THE UNIVERSITY OF TOKYO

2019–2020

Department of
Human and Engineered Environmental Studies

Graduate School of Frontier Sciences
The University of Tokyo






http://www.h.k.u-tokyo.ac.jp/en/

New Horizon in Manufacturing

— Department of Human and Engineered Environmental Studies, envisioning the future beyond the horizon.

Responding to a super-aged nation and achieving a low-carbon society are tasks imposed on Japan today. Japan now faces various complicated and intertwined problems that are difficult to solve through conventional academic frameworks alone.
The Department of Human and Engineered Environmental Studies is working on R&D and system designs for elemental technologies that can help solve the problems related to people and the environment.

INDEX

In this department, we aim at the harmonization of human and environment, which are mutually exclusive, through innovative manufacturing. There is no magic involved in this process. The research projects in each laboratory and the educational curricula in the department are based on authentic elemental technologies and fundamental scientific principles, such as energy engineering, systems engineering, sports engineering, mechatronics, sensing, information communication, and computational engineering. By combining them, we can expect achievements in realizing a low-carbon society and solving problems of a super-aging society, which are the concrete goals of the department.

In Kashiwa Campus there are many opportunities to try out ideas in various research fields, under integrated project management by the Graduate School of Frontier Sciences, research centers, and support facilities. Another characteristic of the department is that many projects are associated with regional cooperation, international cooperation, and demonstration experiments, where you can demonstrate the usefulness of your study in helping the society.

In the future, there will surely be demands on engineers and researchers to "achieve the fusion of various kinds of disciplines." Although it is not easy to accomplish such a task, we expect that working hard together to obtain academic degrees in this department will construct a solid foundation.

Let us keep on challenging ourselves without hesitation, in the quest for a new era formed by humans and environments together.

Toshihiro ITOH

Head of the Department
Department of Human and Engineered Environmental Studies
Graduate School of Frontier Sciences

Curriculum

Various lectures lead to innovation.
The fusion of different disciplines opens the door to the future.

In the Department of Human and Engineered Environmental Studies, we aim to develop human resources capable of responding to various social and technical problems through broad knowledge of humans and artifacts.

In the curriculum, we pursue organically connected disciplines and prepare various lectures based on elemental technologies such as energy engineering, system engineering, sports science, mechatronics, sensing, information and communication technologies, and computational engineering.

CAE Computer Added Engineering — *Simulation*

Mechatronics

Sensors

Assistive technology

Software

Information technology

Sports science

Green energy innovation

Energy engineering

Lecture list

Lectures offered by the department
Advanced Lectures on Environmental Energy Systems
Special Lecture on Environmental Information Equipment
Optimal System Design
Mechatronics for Environmental Studies
Special Lectures on Human and Engineered Environments I and II
Physiological Science of Adaptation to Exercise
Theory of Elastic Vibration
Knowledge Information Processing
Wearable Sensing for Human and Environmental Information
Environmental Simulation I and II
Assistive Technology
Environmental Sound and Vibration
Environment Monitoring Devices
Mechanical and Electrical Design of Flexible Devices
Nanoprocessing and Nanometrology
Human and Engineered Environmental Studies (Basic I, II, Advanced)
Lecture on Human and Engineered Environmental Studies

Lectures offered by EMP (*)
Sustainability Perspectives in Environmental Issues
Fundamentals of Environmental Planning
Environmental Business
Environmental Economics
Introduction to Environmental Systems
Fundamentals of Natural Environmental Studies
Introduction to Sociocultural Environmental Studies
Business and Finance for Sustainable Development
Special Lecture on Project Management

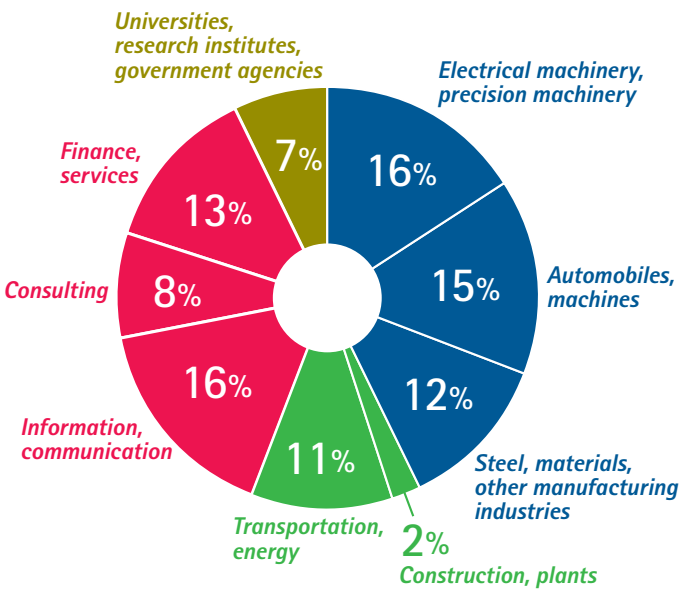
***Environmental Management Program (EMP)**

This is a program for studying environmental technology from perspectives such as economics, business, culture, and society. Those who are interested in comprehensively learning about environmental technologies, transferring technology, and starting businesses may cross-select from each department in the Division of Environmental Studies. Based on an understanding of the structure of environmental problems and their technical and social solutions, we aim to develop students' abilities to conduct various projects designed to create an environmentally friendly society.

Career path after graduation

Many of our graduates hold leadership positions in major companies and research institutes, both in Japan and overseas.

Employment record by type of industry



Each year, about 50 students complete a master's program and approximately 10 complete a doctoral course. Roughly, 10% of master's course graduates advance to a doctoral program, while others find employment with institutions and companies in wide-ranging fields.

Electrical machinery, precision machinery	Sony, Hitachi, Hitachi Medico, Hitachi Appliances, Toshiba, Sharp, Mitsubishi Electric, Olympus, Fujitsu, Fanuc, Nihon Kohden, Huawei, Electric Power Development, Yaskawa, Nippon Juden Kogyo, and others
Automobiles, machines	Toyota Motor, Denso, Honda Motor, Suzuki, Jatco, Mitsubishi Heavy Industries, Daikin, IHI, Komatsu, Advics, Yamazaki Mazak, Johnson Controls-Hitachi Air Conditioning, Aim, and others
Steel, materials, other manufacturing industries	JFE Steel, Nippon Steel, Toray, Hirohama, Roche Diagnostics, Kao, TOTO, Rengo, and others
Construction, plants	JFE Engineering, Mitsubishi Hitachi Power Systems, Mitsubishi Chemical, Toshiba Infrastructure Systems & Solutions, and others
Transportation, energy	JR East, JR Central, JR Freight, ANA, NYK Line, Tokyo Electric Power, Kyushu Electric Power, and others
Information, communication	NTT East, NTT Data, NTT Facilities, NHK, Softbank, Yahoo, IBM Japan, Wingle, User Local, and others
Consulting	Nomura Research Institute, Mizuho Information & Research Institute, Accenture, Simplex, Acroquest Technology, and others
Finance, services	Nippon Life Insurance, Mizuho Bank, J.P. Morgan Securities, Recruit, Slogan, Cygames, Discover 21, D.A. Consortium, and others
Universities, research institutes, government agencies	The University of Tokyo, Kobe University, Kyushu University, Tokyo University of Science, Yokohama National University, The Open University of Japan, Kanagawa Institute of Technology, the National Institute of Advanced Industrial Science and Technology, the Acquisition, Technology & Logistics Agency, Kawasaki City Hall, and others

Examples of employment in recent years ▲

Messages from graduates

Five years in which I learned, discussed, and worked hard. That became my irreplaceable fortune.

