Electronics Express
5. IEICE Trans On Electronics
6. Interdiscipliary Information Science
7. International Journal of Artificial Intelligence, Neural Networks, and Complex Problem Solving technologies
8. International Journal of Computer Science and Network Security
9. International Journal of Energy, Information and Communications
10. International Journal of Information Sciences and Computer Engineering (IJISCE)
11. Journal of Ambient intelligence and Humanized Computing
12. Journal of Communications and Networks
13. Journal of Magnetics Korean Magnetics Society
14. Journal of SPIN

15. Nature Communications
16. Nonlinear Theory and Its Applications, IEICE
17. NPG Asia Materials
18. Optical Fiber Technology
19. The Journal of Computer Animation and Virtual Worlds
20. Virtual Journal of Nanoscale Science and Technology

International Conference programmed by a staff in RIEC

1. 10th Asia Pacific Conference on Computer Human Interaction(APCHI2012)
2. 12th Joint MMM/Intermag Conference
3. 15th International symposium on the Physics of Semiconductors and Applications(ISPSA)
4. 16th Opto-Electronics and Communications Conference(OECC2011)
5. 2011 Conference on Lasers and Electro-Optics(CLEO2011)
6. 2011 Spintronics Workshop on LSI
7. 2012 Conference on Lasers and Electro-Optics(CLEO2012)/Technical Program Committee member
8. 2nd CSIS International Symposium on Spintronics-based VLSIs and 8th RIEC International Workshop on Spintronics
9. 5th International Workshop on Spin Currents
10. 6th Advances in Computer Entertainment Technology Conference(ACE2010)
11. 6th Annual ACM Conference on Interactive Tabletops and Surfaces(ITS2011)
12. 6th International School and Conferece on Spintronics and Quantom Information Technology(SPINTECH6)
13. ACM Symposium on Virtual Reality Software and Technology(VRST)
14. ACSIN:11th International Conferrence on Atomically Controlled Surfaces,Interfaces and Nanostures
15. Asia Pacific Microwave Conference(APMC)
16. Asia Pacific Vision Conference 2013
17. AWAD:Asia-pacific Workshop on Fundamentals and Applications of Advanced Semiconductor Devices
18. CIMTC:4th International Conferrence on Smart Materials,Structures and Systems
19. ESSDERC:European Solid-State Device Research Conference
20. European conference on Optical Communication(ECOC)
21. ICSFS:16th International Conferrence on Solid Films and Surfaces
22. IEEE International Symposium on Asynchronous Circuits and Systems
23. IEEE International Symposium on Multiple-Valued Logic
24. IEEE Symposium on 3D User Interfaces (3DUI)
25. International Multisensory Research Forum(IMRF)2011
26. International Multisensory Research Forum(IMRF)2012
27. International Quantum Electronics(IQEC),Program Subcommittee Member for Quantum Information
28. International Symposium on Nonlinear Theory and its Applications
29. ISCS:International Symposium on Compound Semiconductors
30. Joint Polish-Japanese Workshop,Spintronics-from NewMaterials to Applications
31. OTST:Int.Conf on Optical Terahertz Science and Technology
32. SPIE International Conference on Defense,Security,and Sensing
33. SPIE Photonics West,Physics and Simulation of Optoelectronic Devices
34. The 11Th IEEE International Conference on Cognitive Informatics and Cognitive Computing(ICCI*CC 2012)
35. The 15th International Conference on Network-Based Information Systems (NBiS-2012)
36. The 1st International Workshop on Smart Technologies for Energy,Information and Communication (STEIC2012)
37. The 2012 IEEE/WIC/ACM Intern. Joint Conference on Web Interlligence and Intelligent Agent Technology (WI-IAT2012)
38. The 22th Intern. Conf. Industrial & Engineering Applications of Artif. Intell. & Exp. Systems (IEA/AIE-2012)
39. The 5th International Symposium on Adaptive Motion of Animals and Machines
40. TWHM:Topical Workshop on heterostructure Microelectronics

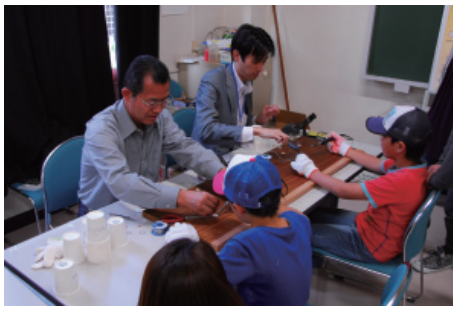
RIEC Open Day

Every year RIEC holds an open day to present research and educational activities to the public, university staffs, students and alumni as well as representatives from the industry.

