Research Institute of Electrical Communication
Tohoku University

2009/2010

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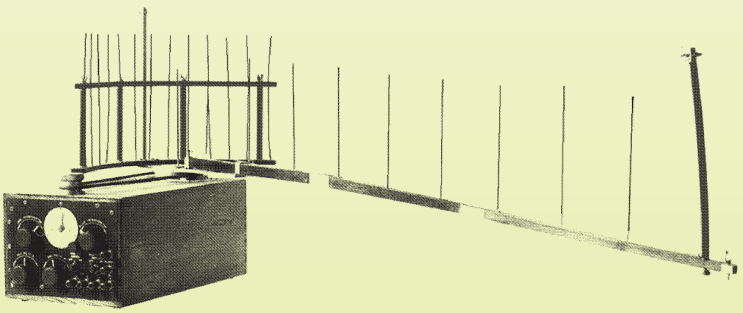
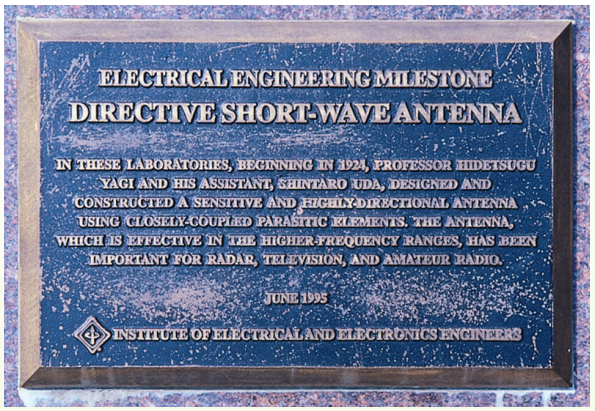
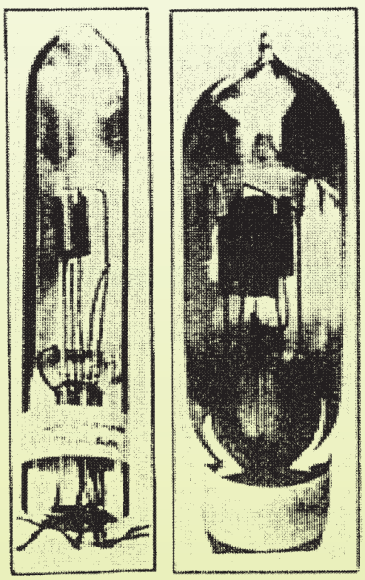


Experimental equipment for Yagi-Uda Antenna（1929）

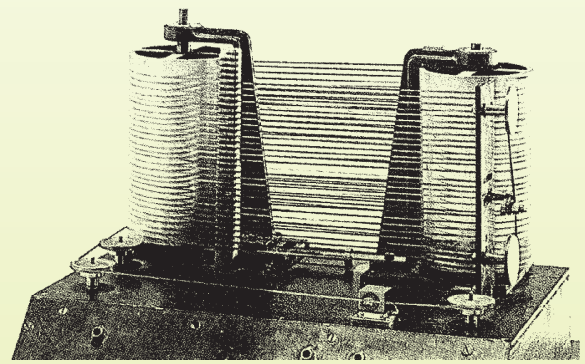


IEEE Electrical Engineering Milestone
for Yagi-Uda Antenna

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



Experimental equipment for Split Anode Magnetron（1927）



Experimental equipment for AC-bias magnetic recording（1937）

Greeting from the Director

Tohoku University was founded in 1907 as Tohoku Imperial University.The Research Institute of Electrical Communication (RIEC) was established in 1935 as a research institute affiliated with Tohoku Imperial University. At that time, within the Department of Electrical Engineering there was a growing tendency towards research on the application of light currents, especially the science and technology for electrical communication. Great efforts in these fields produced pioneering researches such as the Yagi-Uda antenna and divided anode-type magnetron, which were developed in the department in the late 1920s.

In the seven decades since RIEC was established, it has continued to excel as the only research institute affiliated with a national university that addresses information technology, with various research fields ranging from hardware to software. In 1994, our research institute became one of the National Centers for Co-operative research, addressing ‘‘theory and applications of intelligent information science and communication theory”. Information science and communication technology have developed rapidly and brought about great social change including globalization of communication and physical distribution. All the staff members in our institute will assume leadership in creating new information technologies that works in harmony with human nature, through national and international collaboration with researchers in these fields.

To meet the needs and demands of a new age, our 30 or so research groups working on basic research for information communication with a 20 year horizon are organized into four research divisions. Two research facilities with 8 research groups working on next generation technology have been established with a 10 year horizon. The Research Center for 21st Century Information Science and Technology has been established to realize the rapid commercialization of technologies developed by the institute with a 5 years horizon.

Furthermore, this institute's mission is to train researchers and engineers to internationally high standards through close co-operation with the Graduate Schools of Engineering, Information Sciences and Biomedical Engineering.

Director Prof. Masafumi YANO

Preface

The Research Institute of Electrical Communication (RIEC) is a unique university-run institute, which is dedicated to research on communication and information processing. It comprises four research divisions with 23 subsections (including 4 subsections allocated for visiting researchers), three research facilities with 12 subsections. Each of the subsections is headed by a professor. In 1994 the Institute was designated as a National Centre for Cooperative Research, centered on the development of "barrier-free" communication technologies.

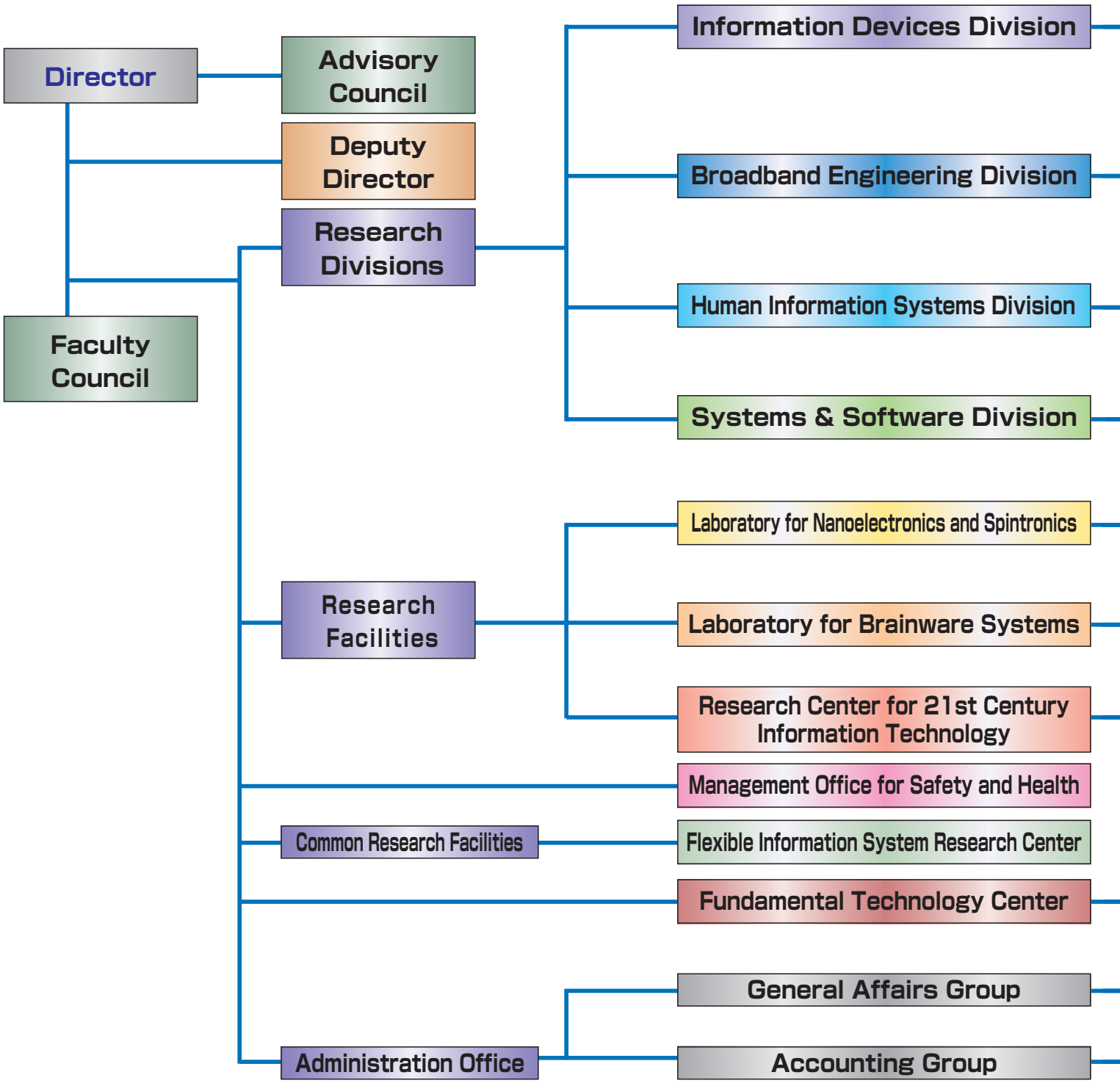
The Information Devices Division carries out research into materials and devices for communication technology, whilst the Broadband Engineering Division focuses on the development of new technologies for the transmission and storage of vast quantities of data. The Human Information Systems Division researches into intelligent information processing and the Systems and Software Division is developing advanced system software for the new information society.

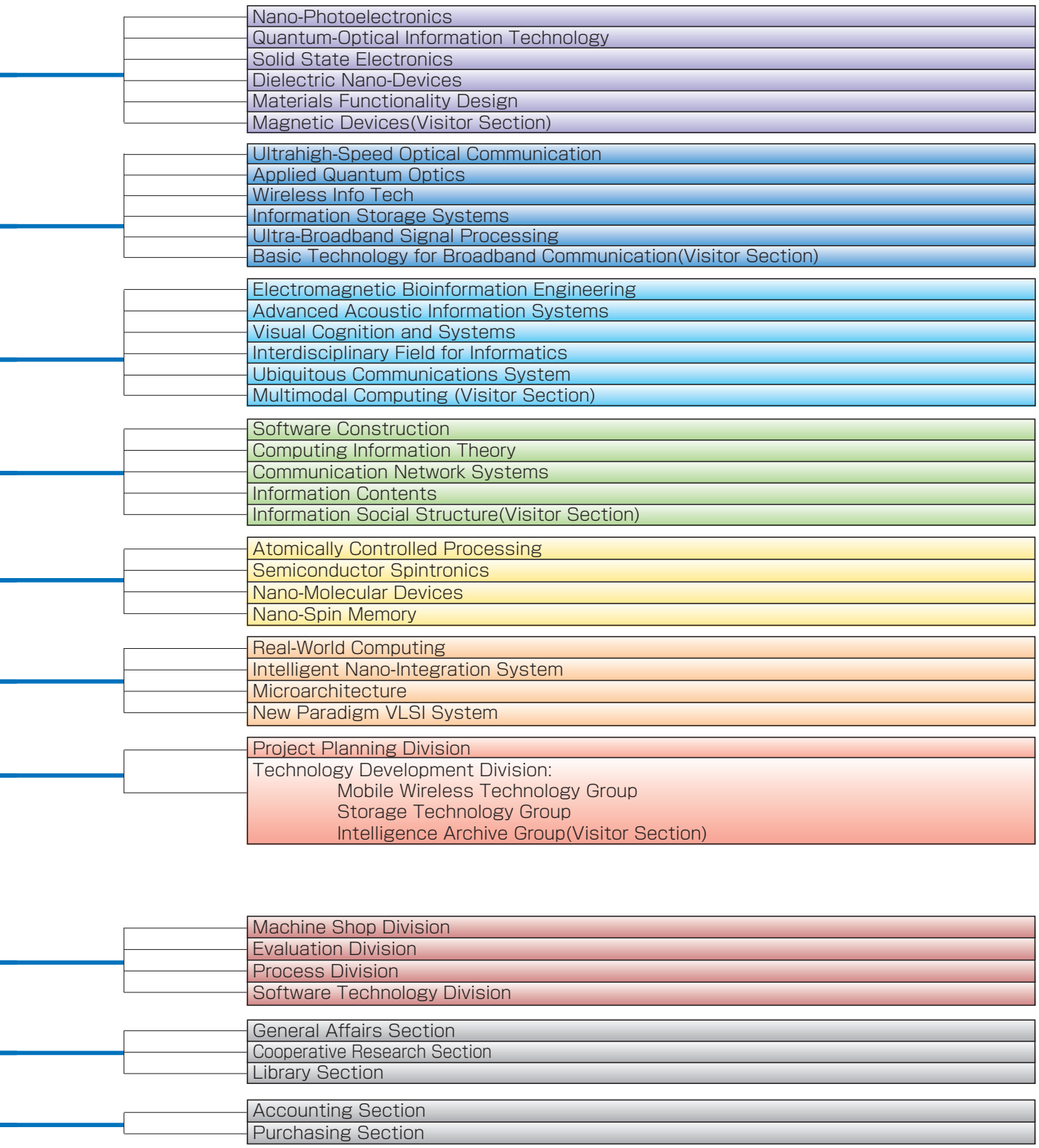
The three research facilities are focused on short, medium and long-term projects. The Research Centre for 21st Century Information Technology was established in 2002 as a five-year collaboration between the Institute and industrial partners. The Centre aims to develop information technology products using the advanced technologies and intellectual property developed at the Institute. For the medium term, the Laboratory for Nanoelectronics and Spintronics, housed in newly-built facilities, is carrying out fundamental research into high-speed semiconductor devices and advanced nano/spin science. Smaller and faster electronic devices, non-volatile memories and molecular and bio-information devices are some of the expected fruits of this research. Meanwhile, the Laboratory for Brainware Systems is working towards its long-term goal of the seamless fusion of real and virtual worlds at the human-computer interface.

Since its establishment in 1935 the Institute has played an internationally leading role in the fields of microwaves, ultrasonics, magnetic recording, optical communication, acoustic communication, semiconductor devices and information theory. The accomplishments in these fields are the result of close cooperation with the Graduate Schools of Engineering, Information Sciences and Biomedical Engineering. The past accomplishments of the Institute have made significant contributions to the betterment of ordinary life by providing many of the basic technologies that became the foundation of the prosperity of the Japanese economy. The Institute and its members aim to continue this tradition of world-class research and innovation far into the future.

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
Wireless Info Tech
Information Storage Systems
Ultra-Broadband Signal Processing
Basic Technology for Broadband Communication(Visitor Section)
Electromagnetic Bioinformation Engineering
Advanced Acoustic Information Systems
Visual Cognition and Systems
Interdisciplinary Field for Informatics
Ubiquitous Communications System
Multimodal Computing (Visitor Section)
Software Construction
Computing Information Theory
Communication Network Systems
Information Contents
Information Social Structure(Visitor Section)
Atomically Controlled Processing
Semiconductor Spintronics
Nano-Molecular Devices
Nano-Spin Memory
Real-World Computing
Intelligent Nano-Integration System
Microarchitecture
New Paradigm VLSI System
Project Planning Division
Technology Development Division:
Mobile Wireless Technology Group
Storage Technology Group
Intelligence Archive Group(Visitor Section)
Machine Shop Division
Evaluation Division
Process Division
Software Technology Division
General Affairs Section
Cooperative Research Section
Library Section
Accounting Section
Purchasing Section

2.Staff

(2009.7.1)

Classification	Division	Laboratory for Nanoelectronics and Spintronics	Laboratory for Brainware Systems	Research Center for 21st Century Information Technology	Fundamental Technology Center	Administration Office			Total
						Head Official	General Affairs Group	Accounting Group	
Professors	19	3	4	3					29
Associate Professors	12	4	1	1					18
Assistant Professors	17	3	5						25
Research Fellows	8	4	3	1					16
Technical Officials					17		1	1	19
Administrative Officials						1	6	7	14
Total	56	14	13	5	17	1	7	8	121

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

(2009.7.1)

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

4.Budget

(Unit:1,000Yen)

Financial Year	Personnel Expenditure	Supplies Expenditure	Research Grant		Total
			Ministry of Education, Science and Culture	Partnership Between Universities and Industry	
2004	902,978	1,233,357	338,459	1,432,607	3,907,401
2005	984,113	1,050,647	554,680	1,303,028	3,892,468
2006	971,482	927,090	599,040	937,441	3,435,053
2007	970,961	813,724	700,615	888,833	3,374,133
2008	879,481	953,000	694,883	1,069,832	3,597,196

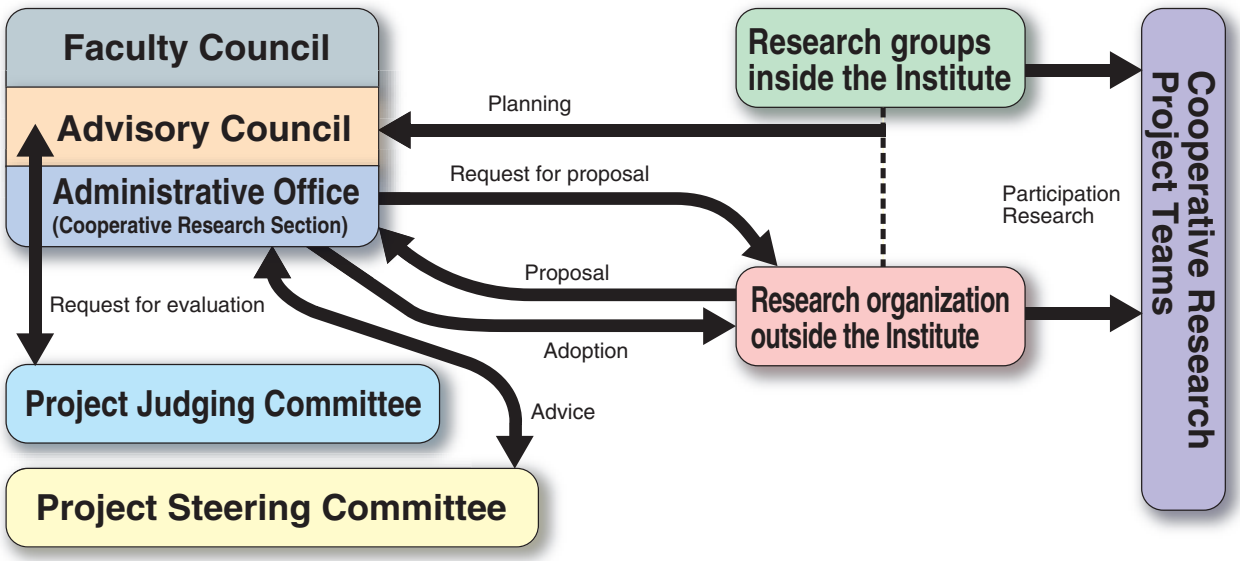
Nation-wide Cooperative Research Projects

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

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

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

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



Research Fields

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

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

Information Devices Division

Materials Science and Device Science

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

Electonic and Optical Quantum Science

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

Plasma Science

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

Visitor Section

- Magnetic Devices

Broadband Engineering Division

Information Technology

- Wireless Info Tech
- Technology Development Division Mobile Wireless Technology Group
- Ultrasonic Micro-Spectroscopy *

Ultrahigh-Frequency Engineering

- Ultra-Broadband Signal Processing
- Communication Engineering *

Optical Communication / Applied Quantum Electronics

- Ultrahigh-Speed Optical Communication
- Applied Quantum Optics
- Optical Physics Engineering *
- Light Medical Engineering *
- Synergetic Photonics *
- Neural Electronic Engineering Laboratory *

