THE UNIVERSITY OF TOKYO

DEPARTMENT OF

HUMAN AND ENGINEERED ENVIRONMENTAL STUDIES

Graduate School of Frontier Sciences, The University of Tokyo

2023–2024

New Horizon for Bright Future

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

Using engineering and informatics as fundamental technologies, along with an understanding of human characteristics, this department conducts research that contributes to human activities by developing novel elemental technologies and system designs. Our research targets focus primarily on the engineered devices and man-made systems that make up our societal and living environment. Among the research themes considered are the development of assistive technologies that will enable people to live their lives in a secure manner, the realization of services that will ensure the safety of the social infrastructure that surrounds us, and the realization of a carbon neutral future for the global environment.
Our mission is to create frameworks that will lead to the realization of a safe and secure society under the motto of *"understanding people, supporting people, and connecting people."*

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While the world is changing at a rapid pace, our department focuses on "human beings" and the "environment" that surrounds them, and aims to "realize a rich life where people and the environment are in harmony." Specifically, we set the realization of a low-carbon society and solutions to the problems of a super-aging society as the targets, and conduct research and educational activities by introducing "academic fusion" across multiple academic fields.

The research projects of each laboratory and the educational curriculum of the department are based on core technologies and fundamental theories such as energy engineering, system design, mechatronics, ergonomics, robotics, sensing, information engineering, and computational engineering. Not only can students pursue academic theories, but they can also apply and develop their strengths through working hand in hand with researchers in different fields.

Furthermore, the Kashiwa Campus is filled with opportunities to integrate ideas from different research fields via the integrated planning and management of the Graduate School of Frontier Sciences, research centers, and support facilities. The Graduate School of Frontier Sciences is also characterized by its providing many projects that involve regional and international collaboration and demonstrational experiments; hence students will be able to experience how their research can be actually useful in society.

We hope that, while aiming to contribute to the growth of "Human Environmental Studies", faculties and students will work hard in our department to find new solutions to the various problems of nature and society. Let us make unabashedly challenging attempts together toward a new era shaped by humans and the environment.

CHEN Yu
Head of the Department,
Department of Human and Engineered Environmental Studies,
Graduate School of Frontier Sciences, the University of Tokyo

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 cultivate people who have immense knowledge about human beings and artifacts and to solve various problems in the community by looking at them from the perspective of the environment. Our curriculum include lectures on energy engineering, system engineering, sports science, mechatronics, sensing, computer science, simulation, etc., which are based on elemental technology and basic theories.
These lectures can be combined in a comprehensive way.

LECTURE LIST

Optimal System Design
Special Lectures on Human and Engineered Environments I and II
International Systems Design Workshop
Theory of Elastic Vibration
Knowledge Information Processing
Wearable Sensing for Human and Environmental Information
Environmental Simulation I and II
Assistive Technology
Actuation Technologies
Biointerface
Modeling and Analysis of Complex Systems
Concept Rapid Prototyping
Teaching Development in Higher Education
Nanoprocessing and Nanometrology
Advanced Course of Mobility Engineering

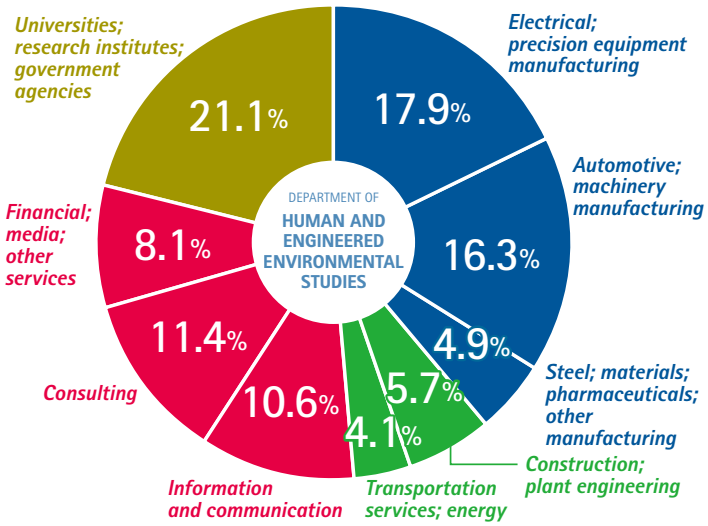
Special Lecture on Human Factors
Special Lectures on Human and Engineered Environmental Studies
Proactive Research Commons
Proactive Environmental Studies II
Human and Engineered Environmental Studies (Basic I, Basic II A, Basic II B and Advanced)
Exercises in Human Environmental Design
Stress Management
Seminar in Aging Control Design
Integrated Environment Design Theory
Special Lecture on i-Construction Systems for Infrastructure Projects
Special Seminar on i-Construction Systems for Infrastructure Projects
Special Lecture on Intelligent Construction System
Dynamics and Control Seminar
Robot Informatics
Special Lecture on Human and Engineered Environment I–V

CAREER PATH AFTER GRADUATION

Many of our graduates now have leading positions in major companies and research institutes in Japan.

Annually, about 50 students complete a master's course and about 10 complete a doctoral course. About 20% of master's course graduates advance to a doctoral course, while others find employment with institutions and companies in a wide range of industries.

