AY2025 Admission Guide

Department of Information Physics and Computing

Graduate School of Information Science and Technology,

The University of Tokyo

Master's Program

Doctoral Program

Contact [Department Administration Office]

7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656

Department administration office (Department of Information Physics and Computing), Graduate School of Engineering / Information Science and Technology Administrative Group,

The University of Tokyo

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Visit: https://www.i.u-tokyo.ac.jp/edu/course/ipc/index_e.shtml

Note: This guide should be read together with the graduate school's admission guide: "AY2024 Admission Guide: {Master's / Doctoral} Program, Graduate School of Information Science and Technology, The University of Tokyo." The details of this guide may be changed. In that case, it will be posted on the Department's admissions page.

This document is a translation from the official Japanese version. In the case of conflict, the Japanese version shall prevail and be conclusive.

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I. Master's Program

Due to the interdisciplinary nature of the Department of Information Physics and Computing, this department seeks applicants from a wide range of fields, both within and outside The University of Tokyo, with a fundamental understanding and knowledge of informatics, mathematics, physics, electrical or mechanical engineering. Written and oral examinations are given to those who pass the document screening, and a comprehensive assessment is used to select applicants for admission. Examination subjects have been selected to allow for fair conditions to be met from a variety of departments outside the university. No priority is given to examinees from within the university.

When applying, choose either the Summer or Winter Entrance Examinations. Please note that the application period differs between the Summer and Winter Entrance Examinations. Summer Entrance Examinations consist of document screening, foreign language, written examinations, and oral examination. Winter Entrance Examinations focus only on document screening, foreign language and oral examination, and do not include written examinations. Only a limited number of examinees will be admitted to the Winter Entrance Examinations. For other instructions, please keep checking the websites for examinees carefully.

i) Summer Entrance Examinations

Written and oral examinations are given to those who pass the document screening, and a comprehensive assessment is used to select applicants for admission.

Select up to nine faculty members to whom you wish to be assigned on the web application system. If there is a faculty member to whom you do not wish to be assigned, enter the number in the "Field 1 for Department-Specific Information". The laboratories in this department conduct research in cooperation with each other, and it is possible for examinees to acquire a cross-sectional study of systems informatics regardless of which faculty member they are assigned to.

a) Document Screening

All of the following documents must be submitted. The screening will be conducted based on

submitted documents. Please refer to the admission guide of the Graduate School for the notification of acceptance or rejection of the application documents.

Submit a document describing the reasons for applying to the Department of Information Physics and Computing, with references if necessary, based on what you have learned and experienced. The document should be written either in Japanese or English. The font size should be around 11 pt. The document should be on three A4-sized or letter-sized pages. Figures can be included. Please put your name on every sheet. Since the document is used for the document screening and evaluation, it should be well-thought out and of appropriate length and content.

b) Written and Oral Examinations, etc.

All of the following examinations should be taken. Those who are absent from one or more of the examinations are considered to have abstained from the entrance examination.

1. Foreign language

   TOEFL scores will be used. For details, please refer to the "Guidelines for Submission of TOEFL Scores (for AY2025 Entrance Examinations)."

2. General education subjects

   For details, please refer to the Admission Guide of the Graduate School.

3. Specialized subjects

   For examinations on specialized subjects, examinees shall choose one subject among the following: “Information Physics and Computing,” “Mathematical Informatics,” “Computer Science,” and “Information and Communication Engineering.” Please note that dates, times, and locations differ depending on the subject.

Specialized Subjects	Examination Dates, Times, and Locations	Scope of Questions
Information Physics and Computing	August 19, 2024 (Monday) 10:00 – 12:00 Onsite	Examinees will be required to select and solve two among three problems: “signal processing,” “electronic circuits,” and “control.” The total time for answering the problems is 100 minutes.
Mathematical Informatics	Please refer to the “Admission Guide” for the Department of Mathematical Informatics.	
Computer Science	Please refer to the “Admission Guide” for the Department of Computer Science.	
Information and Communication Engineering	Please refer to the “Admission Guide” for the Department of Information and Communication Engineering.	