Information Recording / Material Science

- Semiconductor Spintronics
- Information Storage Systems
- Technology Development Division Storage Technology Group
- Nano-spin memory
- Microelectronics *
- Electronic Physics Engineering *
- Algorithm Theory *
- Nanometer-scale Magnetic Recording *
- Medical Nanosystem Engineering *
- Spin Electronics *
- Magnetic Materials *

Visitor Section

- Basic Technology for Broadband Communication

Human Information Systems Division

Bioinformation

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

Human Information Processing

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

Communication Environment

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

Bioelectronics

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

Real World Computing

- Real-World Computing
- Biomedical Electromagnetics *
- System Control Engineering *
- Bioelectromagnetics *

Visitor Section

- Multimodal Computing

Systems & Software Division

Computer Science

- Software Construction
- Computing Information Theory
- Foundations of Software Science *
- Intelligent Systems Science *
- Advanced Management of Integrated System Technology *
- Information Sciences Education *
- Multimedia Education *

Internet Communication

- Communication Network Systems
- Information Contents
- Fundamental Engineering for Information Society *
- Information Network Systems *
- Information Technology *
- Academic Information *

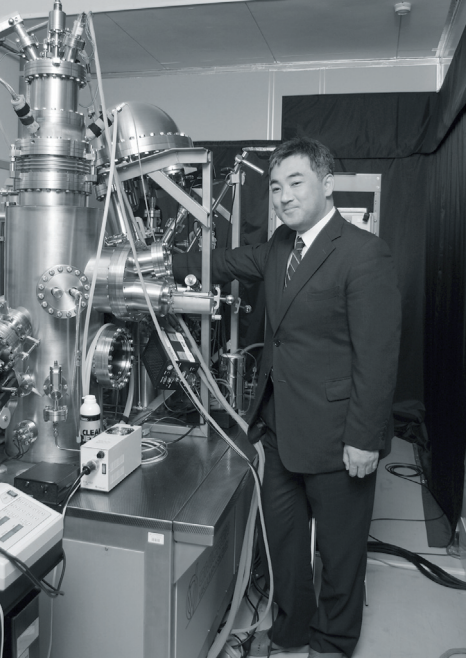
VLSI System

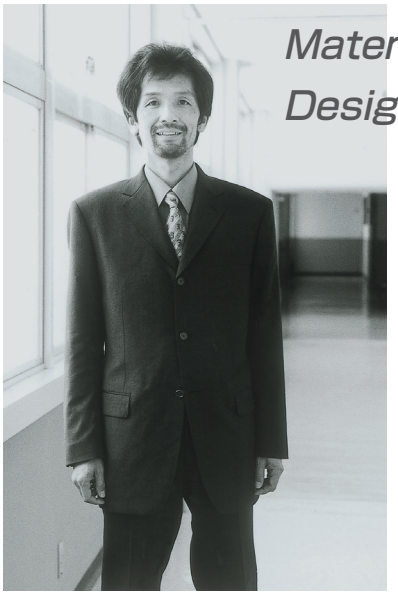
- Intelligent Nano-Integration System
- New Paradigm VLSI System
- Microarchitecture
- Intelligent Electronic Circuits *
- Power Electronics *
- Computer Structures *

Visitor Section

- Information Social Structure

*Laboratories in Graduate Schools





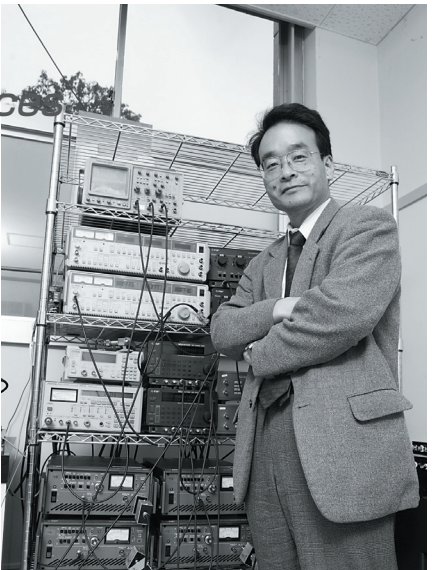
Materials Functionality Design

Nano-Photoelectronics

Information Devices Division

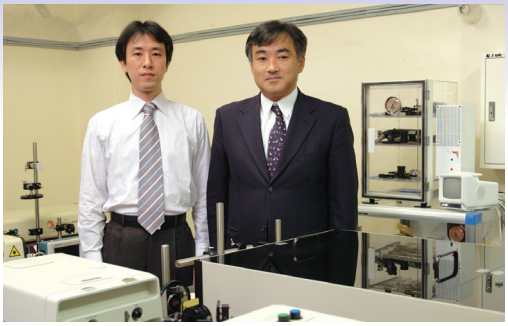
Quantum-Optical Information Technology

Dielectric Nano-Devices



Solid State Electronics

Nano-Photoelectronics



S. KATANO Y. UEHARA

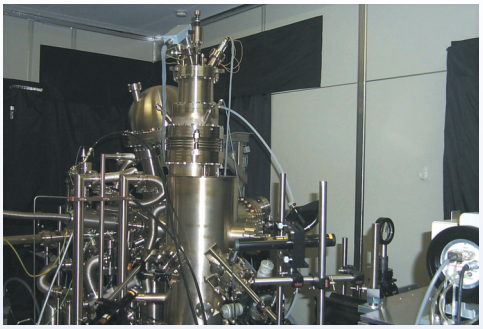
Staff:

Yoichi UEHARA, Professor
Satoshi KATANO, Assistant Professor

Research activities:

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

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



Integrated Surface Analysis System
with Low-temperature STM

Research topics:

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

Quantum-Optical Information Technology

H. KOSAKA K. EDAMATSU Y. MITSUMORI
R. SHIMIZU A. SYOUJI T. KUTSUWA N. MATSUDA

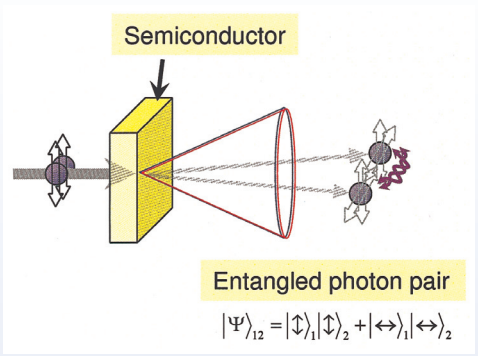
Staff:

Keiichi EDAMATSU, Professor
Yasuyoshi MITSUMORI, Assistant Professor
Ryosuke SHIMIZU, Research Fellow
Nobuyuki MATSUDA, Research Fellow
Hideo KOSAKA, Associate Professor
Atsushi SYOUJI, Research Fellow
Takeshi KUTSUWA, Research Fellow

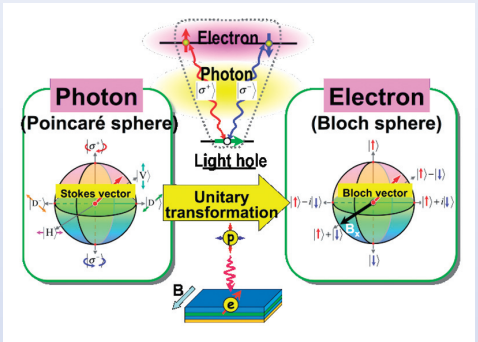
Research activities:

Current information processing 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 info-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 info-communication devices utilizing quantum interaction between electrons and photons in semiconductor nanostructures, to get further understanding of their physics, and to apply them to practical quantum info-communication technologies. We are particularly working toward the development of future quantum info-communication devices utilizing entangled photon pairs and electron spins in semiconductor nanostructures.



Entangled photon generation from a semiconductor.

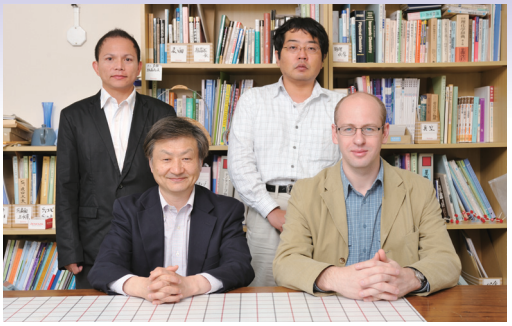


Quantum state transfer from photon polarization to an electron spin.

Research topics:

1. Photon-control devices with semiconductor nanostructures
2. Quantum info-communication devices utilizing photons and electron spins
3. Quantum info-communication technology utilizing entangled states of photons and electrons

Solid State Electronics



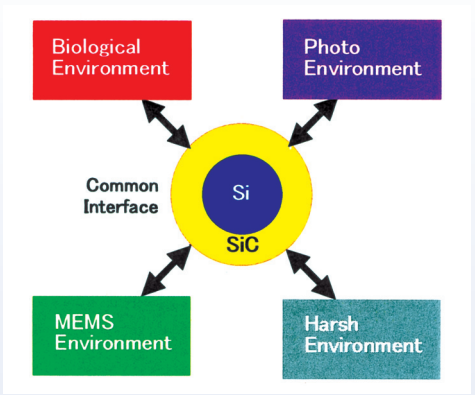
A. C. ALGUNO H. FUKIDOME
M. SUEMITSU S. FILIMONOV

Staff:

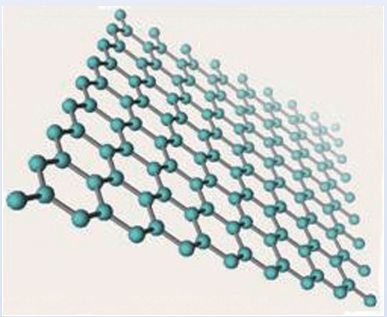
Maki SUEMITSU, Professor
Hirokazu FUKIDOME, Assistant Professor
Arnold Cafe ALGUNO, Research Fellow
Sergey FILIMONOV, Visiting Associate Professor

Research activities:

To realize the ubiquitous (or ambient intelligence) society, in which sensors and their networks are embedded in our ambience to support our daily life, a marriage between non-Si technologies suitable for environmental sensing and the Si technology suitable for signal processings is indispensable. To this goal, we investigate formation of ultrathin silicon-carbide (SiC) films on Si substrates, hoping to use them as a common interface between the two technologies. SiC is a group-IV compound that contains a pair of elements representative of both electronics (Si) and biology & nanoelectronics (ex. graphene) (C). It also bridges the gap between Si and other II-VI or III-V compounds. It is a widegap semiconductor that enables high-temperature operations. High enough strength and hardness of SiC make this material suitable for use in MEMS structures. We are developing gas-sensors, graphene-based ultrahigh-speed devices, LEDs, biosensors, MEMS structures, non-volatile memories, and photovoltaic cells based on the SiC/Si structures. What lies behind these applications is our original technology of SiC gas-source molecular-beam epitaxy (MBE) using organo-silane, which enables a high-quality, low-temperature SiC epitaxy on Si substrates. Our research covers the surface chemistry of Si-related surfaces, targeted to the control of nanostructure formation on Si and SiC surfaces. Fabrication of non-equilibrium Si structures such as amorphous-, microcrystalline-, and poly-Si thin films is also within our interests, and is being intensively investigated using atmospheric-pressure plasma-enhanced chemical vapor deposition (AP-PECVD).



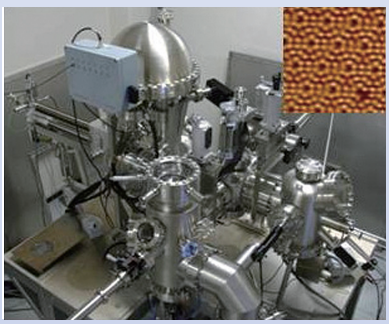
SiC expands the conventional Si technology



Graphene: A two-dimensional network of carbon atoms.

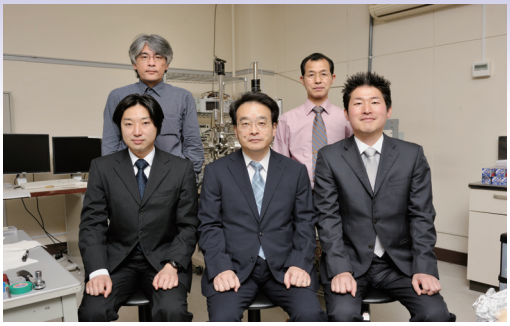
Research topics:

1. Surface reconstruction of Si surfaces and fabrication of nanostructures
2. Surface chemistry during oxidation and film-deposition on Si-related surfaces and development of nanofabrication processes
3. Formation of SiC films on Si substrate and their applications to ubiquitous devices
4. Formation of graphene-on-Si structure and development of ultrahigh speed devices
5. Fabrication of non-equilibrium Si structures using AP-PECVE and their applications to photovoltaic cells and thin-film transistors for flexible displays.



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

Dielectric Nano-Devices



N. OKAZAKI Y. WAGATSUMA
Y. HIRANAGA Y. CHO N.KIN

Staff:

Yasuo CHO, Professor
Yoshiomi HIRANAGA, Assistant Professor
Nobuhiro KIN, Assistant Professor
Yasuo WAGATSUMA, Technical Official
Noriaki OKAZAKI, Research Fellow

Research activities:

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

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

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

Fig1:Commercially available scanning nonlinear dielectric microscope.

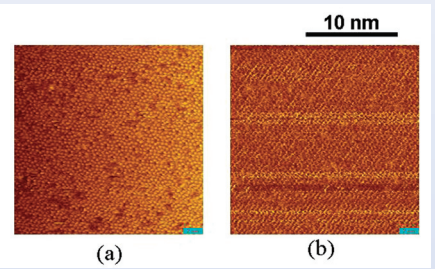


Fig2:S(111) 7X7 atomic structure taken by SNDM.
(a)Topography (b) Electric dipole-moment.

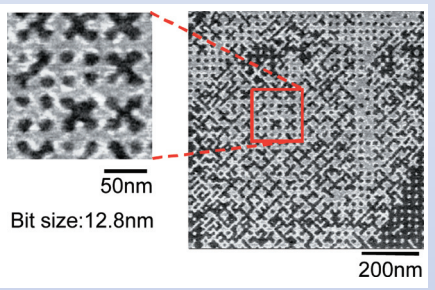
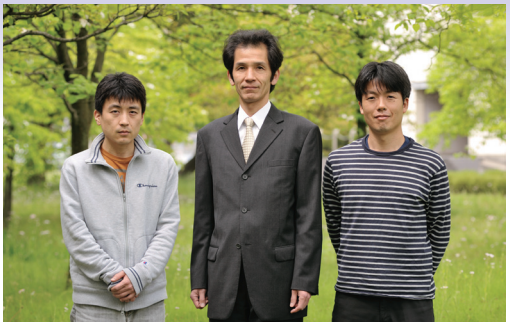


Fig3:Example of a ferroelectric actual information storage (4 Tbit/inch^2).

Research topics:

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

Materials Functionality Design



K. ABE M. SHIRAI Y. MIURA

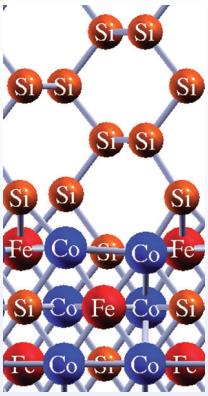
Staff:

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

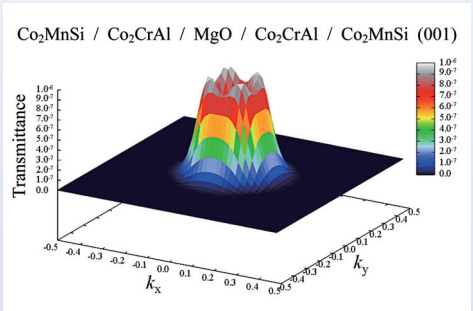
Research activities:

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

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



The highly spin-polarized (110) interface between a Heusler alloy Co_2FeSi and Si



Electron transmittance as a function of in-plane wave-numbers for MgO-based magnetic tunnel junctions with Heusler-alloy (Co_2MnSi / Co_2CrAl) electrodes for the parallel magnetization configuration

Research topics:

1. Computational design of new spintronics materials from first-principles
2. Computational analysis of transport properties in spintronics devices
3. Computational simulation of nanostructure-growth process on surface
4. Development of new computational procedure simulating spin dynamics

Ultrahigh-Speed Optical Communication

Broadband Engineering Division

Applied Quantum Optics

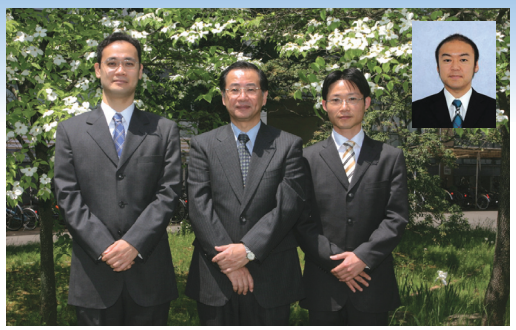
Wireless Info Tech

Information Storage Systems

Ultra-Broadband Signal Processing

Basic Technology for Broadband Communication

Ultrahigh-Speed Optical Communication



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

Staff:

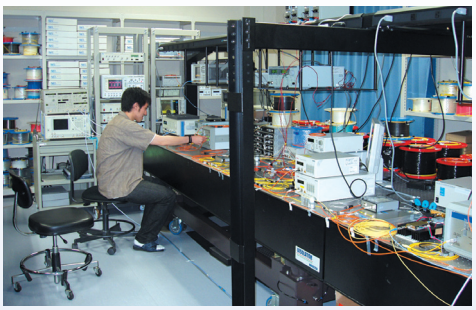
Masataka NAKAZAWA, Professor
Toshihiko HIROOKA, Associate Professor
Masato YOSHIDA, Assistant Professor
Keisuke KASAI, Research Fellow

Research activities:

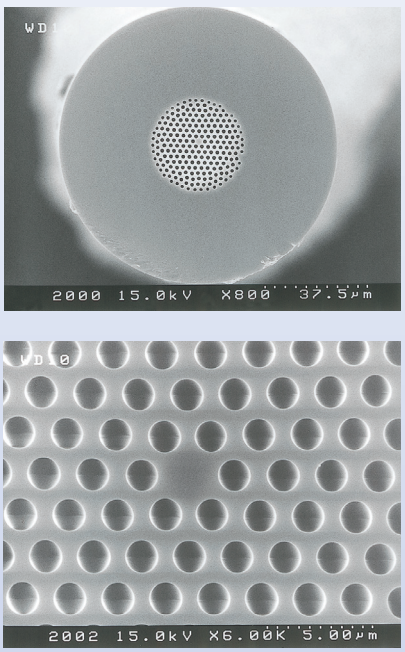
With the vast growth of traffic on the Internet from simple text data to high quality voice, images, and real-time video, it has become increasingly important to realize a high-capacity and high-speed network to support the daily needs of modern communications. Ultrahigh-speed optical communication is the key technology for building such an interconnected world. This laboratory aims to achieve a global ultrahigh-speed optical network in the 21 century by engaging in the research of ultrashort pulse generation and transmission. The research areas include optical solitons, high-speed mode-locked lasers, optical signal processing, and the development of fibers with new functions.