Employment record by type of industry



Electrical; precision equipment manufacturing	Sony / Hitachi / Toshiba / Mitsubishi Electric / Fujitsu / FANUC / Yaskawa Electric / Panasonic / Huawei / Canon / KEYENCE / Lenovo Japan / Seiko Epson / etc.
Automotive; machinery manufacturing	Toyota Motor / Nissan Motor / Denso / Honda R&D / Suzuki / NTN / Mitsubishi Heavy Industries / Daikin Industries / IHI / etc.
Steel; materials; pharmaceuticals; other manufacturing	JFE Steel / Nippon Steel / KOSE / TOTO / Sumitomo Electric Industries / Canon Medical Systems / FUJIFILM / P&G / etc.
Construction; plant engineering	Obayashi / JGC Japan / Chiyoda / INPEX / Komatsu / Mitsubishi Chemical / etc.
Transportation services; energy	JR Central / JR Freight / JAL / Central Research Institute of Electric Power Industry / Kyushu Electric Power / Tohoku Electric Power / Chugoku Electric Power / J-POWER / etc.
Information and communication	NTT / NTT Data / NTT Facilities / Softbank / Yahoo Japan / IBM Japan / KDDI / DeNA / Tencent / etc.
Consulting	Nomura Research Institute / Accenture / Simplex Inc. / KPMG Consulting / Simon Kucher & Partner / Pactera Consulting Japan / McKinsey & Company / etc.
Financial; media; other services	Mizuho Bank / Daiwa Securities / NHK / Asahi Shimbun / Recruit Holdings / Konami Amusement / Salesforce Japan / etc.
Universities; research institutes; government agencies	The University of Tokyo / Osaka University / National Institute of Advanced Industrial Science and Technology / Ministry of Economy, Trade and Industry / Acquisition, Technology & Logistics Agency / Japan Ground Self-Defense Force / Department of Industrial Promotion, The Ministry of Industry (Government of Thailand) / etc.

Examples of employment opportunities in recent years ▲

MESSAGES FROM GRADUATES

"Studying in the Department of Human and Engineering Environmental Studies will be a sound basis for your future.

Lui YOSHIDA

Associate Professor,
Graduate School of Engineering, The University of Tokyo

2010: Graduated from the Department of Systems Innovation, Faculty of Engineering
2012: Master's degree in the Department of Human and Engineered Environmental Studies
2015: Doctoral degree in the Department of Human and Engineered Environmental Studies.

I am engaged in various activities and research in educational technology, with a strong desire to improve education. I am particularly interested in online education and active learning. I am developing online educational tools and programs, and supporting teachers in their desire to improve their courses. Online education has gained much attention due to the COVID-19 pandemic, so I am busy with a lot of work. My daily life is fulfilling, since I am carrying out work that I enjoy.

I researched biomedical engineering in the Department of Human and Engineered Environmental Studies, which is seemingly unrelated to educational technology. But I believe I gained useful skills, even though I am working in new fields with my research activities in the department. These include developing creative and logical thinking skills, such as "What is the originality of my research, taking into account previous research?" and "What kind of logic is necessary to assert the originality?" and the flexibility and tenacity to try again even after making a mistake.

Studying in the Department of Human and Engineered Environmental Studies will be a sound basis for your future. I hope that all students will enjoy immersing themselves in their research!

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

Jingyu SUN

Researcher,
NTT Computer and Data Science Laboratories

2008: Graduated from Beihang University
2013: Master's degree in the Department of Human and Engineered Environmental Studies
2014: Studied at Univeristé Jean Monnet
2016: Doctoral degree in the Department of 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 ● Creating innovative interaction devices that are friendly to human and environment

Next-generation actuation and sensing

Ambient Mechatronics
YAMAMOTO Akio, Professor / YOSHIMOTO Shunsuke, Lecturer

In a future society where humans and machines collaborate extensively, realizing sophisticated interactions among humans, machines, and the environment becomes an important challenge. The conventional heavy and rigid devices may not be suitable, and it is necessary to realize interfaces that are lightweight, flexible, and natural, allowing them to seamlessly blend into the environment and accompany humans. To achieve this, innovations in mechatronics technology, especially in actuation and sensing, are indispensable. With this goal in mind, we are developing unique actuation and sensing technologies. Here, we introduce some cases that utilize electric fields.

Electrostatic actuators are actuated by electrostatic force that acts between electrodes or charged insulators. While electrostatic actuators have been extensively studied in micro-scales, it is also possible to realize practical electrostatic actuators on a macroscopic scale. Unlike conventional motors that rely on electromagnetic forces, macroscopic electrostatic actuators offer advantages in terms of their shape, such as a thin form factor, lightweight design, and mechanical flexibility. It is even possible to create optically-transparent actuators. By fully leveraging these unique features, we have developed various innovative interaction systems. For example, we have designed a motion-vision integrated display, where cards or sheets on the display surface can be actuated in accordance with the visual information (see Figure 1). Additionally, we have been researching robotic applications, including ultra-thin wall-climbing robots that utilize electro-adhesion, as well as high-power and lightweight artificial muscles that can interact with humans in a safer manner than conventional heavy motors (see Figure 2). Through these efforts, we are actively pursuing the innovation of robots and interactive systems to achieve distinctive and sophisticated interactions.

By applying a voltage between electrodes placed on an object, a potential distribution is generated according to the Poisson equation. With a focus on the spatial behavior of these electric fields, we are developing technologies related to Electrical Impedance Tomography (EIT). EIT enables control and measurement of potential distributions, as well as the visualization of functions and states in functional materials and living organisms through inverse analysis. Specifically, we have been developing sensing devices that leverage the simplicity of EIT. This includes tactile sensors capable of being installed on various surfaces to detect contact pressure distributions with high sensitivity, as well as motion sensors that are sheet-like and easily embedded in the environment (see Figure 3). Moreover, we are applying our innovative EIT technology to the human body and advancing its application to wearable interfaces that estimate the state and motion of the human musculoskeletal system (see Figure 4), aiming to understand bodily functions and contribute to human support.

While the generation of electrostatic forces and potential distributions has been a well-known phenomenon for a long time, there are still many unexplored areas, for example in understanding their interactions with functional materials. Also, there are many application areas that have yet to be fully revealed. We are committed to gaining a deeper understanding of those phenomena, which serves as the foundation for optimizing the design of related devices. Through those challenges, we aim to drive innovation in our living environment through the advancements in mechatronics technology.