Dairoku MURAMATSU

Assistant Professor, Department of Electrical Engineering, Faculty of Science and Technology, Tokyo University of Science

2011: Graduated from Faculty of Science and Technology, Tokyo University of Science
2013: Master's degree in Human and Engineered Environmental Studies
2016: Doctoral degree in Human and Engineered Environmental Studies

Since human bodies absorb electromagnetic waves, our bodies can become obstacles to general radio communication systems. When I was a graduate student, my research theme was a new communication system, namely "Intra-body Communication", in which we in effect use the human body as a path for electromagnetic waves. Interactions between electromagnetic waves and the human body, which is intricately composed of many tissues, were hard to understand, and we approached the subject in an integrated manner, through both experiments and numerical analyses. Now, as an assistant professor in the department in which I got my bachelor's degree, I am working on designing physical layers of digital radio communication.

In the graduate school, faculty and students with varied backgrounds get together, and there are many opportunities for international research exchanges. My experience in this environment where I learned a lot, discussed a lot, and worked hard, became my irreplaceable fortune. My hope is that present-day students and prospective students will spend their precious early years meaningfully, and will become talented people, each able to play an active role in society.

During my studies, I grew tremendously and gained great opportunities for exchange studies in France as a researcher.

Jingyu SUN

Researcher,
NTT Network Innovation Laboratories

2008: Graduated from Beihang University
2013: Master's degree in Human and Engineered Environmental Studies
2014: Studied at Univeristé Jean Monnet
2016: Doctoral degree in Human and Engineered Environmental Studies

I am working on IoT-related research at NTT Network Innovation Laboratories. I am encouraged every day by the aim to value information through new sensing technologies, AI, and big data processing.

As a graduate student, I measured and evaluated large, complex 3-D shapes for the manufacturing industry and evaluated processing methods. For shipbuilding companies, I helped to develop an evaluation method for 3-D curved outer plates using 3-D measurement equipment, as well as a generation system for curved outer plates using 3-D shape evaluation for wood-type jigs. In addition, I had the opportunity to study in France for six months as a researcher.

If you plan to go on to graduate school, the experiences you gain during those few years of study will be extremely important for your future career. Please become immersed in research activities and recognize opportunities for growth.

We aim to accumulate and evaluate social experiments and show our solutions to society.

Case 1 ● Environmental information device leading to Society 5.0

Development of gyroscopic generators

Environmental Information and Microsystems Laboratory
Hiroshi HOSAKA, *Professor* / Ken SASAKI, *Professor*

Society 5.0 is a society model that connects everything in a real space to a virtual space through the Internet of Things (IoT), and generates new value from feedback. To realize this, countless numbers of communication terminals are needed, and it is expected that 30 billion terminals will be reached in 2020. The performance of CPUs and memories, which are parts of those terminals, is increasing exponentially, but the progress of the performance of cells is no more than a few percent per year. As a supplemental technology of cells, energy harvesting is gathering attention. This is a technology that converts light, heat, radio waves, and vibration, which are widely found in many environments, into electric power. Energy harvesting that makes use of vibration is being studied worldwide, because of its high energy density.

In a conventional vibration-powered generator, a weight is supported by a spring, and the vibration of the weight is converted to electric power in a piezoelectric element or a coil. The electric power generation reaches a maximum when the weight resonates with an external vibrator, and the power is proportional to the cube of the frequency and the mass. If the device is a wearable type, then its mass and frequency are small, and the upper limit of the power of such devices has so far not exceeded several tens of milliwatts. For example, in a watch generator, even when the kinetic energy of an arm is 1 W or more, the electric power generation is just several micro W, and only one hundred-thousandth of the kinetic energy can be converted to electric power.

We have devised a method to generate high power by vibrating a rotating body. A rotating body has the characteristic of preserving its posture, which is called a gyro effect. As shown in Figure 1, when we make a rotating disc with ω_y tilted with an angular speed ω_z, an inertial torque of $\tau_x = I_x \omega_y \omega_z$ is generated. I_x is the moment of inertia. If we increase ω_y, we can eventually maximize the value of τ_x, hence make the generator rotate fast with a large τ_x.

Figure 2 shows the composition of a gyroscopic generator. First, the rotor is rotated by a motor. When a rotational vibration is added externally, a processional rotation begins, owing to the gyro effect. Its rotation speed is increased by the gear, which makes the permanent magnet rotate, and an induced voltage is generated in the coil. The generated electric power is rectified, the voltage is boosted by the DC/DC converter, and the electric power is returned to the motor. Then the rotation speed increases, the gyro effect increases, and the electric power generation is further enhanced. The generated electric power is accumulated in the rotor as kinetic energy, and it becomes a kind of flywheel battery. Compared with a conventional simple harmonic motion type, the generation power is almost "rotation speed/input frequency" times larger, and it is about 100 times larger than a conventional type when the generator is a wearable type. Furthermore, the gyroscopic-type generator does not use resonance, and the electricity is generated even by natural random vibrations.

Figure 3 shows an experimental generator unit. It generates 1.8 W by rotating a rotor with a diameter of 100 mm at 500 rpm, and vibrating at 2.5 Hz. Figure 4 shows a prototype, modified from a 2.5-inch HDD, which generates 0.25 W. A 3.5-inch HDD generates 1.8 W.

Gyroscopic generators are an example of mechatronics, in which mechanical engineering and electronics are fused. Their production is an industrial field in which precision parts technologies of HDDs and watches are used, and in which Japan is leading the world.