For soliton transmission, we have shown that with the adoption of dispersion management in an optical fiber transmission line, the dispersion tolerance and power margin of a soliton system can be greatly increased in comparison to conventional systems. In the next phase of this work, it is important to increase the bit rate of a single channel to greater than 100 Gbit/s and to apply solitons to high-speed optical signal processing.

We are also actively engaged in work on femtosecond pulse generation and its application to ultrahigh–speed optical time division multiplexed (OTDM) transmission. We have recently generated a 40 GHz-100 fs pulse train with the use of an adiabatic soliton compression technique. We also started to develop a new transmission technique which employs the optical Fourier transformation in the time domain. In addition, we are developing a new frequency standard by stabilizing the mode-locked laser so that it has a highly controlled longitudinal mode separation. This technique is also applicable to the microwave-photonics area. Another important area of our research is in the development of photonic crystal fibers. These special fibers have many air holes in the fiber cross-section, and they have potential applications for new optical communication systems operating in the currently unused 500-1000 nm band.



Experiment on ultrahigh-speed optical transmission



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

Research topics:

1. Ultrahigh-speed optical soliton transmission and nonlinear optics in optical fibers
2. Terabit/s OTDM transmission using femtosecond pulse train
3. Ultrashort mode-locked lasers and their application to frequency standard and microwave-photonics area
4. Photonic crystal fibers and optical fibers with new functionality

Applied Quantum Optics

J. SHIKATA H. YASAKA

Staff:

Hiroshi YASAKA, Professor
Jun-ichi SHIKATA, Associate Professor

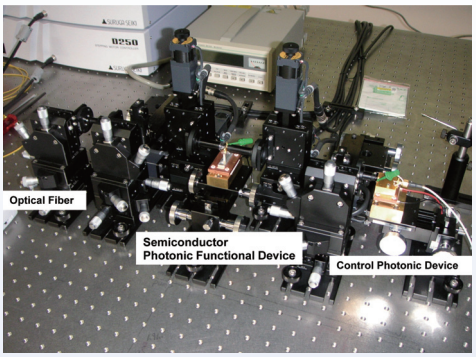
Research activities:

We are investigating novel, highly functional semiconductor photonic devices, which is indispensable to realize new generation information communication networks. We are also investigating novel, compact and widely tunable coherent light sources based on lasers and nonlinear-optical phenomena.

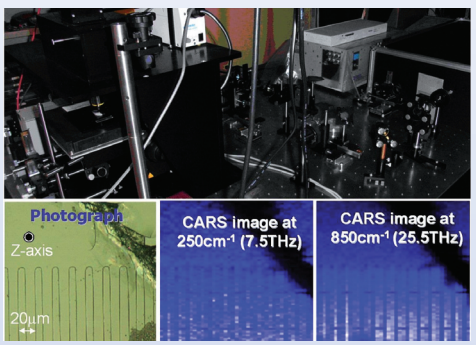
We have been researching highly functional semiconductor photonic devices and semiconductor photonic integrated circuits based on semiconductor lasers and semiconductor optical modulators to create novel semiconductor photonic devices, which can control intensity, phase, frequency and polarization of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

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

Furthermore, our research interests cover ultrafast photonic devices, opto-electronic semiconductor devices and their applications to optical computing and signal processing areas.



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

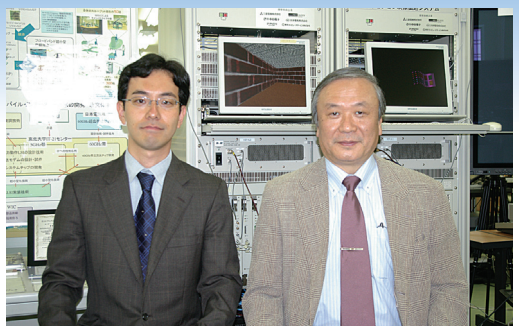


Terahertz CARS microscope and its imaging of periodically poled lithium niobate.

Research topics:

1. Highly functional semiconductor photonic devices
2. New function semiconductor photonic integration circuits
3. Ultra Broadband, coherent tunable light sources using nonlinear optics
4. Terahertz biophotonics

Wireless Info Tech



S. KAMEDA K. TSUBOUCHI

Staff:

Kazuo TSUBOUCHI, Professor
Suguru KAMEDA, Assistant Professor

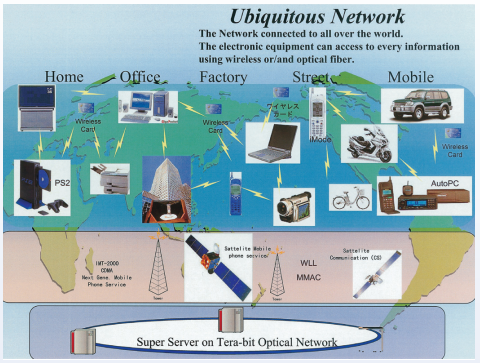
Research activities:

Research and development are progressing toward ubiquitous network in the 21st century's wireless information technology. The ubiquitous network immediately provides any information for everyone at anytime and anywhere.

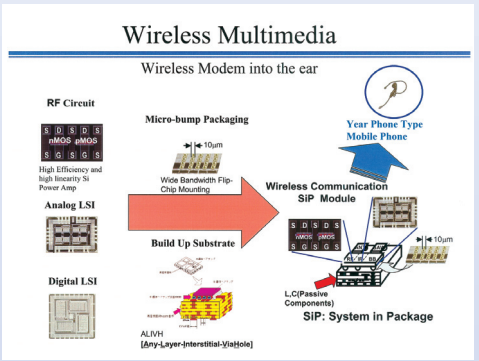
For realizing the ubiquitous network, we are interested in developing following wireless networks;
(1) next-generation mobile broadband wireless access (MBWA), (2) dependable broadband wireless local area network (WLAN), and (3) ultra-broadband wireless personal area network (WPAN).

We are also actively engaged in work on following technology for broadband, low-power consumption and small-size terminals;
(1) RF power amplifier, synthesizer and mixer devices for millimeter wave and GHz-band wireless modems, (2) GHz-band surface acoustic wave (SAW) and film bulk acoustic resonator (FBAR) devices, and (3) Ultra small antennas for mobile terminals. Moreover, seamless interconnection technology using 3-dementional system in package (3-D SiP) has been investigated.

Currently, we are concentrating on the coherent work toward the next-generation "Dependable wireless next generation network (NGN) terminal" which enables signal-demodulation of any band and any type received radio wave.



Ubiquitous network using broadband and dependable wireless technology.



Seamless interconnection technology using 3-dimentional system in package (3-D SiP).

Research topics:

1. Mobile broadband wireless access network
2. Broadband wireless communication system
3. Ultra high-frequency, broadband and low-power RF silicon CMOS device
4. GHz-band SAW & FBAR signal processing devices and materials
5. Seamless interconnect 3-dimentional system in package (3-D SiP)
6. Dependable wireless next generation network (NGN)

Information Storage Systems

K. MIURA H. MURAOKA S. J. GREAVES

Staff:

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

Research activities:

Our main interest lies in high-density information storage technology. The core technology is magnetic recording with fast data transfer and large storage capacity, which is applied for hard disk drives, magnetic tape storage, and flexible disk drives. Recently, multi-media information such as digital movie and music that requires very large storage capacity begins to be used in broad applications from consumer electronics to mobile communication. This trend accelerates the areal density increase of magnetic recording.

Recording theories, devices, and systems based on perpendicular recording are being studied in order to attain ultra-high density information storage. Our target is the terabit storage (1 Tbits/inch^2 areal density and beyond), in which the bit size corresponds to the area of 25 nm by 25 nm. Single-pole heads and perpendicular disks are investigated through read/write experiments, as shown in Fig 1, to improve the recording performance. A computer simulation utilizing micromagnetics is being carried out to obtain a guideline towards ultra-high density recording. For extremely large capacity storage systems, the RAID storage working on a network, as shown in Fig 2, is also explored.

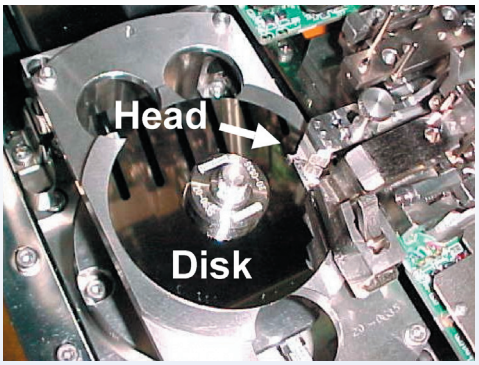


Fig 1 Read/write measurement by using a single-pole head and a perpendicular medium.

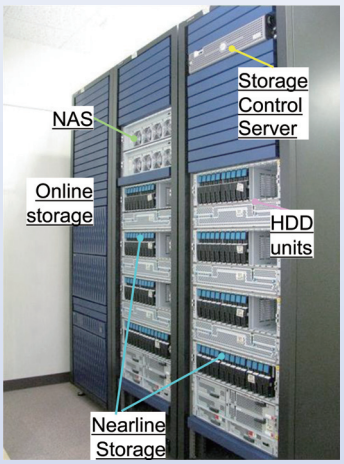
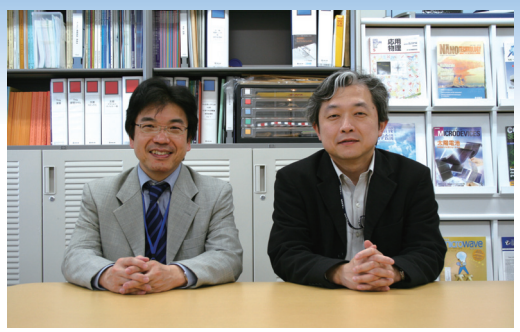


Fig 2 RAID system consisting of many HDDs.

Research topics:

1. High areal density hard disk drives
2. Micromagnetics simulation for high density read/write theory
3. Head/disk devices for high density magnetic storage
4. Digital signal processing for high density storage
5. RAID storage for large capacity file server

Ultra-Broadband Signal Processing



T. OTSUJI T. SUEMITSU

Staff:

Taiichi OTSUJI, Professor
Tetsuya SUEMITSU, Associate Professor

Research activities:

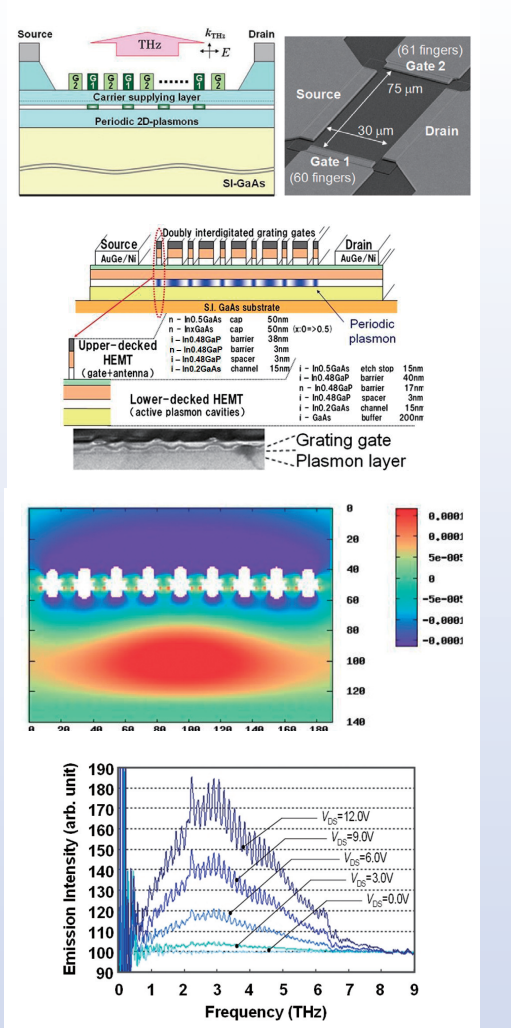
Terahertz (sub-millimeter) coherent electromagnetic waves are expected to diversify the potential applications of imaging, spectroscopy, as well as communications technologies. The terahertz band, however, is still an unexplored region in the sense that no practical integrated device technology exists. This is because conventional electron devices as well as photonic devices face to the substantial limit of operation. That is the motivation of our research.

We are developing novel, integrated electron devices and circuit systems operating in the millimeter-wave and terahertz regions with functionalities of coherent, tunable signal generation and ultra-broadband signal processing. One example is a frequency-tunable plasmon-resonant terahertz emitter/photomixer. Based on both experimental and theoretical investigation on plasmon resonance for heterostructure devices, we have developed a novel device structure that can drastically improve the radiation power and frequency tunability, which has recently succeeded in terahertz emission of radiation at room temperature. Another example is a unique electromagnetic metamaterial circuit systems based on optoelectronic dispersion control of low-dimensional plasmons. We are also pursuing graphene-based new materials and original device structures for ultrafast transistors as well as terahertz lasers to break through the limit on conventional transistor speed and lasing frequency.

By making full use of those devices and circuits, we are exploring new applications including future smart photonic network systems as well as millimeter-wave- and terahertz-band spectroscopic measurement systems.

Research topics:

1. Millimeter-wave and terahertz integrated microelectronic devices and circuits
2. Plasmon-resonant terahertz emitters/photomixers
3. Electromagnetic metamaterial circuit systems based on dispersion control of low-dimensional plasmons
4. Graphene-based ultimate ultrafast transistors and terahertz lasers
5. Application of THz integrated microelectronics to the future communications and measurement systems.



Newly-proposed plasmon-resonant emitter/photomixer operating in the terahertz range. (Upper: cross-sectional view and SEM images of the first sample fabricated with GaAs-based heterostructure material systems, middle: Simulated instantaneous electric field distribution under continuous plasmon excitation at 5.1 THz, lower: FTIR-measured broadband emission spectra in the self-oscillation mode)

Basic Technology for Broadband Communication

K. MIZUNO

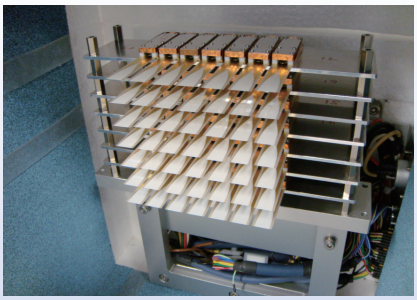
Koji MIZUNO, Visiting Professor

Research activities:

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

The figure shows a 35 GHz-band 7 x 7 imaging array for making millimeter wave imaging movies.

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



35 GHz-band 7 x 7 imaging array fabricated in this section. The response time of each imaging element is 1 ms. As 400 data from each element are averaged to produce a frame of imaging to reduce noise, 0.8 s / frame is the imaging speed of this array.

M. INUTAKE

Masaaki INUTAKE, Visiting Professor

Research activities:

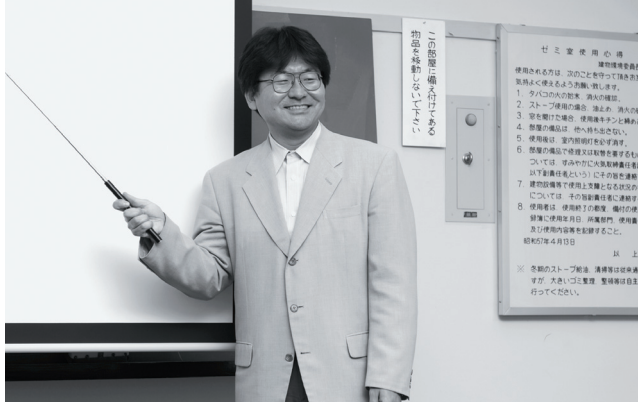
Our main interest is to develop an air-borne synthetic aperture radar (SAR) for the civilian applications and to exploit the system for establishing a safe and secure community. This SAR is very useful for all-weather surveillance and rescue in disastrous fires and smokes as shown in the right figure.

The research & development of a spotlight-mode SAR for the civilian applications with the following features are being under progress in collaboration with scientists and engineers from various universities and industries.

Research topics:

1. Advanced SAR with a high resolution (5-10cm) and small/light weight (20-30kg) using Ku/Ka-band microwaves
2. Platforms such as (unmanned) aircraft suitable for the SAR
3. SAR data-processing system with flexibility and convenience
4. SAR image exploitation system which are open to any parties who contribute in establishing the safe and secure community

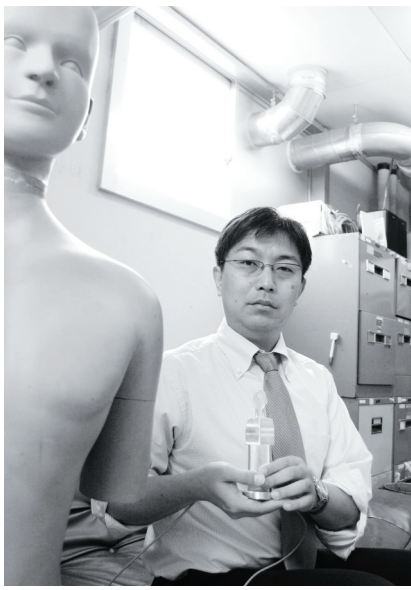
Forest fire in the suburb of Los Angeles, Oct. 2008. Airborne SAR can see objects through fire, smoke and cloud. It will be very useful for all-weather surveillance and rescue in disasters.

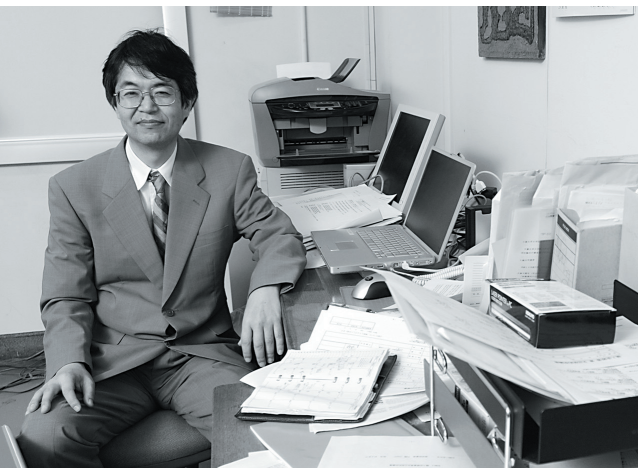


Electromagnetic Bioinformation Engineering

Human Information Systems Division

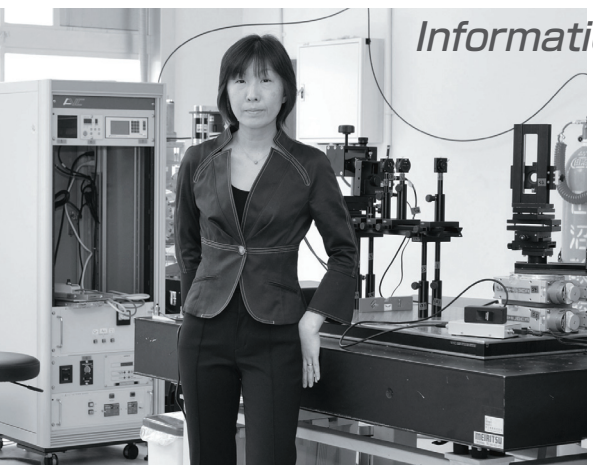
Advanced Acoustic Information Systems





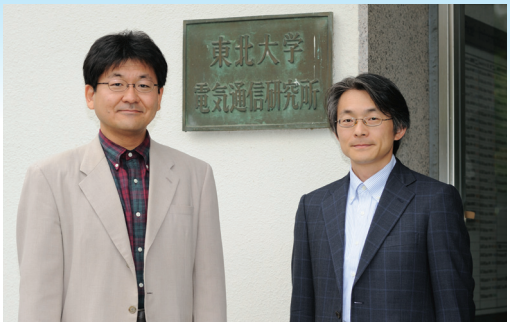
Visual Cognition and Systems

Interdisciplinary Field for Informatics



Ubiquitous Communications System

Electromagnetic Bioinformation Engineering



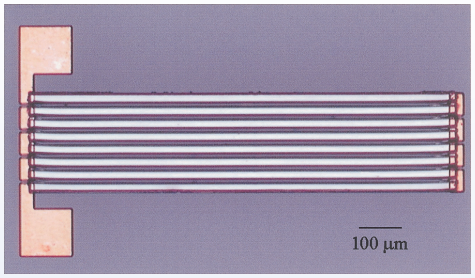
K. ISHIYAMA S. HASHI

Staff:

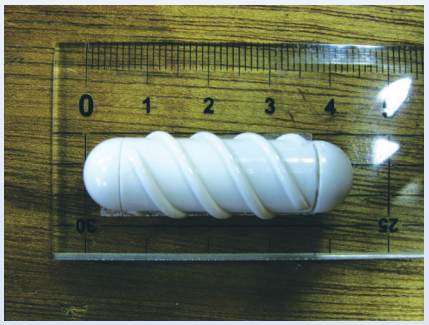
Kazushi ISHIYAMA, Professor
Shuichiro HASHI, Assistant Professor

Research activities:

For realizing good communication with human body, and for realizing the properties of the human body as a 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. High-frequency carrier-type magnetic field sensor 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. In addition, sensors for temperature and for hardness are studied as no contact sensing systems. As one of the approaching system for human body, wireless actuators and manipulators are investigated. This technology is important for a basic study for robots working in the human body. A part of this technology is applied for a motion system for a capsule endoscope working in the colon tube. We are focusing to realize the communication technology with human body and to contribute information and communication systems and medical-welfare spheres.