Figure 1) Electrostatic actuators for interactive applications

Figure 2) High-power and light-weight electrostatic artificial muscle

Figure 3) Flexible tactile sensor and proximity imaging

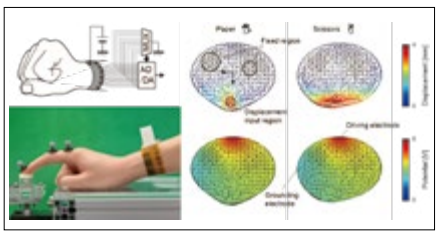


Figure 4) Design of an EIT device to estimate finger motion

Case 2 ● Environmental information device leading to Society 5.0

Developing a new learning system close to human emotions by eye-gaze measurement and facial expressions Heartfelt education for both learning and teaching

Innovative Learning Creation Studies
KURITA Kayoko, Project Professor / HACHISUKA Satori, Project Lecturer

About 30 years have passed since the Lifelong Learning Promotion Act was enacted and the terms "lifelong learning" and "lifelong education" began to be widely used. In general, places where people can continue to study while working or after retirement are being provided in many locations, mainly by local governments and private companies, in addition to the primary and secondary education that starts at elementary school, and higher education at universities. Online learning environments using information and communication technology (ICT) have also been developed in recent years. Nowadays, learning "at any time, anywhere, and by anyone" is becoming possible.

In this way, "learning" has become familiar to a wide range of generations and in diverse environments where both learning and teaching are undertaken. There are many forms of teaching, such as books, the internet, and artificial intelligence (AI). In addition, there are people behind those things (the people who wrote the books, who created the internet materials, and on whom AI knowledge is based). This project focuses on both learning and teaching, and aims to clarify the essence of learning and education by understanding not only the superficial know-how, but also the underlying status (emotions) of humans.

This project concentrates on eye-gaze measurement and facial expressions as a way to understand a person's status. Eye-gaze measurementreveals "where, how much, and how" we are looking (Figure 1, Figure 2). If we think about this in the context of learning, we can see how people who are good at learning run their gaze point along a written question, where they focus their attention to understand the question, and how they arrive at the answer. Also, we can understand the learner's emotional and thinking state as they move their gaze point, such as when they have trouble understanding the content, or getting the answer right but not understanding some essential part of it. For teachres' part, a teacher in the classroom can effectively turn the eyes upon learners to accurately grasp the mental state of them, and to improve their motivation and concentration.

Figure 1) Eye-gaze measurement

Figure 2) Heat map for gaze point

Taro had five apples.
He gave two to Hanako.
How many apples does Taro have now?

Figure 3) Facial expression features

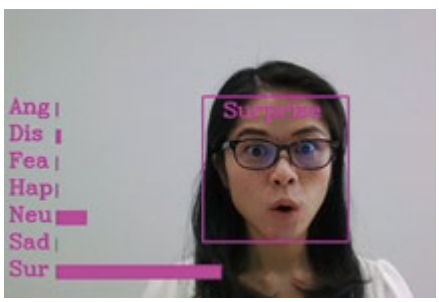


Figure 4) Measurement of emotion from facial expressions

Figure 5) Examination of new teaching method

Sensing facial expressions enables us to understand the mental status of people even more directly than by the gaze point. It is now possible to understand a person's state of emotion or sleepiness by analyzing their facial images and the movement of feature points (Figure 3) on the face (Figure 4). However, unique facial expressions and human states are assumed in a learning environment, and the sensing of these elements requires the extraction of new facial expression features and the building of a database. We are seeking to develop a new teaching method to improve learning by making productive use of the teacher's facial expressions and the learner's mental state (Figure 5).

We would like to establish innovative learning and teaching methods by integrating engineering and pedagogy effectively, and contribute to solving problems such as the use of non-verbal communication, which is considered difficult in today's online learning environment.

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.

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
  - Life Science Data Research Center

Ambient Mechatronics

Lab website http://www.aml.t.u-tokyo.ac.jp/

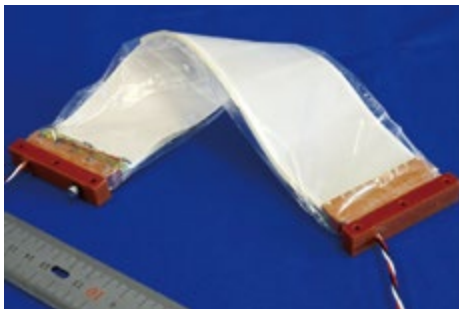
To create innovative human-environment interaction technologies

YAMAMOTO Akio
Professor

Our research group is working on novel actuators and sensors for future robotics and CHI (computer-human interaction) systems. In the area of actuators, a wide range of research topics are covered, with a particular emphasis on electrostatic actuation. For sensors, we are working on built-in sensing for integration with actuators and human-related sensing targeting CHI applications.

We are also working on the development of new robotic systems using our expertise on novel actuators and sensors, such like the thermal walking mechanisms that are actuated by a thermal actuation principle. Development of novel CHI systems is another aspect of our research activities. Especially, we have been working on haptic and tactile systems to realize intuitive CHI.

We welcome new students who are interested in these research fields with a solid background on mechatronics.