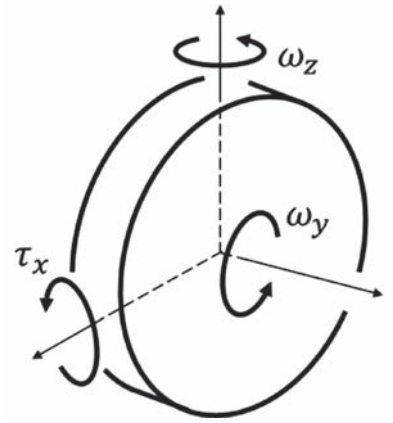


Figure 1) Gyro effect

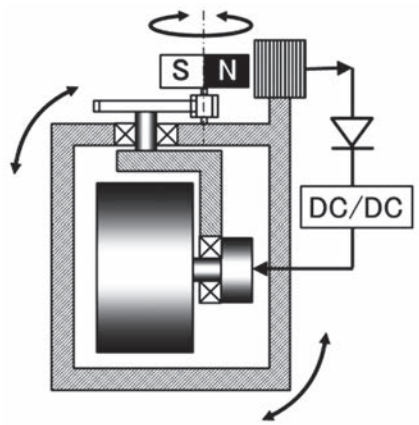


Figure 2) Composition of a gyroscopic generator

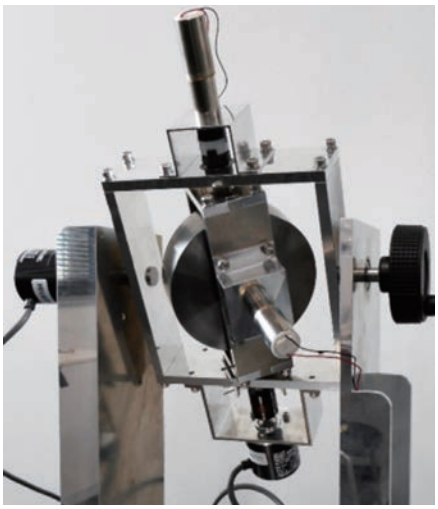


Figure 3) 1.8 W experimental unit


Figure 4) 2.5-inch prototype

Case 2 ● Development an information support robot system for the elderly with cognitive disabilities

Assisting in the daily lives of mild dementia patients, using robots

Assistive Technology Laboratory

Minoru KAMATA, *Professor* / Motoki SHINO, *Associate Professor* / Misato NIHEI, *Lecturer*

The average length of life is increasing because of improvements in medical care, welfare, and lifestyles, and the elderly population worldwide is increasing in number. Japan has proportionately more aged people than other countries, and it is reported that about 2.06 million Japanese are 90 years old and over. On the other hand, since the number of people with frailties, deteriorating cognitive functions, and chronic diseases and other disorders increases with aging, it is necessary for aged people to use support devices to maintain a comfortable and independent life at home. It is predicted that international demand for support devices will surely increase because of the increase in numbers of aged people around the world.

The Cabinet Office set a goal of future investment strategy such that evidence-based care, robots, and so on are used for self-reliance support, to extend healthy life expectancy. It is expected that technologies in the future will solve problems such as self-reliance support and so reduce the burden on nursing. However, there is much uncertainty in the process of introduction of new devices, the effect on user quality of life (QOL), and social effects. Therefore, genuine efforts could not be made in the industrial world.

Against this background, the Japan Science and Technology Agency, a national research and development agency, has a program of "Creation of science, technology, and systems that enrich an aging society" in its Strategic Promotion of Innovative Research and Development. The program aims to realize support for independent lives, and efforts have been undertaken through cross-cutting and long-term industry–academia collaborations. We are participating in this program, conducting the development of an information support robot system to deal with deterioration of memory and cognitive functions for aged people. We participate in establishing a support method to facilitate "information acquisition" and "communication", which are required functions in daily lives and communities. We aim to establish a methodology to make use of information communication technology (ICT) and information robotics technology (IRT).

In this project, based on technology development attached to sites of daily living (field-based innovation), we are developing a robot system to reliably transmit information required for daily living, conducting focus group discussions in local areas, in order that aged people may realize independent and self-sustaining lives. In addition, we aim to create industries of total support for aged people, including an introduction service and a supply system for individual users.

We have gained knowledge of support technologies, such as synthetic sounds that are easy to listen to by adjusting to the characteristics of mind and body functions of aged people, a technology to reliably transmit information using a communication method based on a human dialog model, interface technologies (such as one to read the intention of conversation), a method of introduction evaluation at elderly facilities and at home, and a method of action research in local areas. These pieces of knowledge contribute to the international standardization of support devices for cognitive functions and to the establishment of development and evaluation platforms for audio information support IT services for aged people in the future in Japan. Through this project, we would like to contribute to the development and promotion of ICT/IRT systems for the extension of healthy life expectancy.

Focus group discussion on using support systems

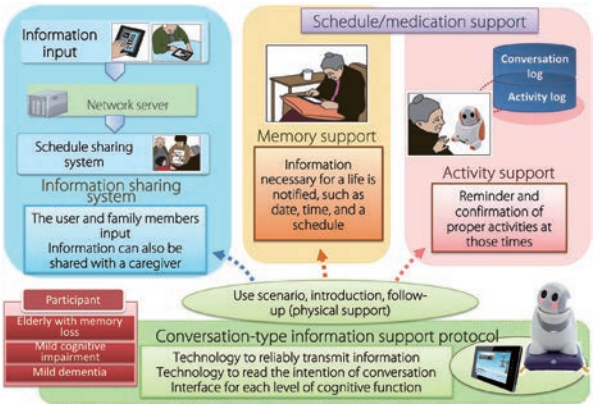


Figure 1) Information support system under development (requested functions obtained by studies based on sites)

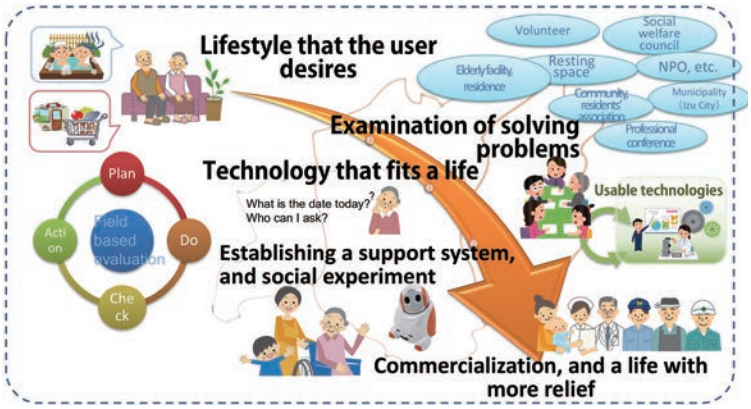


Figure 2) Action research in a local area, and the society we are aiming for

LABORATORY INTRODUCTION

The laboratories of the Department of Human and Engineered Environmental Studies are accepting visits and questions. If you are interested in the details of individual research content, please refer to the laboratory home page and feel free to contact faculty members.

Human and environment informatics

Shin'ichi WARISAWA

Professor

Born in Hiroshima in 1966. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Professional interests include nanomechanics, nano-micro-processing, production systems, medical support systems, and production culture. I believe the desire to make people happy leads to research that can contribute to society.

Rui FUKUI

Associate Professor

Born in Tokyo in 1979. Obtained PhD from the Graduate School of Information Science and Technology, the University of Tokyo. Professional interests include robotics and intelligent sensing systems. I hope to share a feeling of accomplishment for creating new things with students.