The examination for the specialized subject "Information Physics and Computing" will be administered in person.

The log-in information for the “Website for Examinees (Master & Doctor)” will be sent to applicants who have passed the document screening. Information on precautions and examination locations will be posted on the website, so please check it frequently. For information on the examinations for the Department of “Mathematical Informatics,” “Computer Science,” and “Information and Communication Engineering,” please refer to the Admission Guide for the Department in question.

4. Oral examination

The oral examination will be conducted between 9:00 a.m. and 6:00 p.m. on August 20 (Tuesday), 21 (Wednesday), 22 (Thursday), or 23 (Friday), 2024. Detailed schedules will be posted on the website for examinees during the examination period. The Oral Examination schedule for examinees who take written exam subjects other than “Information Physics and Computing” will be adjusted to avoid overlapping with examinations of the specialized subjects.

ii) Winter Entrance Examinations

An oral examination will be given to those who pass the document screening. In principle, the examination will be held between late January and mid-February 2025, and a few applicants will be accepted. The details of the date and place of the examination will be posted on the website

for examinees after the application is received. Select up to nine faculty members to whom you wish to be assigned on the web application system.

a) Document Screening

See Summer Entrance Examinations.

b) Foreign Language

See Summer Entrance Examinations.

c) Oral Examination

In the oral examination, applicants will be asked about the basics of mathematics (differential and integral calculus, linear algebra) and the reasons for their application as stated in their application documents.

II. Doctoral Program

At the time of application, please select either the Summer Entrance Examinations or the Winter Entrance Examinations. Please note that the periods for acceptance of applications differ for the summer and winter examinations.

Persons wishing to be included in the “Special Selection for Professionals” must refer to the “AY 2025 Admission Guide: Doctoral Program [Special Selection for Professionals] Graduate School of Information Science and Technology, The University of Tokyo”. For other detailed instructions, please keep checking the websites for examinees carefully.

i) Summer Entrance Examinations

a) Prior Interview

Persons wishing to apply to the Doctoral Program should refer to the “AY2025 Admission Guide: Doctoral Program, Graduate School of Information Science and Technology,” and must contact the faculty advisor of your choice for a face-to-face or online interview based on your past history, research history, research capabilities, and research plans.

The interview must be completed between April 19 (Friday) and May 28 (Tuesday), 2024, for Summer Entrance Examinations or between October 10 (Thursday) and November 8 (Friday), 2024, for Winter Entrance Examinations. Enter the date of the interview in “Field 1 for Department-Specific Information” in the web application system. Applicants may not be allowed to take the examinations if they fail to complete this procedure.

b) Document Screening

All of the following documents must be submitted. An oral examination will be given to those who pass the document screening. The results of the oral examination will be used to select the applicants.

(a) Describe the content and results of past research as well as the significance of the research in the field in question. The summary should be either in English or Japanese, on no more than four A4-sized or letter-sized pages.

(b) Provide a specific research plan to be conducted after admission to the Doctoral Program and describe how this research will contribute to the field in question. The summary should be either in English or Japanese, on no more than two A4-sized or letter-sized pages.

(c) Provide a list of research achievements on A4-sized or letter-sized pages. Achievements should be categorized into original articles, review articles, oral presentations, and others. If there are no research achievements, write “not applicable.”

Since the above documents (a), (b), and (c) will be used as the basis for the Oral Examinations and subject to scoring, they should be well-thought out and of appropriate length and content.

c) Foreign Language

TOEFL scores will be used for evaluation of English ability. For details, refer to the School Application Guidelines of Graduate School of Information Science and Technology. Persons who have completed or are expected to complete The University of Tokyo Graduate School Master's Program will not be required to submit TOEFL scores.

d) Oral Examinations

The primary examination consisting of Oral Examinations I and II, and the secondary examination are conducted. Persons who have completed, or are expected to complete a Master’s Program in The University of Tokyo or persons who have been approved on the basis of the submitted documents will be exempt from Oral Examination I. Examinees who

are rejected in Oral Examination I cannot take Oral Examination II. The results of Oral Examination I will be posted with the schedules of Oral Examination II on the website for examinees.