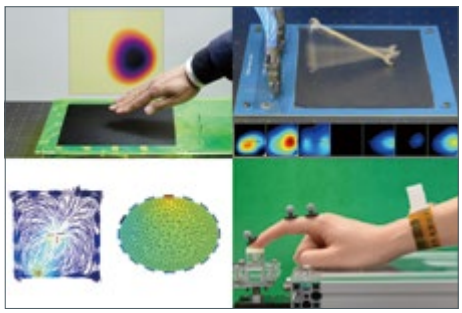
Flexible and high-power Electrostatic Artificial Muscle

YOSHIMOTO Shunsuke
Lecturer

I have been developing biointerface technologies that harmonize machines with humans and environment, and conducting its applied researches. Especially, I am focusing on the interaction between the electromagnetic field and continuum objects such as conductive materials, and biological tissues and developing novel ubiquitous imaging and multimodal sensory display technologies. While making full use of these technologies, I am conducting researches related to the robot environment, human augmentation, evaluation of perceptual characteristics, and applications in industrial and medical fields.

For imaging technologies, I am investigating simple devices such as various shape tactile sensors and sheet-like motion sensors. For sensory display technologies, I am developing novel haptic interface based on the perceptual characteristics.

Through the engineering challenges such as analysis of biological function and structure, investigation on the functional device materials, development of intelligent measurement, and optimization of human machine system, I aim to create innovative interface technologies for the future society.



Versatile imaging by electromagnetic tomography

Sustainable Power and Energy Systems

Lab website http://park.itc.u-tokyo.ac.jp/energy/

Realization of carbon-neutral and convenient energy systems

YAMASAKI Yudai
Professor

To realize a sustainable global environment and society, not only the optimization of individual vehicles and energy devices, but also their organic coordination and cooperation are required. In addition, the design and control of these devices must consider the various characteristics of users, which will lead to the realization of more energy-efficient and convenient devices and systems.

In the field of Sustainable Power and Energy Systems, we are working on automotive powertrains and distributed energy systems. Our research objective is to analyze and synthesize them. The followings are the main topics: 1) the elucidation of phenomena related to energy conversion, 2) modeling using physics and AI, 3) systemization and control using models and information, and 4) the optimization of energy systems considering human behavior.

Model based control of engines considering driver's characteristics

Real World Robot Informatics

Lab website http://www.robot.t.u-tokyo.ac.jp/

Understanding environment and human by robot and sensing technologies

YAMASHITA Atsushi
Professor

Our laboratory focuses on real world robotics based on image processing, computer vision, sensor information processing, and artificial intelligence. We are developing innovative technologies for humans and robots to understand real environments by advanced sensing and information presentation technologies. We are also interested in understanding human and assistive technologies for human.

We are working on a wide range of research topics from fundamental theory to practical applications.

Real world robots

AN Qi
Associate Professor

Japan's elderly population has exceeded 25%, and it becomes a hyper-aged society. As people age, they are more likely to have movement disorders, which increases social security costs and the burden on caregivers, physical therapists, and other professionals. Our laboratory aims to develop technologies to assist people with movement disorders and rehabilitation system for motor learning. In order to assist human motion and provide rehabilitation effectively, it is important to understand the mechanism by which humans achieve movement as fundamental research and utilize this finding in support system.

Our laboratory conducts a wide range of research, from fundamental research to elucidate the mechanism of human motor control to applied research to develop assistive technologies.

Understanding mechanism of motor control and assistive technology

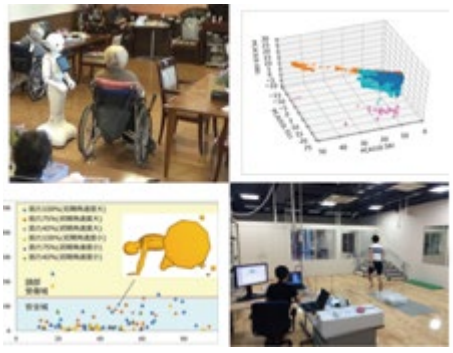
Assistive Technology

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

Practice and scientific approach of practical society useful for society

NIHEI Misato
Associate Professor

The main research fields of this laboratory are human and life support engineering and accessible design, with a focus on assistive technologies and their evaluation for people with disabilities, older adults, and people with dementia. We are researching the development and integration of technologies for the product and environmental design of assistive devices tailored to physical, cognitive, and physiological characteristics, system development for institutional and home care, development of effective assistive devices and evaluation methods, and social acceptability of assistive devices and mobility. In collaboration with researchers in the social sciences, we are investigating the utilization of assistive devices by longevity in local fields. In international joint research, we are studying "care literacy." Our goal is to clarify the relationship between people and assistive devices in their daily lives, which change with social changes. We also aim to develop valuable devices and support systems by extending the engineering framework to examine life and living from various perspectives, including cognitive science, social science, nursing, and medicine.



New Assistive Technologies based on Science and Technology

Mathematical Biology and Bioengineering

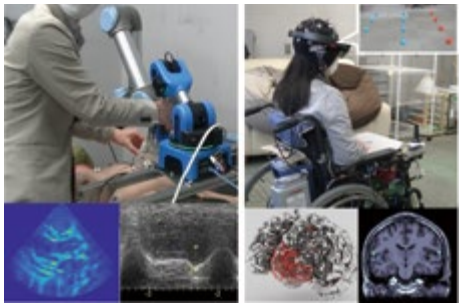
Lab website http://neuron.t.u-tokyo.ac.jp/mbb/home_en/

Elucidating the operating principles of complex biological systems by integrating multiscale information

KOTANI Kiyoshi
Professor

Recent advances in experimental and analytical techniques have revealed that biological systems are organized more precisely than ever imagined to perform various functions. We have been developing measurement methods and theories for dynamical systems to elucidate the underlying mechanisms of complex biological phenomena. We also applied the fundamental biological findings to a wide range of fields such as diagnosis and human interfaces.

Specifically, we have conducted studies on: (a) developing theoretical methods for nonlinear and time-delayed stochastic systems on complex networks, (b) understanding working memory and other cognitive functions using multi-scale brain models and noninvasive brain measurements, and (c) high-speed brain-machine interfaces using virtual reality.