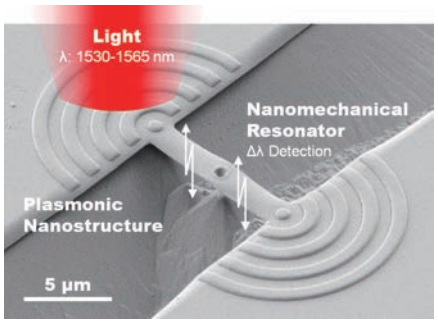
Reo KOMETANI

Associate Professor

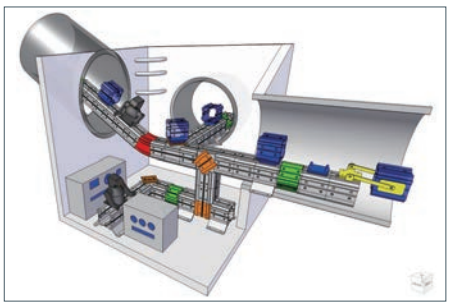
Born in Hyogo in 1981. Obtained PhD from the Graduate School of Material Science, University of Hyogo. Professional interests include charged particle beam engineering, nano/micro processing, nano measurement, nanomechanics, and NEMS (Nano electro mechanical systems). I care about having "fun!" and I would like to create new technologies that will enrich people's lives and society.

It is important to combine sensing technologies with information and communication technologies for innovations in living and production environments. We will present the ideal form of an innovative sensor-based information network system and contribute to the realization of a safe, secure, and comfortable living environment/production site. For this purpose, we are developing nano/microsensing devices with new detection principles that can be incorporated into mobile information terminals and wearable devices. We are also developing environmentally distributed robot systems that observe people and the environment using new sensing technologies. We will also deploy our technologies into human living spaces and production sites, conducting research to acquire and analyze real environmental and human-activity data.

website *http://www.lhei.k.u-tokyo.ac.jp/*



NEMS wavelength sensing device



Distributed robot system for hazardous environments

Assistive technology

Minoru KAMATA

Professor

Born in Kanagawa in 1959. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Professional interests include vehicle engineering and welfare engineering. I am interested in the relationships between people and machinery, as well as between people and society. Using engineering approaches, I aim to solve the problems related to the super-aged society and create social systems and living environments that will become global models.

Motoki SHINO

Associate Professor

Born in Wakayama in 1974. Obtained PhD from the Graduate School of Engineering, Tokyo University of Agriculture and Technology. Professional interests include mechanical dynamics and assistive technology through understanding human adaptability and robotics. I am conducting research on advanced interfaces based on human functions, capabilities, and sensibilities, along with the elucidation of error-generation factors in human interactive scenes. I aim to establish machine designs and technologies that enable comfortable living, safety, and mobility.

Misato NIHEI

Assistant Professor

Born in Miyagi. Obtained PhD from the Graduate School of Advanced Science and Engineering, Waseda University. Professional interests include assistive technology, rehabilitation engineering, and accessible design. To provide truly beneficial assistive devices to people, I elucidate the relationships between living, life, people, and assistive devices from various viewpoints including cognitive science, sociology, and psychology. I aim to propose assistive technologies and gerontechnologies that are useful to people and society.

In this research field, emphasis is placed on understanding the lives of humans, which change along with social changes (e.g., aging, individualization, advanced technology, and globalization) from the viewpoint of quality of life. We aim to promote academic progress and contribute to society by integrating academic knowledge related to daily life, developing new assistive technologies, building social systems, and making policy recommendations.

Our research covers a wide range of design theory on assistive technologies, analysis and modeling, equipment development, assistive product design, elderly mobility, and social implementation. We aim to conduct field-based practical research through understanding human behavior, exercise, cognition, physiology, psychology, and interaction. We pursue research activities through collaboration with a consortium that includes the Institute of Gerontology, national projects, and various companies. In addition, we interact with overseas research institutes that study assistive technology and gerontechnology.

website *http://www.atl.k.u-tokyo.ac.jp/en/*

Vehicle safety research

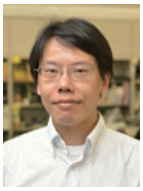
Assistive technology research

Energy environment

Eiji HIHARA

Professor

Born in Hiroshima in 1954. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Specializes in thermal engineering and refrigeration engineering. Research interests include developing a best-mixed energy system, disseminating air conditioning systems with low environmental impact, and establishing fundamental technologies related to innovative refrigeration and air conditioning technology in order to realize a sustainable society.



Chaobin DANG

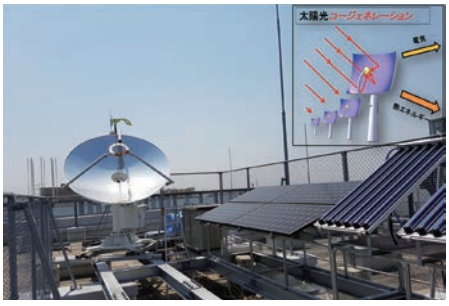
Associate Professor

Born in Sichuan, China, in 1973. Graduated from Beihang University. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Specializes in thermal engineering and refrigeration engineering. Research interests include the effective use of solar energy for expanding renewable energy, air condition systems driven by the waste heat from automobile engines, and the development of next-generation high-efficiency/low-environmental-load air conditioning and microchannel energy equipment.

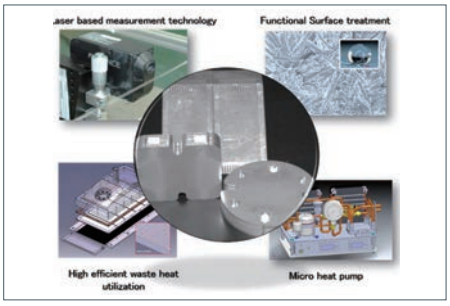
Global environmental problems such as the destruction of the ozone layer, air pollution, and global warming have become serious and must be solved as soon as possible. To solve environmental problems, it is necessary to switch from a mass production/mass consumption society to a recycling society, promote the effective use of energy resources, and form a society that achieves sustainable development.

In this field, we aim to create technologies for using energy in harmony with the environment. Our research areas include 1) air conditioning systems using solar energy, 2) air conditioning systems with processes that separate latent heat and sensible heat, 3) low global warming potential (GWP) refrigerant heat pumps, 4) high-performance heat exchangers using microchannels, and 5) photovoltaic and solar thermal cogeneration systems.

website *http://www.hee.k.u-tokyo.ac.jp/index_e.html*



Solar cogeneration system



Development of energy equipment using microchannels

Low-carbon society

Tetsuo MUNAKATA
Visiting Professor

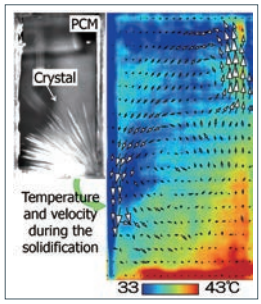
Born in Fukushima in 1961. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Professional interest is in heat transfer. Through the elucidation and control of heat and mass transfer phenomena in new energy-saving equipment and processes, I aim to develop a next-generation energy system for building a low-carbon society.