(Primary Examinations)

Examination Dates and Locations	Examination Times	Examination Subjects	Notes:
The afternoon of August 19 (Monday) or the morning of August 20 (Tuesday) Online	Detailed schedules will be posted on the website for examinees at 10:00 on August 19.	Oral Examination I	Examinees will be required to answer questions related to the fundamentals of Information Physics and Computing and to the applicant's research field.
August 21 (Wednesday) Online	Detailed schedules will be posted on the website for examinees at 17:00 on August 20.	Oral Examination II	Examinees will be required to answer questions on the results of their past research and research plan submitted beforehand.

The log-in information for the "Website for Examinees (Master & Doctor)" will be sent to applicants who have passed the document screening.

(Secondary Examinations)

Secondary examinations consist of an oral examination on the master's thesis or research paper, in addition to the previously submitted past research results and the research plans. A master's thesis or an alternative research paper must be submitted.

Detailed schedules and locations will be posted on the website for examinees later.

ii) Winter Entrance Examinations

As a general rule, the primary and secondary examinations will be conducted between late January and mid-February, 2025. Acceptance will be limited to a few examinees. Examination methods will be in accordance with those used for Summer Entrance Examinations. Detailed schedules and locations will be posted on the website for examinees after applications have been

received.

a) Prior Interview

See Summer Entrance Examinations.

b) Document Screening

See Summer Entrance Examinations.

c) Foreign Language

See Summer Entrance Examinations.

d) Oral Examinations

For the winter entrance examination, the secondary examination will be conducted concurrently with the Oral Examination II.

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Department-specific Conditions on Submitted Documents

For other conditions on submitted documents common to all the departments, check the Admission Guide of the Graduate School.

	Summer Entrance Examination		Winter Entrance Examination	
	Documents to be Submitted	Who to Submit	Documents to be Submitted	Who to Submit
Master's Program	Reason for Application (three A4-sized or letter-sized pages, either in English or Japanese)	All Applicants	Reason for Application (three A4-sized or letter-sized pages, either in English or Japanese)	All Applicants
Doctoral Program	(a) Content and results of past research (no more than four A4-sized or letter-sized pages, either in English or Japanese) (b) Research Plan for Doctoral Program (no more than two A4-sized or letter-sized pages, either in English or Japanese) (c) List of research achievements (A4-sized or letter-sized page. If not applicable, please mention.)	All Applicants	(a) Content and results of past research (no more than four A4-sized or letter-sized pages, either in English or Japanese) (b) Research Plan for Doctoral Program (no more than two A4-sized or letter-sized pages, either in English or Japanese) (c) List of research achievements (A4-sized or letter-sized page. If not applicable, please mention.)	All Applicants
Doctoral Program <Special Selection for Professionals>	(a) Content and results of past research (no more than four A4-sized or letter-sized pages, either in English or Japanese) (b) Research Plan for Doctoral Program (no more than two A4-sized or letter-sized pages, either in English or Japanese) (c) List of research achievements (A4-sized or letter-sized page. If not applicable, please mention.)	All Applicants	(a) Content and results of past research (no more than four A4-sized or letter-sized pages, either in English or Japanese) (b) Research Plan for Doctoral Program (no more than two A4-sized or letter-sized pages, either in English or Japanese) (c) List of research achievements (A4-sized or letter-sized page. If not applicable, please mention.)	All Applicants

Department-specific Conditions on TOEFL Scores

	Summer Entrance Examinations	Winter Entrance Examination
Master's program	All applicants must submit.	All applicants must submit.
Doctoral Program	All applicants must submit, except those who have completed (or are expected to complete) Master's program in the University of Tokyo.	All applicants must submit, except those who have completed (or are expected to complete) Master's program in the University of Tokyo.
Doctoral Program <Special Selection for Professionals>	All applicants must submit, except those who have completed Master's program in the University of Tokyo.	All applicants must submit, except those who have completed Master's program in the University of Tokyo.