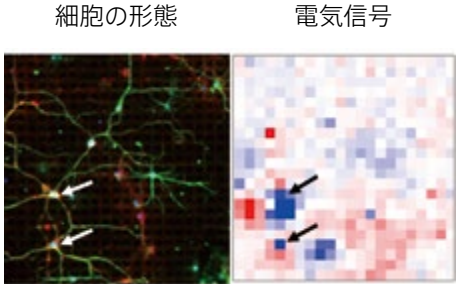


Non-invasive measurement and mathematical analysis of human heart (left) and brain (right)

SHIMBA Kenta
Associate Professor

Biological systems express their functions with hierarchical structures at various scales, such as molecule-cell-tissue. We aim to experimentally elucidate biological phenomena from the microscopic level and to develop experiment-based mathematical models toward understanding macroscopic biological systems. We are mainly working on cultured neuronal networks and sliced brain tissues using multi-site electrical recording of neural activity and microfabrication techniques.

Specifically, we have been (a) developing measurement techniques to evaluate neuronal functions, types, and structures in an integrated manner, (b) constructing experimental models that mimic biological functions such as pain transmission, (c) devising analysis methods to integrate acquired multi-scale data, and (d) elucidating the pathogenic mechanisms of neurological diseases using human iPS cells.



Simultaneous evaluation of structure and function

Intelligent Systems Design

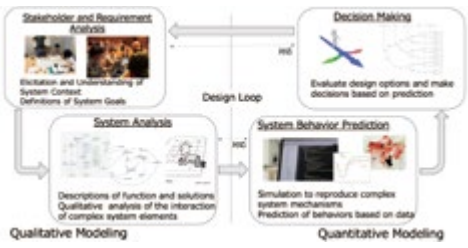
Lab website https://is.edu.k.u-tokyo.ac.jp/

Transformation of Industry and Society

HIEKATA Kazuo
Professor

Large complex systems are systems, which consist of various elements and have emerged functions. In modern days, we are facing with many significant problems caused by large complex systems. To solve these problems, perspectives from several academic disciplines, such as engineering, information technology, economics, business administration and domain specific knowledge, are necessary to be integrated. We work on following items. 1) Development of methodology for designing systems by systems approach, which identify objectives, functions, behavior and dependency of system elements. 2) Development of methodology for communication and collaboration of teamwork to integrate multidisciplinary experts by mutual understanding on the bases of systems approach.

Our lab applies, we apply systems approach to marine transportation system, shipbuilding industry and information system integration industry to create structures of industries by utilizing advanced technologies.



Design Process for Comples Systems

Human and Environment Informatics

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

Make human society comfortable, safe and secure by sensing and robot technologies

WARISAWA Shin'ichi
Professor

In order to realize a safe, secure and comfortable living environment, we are promoting research on sensing technology for various information emitted by humans, higher-order information processing technology that extracts body and mental state, behavior change and intervention technology. Specifically, based on stress and emotion sensing technology, we are conducting research on methods for evaluating and predicting intellectual productivity, how to realize high-quality breaks and sleep with a real feeling, and intervention methods to improve personal comfort, productivity and group communication.

Through these researches, we will build a human environment model that contributes to promotion of mental and physical health, and show our society the creation of new lifestyles from both physical and psychological environments.

System platform promoting mental/physical health

FUKUI Rui
Associate Professor

Our research group is studying various autonomous systems using ROBOT technologies. Especially we focus on distributed and integrated robot systems with unprecedented shapes, mechanisms, and strategies. When you see our robot, you might say "Is this really a robot !?"

Each robot is not only a machine, but also has various forms such as sensors, electronic circuits, and artificial intelligence (AI). Sometimes our robots get into the environment as if they were an original part of the environment. This approach is called environmental structuring technology that helps humans live comfortably and other robots work efficiently.

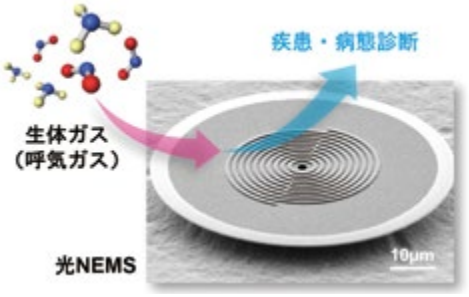
Please Imagine a world where "robots" that do not look like robots cooperate with each other, execute great work to help people, and make people happy. We are looking forward to studying with students who are interested in innovation with technologies.

HanGrawler: Large-payload and high-speed ceiling mobile robot using crawler.

KOMETANI Reo
Associate Professor

As represented by the advancement of IoT devices, mobile/wearable devices, automobiles, healthcare devices, and so on, people's life, society, and industry are supported by various sensor technologies and sensor information networks. Aiming to enrich the living environment in the future, we are researching on sensor devices and sensing technology, which are core technologies for this purpose. Specifically, in order to create technologies that closely related to support our daily lives, such as advanced healthcare technology (breath diagnosis technology, etc.) and large-capacity optical communication technology, we are developing sensing nanodevices based on new detection principles by using NEMS (Nanoelectromechanical systems) technology, semiconductor technology, nanofabrication, device measurement technology, and information technology. We combine device technologies with information technology in order to create new sensing devices and technologies.

We value the sense of feeling "Interesting!", and we are challenging to create new technologies.