To contribute to the realization of a sustainable social system with a low environmental impact, we are working on the development of heat and fluid flow measurement and simulation technologies, as well as basic research and application research on thermal fluid systems using these technologies. In cooperation with the National Institute of Advanced Industrial Science and Technology, we are promoting green innovation aimed at realizing a low-carbon society, such as the highly efficient use of natural energy and energy conservation systems.

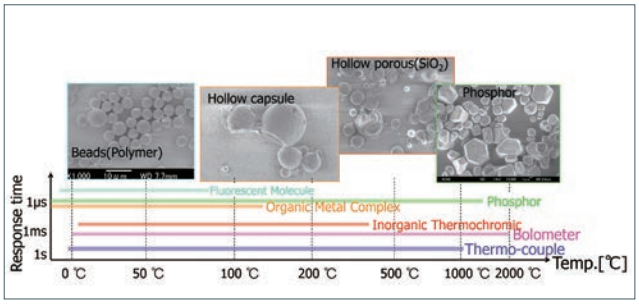
We are unveiling unknown phenomena through the "visualization of invisible things" and working to develop highly efficient thermal energy equipment.

Our research areas include 1) visualization, measurement, and simulation techniques for highly efficient thermal fluid systems, 2) thermal energy storage and transport systems for the effective utilization of unused thermal energy, and 3) fuel-cell systems.

website *http://lcs.k.u-tokyo.ac.jp/*



Development of latent heat storage system (visualization of velocity and temperature fields)



Development of functional tracer particles for the visualization of velocity and temperature fields

Global energy systems

Hiroshi ASANO
Visiting Professor

Born in Gifu in 1960. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Professional interest is in energy system engineering. I study next-generation energy systems and their realization methods from both technical and economic perspectives while training people to contribute to solving global problems.

Shigeru BANDO
Visiting Associate Professor

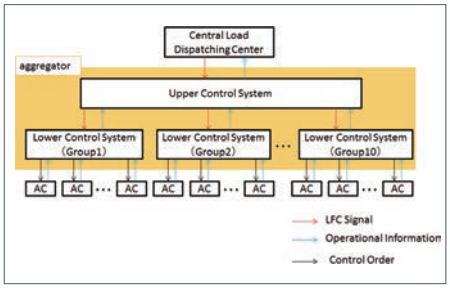
Born in Nara in 1976. Obtained PhD from the Graduate School of Frontier Sciences, the University of Tokyo. Professional interest is in energy system engineering. Our laboratory is developing research on so-called smart grids and exploring how demand-side "smartization" can contribute to a huge power grid.

It is impossible to prevent global warming by developing and disseminating a single technology. We need to strengthen multifaceted efforts such as energy-production technologies with low environmental loads, easy-to-use and efficient energy-use technologies, social systems that will produce a low-carbon society, and environmental policies from international perspectives. This collaborative chair with the Central Research Institute of Electric Power Industry recognizes the need to change the social system to realize a low-carbon society, study technology that balances energy security and environmental conservation from a global perspective, and train human resources who can be globally active.

Students in this laboratory are interested in both technology and socioeconomics, and they acquire basic knowledge of electric power systems, economics, control engineering, and thermodynamics. They engage in the following areas of research for next-generation energy systems: 1) designing a demand-adjustment mechanism for the mass dissemination of solar power generation and wind power generation, 2) controlling energy storage functions and smart devices, and 3) the economic evaluation of demand management through an optimal power supply configuration model.

website *http://www.ges.k.u-tokyo.ac.jp/index-e.htm*

A mechanism that controls consumer equipment and stabilizes the operation of the electric power system



Hierarchical control structure for smart grids using air conditioners

Industrial information systems and environment

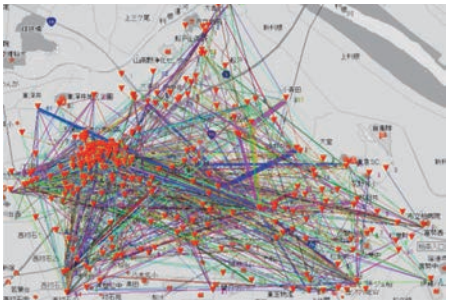
Kazuo HIEKATA
Associate Professor

Born in Kanagawa in 1974. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Professional interests include design engineering and information systems. He supports the use of advanced information technologies in the industrial field. He aims to build a systems design methodology to re-frame complex systems such as the industrial environment and social systems using information technologies.

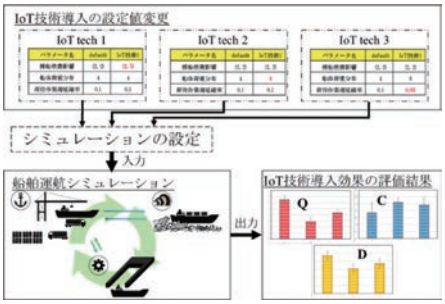
Presently, industries and society work as a complex and large-scale system of systems, which is composed of a combination of various artificial systems. To quickly solve problems in industries and society, it requires the introduction of excellent technologies used in different fields that can deal with changes in external environments, and even a revolution in organizations and processes. Against this background, in our research field of industrial information systems and environment we are working on such subjects as: the establishment of a methodology to describe the purpose, functions, behaviors, and interests of a system, and the relationship between subsystems; the development of a model to simulate behaviors of large-scale and complex systems in society and industries; and the establishment of a teamwork environment to support deep communications and collaborations between experts in different fields.

Specifically, to create unconventional industries, we are examining maritime industries such as shipbuilding and marine logistics, information system industries, and public transportation in an aging society.

website *https://is.edu.k.u-tokyo.ac.jp/top-english*



On-demand bus in the demonstration experiment at Kashiwa



Stakeholder Analysis for System Re-Framing of Marine Industry

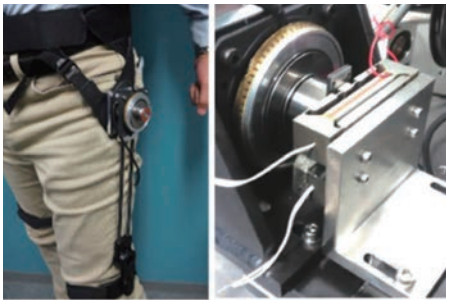
Human support device

Takeshi MORITA
Professor

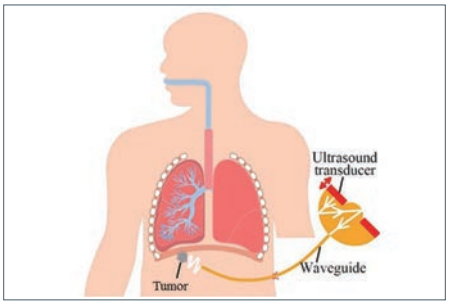
Born in Saitama in 1970. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Professional interest is in applied ferroelectric devices. It can be quite difficult to seriously enjoy your studies; let's do our best to enjoy a fulfilling student life together.

