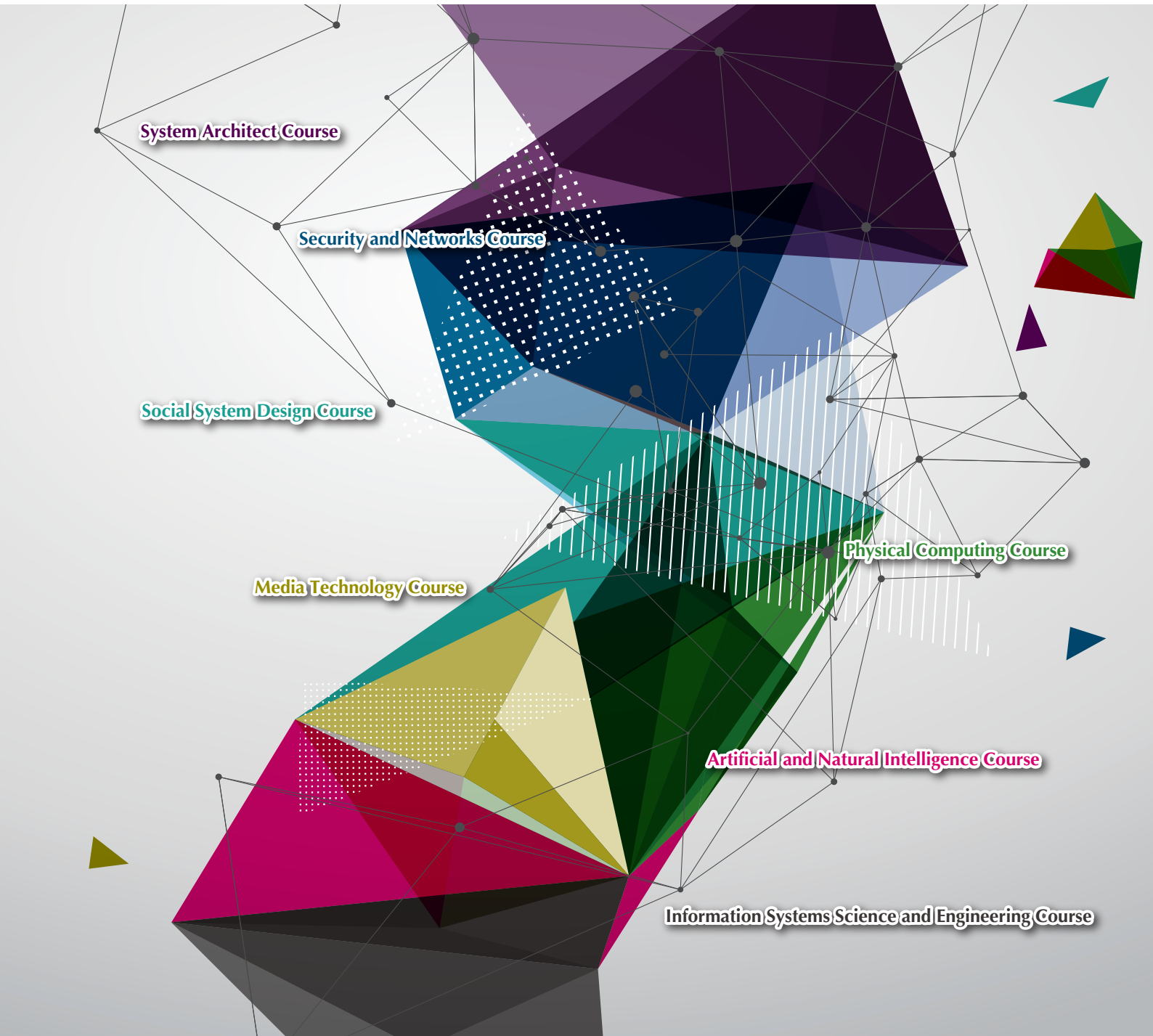
RITSUMEIKAN

Challenge your mind
Change our future

College of Information Science and Engineering Ritsumeikan University Laboratory Introduction

2026



The College of Information Science and Engineering was established in 2004 as one of the largest colleges in Japan dedicated to education and research in information and communication technology (ICT). Since its founding, top level education and research have been conducted with results being actively shared and made public through international and domestic journals and research conferences.