Faculty members and laboratories

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<table>
<tr><td colspan="2">Sound Media Informatics Lab. (Saruwatari and Saito Lab.)
http://www.sp.ipc.i.u-tokyo.ac.jp/</td></tr>
<tr><td>Professor
Hiroshi
Saruwatari[1)]

Lecturer
Yuki
Saito</td><td>This laboratory mainly innovates in new signal processing and information processing systems, focusing our attention on understanding, processing, and controlling sound media (speech, music, etc.). For example, theories on new statistical modeling and machine-learning-based algorithms are of interest for solving optimization problems under acoustical generative models and physical constraints. Through our research, we extend human hearing systems, create new human-machine interface systems, and bring our innovative contribution to music creation.

(1) Auditory Communication Augmentation via Unsupervised Learning
We realize versatile unsupervised source separation combining statistical estimation theories and low-rank modeling. Also, we address a new combination of deep learning and spatial acoustics, which can be applied to semi-supervised source separation. Thanks to these methods, new human-machine interfaces, auditory communication augmentation systems, and user-oriented music information systems can be developed.

(2) Augmented Speech Communication Based on Machine Learning
We investigate signal processing and machine learning theories for speech synthesis and conversion for human-human and human-machine communication. We interpret speech from the perspectives of physics and informatics and deal with accurate modeling of speech signals and speech information. We also develop speech-based virtual reality systems by using human-in-the-loop speech modeling that integrate humans into machine learning.

(3) Sound Media Processing and Its Application to Virtual Reality
We construct a theory of acoustic scene analysis based on multi-channel signal processing and deep learning. Specifically, we study environmental sound recognition/synthesis for various acoustic data not limited to human speech. We also conduct research toward the realization of sound media monitoring and acoustic virtual reality systems on the basis of these methods.</td></tr>
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1) Department of Creative Informatics

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Biomechanical system Lab. (Kawashima and Miyazaki Lab.) http://www.bmc.ipc.i.u-tokyo.ac.jp/index_e.html	
Professor Kenji Kawashima Lecturer Tetsuro Miyazaki	We are dedicated to studying living organisms' advanced measurement and control systems through a comprehensive approach to developing innovative medical robots and human-machine interfaces. Our research focuses on leveraging the properties of soft, compressible, fluid-driven systems, such as their flexibility and nonlinear dynamics, to design intelligent systems. (1) Image-Based Autonomous Control of Medical Robots: Despite the advancements in AI-based diagnostic imaging, applying AI to surgical procedures remains challenging due to the variability and deformation of surgical targets. Our research aims to minimize patient stress by autonomously conducting surgeries—like needle insertions, organ removals, and securing hemostasis—leveraging multimodal learning that combines camera imagery with pressure data from pneumatic robots. (2) State Estimation and Control Using Reservoir Computing: We are developing a method for the real-time estimation and control of physical support systems for body movement. This method relies on the dynamic properties of soft actuators, such as pneumatic artificial muscles, without the need for body-mounted sensors. This method utilizes reservoir computing to exploit these actuators' nonlinear and distributed nature. (3) Motion Instruction System with Pneumatic Artificial Muscles: Our team is testing a multimodal motion instruction system that utilizes the contraction force of pneumatic rubber artificial muscles combined with virtual reality feedback. The system's effectiveness is assessed through electromyography and other biomedical measurements. (4) Control of Bending Soft Actuators: Moving beyond simple expansion and contraction, this project explores the control of soft actuators through external environmental stimuli, such as heat and lasers, to achieve complex movements like bending. This involves manipulating the elastomers within soft actuators. We conduct prototype development and evaluati