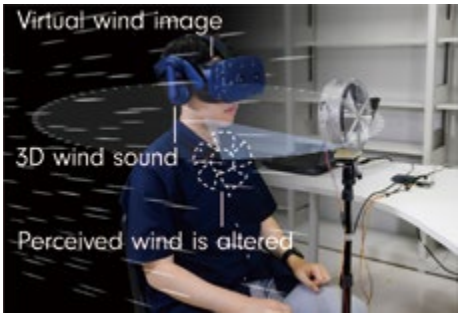


NEMS gas sensing device for the healthcare (Breath diagnosis)

BAN Yuki
Project Lecturer

We are researching on elucidation of human perception and cognition, and development of control methods of them to realize innovative experiences and comfortable lifes. In particular, we have been focusing on the cross-modal effect, in which several different senses, such as vision and haptics, influence each other's senses, and have been discovering new effects and developing sensory display technologies using them. Specifically, we have researched on the presentation of sensory information such as virtual objects, wind, and water by using the cross-modal effect, and on the enhancement of human abilities such as the work efficiency by using illusions.

We are also working on a display that induces people's emotional states by combining sensory feedback and biometric measurement. We aim to create innovative sensory display technologies that utilize human perception and cognitive characteristics based on the technology of XR, AI, biometric measurement, and the knowledge of human interface and cognitive psychology.



Cross-modal Wind Display: Modifying Perceived Directions of Wind Using Visuo-audio-haptic Interaction

Simulation of Complex Environmental Systems

MSLab website https://www.multi.k.u-tokyo.ac.jp/indexen.php CSLab website http://www.scslab.k.u-tokyo.ac.jp/

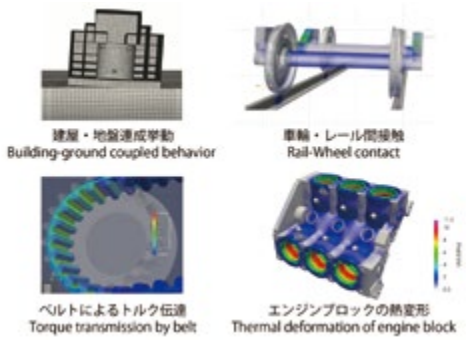
The Multi-Scenario Simulator & Simulation Complex Systems

OKUDA Hiroshi
Professor

Based on the mathematics of solid mechanics using the parallel finite element method and the technology of using supercomputers, cloud, and network, we will create practical industrial simulation and green innovation that are useful in a wide range of fields such as machinery, architecture, civil engineering, electronic and electricity. Aiming for this, we are conducting the following research.

1) Advancement of parallel finite element analysis system FrontISTR and its industrial applications, 2) Development of mathematical method for multiphysics problems including coupling with particle method, 3) Optimization for next-generation computer system, 4) Enhancement of computing efficiency by AI utilization.

https://www.multi.k.u-tokyo.ac.jp/indexen.php



Parallel FEM simulations of artifacts

CHEN Yu
Professor

Research theme of CSLab is "simulation of complex systems," exploring diverse areas such as social-economics, complex fluids, and biological systems. Our four primary directions include: 1) Utilizing multi-agent cooperative evolutionary games for modeling and simulating financial markets, understanding agent decisions and their impact on market dynamics; 2) Employing discrete kinetic models to simulate complex fluids, providing microscopic-level insights into fluid dynamics; 3) Using cellular automata and heterogeneous stochastic agent models for simulating biological phenomena like cancer proliferation and aging; 4) Investigating agent-based modeling and simulations to analyze societal and technological transitions, focusing on how individual behaviors influence these significant shifts. The objective is to deepen our understanding of complex systems and devise innovative solutions for societal challenges.

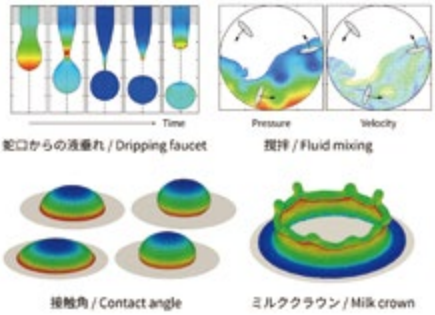
http://www.scslab.k.u-tokyo.ac.jp/

Simulations of colloidal fluids, growth of tissues, and financial crises

MATSUNAGA Takuya
Lecturer

This laboratory carries out research on computational fluid dynamics using the particle method. The particle method is characterized by its meshfree calculation framework which enables us to numerically simulate fluid flows with complex gas-liquid interface behaviors. Since flows involving gas-liquid interfaces are ubiquitous in nature and industry, the particle method has been applied to the academic research and the industrial applications in a wide range of fields including automobiles, ships, chemical processes, and computer graphics. However, there are still many complex problems that cannot be solved with the current technology.

We challenge the frontier of computational science by developing new computational algorithms, integrating finite element methods, and using advanced HPC environments, and aim to solve the problems faced by industry and society.



Fluid simulation using a particle method

Human Augmentation

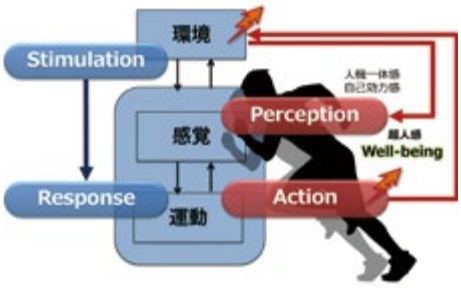
Lab website https://unit.aist.go.jp/harc/en/

Research on systems to be attached to human, in order to enhance and empower human functions

MOCHIMARU Masaaki
Visiting Professor

Human augmentation is a new research field for enhancement of physical and psychological functions of humans through wearable sensors, VR / AR, robots, etc. In our laboratory, elemental technologies are integrated for improving physical ability, willingness to continue, and cognitive ability based on an active model (Action-Perception) in which a person changes the environment by his / her own actions with augmented ability and perceives the change.