High frequency carrior-type thin film magnetic field sensor



A prototype for motion of capsule-endoscope

Research topics:

1. Magnetic sensing system
2. Micro magnetic actuators
3. Functional magnetic materials
4. High-frequency magnetic measuring system
5. New medical equipments using magnetic

Advanced Acoustic Information Systems

W. TERAMOTO Y. SUZUKI Y. IWAYA F. SAITO S. SAKAMOTO
M. KOBAYASHI T. OKAMOTO M. OTANI

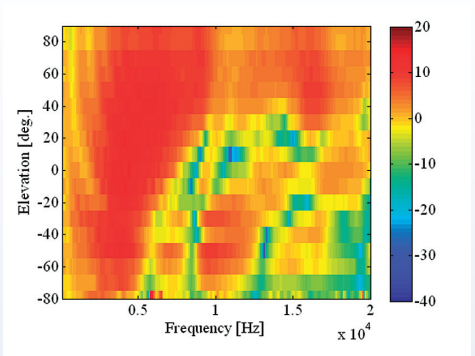
Staff:

Yôiti SUZUKI, Professor
Shuichi SAKAMOTO, Assistant Professor
Makoto OTANI, Research Fellow
Maori KOBAYASHI, Research Fellow
Yukio IWAYA, Associate Professor
Fumitaka SAITO, Technical Official
Takuma OKAMOTO Research Fellow
Wataru TERAMOTO, Research Fellow

Research activities:

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

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



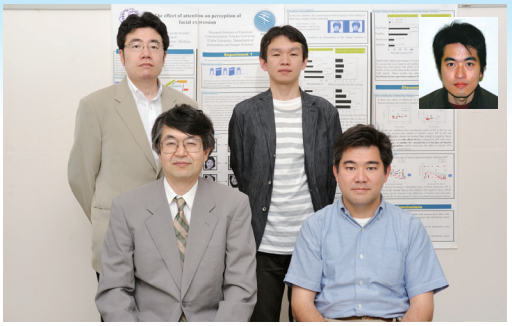
Head related transfer functions as a fuction of elevetion. Poles and zeros change systematically with the rise of elevetion.

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

Research topics:

1. Auditory perception process and its modeling.
2. Development of new algorithms of digital watermarking.
3. Sound localization process and transmission of spatial information.
4. Development of advanced hearing aids.
5. Measurement and estimation of environmental noises.

Visual Cognition and Systems



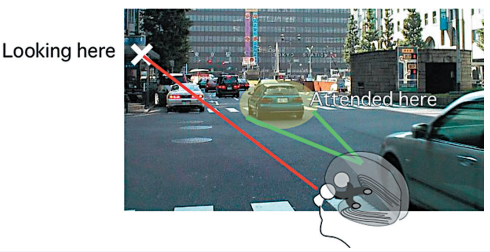
K. MATSUMIYA M. OGIYA K. MATSUBARA
S. SHIOIRI I. KURIKI

Staff:

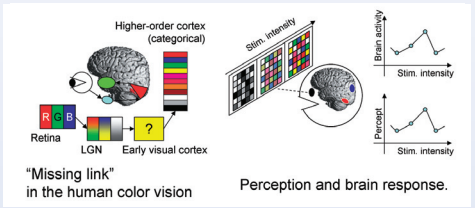
Satoshi SHIOIRI, Professor
Ichiro KURIKI, Associate Professor
Kazumichi MATSUMIYA, Assistant Professor
Mitsuharu OGIYA, Research Fellow
Kazuya, MATSUBARA, Research Fellow

Research activities:

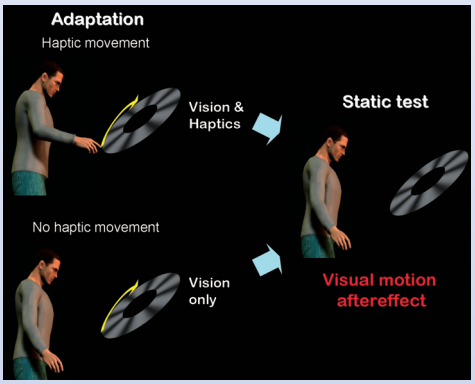
Human brain is one of the most adaptable systems in the world. Understanding the brain functions is one of the most important issues for evaluating and designing things around us to improve the quality of life. We investigate the brain through visual functions to apply the knowledge to human engineering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



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.

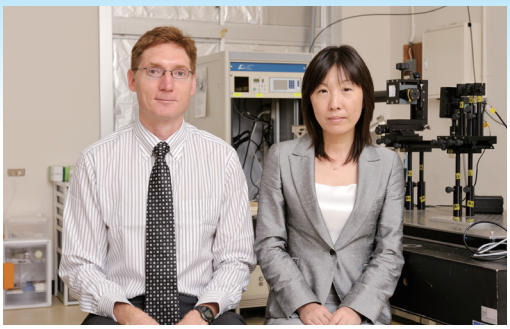


How does the perceptual system integrate visual and haptic information in motion processing? We compared the magnitude of visual motion aftereffect in the haptic movement condition with that in the no haptic movement condition. This study may reveal the mechanism underlying visual-haptic integration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

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.
4. Mechanisms of color information processing in human brain.

Interdisciplinary Field for Informatics



V. CRAIG K. TAMADA

Staff:

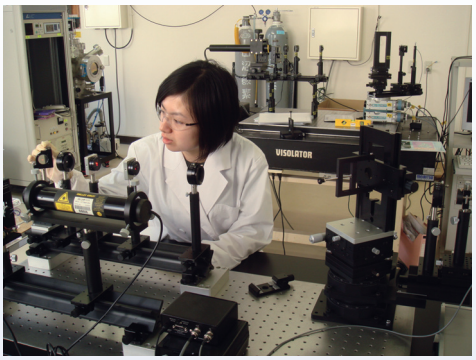
Kaoru TAMADA, Professor
Vincent CRAIG, Visiting Associate Professor

Research activities:

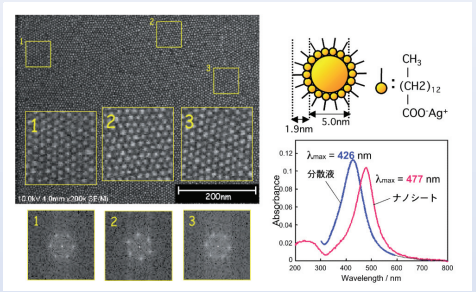
The interdisciplinary field of research combining nanobiotechnology and information technology attracts our exceeding interests. These studies stand on the development of new materials created by self-assembly of functional molecules and nanomaterials, leading to new classes of biosensing devices. The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

Research topics:

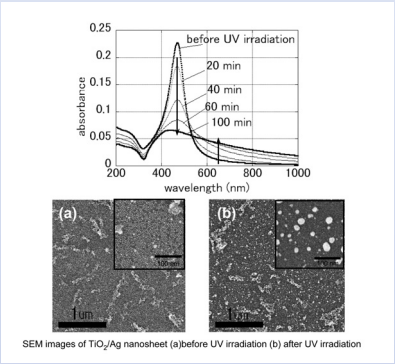
1. Propagating / local surface plasmons and waveguide modes
2. Plasmonic nanosheet composed of Ag nanoparticles
3. Design of devices based on nano-structured materials
4. Characterization of interfaces between various nanomaterials



Surface plasmon resonance (SPR) spectroscopy



Plasmonic nanosheet composed of Ag nanoparticles



Characterization of remote photocatalytic reaction of TiO_2 nanotube with Ag nanosheet

Ubiquitous Communications System

Staff:

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

H. SAWADA S. KATO H. NAKASE

Research activities:

Wireless communications technologies have been an indispensable tool for our modern society ranging from radio/TV sets to cellular phones and wireless LANs. Unfortunately it requires a kind of professional knowledge to make full use of wireless communications capability at present and it may need a bit more time to become for everybody to be able to use wireless communications systems freely/unconsciously. Moreover, the applications such as so called Digital Home and anti-disaster wireless communications and wireless medical services for remote diagnosis/treatment are waiting to be exploited.

The goal of this Research Group is to realize environments in which customers can communicate without worrying about the way to communicate but with a single terminal and with a designated communications mode set by the customers' policy such as best pricing, highest throughput and so on through researches on communications systems, terminals, propagation characteristics and interference mitigation.

In this year, this Research Group will focus on the following activities:

(1) Research and development of mobile terminal mountable beamforming antenna and power amplifiers for high data rate millimeter wave wireless communications,
(2) Basic technology development for higher quality wireless communications,
(3) Advanced cognitive radio technology development for wireless communications systems and terminals to utilize spectrum very efficiently; for one terminal to use multiple frequency bands dynamically.
(4) Identifying applications suitable for 60 GHz wireless communications. These applications include Super Digital Home in which various electronic appliances are connected by ultra high speed (such as 3 Gbps) millimeter wave systems, Super Information Portal in which portable terminals with 60 GHz ultra high speed (such as 3 Gbps) I/O and several 10 G bytes Flash memory will play an important role to change our business model such as DVD rental and the concept of “portable PC”.
(5) Contributions to global standardization in technology and/or leading global standardization (IEEE802.15.3c)) to the success - to get our own / Japanese industry's ideas standardized.

Research topics:

1. Research and development of mobile terminal mountable beamforming antenna and power amplifiers for high data rate millimeter wave wireless communications
2. Propagation characterization for various applications
3. Enhanced modulation/demodulation, forward error correction schemes
4. Fading and interference mitigation technologies
5. Cognitive radio (one terminal to use multiple frequency bands dynamically)
6. Wireless system and terminal control (MAC) technologies
7. Application exploitation: Super Digital Home, Super Information Portal, and remote wireless medical network systems

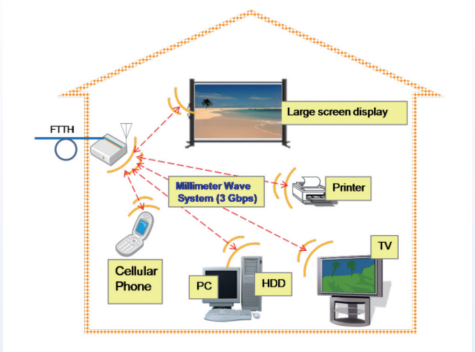
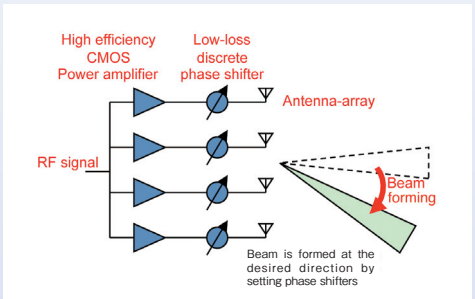
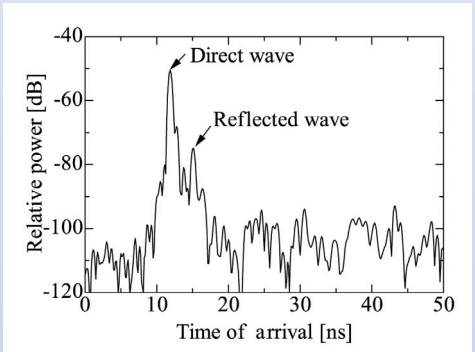


Image of Super Digital Home

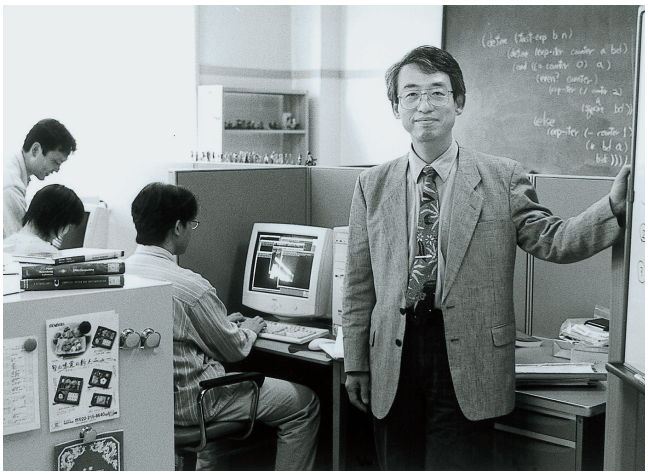


Millimeter wave beamforming antenna



Example of 60GHz propagation measurement

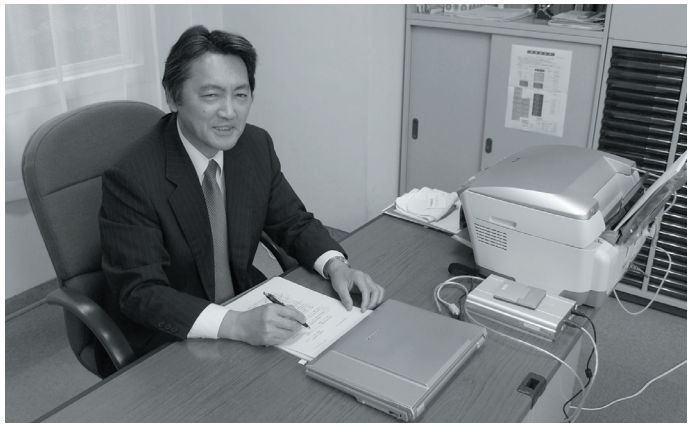
Computing Information Theory



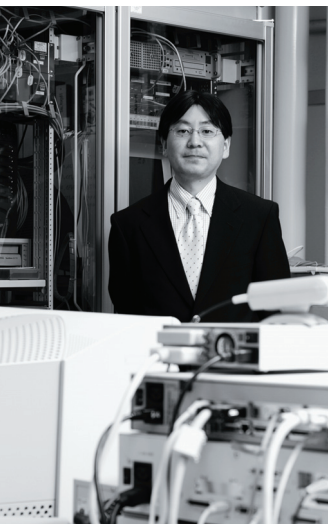
Software Construction

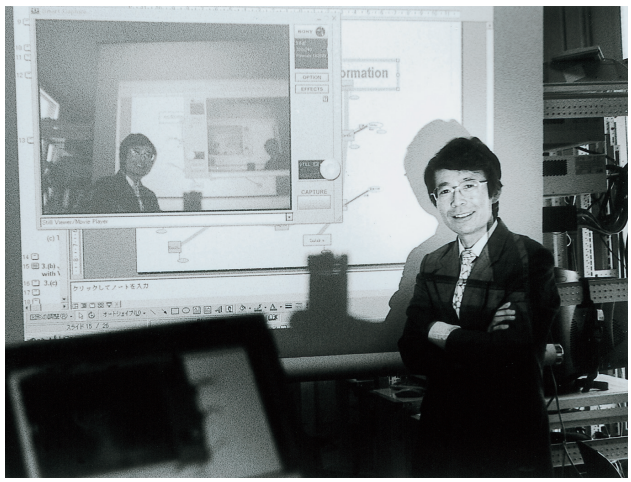
Systems & Software Division

Information Contents



Communication Network Systems





Software Construction

A. OHORI K. UENO

Staff:

Atsushi OHORI, Professor
Katsuhiro UENO, Assistant Professor

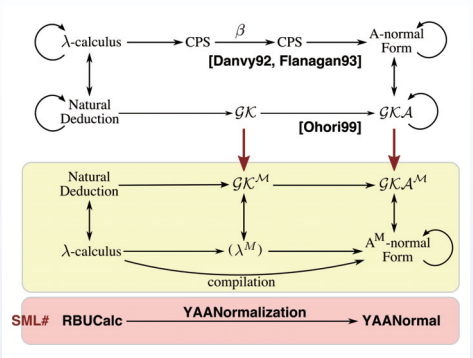
Research activities:

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

Based on this general observation, our research aims at establishing both firm theoretical basis and implementation method for flexible yet reliable programming languages for advanced Internet computation. One direction toward this goal is to establish logical foundations for compilation. We aim at establishing a proof-theoretical framework that accounts for the entire process of compilation - including pattern matching, closure conversion, and code generation - as a series of proof-transformations. Another research direction, which complements to the above, is type-directed compilation method that can produce efficient code for high-level programming languages. In addition to those foundational research, we are also developing a new practical ML-style programming language that embodies some of our recent results such as record polymorphism, rank1 polymorphism, and high-degree of interoperability with existing languages and databases.