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Physical Informatics & Inverse Problem Lab. (Nara and Miyazako Lab.) http://www.inv.ipc.i.u-tokyo.ac.jp/	
Professor Takaaki Nara Lecturer Hiroki Miyazako	Inverse problems are ubiquitous in science and engineering. In these problems, unknown quantities are inversely estimated from indirect measurements through mathematical reconstruction. Our laboratory develops fundamental theories, measurement methods, and applied systems for diverse inverse problems. (1) Direct reconstruction and measurement methods for inverse problems: We derive the algorithms for inverse source/coefficient/governing-equation problems that directly express the unknown quantities in terms of data using mathematical physics such as complex analysis, potential theories, tensor analysis, and reproducing kernel theories. We also develop sensors that directly measure the Fourier transform of the physical quantities for inverse problems. (2) Medical imaging and nondestructive testing: We develop mathematical methods for medical imaging, such as neural current estimation based on magnetoencephalography, epileptic focus identification, and magnetic-resonance-based imaging of electrical, mechanical, and thermal properties inside the body. We also develop algorithms and sensors for nondestructive inspection of infrastructure. (3) Disaster prevention: We develop a system to localize victims buried in rubble, landslides, and avalanches. In this system, a rescuer generates the sound and/or magnetic fields, and then victims' smartphones measure them, compute their locations, and transmit them to the rescuer. (4) Predictive design of biorobots based on biological cells and molecules: Biorobots built from biological cells and molecules have many possible applications in regenerative medicine, drug discovery, biosensing, and so on. To systematically design such biorobots without many experiments, we develop predictive design method for the biorobots based on mathematical and physical models of cells and molecules. In particular, by using theories of nematic liquid crystals and complex analysis, we build a design method for controlling the shape and deformation of cellular sheets and molecular robots and verify the proposed method by experiments.

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Real-World Informatics Lab. (Shinoda and Makino Lab.) https://hapislab.org/?lang=en	
Professor Hiroyuki Shinoda[2)] Associate Professor Yasutoshi Makino[2)]	We realize a real-world informative environment that goes beyond conventional barriers by introducing new physical phenomena and physical structures into the system. In particular, we propose technologies from hardware to applied systems for sensing humans, environments, and their interactions, and for supporting humans through haptic and other human senses. Research topics include basic and universal discoveries based on novel ideas and the process of solving social problems and using them in practical technologies. (1) Haptic Interface: A system that supports human life and behavior by stimulating the sense of touch simultaneously with audiovisual information. Clarify the relationship between the tactile sensation and the mind and emotions that support the base of human intelligence, and apply it to real systems. (2) 2D Communication: Information and electricity transmission through a thin sheet using electromagnetic waves to realize wireless power supply and high-speed signal transmission without interfering with conventional wireless LAN. (3) Use of human behavior: Based on the features of human behavior, we predict near-future motion and estimate haptic characteristics of the object in touch. This technology can be used for preventing falls and for sports. (4) Other topics such as physical informatic devices, human-machine interfaces, non-contact measurement of haptic information, artificial robot skin, wearable computing, remote interactions for understanding animal behavior, etc.

2) Department of Complexity Science and Engineering, Graduate School of Frontier Sciences

This document is a translation from the official Japanese version.