To realize a sustainable society in which everyone can enjoy a healthy, safe, and secure life, human support device laboratory is trying to contribute a super-aging society. In particular, we research on human related systems, such as a walking support system, a nursing robot, and an internal body monitoring endoscope, mainly for elderly people. For developing these systems, just combining conventional technologies is insufficient; instead, revolutionary researches on elemental devices for actuators and sensors are essential, which are based on the original and new ideas. That is to say, fundamental researches are indispensable, including materials engineering, mechanical engineering, electrical engineering and control engineering. Moreover, in addition to these elemental technologies and systemization, it is important to examine the cooperative relationship between developed systems and humans, and to confirm the effective operation to the human behaviors. From these points, the cross-cutting researches such as human interfaces and biological monitoring are also included in our research topics.

website *http://www.hsd.k.u-tokyo.ac.jp/contents/english/index.html*



Walking assistance system and new-concept actuator



Next-generation medical device using strong ultrasound

Human environment monitoring

Toshihiro ITOH

Professor

Born in Gifu in 1965. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Professional interests include network MEMS (wireless sensors) and manufacturing technology for large-area devices. I believe that problem consciousness and problem setting are important for research. The first thing we need to do is identify challenges we can work seriously on.

Seiichi TAKAMATSU

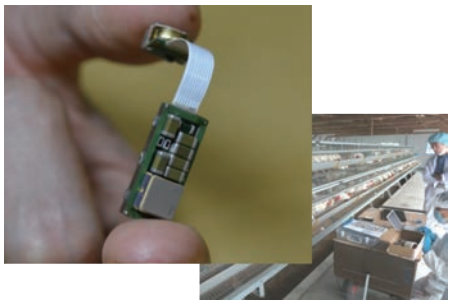
Associate Professor

Born in Hiroshima in 1979. Obtained PhD from the Graduate School of Information Science and Technology, the University of Tokyo. Professional interests include organic MEMS and electronic textile manufacturing technology. I aim to solve the problems of people and society by incorporating sensors into clothing, carpets, wallpaper, etc. Let's create a new sensor system together.

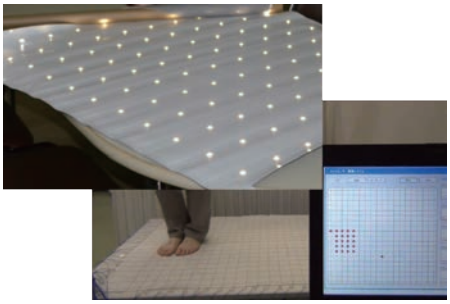
We conduct research and development on equipment that supports people based on the mounting and integration technology of N/MEMS (nano/micro-electro mechanical systems) as well as sensing technology to recognize the ever-changing movement of people's environments (e.g., living environments, manufacturing sites, and social infrastructure). To achieve the social implementation of these sensing technologies, we are actively conducting field experiments.

The following are examples of our research themes: 1) developing ultra-low power and sensitive MEMS sensors and wireless sensor network systems to monitor the health of farm and companion animals, 2) developing wireless sensor network systems for the condition-based maintenance of industrial infrastructure equipment, 3) developing a sensitive strain sensing sheet for monitoring the health of social infrastructure such as bridges, and 4) developing wearable sensor textiles through fiber processing and integration technology.

website *http://www.hem.k.u-tokyo.ac.jp/index_e.html*

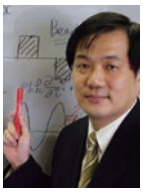


Wireless sensor for animals



Integration technology for large-area devices

Environmental information and microsystems



Hiroshi HOSAKA

Professor

Born in Tokyo in 1956. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Professional interests include machine dynamics and sensor networks. Futuristic machines can collect surrounding information and adapt themselves to people and the environment. I use dynamics, statistics, and algorithms to achieve this.

Ken SASAKI

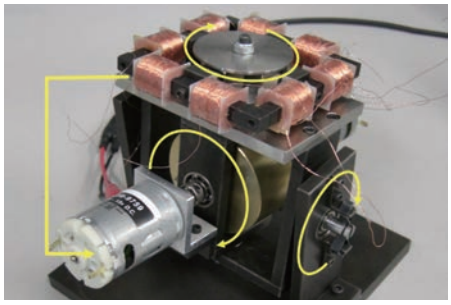
Professor

Born in Kanagawa in 1957. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Professional interests include mechatronics and signal processing. Technology is a knowledge system for the survival and prosperity of mankind. I value popular sentiments and playfulness as well as intellectually inquiring minds.

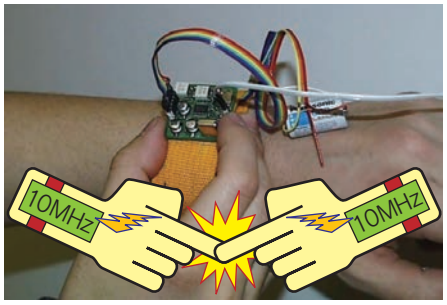
We promote the construction of environmental information networks using ubiquitous information equipment based on information communication, sensing, and mechatronics as foundation technologies. We aim to miniaturize devices as much as possible and diversify input information, making devices wearable on humans and artifacts. A terminal consists of a sensor, an energy source, a CPU, and a wireless device. It has the minimum function of capturing information from the natural world into the network.

Students in this laboratory acquire basic knowledge (e.g., dynamics, mechatronics, biometric measurement, and information processing) and work in the following research areas: 1) Wireless personal area network using the human body as a signal transmission path, 2) Micro-power generation in which minute vibrations of a human body or a natural object are converted to electrical energy, 3) Remote control system on which tactile information is superimposed, 4) Recognition of environmental sound (other than human voices), and 5) Location finding that uses mobile communication network and position data mining.

website *http://www.ems.k.u-tokyo.ac.jp/e/*



Gyroscopic generator



Communication system using a human body as a transmission line

Simulation of complex environmental systems

Hiroshi OKUDA

Professor

Born in Fukui in 1962. Obtained PhD from the Department of Nuclear Engineering, Graduate School of Engineering, the University of Tokyo. Why not create an "artifacts simulator" to quantify the value of artifacts in the relations among people, society, and the environment? We welcome students who can accurately record ideas and research processes, and be optimistic.

Yu CHEN

Professor

Born in Shanghai, China, in 1967. Graduated from the Department of Power Machinery, Shanghai Jiao Tong University. Obtained PhD from the Department of Quantum Engineering and Systems Science, Graduate School of Engineering, the University of Tokyo. My specialty is the modeling and simulation of complex systems. Let's enjoy doing computational studies on physical, biological and socio-economic systems together!

Gaku HASHIMOTO

Assistant Professor

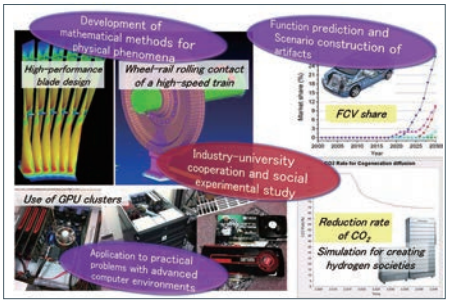
Born in Mie in 1978. Obtained PhD from the School of Science for Open and Environmental Systems, Keio University. Specialty fields include computational mechanics and multiphysics. By using High Performance Computing technologies effectively, let's integrate different disciplines, such as mechanical systems, social systems, and information systems, and create a novel simulation model that can predict the human environment together. It is important to think outside the box of the conventional discipline.