Research topics:

1. Development of SML#, a new ML-style polymorphic programming language
2. Logical foundations for compilation
3. Verification of low-level code
4. Type-directed compilation for polymorphic languages
5. Programming language design for dependable system software

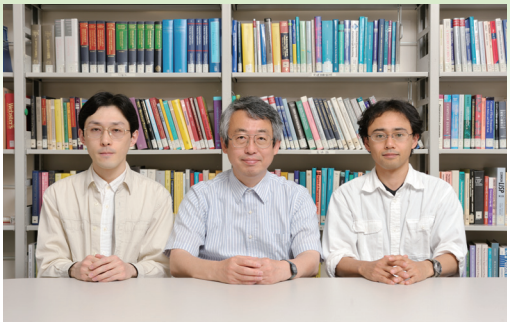


Logical foundation for compilation

```
# val libc =
  DynamicLink.dlopen "libc.dylib";
val libc = 0x8fe31cf0
  : DynamicLink.dllHandle
# val qsortC =
  DynamicLink.dlsym (libc, "qsort");
val qsortC = 0x930dcca9
  : DynamicLink.symbol
# fun qsort (base, nmemb, compar) =
    _ffiapply qsortC
      (base : 'a array, nmemb : int,
       _sizeof('a),
       compar : ('a ptr, 'a ptr) -> int
      ) : unit;
val qsort =
  fn : ['a.'a array * int
        * ('a ptr * 'a ptr -> int)
        -> unit]
```

SML#: A new polymorphic programming language

Computing Information Theory



K. KIKUCHI Y. TOYAMA T. AOTO

Staff:

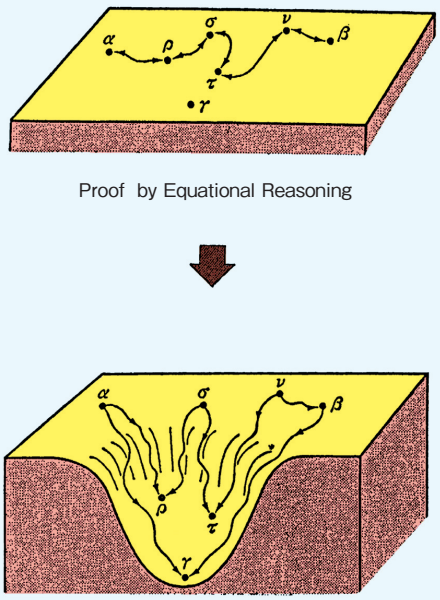
Yoshihito TOYAMA, Professor
Takahito AOTO, Associate Professor
Kentaro KIKUCHI, Assistant Professor

Research activities:

Rewriting systems are mathematical formalisms which can offer both flexible computing and effective reasoning with equations. Thus, rewriting systems play an important role in various areas, such as automated theorem proving, formula manipulation systems, algebraic specifications, and functional and logic programming languages.

Our research focuses on important theoretical features of the rewriting paradigm, such as the Church-Rosser property, the termination property, and the modular property. The goal of this research is to obtain a unified theory of functional-logic-algebraic systems.

Rewriting systems can provide a useful tool for program transformations. We investigate this by developing a program transformation system for functional programs which base their semantics on rewriting systems. As a theoretical framework, we pay much attention to higher order rewriting and inductive theorem proving. We are also interested in the 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



Computation by Rewriting Systems

Research topics:

1. Rewriting theory
2. Foundations of softwares
3. Automated theorem provers

Communication Network Systems

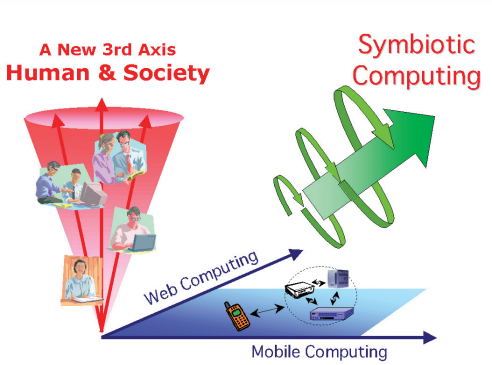
H. TAKAHASHI D. CHAKRABORTY S. UTSUMI
T. SUGANUMA N. SHIRATORI

Staff:

Norio SHIRATORI, Professor
Takuo SUGANUMA, Associate Professor
Debasish CHAKRABORTY, Visiting Associate Professor
Hideyuki TAKAHASHI, Research Fellow
Satoshi UTSUMI, Research Fellow

Research activities:

Aiming towards the next generation ubiquitous stage we are pursuing a research on information and communication paradigm, called "Symbiotic computing". The purpose is to establish a method for the composition of flexible information and telecommunication system with the co-existence of man and IT environment. Previously, ubiquitous environment was composed of two characteristics: mobility and pervasiveness. The symbiotic computing is a new paradigm of information and communication, named as "Flexible computing" as the third new axis in addition to the two axes, and is composed by integrating all these three axes. The flexible computing is the basic of the symbiotic computing capable of handling a wide range of problems, such as operational mistakes, traffic congestion, breakdown of nodes, and various user requirements in a graceful manner. In the flexible computing, these problems are regarded as "changes" in the system, both external and internal. It absorbs these changes with its intelligence, homeostasis, and evolution mechanism. It is a computing paradigm that operates with stability while satisfying user and system provider's criteria. We have been promoting both theoretical and experimental researches based on the concept of flexible information network where man and IT environment co-exist. Our focus also includes performance evaluation of super-high-speed network and its efficient management.



Concept of Symbiotic Computing

Research topics:

1. Symbiotic computing: Theory and application
2. Symbiotic society and health-care/watch-over support
3. Integration of real space and digital space
4. Measurement and analysis of super-high-speed and wide-area networks
5. Mobile network management

Information Contents

Staff:

Junji NUMAZAWA, Professor
Terumasa AOKI, Associate Professor

T. AOKI J. NUMAZAWA

Research activities:

Information content is expected to be one of the most important industries in 21st century in Japan because Japan does not keep enough natural resources. Actually Japan is now good at generating information content in some fields such as animation, computer games etc.

However the circumstances around information content have drastically been changing for a few years. The wide spread and revolution of the Internet and mobile phones, upsurge of CGM (Consumer Generated Media), generalization of HDTV, population of 3D videos are the typical examples of these trends.

In our laboratory, we are discussing how information content should be from a long-term's point of view and furthermore tackling the following research areas which we believe are especially important for information content in the future.

- Computer supported video creation technologies in order for everyone, including not only experts but also beginners, to create and distribute their own video content.
- Video comprehension technologies by computers in order to retrieve and reuse video content.
- Creation, preservation, and distribution technologies for super-presence video content.

Research topics:

1. Content Creation Technologies
   Collaborative Movie Creation System over the Internet (Fig.1)
   Automatic CG animation Creation System only by Scenario Input (Fig.2)
2. Content Archiving/Retrieval Technologies
   High-performance Shot Boundary Detection Technology for Video content (Fig. 3)
   Automatic Metadata Insertion Technology for Retrieving Video Content
3. Content Distribution/Protection Technologies
   Simple Broadcasting Technology over the Internet
   CoFIP : Secure Content Distribution System with Tracing Function of Illegal User
   Moral Filtering Against User Uploaded Video Content
4. Next-generation Media Technologies
   DFFI (Displa-free Floating Image) technology

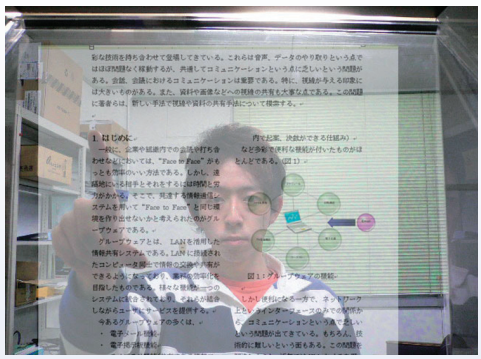


Fig.1 Collaborative Creation System over the Internet

Fig.2 Automatic CG Animation Creation System by Scenario Input

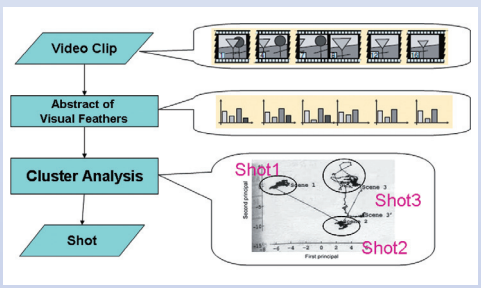
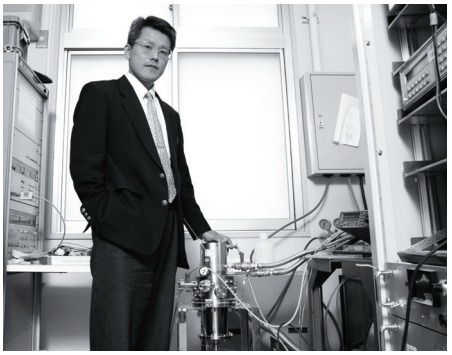
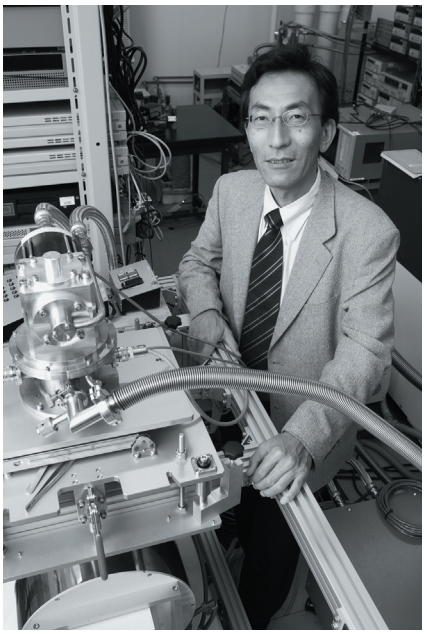


Fig3 High-performance Video shot boundary Detection System

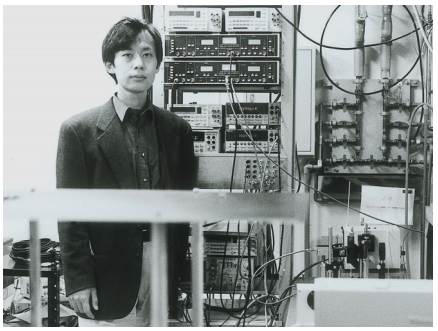


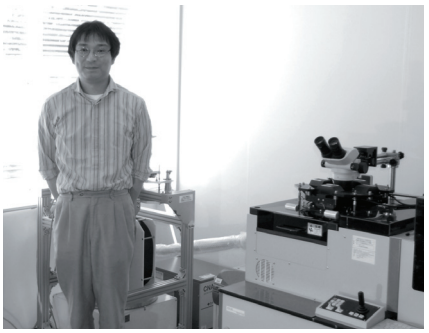
Atomically Controlled Processing

Semiconductor Spintronics



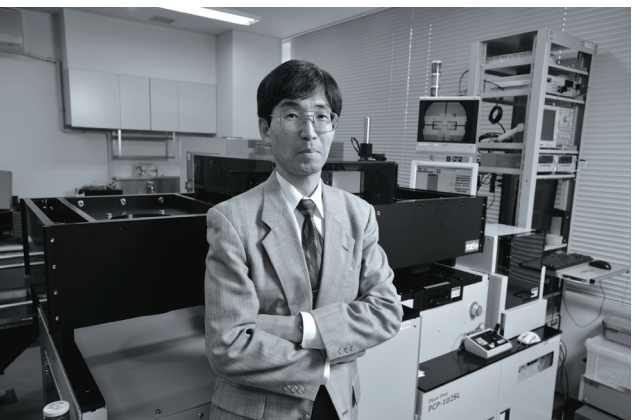
Laboratory for Nanoelectronics and Spintronics



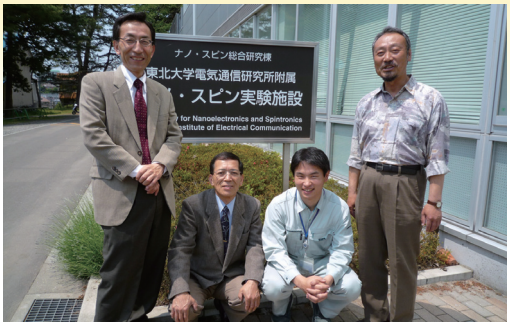


Nano-Spin Memory

Nano-Molecular Devices



Laboratory for Nanoelectronics and Spintronics



H. OHNO T. MEGURO R. SASAKI S. TSUCHIDA

Staff:

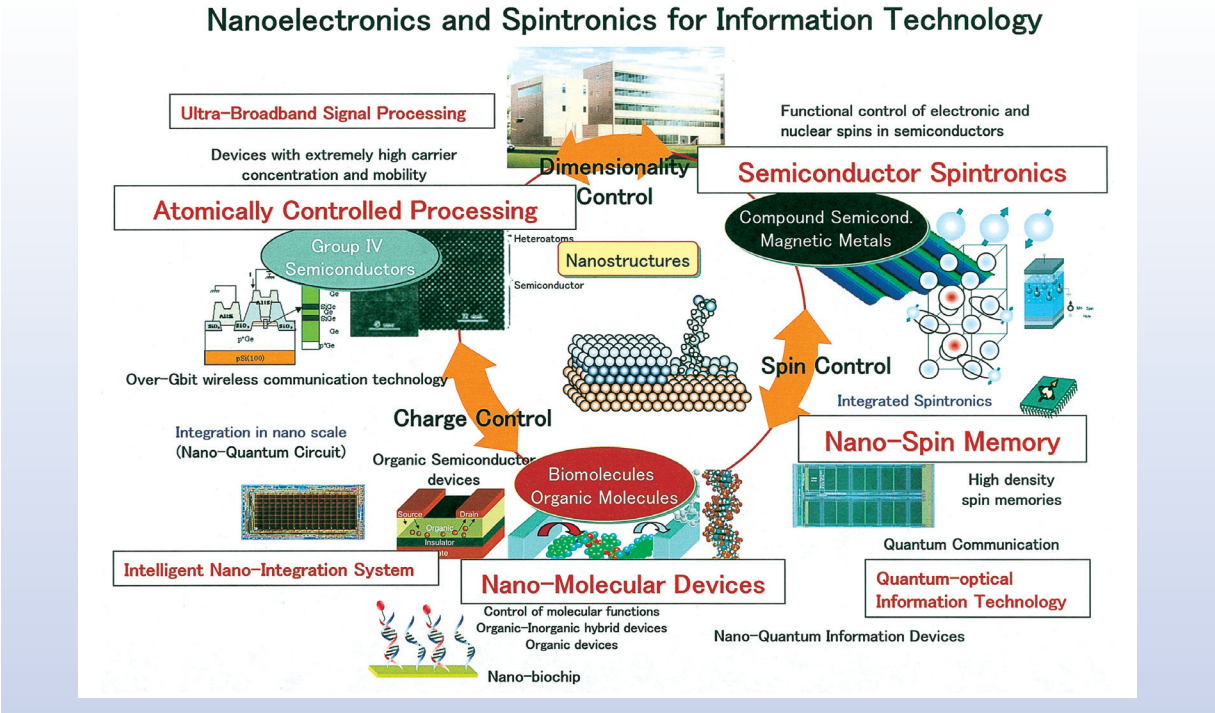
Director: Hideo OHNO, Professor
Ryutaro SASAKI, Technical Official
Sadao TSUCHIDA, Technical Official
Toshiyasu MEGURO, Research Fellow

Research activities:

The Laboratory for Nanoelectronics and Spintronics of the Research Institute of Electrical Communication was established in 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 having 1300 m^2 of cleanroom area. The Laboratory for Nanoelectronics and Spintronics consists of four Sections:

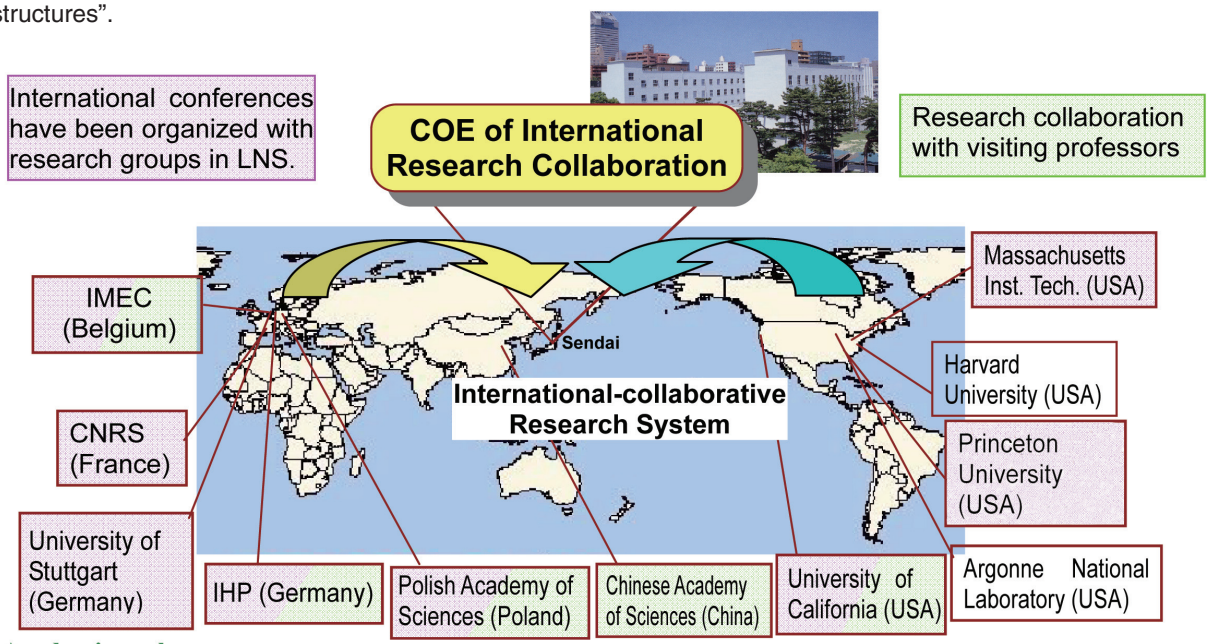
Atomically Controlled Processing (Junichi Murota, Professor)
Semiconductor Spintronics (Hideo Ohno, Professor)
Nano-Molecular Devices (Michio Niwano, Professor)
Nano-Spin Memory (Shoji Ikeda, Associate Professor)

These Sections cooperatively carry out the research aimed at establishing nanoelectronics and spintronics, together with the groups of Intelligent Nano-Integration System, Quantum-optical Information Technology, and Ultra-Broadband Signal Processing and with the research groups of the Institute, the Graduate School of Engineering, the Graduate School of Information Science, Tohoku University, and nation-wide cooperative research projects in the field.



COE of International Research Collaboration in Nanoelectronics

The aim of this program (FY2005-2009) is to build a system for international research collaboration, and establish COE in research fields of “Fabrication and application of semiconductor 3D-nanostructures”, “Establishment and application of spin-control technologies in semiconductors”, and “Realization and application of information processing using molecular nanostructures”.