Systems Control Lab. (Ishii Lab.) http://www.scl.ipc.i.u-tokyo.ac.jp/index_e.html	
Professor Hideaki Ishii	In the area of systems control, progresses in communication and computation technologies have enabled the design of large-scale systems achieving complex control objectives by connecting various systems and devices that effectively exchange data over heterogeneous networks. The study of such networked control systems and cyber-physical systems requires the two areas of systems control and informatics to meet in new forms. Our group works on a range of problems related to networked systems from their fundamental characterizations to more application-oriented design methodologies. The specific research topics are described as follows: (1) Control over Networks: Networked control systems connect a number of sensors and actuators over shared channels. We aim at developing analysis and design methods for the control of such systems by taking account of properties in communication. Our goal is to expose limitations on control performance under communication constraints on data rates. We further consider enhancing robustness against model uncertainties in the systems to be controlled and the networks. (2) Distributed Cooperative Control of Multi-agent Systems: We study distributed cooperative control of systems consisting of autonomous agents such as multi-mobile robots and sensor networks. There, numerous agents exchange information and make their own decisions locally. Our research centers around fundamental theories and their extensions to resilient approaches in the presence of faults and adversaries as well as inter-disciplinary problems for brain neuronal oscillations, epidemiological networks, social networks, and so on. (3) Cyber-physical Security of Control Systems: Cyber-attacks manipulating sensor/control signals can result in irregular responses in the physical systems, which can be extremely dangerous. From the viewpoints of both control and informatics, we analyze the effects of cyber-attacks such as communication disruptions and false data injections and develop security measures for robust control, fault detection, and privacy protection. Security of the critical infrastructure of power systems is also of our interest. (4) Control Methods Utilizing Machine Learning: Due to complexities in the systems to be controlled, mathematical models can be difficult to obtain at times. For example, it may be hard to model robots working in complex environments such that controllers can be designed in a reasonable manner. We study comprehensive methods based on machine learning techniques for finding controllers from data, where control theory provides certain guarantees on reliability and so on.

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Neural Information Lab. (Amano, Sawayama, and Nakayama Lab.) https://www.brain.ipc.i.u-tokyo.ac.jp/	
Professor Kaoru Amano Lecturer Masataka Sawayama	We investigate the neural mechanisms underlying human perception and cognition using non-invasive neuroimaging techniques such as magnetoencephalography (MEG), electroencephalography (EEG), functional magnetic resonance imaging (fMRI). Furthermore, we develop methods for non-invasive manipulation of brain information to elucidate the neural process that causally contributes to behaviors. In recent years, we have been focusing on the functional roles of neural oscillations in information integration, the mechanisms of the individual differences in brain activity and perception/cognition, and fusion of machine learning techniques and neuroscience. (1) Development and application of brain information control technology: We are developing techniques for non-invasive manipulation of brain information based on transcranial electrical/magnetic stimulation and neurofeedback. Using these techniques, we investigate the changes in perception, cognition, and behavior associated with the changes in brain information. (2) Neural oscillations as a clock for visual processing: Neural oscillations such as alpha (8-13 Hz) and theta (4-8 Hz) oscillations are thought to work as a clock for information processing in the brain. We investigate this clock function by combining functional brain imaging such as EEG and MEG with non-invasive manipulative techniques. (3) Mechanism of brain state dynamics: Human behavior invariably accompanies fluctuations, one cause of which lies in the fluctuations of brain states. This research aims to elucidate the neural mechanisms behind these fluctuations by exploring the relationship between fluctuations in brain states measured by fMRI, MEG/EEG, and outcomes in brain network connectivity and cognitive task performance. Additionally, it investigates changes resulting from learning and how humans control their brain states, shedding light on the underlying neural mechanisms. (4) Hierarchical visual processing of object recognition in humans and machines: Recent machine learning models trained on large-scale datasets have succeeded in solving various real-world tasks. In this project, we will analyze brain activity using machine learning models to clarify information representation in the visual cortices.