The Human Augmentation Laboratory has been established in the AIST Kashiwa Center at the Kashiwa II Campus, and three researchers belonging to Human Augmentation Research Center of AIST have been assigned as visiting professors. Our research interests are related to nursing care, health, and work situations. We set concrete research topic through collaboration with companies and medical institutions.

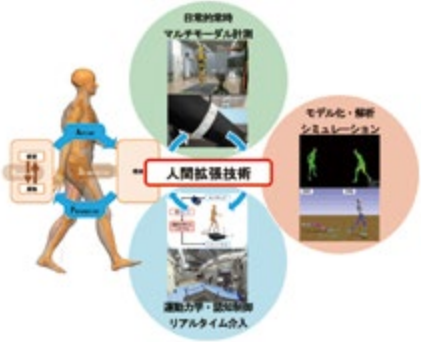


Human augmentation research based on the Action-Perception model

MURAI Akihiko
Visiting Associate Professor

Human augmentation technology augments human motor and sensory capabilities by designing their interactions. This technology consists of ①daily multimodal measurement, ②modeling, analysis, and simulation, and ③kinodynamic / cognitive control and real-time intervention.

① involves a development of human measurement technology using an image recognition by machine learning technology and wearable devices using flexible sensors, ② involves a development of musculoskeletal knodynamic analysis technology based on biomechanics and motion generation technology using deep learning technology, and ③ involves a development of real-time intervention system using environmental kinodynamic / cognitive control based on robotics technology. Real-time loop of ①-②-③ would modify human behaviors and realize human augmentation technology.



Interaction Design for Human Augmentation

KIMURA Kenta
Visiting Associate Professor

To enhance physical and psychological functions of human, we are conducting cognitive/affective research to understand the psychological and biological mechanisms that support the interaction between human and environment/information, and to construct the computational model of behavior and the physiological activity.

Research topics include 1) a development of technologies to measure cognitive functions and affective state using behavioral and physiological indices, 2) a development of a model for the interaction between cognition and affect using cognitive neuroscience techniques, 3) a development of intervention and behavior change technologies based on these research. Our research contritubes to a development of designing human-information interaction, and promote the social implementation of technologies to improve physical and psychological functions in real life situation.

Human Augmentation based on cognitive/affective research

Innovative Learning Creation Studies

Lab website http://www.ilcs.k.u-tokyo.ac.jp/index_e.html

Realizing an inclusive society by clarifying the mechanism of "Learning"

KURITA Kayoko
Project Professor

Our main research theme is to establish innovative methodology of learning and teaching. In particular, we focus on effective teaching methods, and develop programs for instructors, such as single-lesson design, evaluation, course design, and mock classes, and verify their effectiveness. My area of expertise is the development and evaluation of faculty development (FD) programs for university faculty and pre-FD programs for graduate students.

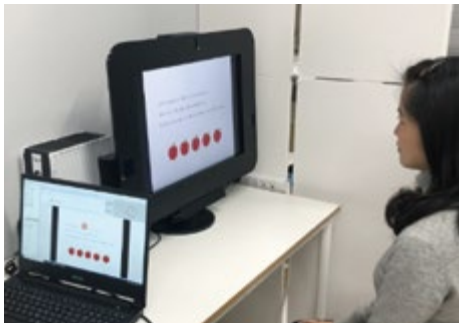
We will also explore the characteristics in each topic and effective feedback methods from the perspectives of pedagogy and engineering. In addition, we are focusing on "reflection" as an element of educators' own quality improvement, and are conducting research on effective mentoring in the process of creating teaching portfolios and academic portfolios, on the effectiveness of reflection itself, and on dissemination and support, including renewal programs.

Development of a worksheet which facilitates one's own reflection

HACHISUKA Satori
Project Lecturer

We are researching to establish innovative learning and teaching methods by elucidating the mechanism of human "Learning." We will systematize methods for sensing human physiological and psychological condition, effective feedback methods for learning, and multiple evaluation methods by focusing on human "Learning."

Our research areas are based on knowledge of ergonomics (human factors), human interface, pedagogics, and technologies of signal processing, AI, XR and more. Our goal is to combine those knowledge and technologies to develop human-centered learning system. Specifically, we are researching eye gaze tracking and facial expression measurement during online learning, quantification of teaching methods by teacher movement analysis, improvement of learning effect by multimodal stimuli and VR. In the future, these research results will support both the learning and the teaching sides and help the development of diverse human resources. In addition, this course features efficient and speedy research suitable for real world by cooperation with Nagase Brothers Inc.



Eye gaze tracking during online learning

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* (https://www.h.k.u-tokyo.ac.jp/index_e.html).

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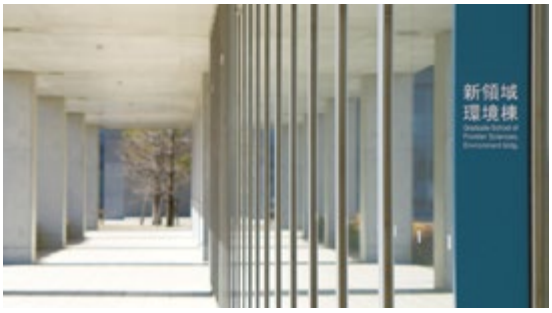