One of the characteristics of our research is active individual and team collaborations with other researchers, both from inside and outside the university, who are working in various fields such as the humanities, social sciences, medical sciences, and disaster mitigation. For example, the Research Center of Advanced ICT for Medical Healthcare conducts research and development on ICT platform technologies that support the entire clinical process from diagnosis to surgery, treatment, postoperative care, and follow-up. The Center for Cognitive Sciences aims to elucidate human cognitive processes and to develop systems to support various kinds of human activities in collaboration with the College of Comprehensive Psychology. In 2020, the Research Center for IoT Security and the Research Center for Computational Research on Designing Sustainable Society were established in order to contribute to the realization of a new smart society.

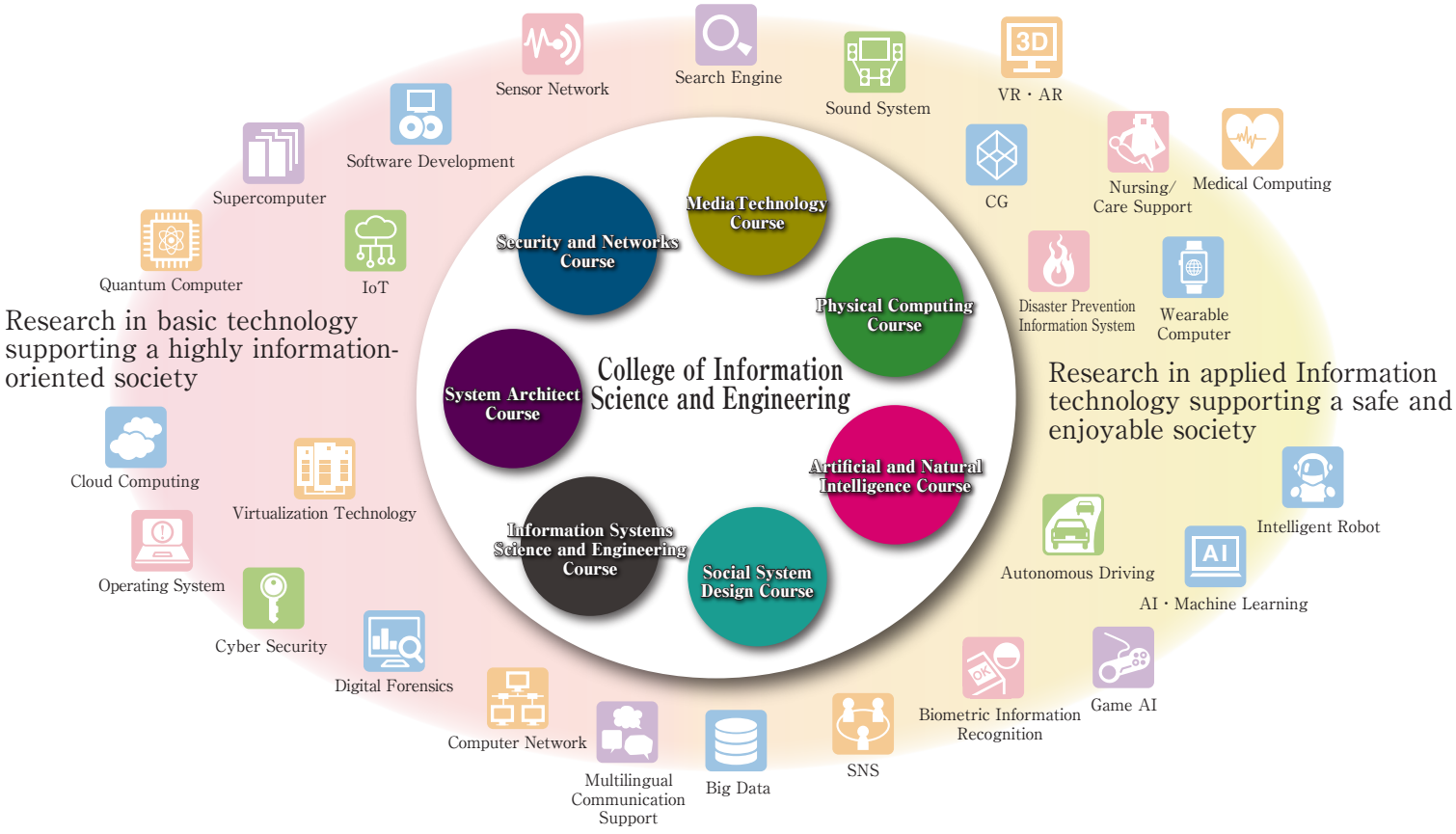
Another characteristic of our research is active collaboration with companies. Some professors engage in joint research within their own laboratories, while others collaborate in teams across multiple laboratories. This is evidenced by the fact that the amount of funds received from joint and funded research in the College accounts for about 25% to 30% of the total research funds. Research conducted by faculty members and students covers a wide range of fields—including quantum computing, autonomous driving, cybersecurity, chatbots, assistive robots, VR/MR/AR, acoustic systems, computer vision, medical and healthcare AI, games and entertainment, neuroscience, and e-government—and has produced achievements both in fundamental technologies and in their practical applications and business development.