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Information Photonics Lab. (Horisaki and Röhm Lab.) http://www.infotonics.ipc.i.u-tokyo.ac.jp/index_e.html	
Associate Professor Ryoichi Horisaki	「Photonics×Computing」: We aim to create new optical systems and computing systems by mutually complementing optics/photonics and information science. In particular, we aim to construct new system architectures from the perspective of systems information science, while leveraging the advantages of light as a medium for information transmission and processing, such as high speed, parallelism, and low loss. More specifically, as shown below, we are advancing research with two main focuses: Computing for Photonics and Photonics for Computing. Through these research efforts, we also aim to cultivate individuals proficient in both natural sciences and information science, who will contribute to society in the future. (1) Computational imaging － Computing for Photonics: We are exploring advanced imaging technologies that extend beyond traditional imaging by integrating optics and information science, including the rapidly evolving field of machine learning. This integration aims to harmonize signal processing with optical measurement and control. Such technologies are highly anticipated across various fields, such as life sciences, astronomy, and next-generation visual interfaces. Our approach, guided by a minimalist yet sophisticated design philosophy rooted in the fundamentals of optics and information science, focuses on advancing information visualization, enhancing performance, and simplifying optical hardware. These goals include the development of innovative microscopes, imaging through scattering techniques, and three-dimensional displays. (2) AI photonics － Photonics for Computing: As the demand for information communication and computation increases, relying solely on electronic processors for computation leads to finite computational resources that need help to keep up with demand. Therefore, it is essential to develop computers and accelerators that exploit the properties of natural and physical systems to achieve energy-efficient and high-speed systems. With this in mind, we are driving research and development of computers and accelerators that physically address the above challenges by exploiting various properties of light. In particular, we are creating new principles and application systems, such as decision-making using chaotic light, which has fast and complex oscillations, and quantum walks with localization and linear propagation, as well as optical reservoir computing.

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Computing System Lab. (Nakamura and Takase Lab.) http://www.hal.ipc.i.u-tokyo.ac.jp/	
Professor Hiroshi Nakamura Associate Professor Hideki Takase	Our goal is to establish a design methodology for high-quality computing in which advanced interactions between the physical world and the cyber world are realized. Here, high-quality includes performance, responsiveness, power consumption, reliability, and security. These qualities are in a trade-off relationship, and the system needs to be optimized according to its characteristics and requirements. We are researching the comprehensive system-level design methodology to optimize the entire system, including edge devices, such as sensors and robots, servers, and networks by coordinating device, circuit technology, architecture, and software. (1) Cyber-physical systems: Cyber-physical systems connect everything in the physical world to the Internet, process enormous amounts of obtained data in the information or cyber world, and work on the physical world. We are conducting research on optimization of computing to improve performance, responsiveness, power efficiency, reliability, and security by making full use of characteristics of the target processing task. (2) Highly Efficient Accelerated Computing: Significant performance improvements are required in various types of computing, including high-performance computing and machine learning. To meet this demand, we are conducting research to improve the speed of high-efficiency computing by coordinating and linking devices, circuit technology, architecture, and system software across design layers. To this end, we are studying coarse-grain reconfigurable architecture and approximate computing which makes good use of parallelism, locality, and allowed accuracy degradation. We are also working on quantum computing based on new computing principles. (3) Communication technology and design optimization for cloud robotics systems: Based on ROS (Robot Operating System), we are researching a lightweight runtime environment for embedded devices, and a highly autonomous communication library for IoT systems using the functional language Elixir. We are also working on development methodologies that utilize cloud-native technologies and virtual environments for robot applications in large-scale IoT environments. (4) Comprehensive computing technology for IoT systems: We are researching distributed machine learning infrastructures, especially for processing allocation optimization that adapts to changes in resource and geographic information of IoT nodes, and a programming model for comprehensive representation of fairness and diversity in the AI model. In addition, we are researching a resource-permeating distributed processing platform based on a functional programming paradigm.