In 2011, the RIEC Open Day was taken place on Saturday 8th and Sunday 9th of October. All the research laboratories, research centers, and machine shops of RIEC exhibited various types of demonstrations focused on their research fields.

The exhibitions included some historical devices and instruments developed in RIEC, such as magnetron tubes and steel recorders, historical milestones of RIEC activities. On the other hand, experiments on cutting-edge researches were also demonstrated, such as ultra-high speed optical fiber data transmission, scanning probe microscope, remote sound space listening, and interactive contents. Furthermore, visitors were able to join handicraft courses for some simple electronic gadgets such asfuel batteries, germanium radios, wireless devices with solar cells, and go stone puzzles.

In 2012, the RIEC Open Day will be held on Saturday 6th and Sunday 7th of October. Your participation is greatly welcomed.



Visitors having fun during handicraft courses.

RIEC News

As a part of RIEC's publication service, "RIEC News" was launched.

With the 75th anniversary of the establishment of RIEC, RIEC News introduces cutting-edge's research and the vision of the future from RIEC's contributions to the progression of science and technology in Japan. Since the launch in March 2011 to March 2012, four issues have been published. Every issue introduces special topics such as large scale projects and the establishment of the Research Organization of Electrical Communication (ROEC), etc. RIEC News also includes current information about each laboratory and center, all kinds of RIEC events, research exchange meetings, laboratories open to the public (RIEC Open Day), etc. Further, RIEC News offers a notification service by mail whenever a new issue is released and an electronic version of every issue published so far can be downloaded by following the link below.

http://www.riec.tohoku.ac.jp/riecnews/

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(as of 1st July 2012)

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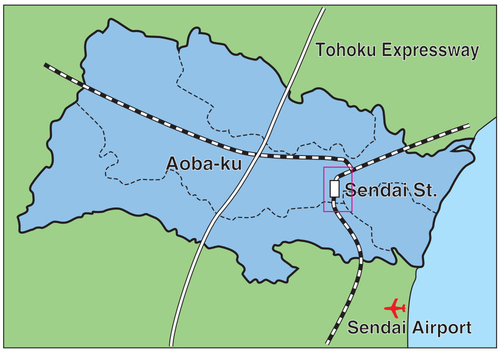
Specially Appointed Professor	Junichi Murota

* Joint Appointment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Tokyo
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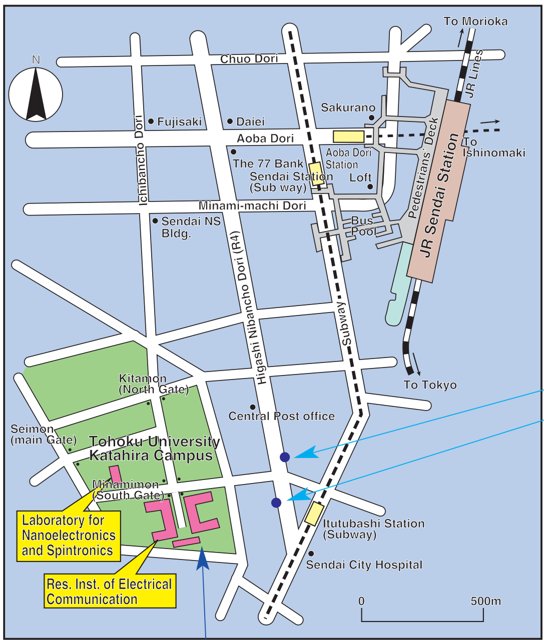
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The Cradle of Optical Communication
(東北大学電気通信研究所)


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THE CRADLE OF OPTICAL COMMUNICATION

東北大学電気通信研究所

Research Institute of Electrical Communication Tohoku University

〒980-8577 仙台市青葉区片平二丁目1-1 TEL (022) 217-5420 FAX (022) 217-5426

http://www.riec.tohoku.ac.jp

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