The College consists of six Japanese-medium courses that provide deep expertise aligned with societal needs, along with an English-medium course designed to foster problem-solving skills in a global environment by integrating knowledge across multiple domains. Our curriculum enables students to easily take courses across different specialties, while close communication among faculty members ensures an educational and research structure that adapts to the rapid evolution of the ICT field. In April 2024, the College moved to the Osaka-Ibaraki campus, where we are taking on the challenge of building a new educational and research environment. We greatly appreciate your continued support and cooperation as we engage in our pursuit of developing skilled professionals and enhancing ICT research.

Seven courses to develop high expertise and a diverse perspective

Taking from seven different academic approaches, students can study beyond borders.

How our research areas relate to society



Ubiquitous Computing and Networking Laboratory

Research/Development Areas

Smart space systems linking the real/ edge and virtual/cloud.

Head researcher: NISHIO Nobuhiko

Research and development to provide a system that connect the real world at any scale (personal, indoor, urban) with the virtual world by countless computers and sensors connected to ubiquitous networks.

[IoT]
We are developing technologies to recognize the user's situation and surrounding environment status using sensors in mobile devices, wearable devices and robots/ AGVs. We recognize and predict the environment status and human behavior, and aim to realize a variety of services that intelligently adapt to the current environment. Until now, we have been researching and developing energy harvesting for indoor positioning, Wi-Fi packet human flow analysis, disaster prevention systems and smart building infrastructure system.

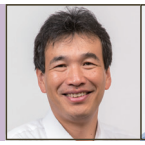
[Real world oriented computing]
We aim to build an intelligent environment system that collects and recognizes information linked to real world objects and things with sensors, has a server system that manages and analyzes the obtained information, and provides a new UI / UX. Until now, we have been researching and developing barrier-free navigation, an unmanned panoramic viewer, and a landmark visibility confirmation dialogue navigation system in the underground shopping mall around Osaka Station and Umeda Station.

[Edge computing]
The "edge" is used in contrast with "cloud", the "site" where the system interacts with the real world. Here, sensors recognize changes in the real world and the environment without human intervention. Such embedded systems will play an active role in home appliances, automobiles and industrial machinery, and in future urban infrastructure. Until now, we have been conducting research and development on an open source project (Autoware) for an autonomous car driving software using a robot OS and dynamic map generation and distribution based on a cooperative distributed platform of embedded system with GPGPU.