Academic exchange programs

IHP-Innovations for High Performance microelectronics, Germany
Research Center of Condensed Material and Nanosciences, National Center for Scientific Research, France
Institute of Semiconductors, Chinese Academy of Sciences, China
Institute of Physics, Polish Academy of Sciences, Poland
University of California, Santa Barbara (UCSB), 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))

RIEC International Workshop on Spintronics

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

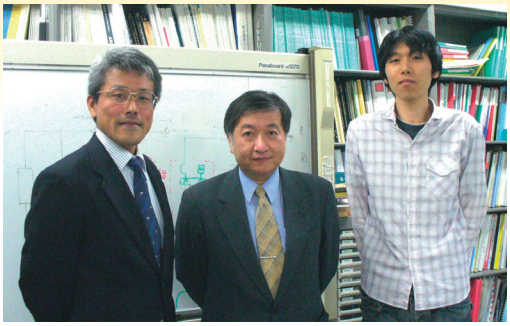
International Workshop on Nanostructure & Nanoelectronics

(1st: November 21-22, 2007)

3rd Int. Workshop on New Group IV Semiconductor Nanoelectronics

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

Atomically Controlled Processing



M. SAKURABA J. MUROTA K. SUGAWARA

Staff:

Junichi MUROTA, Professor
Masao SAKURABA, Associate Professor
Katsutoshi SUGAWARA, Research Fellow

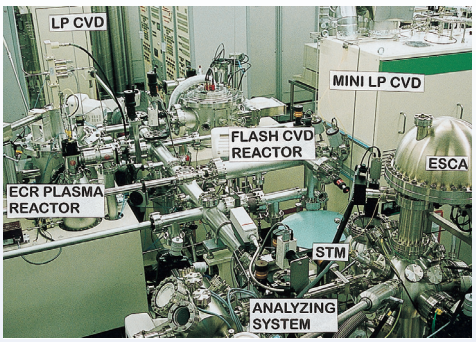
Research activities:

For highly functional semiconductor devices with ultrahigh speed and ultralow power for the Si LSIs, our atomically controlled processing technology by control of Langmuir-type adsorption and reaction in CVD (Chemical Vapor Deposition) becomes important increasingly. Utilizing the technology, we aim to create non-equilibrium strain-controlled Si-Ge-C group IV semiconductors with high carrier concentration and high carrier mobility by advancing atomically controlled heteroepitaxial growth of Si, Ge, SiGe, SiGeC and impurity (B, P, C, N and so on) to the extremity. Moreover, we also aim to establish a technological basis for highly controlled nanometer-order three-dimensional structure formation. In detail, the following researches are being advanced: (1) Control of extremely high carrier concentration due to non-equilibrium atomically controlled heteroepitaxial growth which utilizing thermal and plasma-enhanced reaction and so on at low temperatures, (2) Modulation of energy band structure and carrier mobility due to introduction of atomically controlled strain into Si and Ge, (3) Formation of the nanometer-order three-dimensional structure with subnanometer precision in in-plane direction by breaking the limit of lithography technology utilizing selective CVD epitaxial growth and selective etching with atomic layer control.

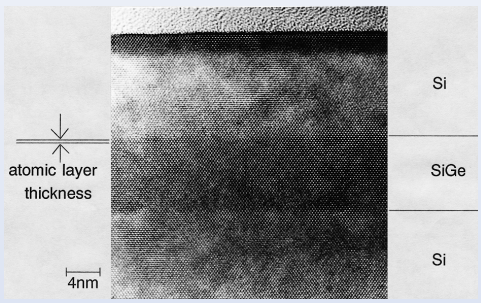
By the above researches, highly strained nanometer-order three-dimensional structures and room temperature resonant tunneling structures with higher performance which exceeds the limit of physical properties in use of existing Si, SiGe alloy and Ge materials will be created. Simultaneously, by applying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

Research topics:

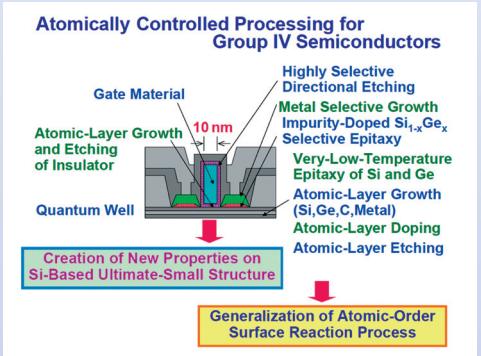
1. Atomically controlled heteroepitaxial growth of Si-Ge-C group IV semiconductors
2. Atomic layer doping into nanometer-order heterostructures of group IV semiconductors
3. Three-dimensional nanometer-order fabrication of group IV semiconductor heterostructures
4. Control of properties in three-dimensional nanometer-order group IV semiconductor heterostructures
5. Development of advanced CVD equipment for formation of three-dimensional nanometer-order group IV semiconductor heterostructures
6. Fabrication process of Si-based nanometer-order heterostructure devices



Atomically controlled processing systems for group IV semiconductors



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



Atomically controlled processing for group IV semiconductors.

Semiconductor Spintronics

H. GAN H. YAMAMOTO H. HASEGAWA S. MATSUZAKA K. OHTANI K. MIURA H. YAMAMOTO
F. MATSUKURA T. Dietl H. OHNO S. IKEDA Y. OHNO

Staff:

Hideo OHNO, Professor
Tomasz DIETL, Visiting Professor
Fumihiro MATSUKURA, Associate Professor
Keita OHTANI, Assistant Professor
Shunichiro MATSUZAKA, Research Fellow
Hiroyuki YAMAMOTO*, Research Fellow
Haruhiro HASEGAWA*, Visiting Professor
Yuzo OHNO, Associate Professor
Shoji IKEDA*, Associate Professor
Katsuya MIURA*, Research Fellow
Huadong GAN*, Research Fellow
Hiroki YAMAMOTO*, Research Fellow

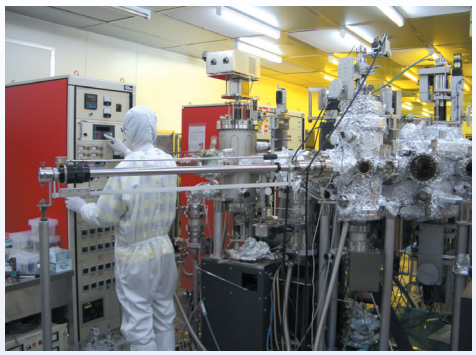
Research activities:

Our research activities cover the areas of preparation, characterization, and application of new classes of compound semiconductors and their quantum structures for new functional high-speed devices, which can be realized by controlling the electronic and spin states in semiconductors. More specifically, our research is focused on (1) Semiconductor Spintronics, where non-volatile spin memory and new functionality based on the spin degree of freedom using III-V based ferromagnetic/non-magnetic semiconductor heterostructures are being explored, (2) THz-far infrared lasers based on the intersubband optical transition in broken-gap semiconductor heterostructures (InAs/GaSb), (3) the quantum transport phenomena in two-dimensional electron gases, and (4) non-volatile spin memories based on magnetic metal devices.

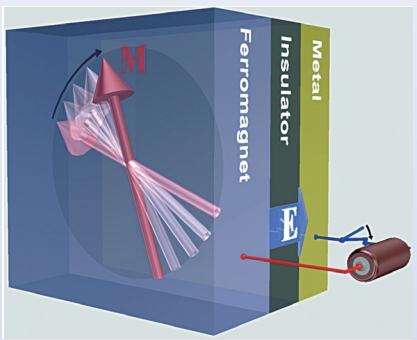
Materials of interest include such nonmagnetic semiconductor heterostructures as GaAs/AlAs and InAs/GaSb, and III-V based ferromagnetic semiconductors such as (Ga,Mn)As and (In,Mn)As. All these materials are prepared by Molecular Beam Epitaxy.

Research topics:

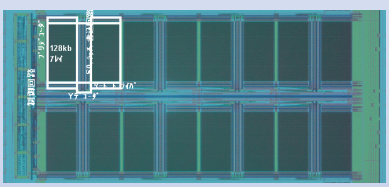
1. Semiconductor Spintronics
   a. Properties and Application of III-V Based Ferromagnetic Semiconductors and their Quantum Structures
   b. Spin Memory
   c. Spin Coherence in Semiconductor Nanostructures and Its Application to Quantum Information Technology
2. Quantum Cascade Structures and Their Application to THz Optical Devices
3. Growth and Characterization of Semiconductor Quantum Nano-Structures
4. Magnetic Metal Devices and their Application to Nonvolatile Spin Memories



Molecular beam epitaxy (MBE)- sputtering equipment for the growth of III-V based ferromagnetic/nonmagnetic semiconductor heterostructures and magnetic metal devices.



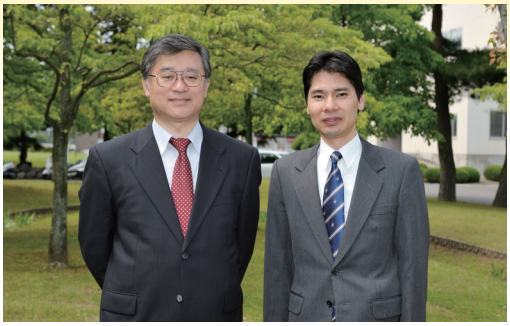
Schematic of magnetization direction control by the application of electric-filed.



2Mb Spin-Transfer Torque RAM (SPRAM) chip developed in collaboration with Hitachi.

*Nano-Spin Memory

Nano-Molecular Devices



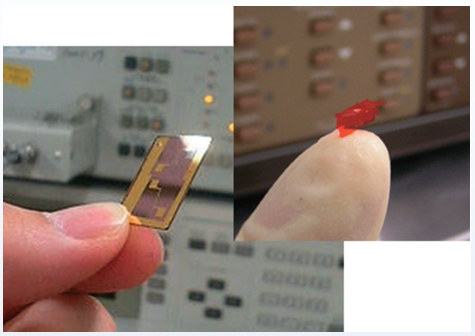
M. NIWANO Y. KIMURA

Staff:

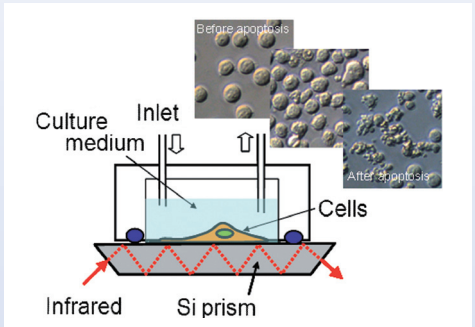
Michio NIWANO, Professor
Yasuo KIMURA, Assistant professor

Research activities:

Tremendous progress has been seen in recent years in the development of electronic devices as tiny as a single molecule and molecular sensor devices that can carry out the tasks of both molecular recognition and signaling. The continuously increasing amount of data to be stored and manipulated is strong impetus in the search for molecular electronic devices that are fabricated from various molecules with unusual electrical and optical properties. The use of supramolecules such as C60, organic metals and semiconductors, and biomolecules such as DNA will open entirely new horizons in the field of molecular device technology. The need to manipulate large amounts of genetic data requires the development of new types of bio-information devices, which may be constructed by combining molecular device technology with biotechnology.



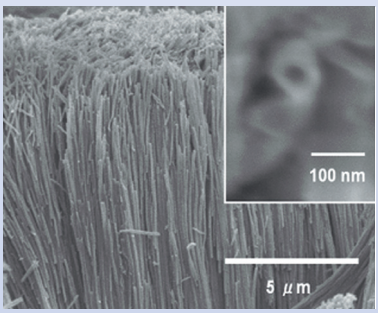
Organic single crystal of rubrene and a polymer organic semiconductor FET on a transparent substrate



Apoptosis (programmed cell death) of cells and infrared spectroscopy for the analysis of cell functions

Research topics:

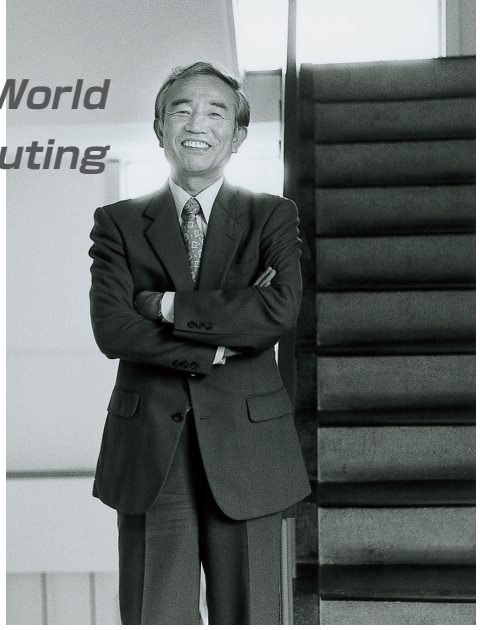
1. Bioanalysys using semiconductor surfaces (surface-biotronics)
2. Development of a bio-sensing system
3. Development of flexible devices using organic semiconductors
4. Nanoscale analysis and control of surfaces and interfaces of organic molecular devices
5. Fabrication and characterization of dye-sensitized solar cells



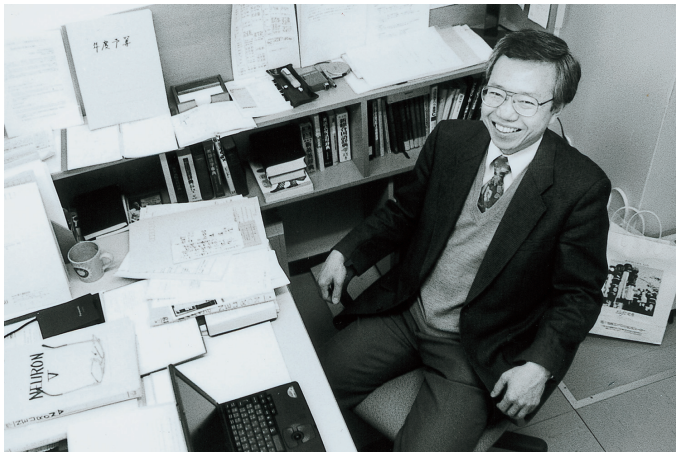
TiO_2 nanotubes fabricated by the electrochemical method (application to dye-sensitized solar cells)

New Paradigm
VLSI System

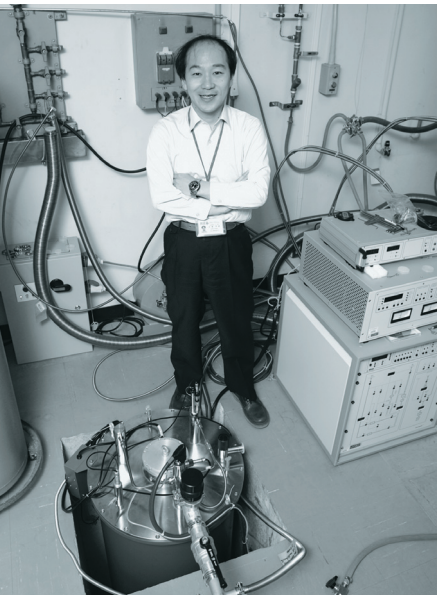
Real-World
Computing



Laboratory for Brainware Systems



Intelligent Nano-Integration
System



Microarchitecture

Laboratory for Brainware Systems

K. NAKAJIMA

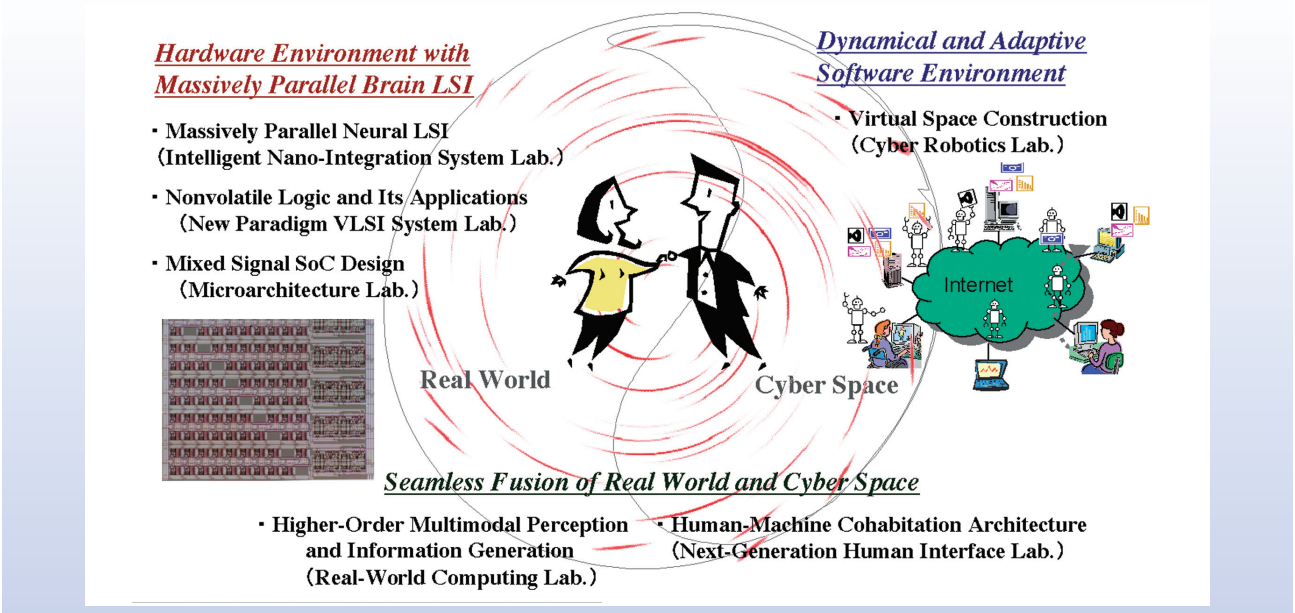
Staff:

Director: Koji NAKAJIMA, Professor

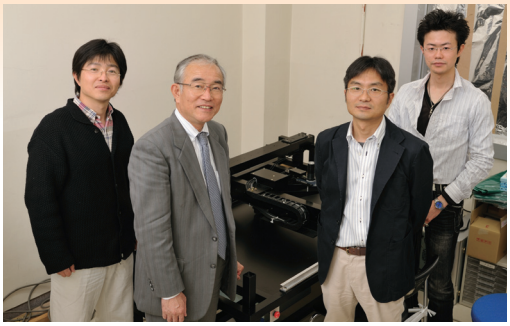
The Laboratory for Brainware Systems of the Research Institute of Electrical Communication was established in 2004. Its purpose is to contribute to the research and development of advanced information science and technology for Brainware systems which realize a seamless fusion of the changeable and complex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

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

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



Real-World Computing



K. SAKAMOTO M. YANO Y. MAKINO N. TOMITA

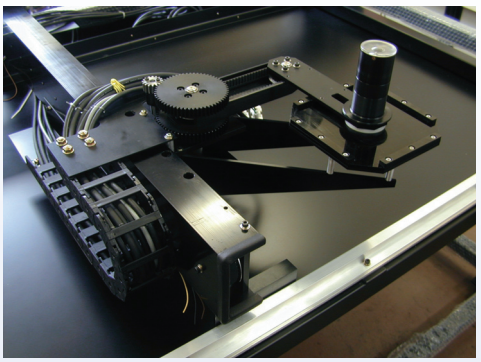
Staff:

Masafumi YANO, Professor
Yoshinari MAKINO, Research Associate
Kazuhiro SAKAMOTO, Research Associate
Nozomi TOMITA, Research Fellow

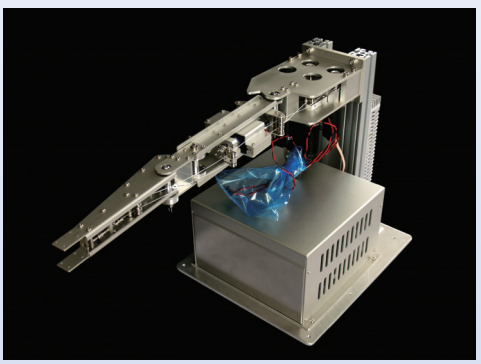
Research activities:

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

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



Manipulandum system for arm reaching movements. By measuring motions under various external force conditions, control mechanisms for voluntary movements can be clarified.

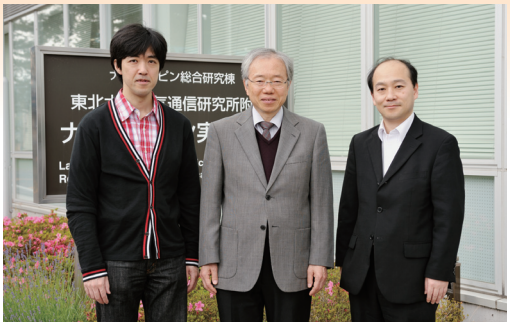


2-joint-6-muscle arm robot. By using the redundant actuators and the sensory information about the joints and the actuators, the controller can create movements appropriate to unpredictable environments.