Employing frontier computational science and advanced IT technology, we are doing researches on complex systems related to human beings and environments.

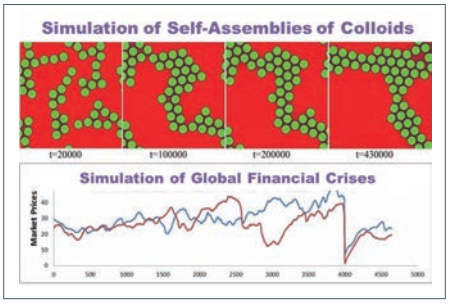
The *Multiscenario Simulation (MS) Laboratory* aims to develop a simulator that can modify and reconstruct the functions of artifacts and introduction-evaluation scenarios. We are conducting research in the following areas to create Green Innovation by performing real simulations on supercomputers: 1) designing an environmental agent for construction of a low-carbon society, 2) developing a parallel finite element analysis system, "FrontISTR," with industrial applications, 3) developing a mathematical method for multiphysics problems, and 4) developing HPC infrastructure for next generation exascale computer systems.

In the *Simulation of Complex System (CS) Laboratory* we are conducting research to construct discrete micromodels and to perform simulations of complex systems. We set three research directions as typical studies on complex systems: 1) analyzing financial markets using multi-agent cooperative evolution games, 2) simulating complex fluids using a model based on the discrete kinetic theory, and 3) cell-based modeling and simulation of aging and cancer genesis.

website *http://www.multi.k.u-tokyo.ac.jp/indexen.php, http://www.scslab.k.u-tokyo.ac.jp/indexE.html*



Multiscenario simulator developed in the *MS laboratory*



Complex system simulation performed in the *CS laboratory*

Sports science for health and activity

Naokata ISHII

Professor

Born in Tokyo in 1955. Obtained PhD from the Department of Biology, Graduate School of Science, the University of Tokyo. Professional interests are in muscle physiology and exercise science. I have been involved in elucidating the adaptation mechanism of muscles to mechanical environments and developing new training methods. I want to study not only muscles but also the fundamental mechanisms of life, and conduct research leading to the development of new technologies.

Chiho FUKUSAKI

Associate Professor

Born in Kanagawa in 1970. Obtained PhD from the Graduate School of Education, the University of Tokyo. Professional interest is in exercise physiology. In addition to researching biological responses to hypoxic and hyperoxic environments, I also teach elderly and handicapped people aquatic and walking exercises. I aim to develop new methods to maintain and improve physical functions with stimuli such as exercise and environmental changes.

To improve the quality of life (QOL) in a super-aged society, there is increased emphasis on the value of individual freedom of activity. Elderly people should not passively receive care but should proactively live and act. For this purpose, it is necessary to maintain and promote appropriate physical strength for middle-aged and elderly people. Therefore, in this laboratory, we aim to research and develop methods for safe, effective, and continuing exercise while considering the health conditions and lifestyles of middle-aged and elderly people.

Our research areas include the following: 1) research on the physiological mechanisms of physical functions related to exercise, 2) developing new exercise and training methods based on the mechanisms of muscle and brain functions, 3) developing new exercise and training methods based on the mechanism of respiratory circulation function (training method applying low-oxygen/high-oxygen environments).

website *http://webpark1277.sakura.ne.jp/e/*

Environment simulator room in which the oxygen concentration can be controlled

Isokinetic measurement of muscle strength

Human augmentation

Masaaki MOCHIMARU
Visiting Professor

Born in Kanagawa in 1964. Obtained PhD from the Graduate School at Keio University. Currently, Director of the Human Augmentation Research Center at the AIST. My specialties are ergonomics, biomechanics, and service engineering. I have been conducting research on the measurement of human body and motion, to reproduce them digitally, and to utilize them to manufacturing and services. I will next conduct research on *human augmentation* based on these technologies.

Yoshio MATSUMOTO
Visiting Professor

Born in Saitama in 1970. Obtained PhD from the Graduate School of Engineering, the University of Tokyo. Worked at the Australian National University, Nara Institute of Science and Technology, and Osaka University. Currently, Research Team Leader in the Human Augmentation Research Center at the AIST. I have been conducting research on assistive robotics, social robotics, and robot vision. My research aims to expand life functions through robot technologies.

Akihiko MURAI
Visiting Associate Professor

Born in Nara in 1980. Obtained PhD from the Graduate School of Information Science and Technology, the University of Tokyo. Currently, Senior Research Scientist of the Human Augmentation Research Center at the AIST. My specialties are robotics and biomechanics. I am conducting research to understand the mechanisms of human motion generation and control, and to expand human motor ability and sensibility based on kinetics and cognitive interventions.

In this research field, we conduct development and research on systems that enhance human physical functions by approaching not only people whose functions have deteriorated due to aging and disorder, but also people who are living normally. We think that people can be more active after they feel that their body function is enhanced. Through this research, we aim for improved healthcare and nursing care services, and improved opportunities for working.

Systems enhancing human are composed of wearable sensors, robots, VR devices. For realizing systems that augment human functions, it is also important to conduct basic research to deeply understand human sensation, dynamics and psychological functions, and to represent them with a human model. We will undertake both basic researches to understand humans and to develop application system in order to realize human augmentation. The laboratory is located in the AIST Kashiwa Center in Kashiwa II Campus, and there will be collaborations with AIST researchers on sensors, robots, psychology, service engineering, and design. We place emphasis on the implementation of technologies, and we proceed with research based on projects collaborating with companies.

website *https://unit.aist.go.jp/harc/en/index.html*

Sensing and enhancing human life functions by robotic devices for elderly care.

Superhuman sports using artificial muscles and strengthening environmental sound

Universal sports health science (Xebio)

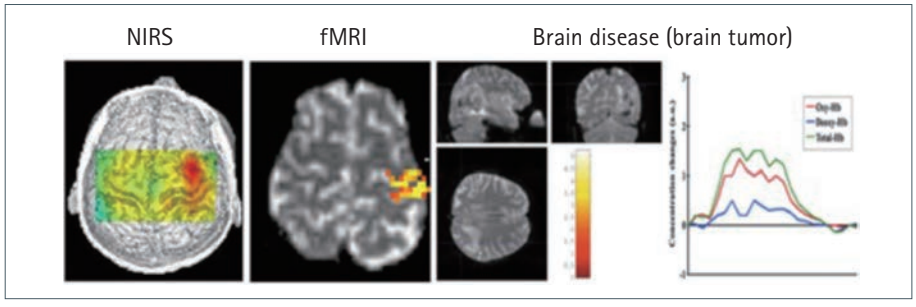
Kaoru SAKATANI
Project Professor

Born in Kobe in 1955. Completed the doctoral course in the Graduate School of Medicine, Osaka Medical College. PhD from the Graduate School of Engineering, Hokkaido University. I am conducting research and development of a next-generation healthcare system, in which brain and mental disorders, such as dementia and stress disorder, can be detected at an early stage, using advanced technologies such as IoT and AI, and diseases can be prevented by non-drug treatments such as doing sports.