Distributed and Collaborative Systems Laboratory

Research/Development Areas

Designing Distributed and Collaborative Systems to Support People's Everyday Activities




Head researchers: TAKADA Hideyuki, SONO Taichi

We conduct research on distributed and collaborative systems that facilitate human activities and enhance creativity in various contexts such as learning environments, offices, and public spaces. Our current research topics include:

[Health Behavior Support Systems] Systems that monitor daily activities such as exercise and sleep, and use generative AI to recommend personalized health behaviors.

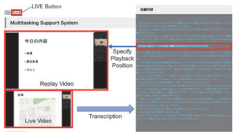
[AI-Enhanced Search Support Systems] Support technologies that leverage generative AI to refine even vague search requests for products or academic literature into concrete, actionable queries.

[Reducing Loneliness in Remote Work] Development of communication environments that alleviate feelings of isolation during remote work by providing a sense of natural connection.

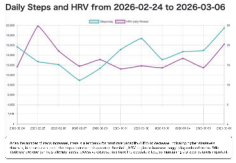
[Adaptive Support Based on Engagement in Remote Meetings] Extension technologies for remote meeting systems that enable appropriate multitasking based on participants' levels of focus and engagement.

[Collaborative Programming Environments for Children] Creative and collaborative learning environments that enable multiple children to cooperatively build a single project.

Through these research efforts, we aim to make people's daily activities smoother, more enjoyable, and more creative.



Support for Participating in Online Meetings with Low Engagement Involving Multitasking



Monitoring Activity States and Providing Feedback with Generative AI

New Generation Computing Laboratory

Research/Development Areas

New Computing Paradigm and It's Design Methodology

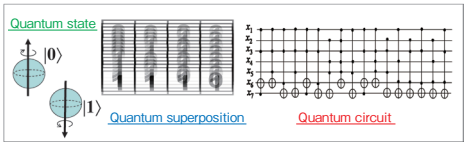

Head researchers: YAMASHITA Shigeru, Zanhe QI

The New Generation Computing Laboratory works on methods of designing next-generation computers to meet the demands of high failure resistance and low power consumption; this contrasts with most computers to date, which tend to consider only the need to meet conventional demand for performance. The Lab is also researching theoretical analysis of operating principles and ways of designing radically different computing methods from today's methods-technologies such as quantum computers and biocomputers. Related to the above-mentioned researches, the Lab is also researching theoretical aspects of algorithms and data structures, and parallel high-performance computing with GPUs, etc. Some of the Lab's current research areas are:

Highly dependable computers
-Research on ways of designing computers that can avoid failures
Increasing LSI miniaturization has made the problem of hardware failures during manufacture and operation. This research is addressing ways of dealing with such hardware failures.

Quantum computers
-Creating methods and tools for efficient design of quantum circuits
By controlling microscopic physical states such as electron spin, we can perform a type of parallel computation known as "quantum parallel computation." This approach results in computers that are significantly faster than current supercomputers for solving particular types of problems. This Lab is researching theoretical analysis of quantum computation as well as developing design methods and tools for quantum circuits, which are components of quantum computers.

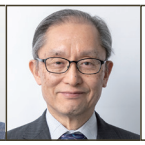
Quantum superposition and a quantum circuit.



Automated Software Engineering Laboratory

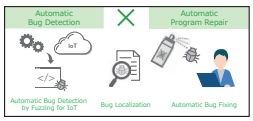
Research/Development Areas

Automation of software development and verification

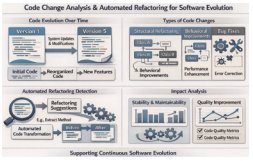




Head researchers: YOSHIDA Norihiro, INOUE Katsuro, Shiyu YANG

Building Automated Testing and Bug Repair Infrastructure for IoT
IoT devices connected to the Internet, such as smart home appliances, are becoming increasingly popular. Practitioners that develop IoT devices have to release them only after thorough verification to ensure that bugs do not exist. However, detecting and fixing bugs is not easy because IoT devices have complex user- and device-specific behaviors, identifying multiple users and other devices. For secure IoT devices, it would be helpful if computers could automatically find bugs and automatically fix them. In our laboratory, we are conducting research toward realizing such automatic bug detection and repair techniques.