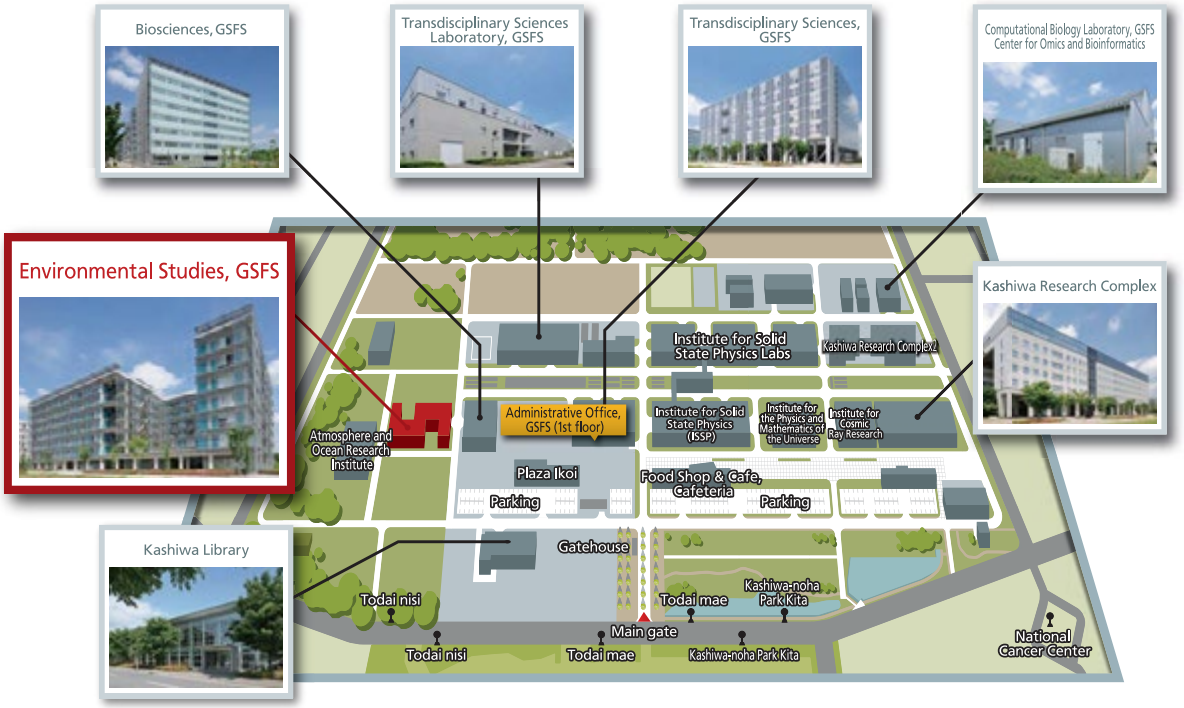

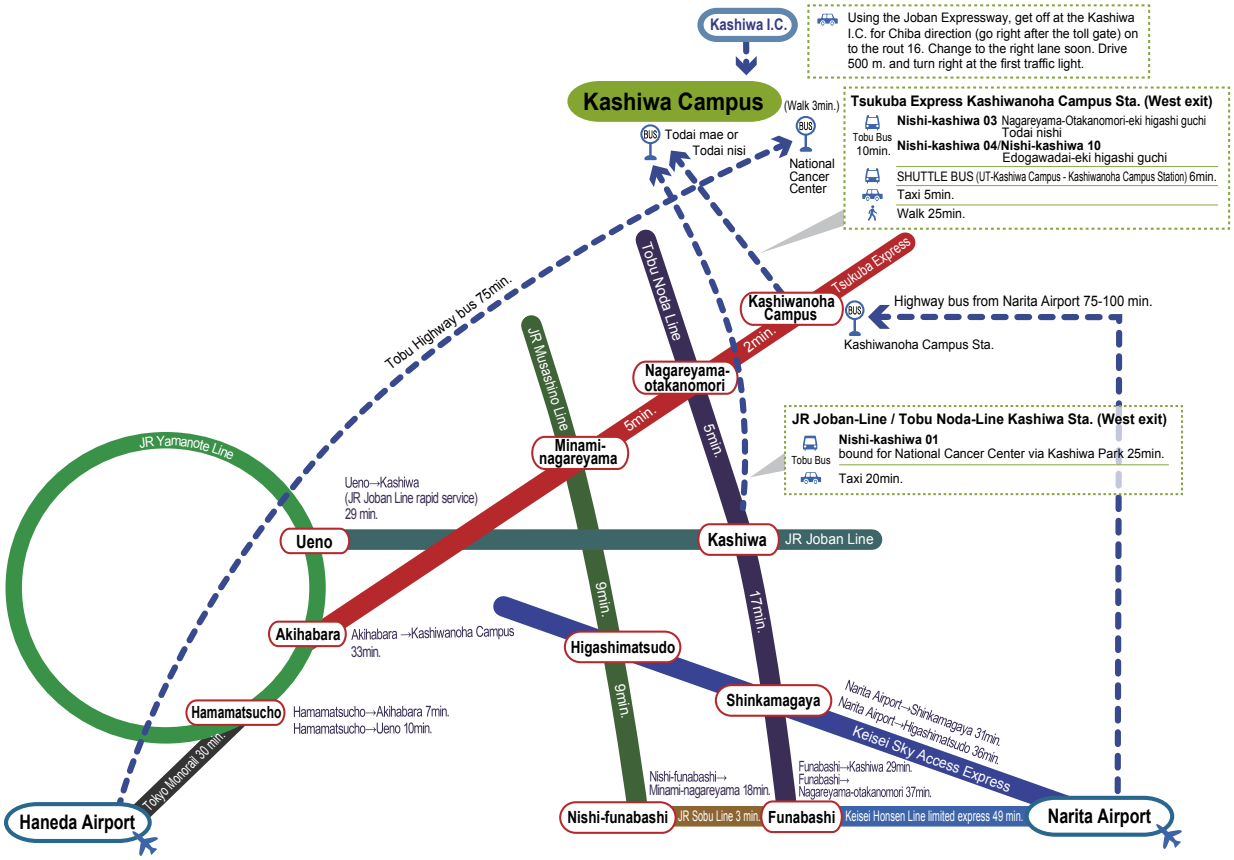

DEPARTMENT OF
HUMAN AND ENGINEERED ENVIRONMENTAL STUDIES

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