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Information Somatics Lab. (Inami and Monnai Lab.) https://www.star.rcast.u-tokyo.ac.jp	
Professor Masahiko Inami Associate Professor Yasuaki Monnai	We are conducting research on "Information Somatics," which explores the mechanisms of the body as a physical information system based on physiological, cognitive, and physical findings. It aims to enhance the innate human sensory functions, motor functions, emotional functions, and intellectual processing abilities through measurement, communication, and control technology. (1) Extended Body: Research on technologies that extend human input/output by integrating biometric information such as gaze, facial expressions, and heart rate, with sensory and perceptual measurement technologies such as motion prediction and intention, and intervention technologies like robot control or electrical muscle stimulation. This involves engineering research and development aimed at enhancing human capabilities and acquiring new bodily perceptions by appropriately sensing the user's intent and feeding back information about the task object to the user's body. (2) Extended Communication: The human body and mind are inseparably related, and subjective experiences such as perception and emotions are constituted through the mediation of one's own and others' bodies. In a system that includes both self and others, this research aims to transform subjective experiences by controlling the flow of physical and cognitive information using Virtual Reality (VR), augmented reality, wearable technology, wireless technology, robotic technology, and telexistence. The goal is to socially implement support for communication among users with different attributes and preferences, aiming for the realization of super-aged societies and smart cities where diverse people thrive. (3) Wireless Interaction: We are working on terahertz technology research to wirelessly connect the wet interior environment of the body with the dry exterior environment, from both hardware (manufacturing) and software (signal processing) perspectives. Specifically, this includes working on increasing the power and resolution of new technologies that modulate terahertz waves on the body surface to generate ultrasound inside the body without contact, and new beam tracking technologies that compensate for wave diffraction effects while transmitting terabit-level data wirelessly to people or devices moving through space. The goal is to apply these technologies to biometric measurement and wireless communication, aiming to support cognitive actions without compromising the user's physicality.

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<table>
<tr><td colspan="2">Information Communication System Architecture Laboratory
https://www.sekiya-lab.info/</td></tr>
<tr><td>Professor
Yuji
Sekiya[3)]</td><td>In this laboratory, we research communication infrastructure technology and its architecture using software and virtualization, and methods for detection and countermeasures against cybersecurity threats using machine learning.

This laboratory cooperates with the Information Technology Center and Security Informatics Education and Research Center at the University of Tokyo. We aim to contribute to improving the system architecture using software technology and cybersecurity measures based on actual operations.

(1) Virtualization and software technologies have been introduced as fundamental technologies for information communication systems (ICT) such as cloud computing and 5G. In recent years, flexibility and promptness are required on ICT systems. Therefore, virtualization and software technology are being introduced into, classically, hardware-based architectures. In this laboratory, we research software technologies for ICT systems and their new architecture.

(2) Cybersecurity is a big problem for ICT systems. Attackers steal confidential information and hijack systems through organized and sophisticated attacks. In this laboratory, we research methods to detect cyber threats using machine learning technologies with various types of datasets from communication infrastructure to social trends. This research improves the safety of ICT systems that support society’s infrastructures.</td></tr>
</table>

3) Security Informatics Education and Research Center

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Systems Pharmacology (Prof. Ueda) http://sys-pharm.m.u-tokyo.ac.jp/	
Professor Hiroki Ueda[4)]	**Our goal: Understanding and controlling sleep and consciousness through the integration of medicine and information science** Whole-brain & whole-cell analysis Our laboratory has developed a whole-brain clearing and imaging method (CUBIC) which can make brain samples look transparent, such that all cells in the brain can be analyzed at a single-cell resolution, including the position of all cells. Aiming at understanding brain functions, we will develop analysis and visualization methods for large image data (14 terabytes per brain) obtained by CUBIC, and apply it to the study of sleep/wake rhythms. **Keywords**: Cloud computing, Brain function analysis, Image analysis Chemoinformatics-driven drug discovery Chemoinformatics is becoming more and more widespread such as for drug discovery research, but it still requires development in many aspects, such as activity prediction and structure prediction. In our laboratory, we will develop algorithms to predict drug discovery and experimental reagent candidates by predicting compounds with specific activities, and apply it to the study of sleep/wake rhythms. **Keywords**: Machine learning, Bayesian optimization, Drug screening Development of sleep classification algorithm using biological data Accurate sleep classification of humans is performed by measuring brain waves. Based on easily acquired time-series data such as breathing and arm movements, we have developed a simple and high-performance sleep classification algorithm using machine learning. By improving this algorithm, we will carry out a big data analysis of sleep and understand sleep/wake rhythm. **Keywords**: Machine learning, Time series analysis, Biological data

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