To deal with health problems in an aging society, we are developing a next-generation healthcare system in which medical science and advanced engineering are integrated. It is an important research subject, to realize early detection of brain disorders such as dementia and body disorders such as frailty, and to prevent those types of disorders. Another research subject is the understanding of health disorders of children due to stress and lack of exercise.

To solve these problems, we are developing a next-generation healthcare system in which advanced technologies such as IoT and AI are employed, and we are undertaking research to realize social implementation of the system. We carry out clinical research for patients, collaborating with medical institutions. In particular, we put emphasis on brain science research using an imaging instrument, such as near-infrared spectroscopy (NIRS). We also carry out research and development in academic–industrial collaboration, with enterprises including Xebio Holdings. It is essential to collaborate not only with medical enterprises, but with various types of enterprises. We are sure that our research will bring innovation to medical health fields.

website *http://sakatani-lab.org*



Functional neuroimaging of a brain tumor patient by NIRS and fMRI

Organization

- Graduate School of Frontier Sciences
  - Division of Transdisciplinary Sciences
    - Department of Advanced Materials Science
    - Department of Advanced Energy
    - Department of Complexity Science and Engineering
  - Division of Biosciences
    - Department of Integrated Biosciences
    - Department of Computational Biology and Medical Sciences
  - Division of Environmental Studies
    - Department of Natural Environmental Studies
    - Department of Ocean Technology, Policy, and Environment
    - Department of Environment Systems
    - **Department of Human and Engineered Environmental Studies**
    - Department of Socio-Cultural Environmental Studies
    - Department of International Studies
    - Graduate Program in Sustainability
  - Facilities
    - Research Center for Total Life Health and Sports Sciences
    - Center for Omics and Bioinformatics
    - Bioimaging Center
    - Functional Proteomics Center
    - TJCC (UTokyo-JAXA Center for Composites)

Human and environment informatics P.8
Shin'ichi WARISAWA, Rui FUKUI, Reo KOMETANI

Assistive technology P.9
Minoru KAMATA, Motoki SHINO, Misato NIHEI

Energy environment P.9
Eiji HIHARA, Chaobin DANG

Low-carbon society P.10
Tetsuo MUNAKATA, Satoshi SOMEYA

Global energy systems P.10
Hiroshi ASANO, Shigeru BANDO

Industrial information systems and environment P.11
Kazuo HIEKATA

Human support device P.11
Takeshi MORITA

Human environment monitoring P.12
Toshihiro ITOH, Seiichi TAKAMATSU

Environmental information and microsystems P.12
Hiroshi HOSAKA, Ken SASAKI

Simulation of complex environmental systems P.13
Hiroshi OKUDA, Yu CHEN, Gaku HASHIMOTO

Sports science for health and activity P.13
Naokata ISHII, Chiho FUKUSAKI

Human augmentation P.14
Masaaki MOCHIMARU, Yoshio MATSUMOTO, Akihiko MURAI

Universal sports health science (Xebio) P.14
Kaoru SAKATANI

Inquiries concerning the entrance examination

For information about the entrance examination, please refer to the graduate school application guidelines and the entrance examination guide. For details on how to obtain these documents and a detailed schedule of the entrance examination briefing session, visit the website of the Department of Human and Engineered Environmental Studies, Graduate School of Frontier Sciences, the University of Tokyo (http://www.h.k.u-tokyo.ac.jp/en/).

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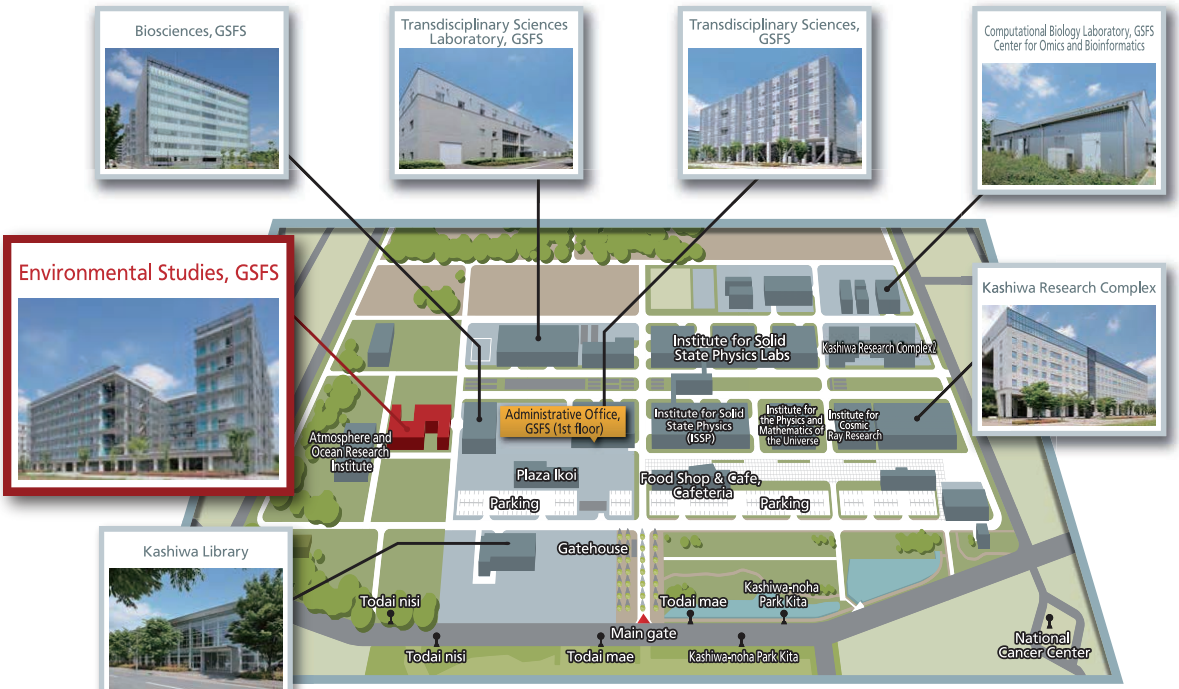

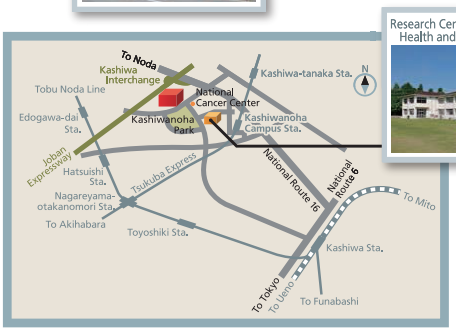

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