Research topics:

1. Mechanisms of learning and memory in olfaction
2. Speaker independent speech recognition by evaluating global spectrum shape
3. Three-dimensional visual recognition by integrating motion vision and form vision
4. Real-time control mechanisms for voluntary movements

Intelligent Nano-Integration System



T. ONOMI K. NAKAJIMA S. SATO

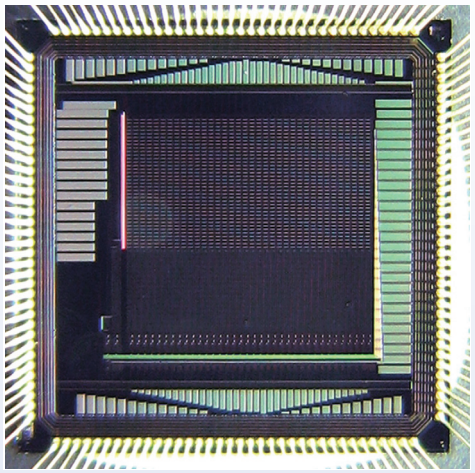
Staff:

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

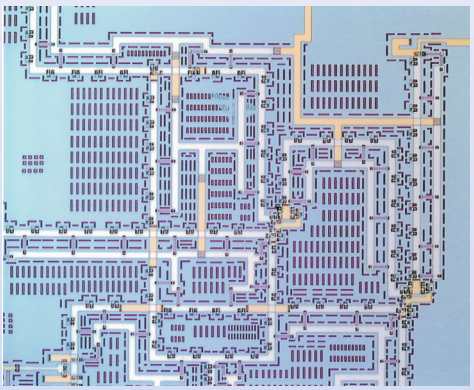
Research activities:

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

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 by using the CMOS technology. We have also presented an FFT and a neural system operated by using a flux quantum logic in superconducting integrated circuits At present research is focused on the large scale integration of Brain computing system and exploitations of new neural devices proposing a neuromorphic quantum computation.



Microchip of a neural network



Microchip of a single flux-quantum circuit

Research topics:

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

Microarchitecture

S. MASUI

Staff:

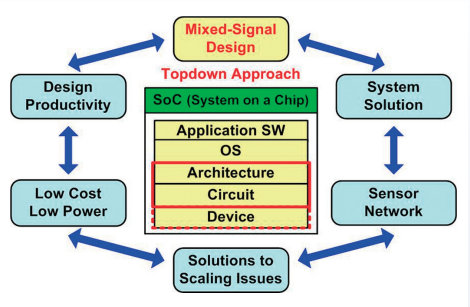
Shoichi MASUI, Professor

Research activities:

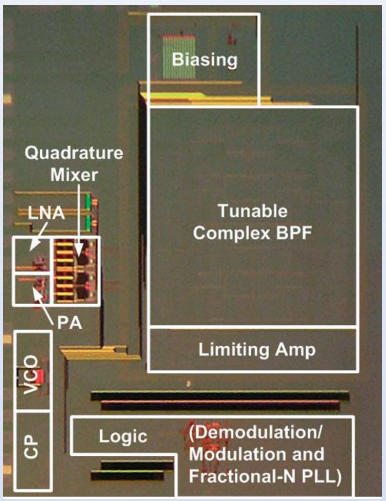
Ubiquitous society has been established by the deployment of various wireless systems ICs, and it demands advances in mixed-signal (analog and digital) design technique as well as higher integration through SoC (System on a Chip). Our research activities include architecture and circuit design of mixed-signal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

Our approaches to solve these problems are to expand digital-assisted analog design techniques to realize mixed-signal platform, and to develop automatic design optimization flows for RF/analog circuit. The mixed-signal platform includes the software-definable RF/analog circuit and the integration of nonvolatile memory for the control of digital-based analog calibration.

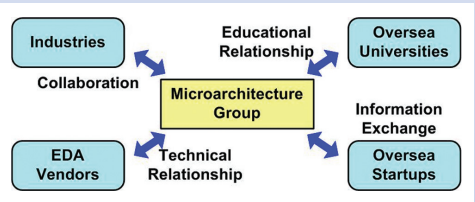
The planned research project will take advantage of collaborations with semiconductor industries and EDA (Electronic Design Automation) vendors and relationships with oversea universities and startup companies.



Mixed-Signal SoC and design hexagon



Transceiver IC for Sensor Network Systems



Vision of Collaboration

Research topics:

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

New Paradigm VLSI System

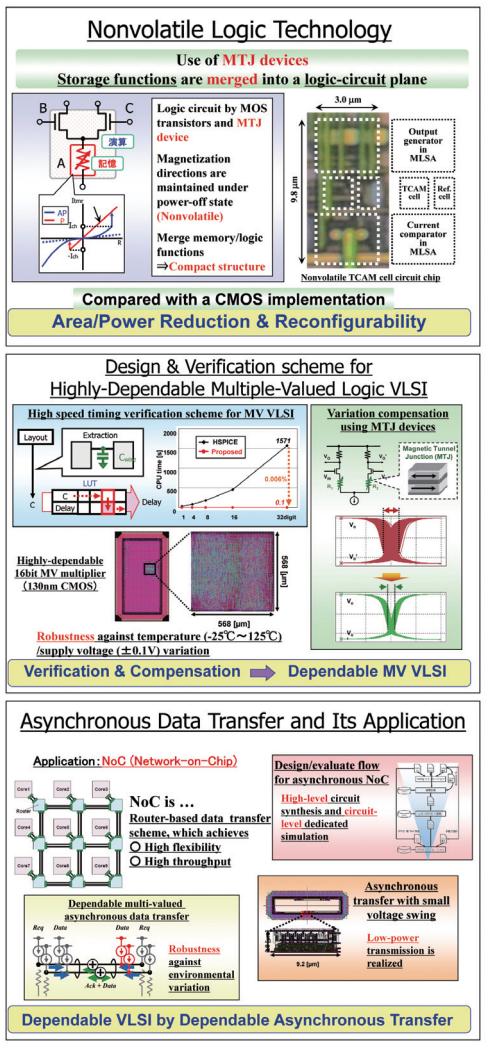
T. HANYU A. MATSUMOTO M. NATSUI

Staff:

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

Research activities:

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



Research topics:

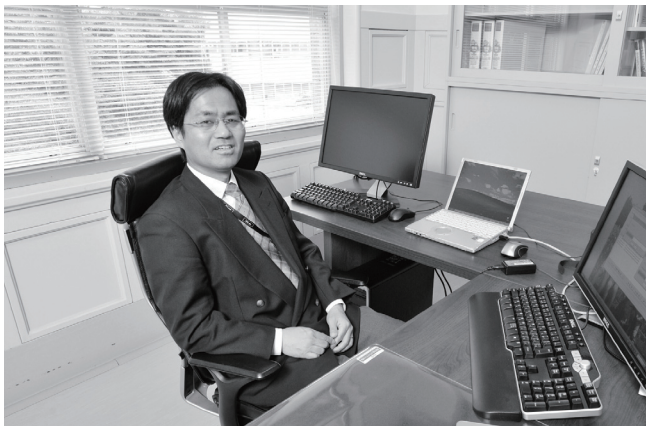
1. Logic-in-memory VLSI architecture and its applications
2. Self-controllable VLSI processor and its applications
3. Information-communication super chips based on new-paradigm VLSI architecture
4. Device-model-based new-paradigm VLSI computing architecture
5. Asynchronous-control/multiple-valued data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

Project Planning Division

Research Center for 21st Century Information Technology

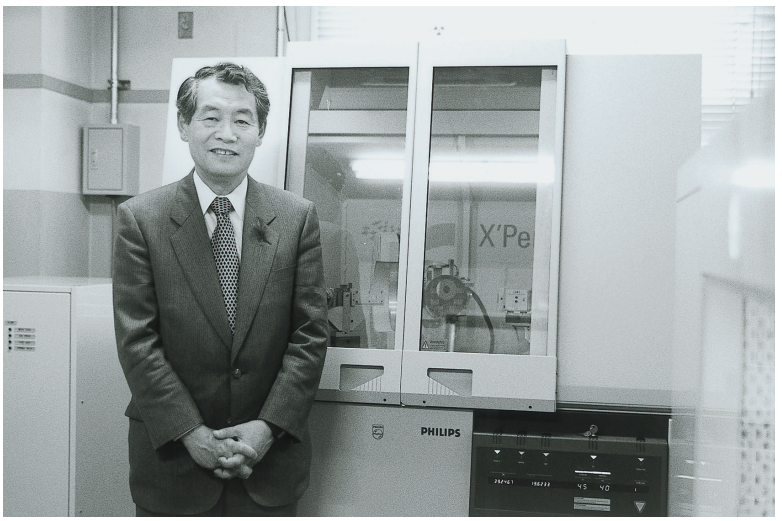
Technology Development Division

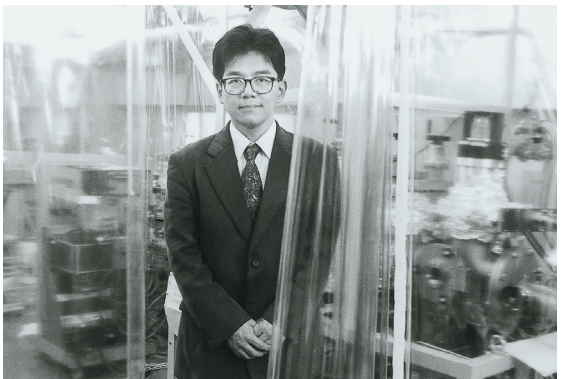
Mobile Wireless Technology Group



Technology Development Division

Storage Technology Group





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

K. TSUBOUCHI

K. SAGAE

Director: Kazuo TSUBOUCHI, Professor

Katsumi SAGAE, Technical Official

Project Planning Division

Makoto FURUNISHI, Professor

Technology Development Division

Development of Dependable Wireless System and Device

Project Leader : Kazuo TSUBOUCHI, Professor

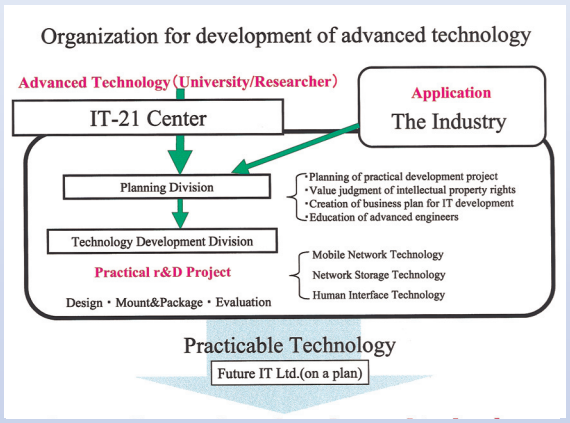
Tadashi TAKAGI, Professor
Makoto IWATA, Visiting Professor

Development of Super High-Speed Mass Storage HDD Systems

Project Leader : Hiroaki MURAOKA, Professor

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

IT-21 Center



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

Project Planning Division

M. FURUNISHI

Staff:

Makoto FURUNISHI, Professor

We are participating in establishing R&D strategy not only for the Research Center for 21st Century Information Technology (IT-21 Center) but also for the Research Institute of Electrical Communication (RIEC).

1. Plan for R&D

Our goal is to participate in and contribute to national projects based on the government's science and technology policy. We play as a liaison office to the research team that was established in the President Office for collecting information on grant schemes, etc..

Succeeding the IT projects implemented since 2002FY sponsored by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), we launched in 2007FY a project, "Development of super high-speed mass storage HDD systems" headed by Prof. Muraoka under the MEXT's scheme of "Research and Development for Next-Generation Information Technology", as well as a project, "Development of CMOS Wireless LAN by 3D SiP" headed by Prof. Tsubouchi, under the scheme of the Core Research for Evolutional Science and Technology sponsored by the Japan Science and Technology Agency.

We also held a seminar or an explanatory meeting for our goal.

2. Plan for Co-operation with Industries

Besides presenting our idea about the application of the intellectual property rights, we introduced a model cooperation framework in which "Development of super high-speed mass storage HDD systems" is carried out with business enterprises on the basis of equal partnerships.

Aiming at realization of collaborative researches, we also coordinate and promote technology exchanges with research organizations with which RIEC has concluded comprehensive co-operation agreements.

We plan to issue an article about an ideal university - industry relationship based on our experiences.

3. Plan for Publications

Working with the RIEC Flexible Information Research Center, we are providing patent information on our Web sites. We are compiling the results of R&D under the IT Project that ended 2007FY and publishing a brochure on the activities of the IT-21 center.

Explanatory Meeting about JST Grant Scheme


Seminar on Research & Development Strategy

Technology Development Division
Mobile Wireless Technology Group

T. TAKAGI

M. IWATA

Staff:
Tadashi TAKAGI, Professor
Makoto IWATA, Visiting Professor

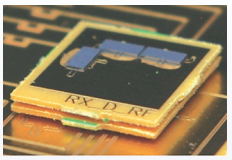
Research activities:

Mobile wireless communication technology is one of the significant communication technologies that supports 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 3D system-chip and using high density packaging for next generation mobile wireless communication. As a result, so far, (1) 324Mbit/s, 5GHz band wireless LAN terminal, (2) ultra small sized SiP millimeter wave wireless terminal for uncompressed HDTV transmission have been successfully developed, and (3) seamless handover technology for wide area broadband mobile wireless access (MBWA) and seamless roaming technology between MBWA and wireless LAN have been successfully demonstrated by field tests.

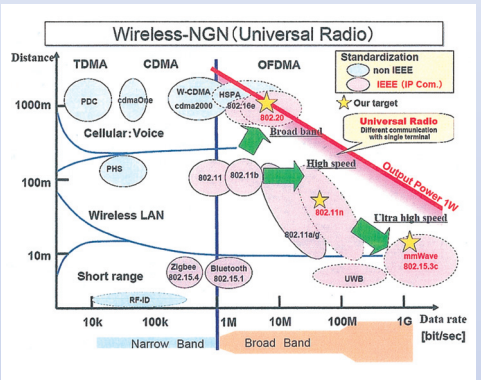
From 2007, the mobile wireless technology group will make a progress toward development of advanced practical technologies for new concept Wireless-NGN (Universal Radio) which integrates all wireless systems. In addition, our group has a will for contributing to the industry in Sendai area such as build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

324Mbit/s 5GHzBand WLAN terminal



Ultra small sized SiP millimetor wave wireless terminal for uncompressed HDTV

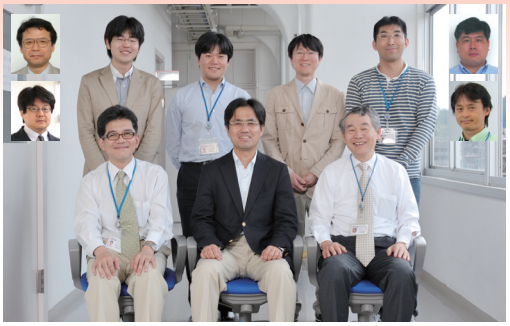
MBWA field test (Base station)



Research topics:

1. Broadband wireless communication technologies for Wireless-NGN
2. High-speed and high frequency mixed signal Si system chip for Universal Radio

Technology Development Division
Storage Technology Group



K. YAMAKAWA K. MITSUZUKA M. YAMADA H. AKAIKE H. KATAOKA H. SAGA
H. TAKAHASHI T. SHIMATSU K. FUJIMOTO H. AOI Y. OSAWA

Staff:

Kazuhisa FUJIMOTO, Professor
Takehito SHIMATSU, Associate Professor
Kaname MITSUZUKA, Research Fellow
Masaki YAMADA, Research Fellow
Junichi SAYAMA, Research Fellow
Yuichi OSAWA, Research Fellow
Hajime AOI, Visiting Professor
Kiyoshi YAMAKAWA, Visiting Associate Professor
Hiromasa TAKAHASHI, Research Fellow
Hideki SAGA, Research Fellow
Hirotoshi AKAIKE, Research Fellow
Hiroyasu KATAOKA, Research Fellow

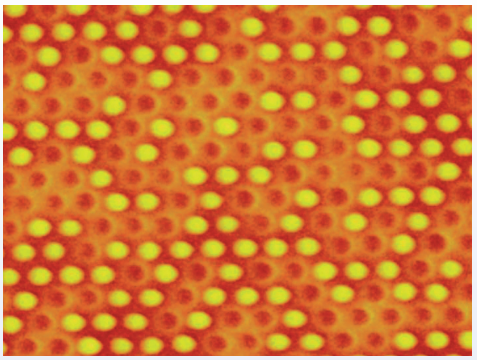
Research activities:

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

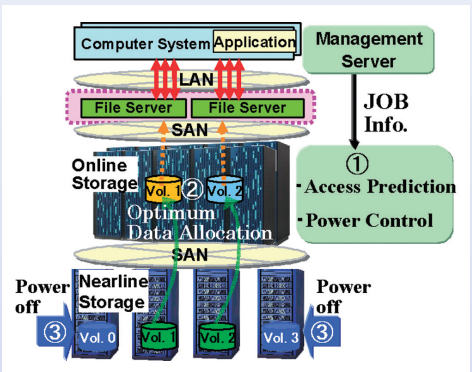
In March 2007, the IT21 cooperative research project between industry, academia and government was successfully finished. An ultra-high small perpendicular magnetic recording prototype HDD and basic technologies for densities of 0.5 to 1 Tbits/inch^2 were developed during the project.

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

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



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



2-dimension data allocation method with an access prediction

Research topics:

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

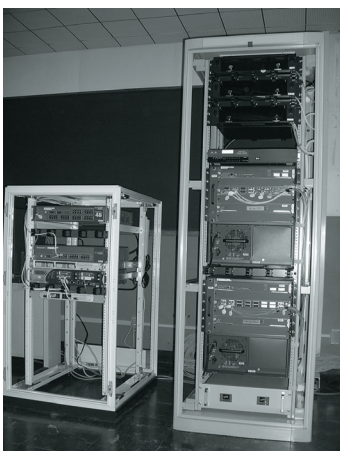
Fundamental Technology Center

Flexible Information System Research Center

Fundamental Technology Center

Management Office for Safety and Health

Flexible Information System Research Center



Flexible Information System Research Center

Y. SUZUKI G. KITAGATA K. SASAI

Staff:

Director: Yôiti SUZUKI, Professor

Yoshihito TOYAMA, Professor*
Gen KITAGATA, Associate Professor
Tetsuo KINOSHITA, Professor*
Kazuto SASAI, Assistant Professor

Research activities:

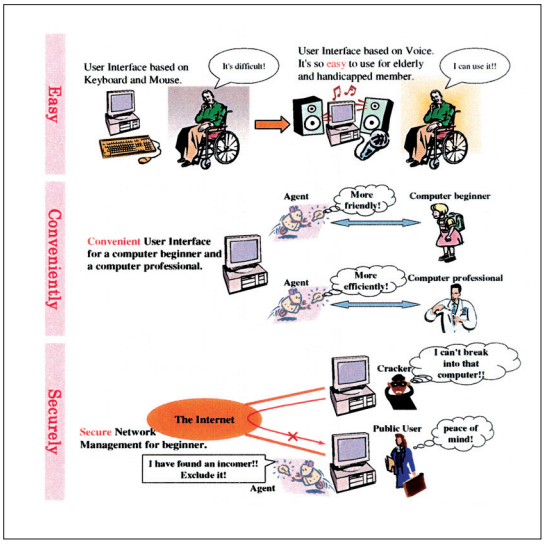
The present information systems such as computers are inflexible systems, because their purpose is predefined and they provide only the fixed procedures and functions. On the other hand the flexible information system can perform the flexible information processing adapted to the human intention and situation of its environment.

Our goal is to investigate principles of the flexible information processing through the theories and experiments, and establish their system construction methodology. Moreover, we also study the flexible distributed systems for advanced organization, utilization, administration, operation and putting out scientific information. Through practical applications of above results to the real network in RIEC, we confirm effectiveness of our methods.

Network room

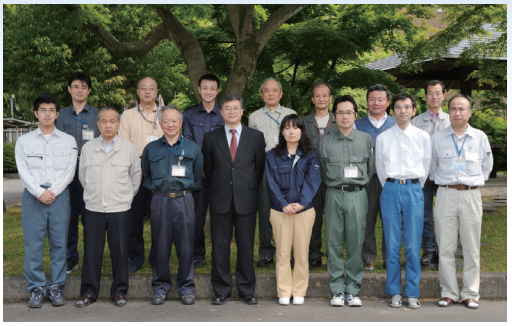
Research topics:

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



Flexible Global Network

Fundamental Technology Center



T. SUENAGA Y. KONNO K. SATO H. WATANABE R. YONEZAWA C. TAKYU Y. WAGATSUMA
K. ABE S. AGATSUMA M. SUGAWARA M. NIWANO M. ABE T. YAMASHITA S. SATO K. SHOJI

Staff:

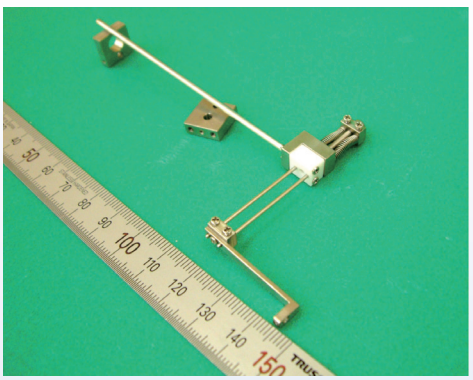
Director: Michio NIWANO, Professor

Nobuyuki SATO, Assistant Professor
Shigeto AGATSUMA, Technical Official
Tamotsu SUENAGA, Technical Official
Maho ABE, Technical Official
Kento ABE, Technical Official
Munetomo SUGAWARA, Technical Official
Ryuji YONEZAWA, Technical Official
Yasuo WAGATSUMA, Technical Official
Koichi SHOJI, Technical Official
Takeshi YAMASHITA, Technical Official
Keisuke SATO, Technical Official
Hiroshi WATANABE, Technical Official
Yuji KONNO, Technical Official
Choichi TAKYU, Technical Official

The fundamental technology center will use its advanced specialist knowledge and technology to provide close technical support for in-house research. The university views the development of cutting-edge research and technology as one of its major roles in contributing to society, and needs to sustain and develop its existing system for cultivating and transmitting advanced knowledge and technology in order to carry out this role. Based on this philosophy, the center will establish and support four research divisions: machine shop, evaluation, process, and software technology.

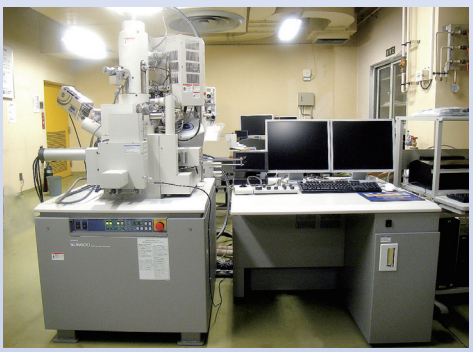
In addition to developing and manufacturing research devices in response to requests from all research fields and experimental facilities and developing advanced machining technology, the machine shop division will provide machining instruction to students and faculty members. The evaluation division will be a joint-use facility for both in-house researchers and researchers in the fields of electrical and information systems in the engineering research department, internal research, joint project research. It will be responsible for the measurement, evaluation and analysis of electric and electronic materials, electronic devices and systems, the maintenance and control of common measuring devices and equipment, the production of scientific glassware, and the supply of liquid nitrogen and liquid helium. The process division is responsible for the manufacture and processing of all types of electronic materials and devices, and the development and manufacture of the testing equipment necessary for this. It will also provide research support to all research fields by maintaining and controlling common processing devices and clean rooms. The software technology division will maintain, control and operate the networks, both in-house and for associated research facilities. Furthermore, it will provide a service for gathering, organizing and using academic information, to support all research fields and aid in the publication of their results.

Each division, through cooperation with all other divisions, will provide research support and technical and safety instruction to students and faculty members.



Silicon electrode holder

Focused Ion Beam System (FIB)



Electron Probe X-ray Micro Analyser (EPMA)

Management Office for Safety and Health

Staff:

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

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

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

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

Safety and health seminar

High-pressure gas seminar

Activity contents:

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

Research Activities

Study Groups on Electrical Communication

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

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

Title of Sub-Group

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

The 7th International Symposium

Symposiums Organized by the Institute

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

Past Symposium

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

International Symposium organized by the Institute

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

Periodicals Published by the Institute

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

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

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

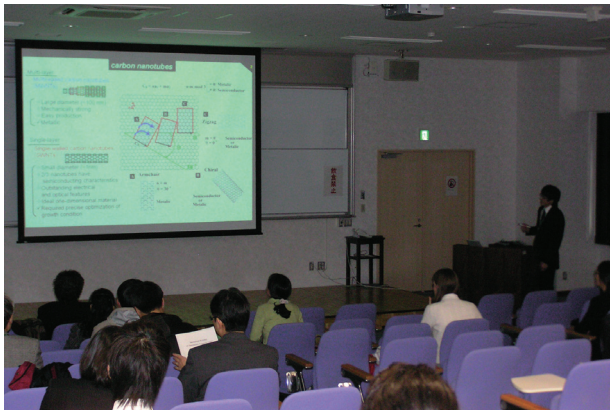
The name of the Journal 'Conversazione' is attributable to the 'Tuesday Conversazione' at the Department of Electrical Engineering, which had been held once a week on Tuesday since around 1920. Minutes of the meetings had been distributed to researchers outside of the University via various routes and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

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

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

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

Educational Activities



Presentation scene at a workshop


Seminar scene at a laboratory

The Institute is keeping close contact with the Graduate Schools of Engineering, Information Sciences and Biomedical Engineering, not only in research activities but also in educational activities. For example, all the members of the faculties of the Institute also hold positions with the faculties of the four Departments and give lectures there. Moreover, undergraduate and graduate school students related to the Departments belong to the laboratories of the Institute for their theses. In 2009, there are 57 undergraduate students, 143 masters course students, and 74 doctors course students belonged to the Institute.

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


Marathon relay race


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

International Activities

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

International academic exchange programs:

The Institute of Physics, Polish Academy of Sciences (Poland)
The Faculty of Science, Chulalongkorn University (Thailand)
Harbin Institute of Technology (China)
The James Frank Institute, The University of Chicago (U.S.A.)
Queen Mary and Westfield College, University of London (U.K.)
Scientific Research Department, Shenzhen University (China)
Institute of Information and Communication Technology, Sung-Kyun-Kwan University (Korea)
Institute of Materials Science, Faculty of Applied Physics, University of Twente (Netherlands)
The Institute of Radioengineering and Electronics Russian Academy of Sciences (Russia)
Department of Electronics Science and Engineering, University of Naujing (China)
School of Computer and Communication Engineering, Taegu University (Korea)
Reesarch Center of Condensed Materials and Nanosciences, National Center for Scientific Research (France)
IHP-Innovations for High Performance microelectronics (Germany)
Institute of Semiconductors Chinese Academy of Sciences (China)

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

1. Acoustical Science and Technology
2. Applied Acoustics
3. Electronics Express
4. International Journal of Communication Systems (IJCS)
5. International Journal of Infrared, Millimeters, and terahertz Waves
6. Japanese Journal of Applied Physics, The Institute of Pure and Applied Physics
7. Journal of Applied Physics
8. Journal of Communications and Network (JCN)
9. Journal of Higher - Order and Symbolic Computation
10. Journal of Magnetism and Magnetic Materials
11. Optical Fiber Technology
12. Optics Communications
13. Smiconductor Science and Technology, Institute of Physics
14. Solid State Communications
15. Superlattices and Microstructures
16. Virtual Journal of Nano scale Science and Technology, American Institute of Physics / America Physical Society

International conferences programmed by a staff in RIEC:

1. 14th International Conference on Modulated Semiconductor Structures (MSS-14 2009)
2. 1st International Workshop on Si based nano-electronics and -photonics (SiNEP-09)
3. 2009 International Conference on Solid State Devices and Materials (SSDM)
4. Asia-Pacific Conference on Vision 2010
5. 20th International Colloquim on Magnetic Films and Surfaces, 2009
6. 2nd Semiconductor Technology for Ultra Large Scale Integrated Circuits and Thin Film Transistors (ULSIC vs. TFT)
7. 38th International School & Conference on the Physics of Semiconductors "Jaszowiec" 2009
8. 5th Int. Workshop on New Group IV Semiconductor Nanoelectronics
9. 5th International Conference on Molecular Electronics and Bioelectronics (M&BE5)
10. 5th International School and Conference on Spintronics and Quantum Information Technology, 2009
11. 5th RIEC Int. Workshop on Spintronics, RIEC-CNSI Workshop on Nanoelectronics, Spintronics and Photonics, 2009
12. 6th International Conference on Silicon Epitaxy and Heterostructures (ICSI-6)
13. Engineering Conference International (ECI), 2009
14. European Conference on Optical Communication (ECOC)
15. European Solid-State Device Research Conference (ESSDERC)
16. Fuji International Symposium on Functional and Logic Programming (FLOPS2008)
17. Global Symposium on Millimeter Waves 2009 (GSMM2009)
18. IEEE Computer Society Technical Committee on Multiple-Valued Logic (TCMVL)
19. IEEE International Magnetics Conference (INTERMAG2009)
20. International Conference of Magnetism (ICM 09)
21. International Conference on Indium Phosphide and Related Materials · (IPRM2010)
22. International Conference on infrared, Millimeter, and Terahertz waves
23. International Symposium on Graphene Devices
24. International Symposium on Surface Science and Nanotechnology (ISSS-5)
25. International Workshop on the Principles and Application of Spatial Hearing
26. Sixth International Conference on Physics and Application of Spin-related Phenomena in Semiconductors (PASPS) 2010
27. SPIE Defense and Security Conference 2009
28. Symp. E10: "ULSI Process Integration6", 216th Meeting of the Electrochem. Soc.
29. The 11th Joint MMM-Intermag Conference 2010
30. The 2010 International Conference on Computational Science and Its Applications (ICCSA2010)
31. The 20th Personal, Indoor and Mobile Radio Communications Symposium 2009 (PIMRC '09)
32. The 8th Pacific Rim Conference on lasers and Electro-Optics (CLEO/PR20 · 09)
33. The ACM SIGPLAN Workshop on Types in Language Design and Implementation (TLDI2009)
34. The Eighth Perpendicular Magnetic Recording Conference (PMRC)
35. The Korean Magnetic Society
36. The Sixth International Conference on Ubiquitous Intelligence and Computing (UIC2009)
37. Topical Workshop on Heterostructure Microelectronics (TWHM)
38. International Symposium on Nonlinear Theory and its Applications (NOLTA)

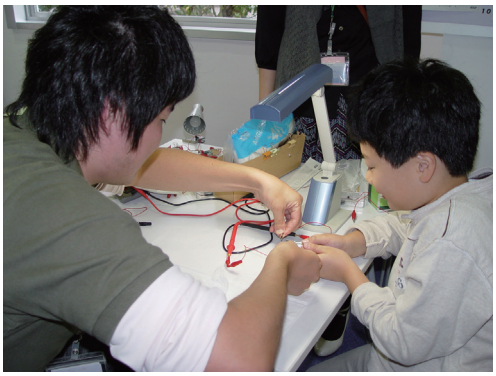
RIEC Open Day

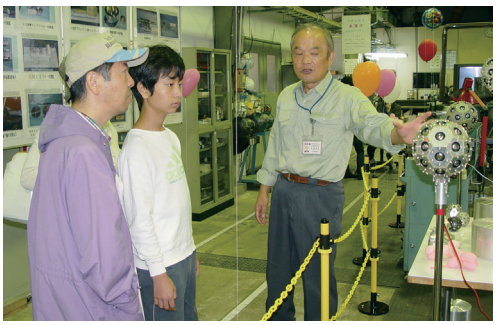
The Research Institute of Electrical Communication holds an open day every year in order to present our research and educational activities to the public, university staff, students and alumni and to representatives from the industrial sector.

On Oct. 4(Sat)-5(Sun), 2008, all the research laboratories, research centers and machine shops of RIEC exhibited various types of demonstration focused on their respective research field and activities.

Demonstration experiments were organized for ground breaking accomplishments of the RIEC, such as Magnetron tube and Steel recorder. Experiments of recent research were also conducted such as ultra-high speed data transmission using photonic fiber, learning next generation language SML#, counting quantum and photon, and . Workshops relating to the creation of simple anime movies, the play by vision, the building of a germanium radio, the development of a solar battery from a hibiscus plant, and the fabrication of spectrometer for probing color and atoms were presented.

We sincerely hope for your participation in our open day. We will be holding the open day 2009 on Oct. 10(Sat) and 11(Sun). Simple and easy explanations of our research labs are also available on the Internet. This site is accessible to everyone at any time. Please feel free to access our virtual RIEC open day at:
http://www.riec.tohoku.ac.jp/koukai/index.html
(Available in Japanese only)





Staff (as of 1st July 2009)

Director: Masafumi YANO, Professor

Research Divisions

Information Devices Devision

- **Nano-photoelectronics**
  Yoichi UEHARA, Professor
  Tatsuo UCHIDA, Professor*
  Tetsuya MIYASHITA, Associate Professor*
  Satoshi KATANO, Assistant Professor
- **Quantum-optical Information Technology**
  Keiichi EDAMATSU, Professor
  Mitsuyuki NAKAO, Professor*
  Hideo KOSAKA, Associate Professor
  Norihiro KATAYAMA, Associate Professor*
  Yasuyoshi MITSUMORI, Assistant Professor
  Atsushi SHOJI, Research Fellow
- **Solid State Electronics**
  Maki SUEMITSU, Professor
  Takashi ITO, Professor*
  Koji KOTANI, Associate Professor*
  Hirokazu FUKIDOME, Assistant Professor
- **Dielectric Nano-Devices**
  Yasuo CHO, Professor
  Sinichiro UMEMURA, Professor*
  Yoshiomi HIRANAGA, Assistant Professor
  Nobuhiro KIN, Assistant Professor
  Yasuo WAGATSUMA, Technical Official
  Noriaki OKAZAKI, Research Fellow
- **Plasma Electronics**
  Akira ANDO, Professor*
  Satoru IIZUKA, Associate Professor*
- **Materials Functionality Design**
  Masafumi SHIRAI, Professor
  Kazuyuki TANAKA, Professor*
  Yuji WAIZUMI、Lecturer*
  Yoshio MIURA, Assistant Professor
  Kazutaka ABE, Assistant Professor
- **Magnetic Devices (Visitor Section)**
  Masahide SASAKI, Visiting Professor
  Koichiro HONDA, Visiting Professor
  Sergey FILIMONOV,Visiting Associate Professor

Broadband Engineering Division

- **Ultrahigh-speed Optical Communication**
  Masataka NAKAZAWA, Professor
  Hirohito YAMADA, Professor*
  Yuji MATSUURA, Professor*
  Toshihiko HIROOKA, Associate Professor
  Yasuo OHDERA, Associate Professor*
  Masato YOSHIDA, Assistant Professor
- **Applied Quantum Optics**
  Hiroshi YASAKA, Professor
  Hiroyuki YOKOYAMA Professor*
  Jun-ichi SHIKATA, Associate Professor
  Takashi WATANABE, Associate Professor*
- **Wireless Info Tech**
  Kazuo TSUBOUCHI, Professor
  Jun-ichi KUSHIBIKI, Professor*
  Suguru KAMEDA, Assistant Professor
- **Information Storage Systems**
  Hiroaki MURAOKA, Professor
  Takao NISHIZEKI, Professor*
  Simon J. GREAVES, Associate Professor
  Xiao ZHOU, Associate Professor*
  Kenji MIURA, Assistant Pofessor
- **Ultra-Broadband Signal Processing**
  Taiichi OTSUJI, Professor
  Fumiyuki ADACHI, Professor*
  Tetsuya SUEMITSU, Associate Professor
- **Basic Technology for Broadband Communication (Visitor Section)**
  Koji MIZUNO, Visiting Professor
  Masaaki INUTAKE, Visiting Professor
  Akira YASUDA, Visiting Professor
  Noriharu SUEMATSU, Visiting Professor
  Atsufumi HIROHATA, Visiting Associate Professor

Human Information Systems Division

- **Electromagnetic Bioinformation Engineering**
  Kazushi ISHIYAMA, Professor
  Masahiro YAMAGUCHI, Professor*
  Kotaro HAMASHIMA, Professor*
  Satoru TSUDA, Associate Professor*
  Yasushi ENDO, Associate Professor*
  Shuichiro HASHI, Assistant Professor
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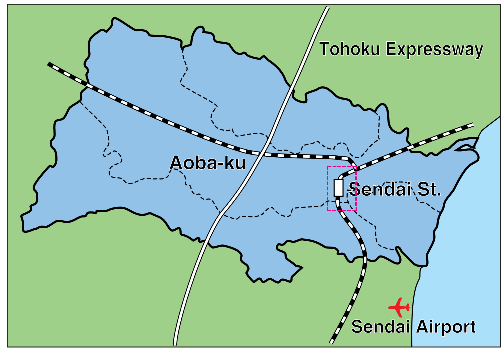
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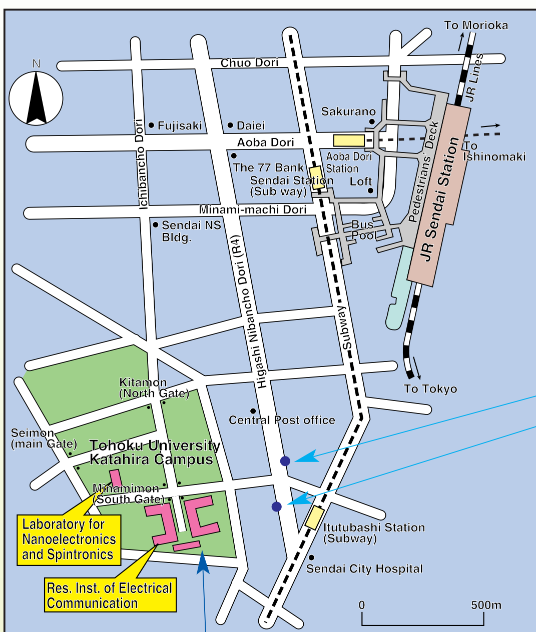
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The Cradle of Optical Communication
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