Code Change Analysis and Automated Refactoring Identification in Software Evolution
Software systems undergo continuous changes throughout long-term maintenance and version evolution. Such changes may involve functional enhancements or behavioral optimizations in various forms. As systems scale and development histories accumulate, systematically characterizing code changes and assessing their impact becomes increasingly important. Grounded in the analysis of code evolution, this work addresses the automated identification of refactoring activities and evaluates how different types of code changes influence system stability and maintainability. By advancing analytical techniques for software evolution, it supports sustainable evolution and quality improvement in software systems.



Integrated Systems Laboratory

Research/Development Areas

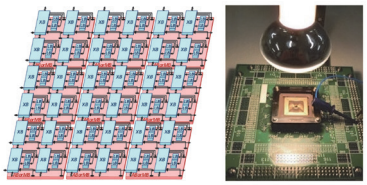
VLSI System Design and its Design Methodology

Head researcher: OCHI Hiroyuki

To improve the performance, power consumption, cost, and size of computers and other information devices/systems, we research integrated circuits as well as systems built on them.

Reconfigurable Hardware
Unlike ordinary integrated circuits whose functionality cannot be changed after fabrication, reconfigurable devices provide programmability to cover various applications flexibly. They are getting critical, especially in the field of artificial intelligence, such as image recognition. We are researching the architecture, design tools, applications, etc., of reconfigurable devices.

Ultra-low-power System
Mobile information devices such as cell phones, PDAs, and portable game consoles work with battery power, and thus reduction of power consumption is desired to achieve longer operation. Extremely low-power design is essential in devices supplied by solar cells such as sensor nodes. We are developing low-power architectures and circuits for systems that operate with energy harvested by solar cells.



Left: Developed Reconfigurable Device Architecture
Right: Measurement Setup of Integrated Circuit with On-chip Solar Cells

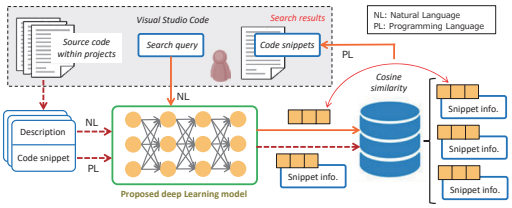
Software Science and Technology Laboratory

Research/Development Areas

Development Techniques and Environments for Reliable and Maintainable Software

Head researchers: MARUYAMA Katsuhisa, Xiqin LU

Our research group is exploring principles and methods that make software construction and evolution easier and faster, and tackling studies on the design and implementation of software development environments that incorporate those principles and methods. Recent research topics include: (1) tool platforms that facilitate building software-development support tools, (2) mechanisms that track the evolution of a software application by analyzing its development history, structure, and behavior, (3) automated refactoring techniques that improve the internal structure of existing software without changing its external behavior, making it easier to understand or cheaper to modify, and (4) automatic evolution of software, such as extending functionality and repairing bugs based on development histories. Our group also advances programming support that embraces AI-generated code and deep learning-based software development support.



Semantic Code Search using a Deep Learning Model

Intelligent Interactive System Laboratory

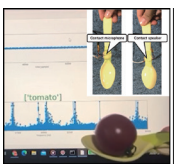
Research/Development Areas

Sensor data processing and human computer interfaces for mobile/ ubiquitous/wearable computing

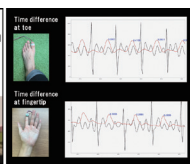
Head researchers: MURAO Kazuya, FUTAMI Kyosuke

With the advent of mobile, wearable, and ubiquitous devices, data on human activities, situations, and physical conditions can be collected. Systems and services that utilize the results of analyzing such data provide advanced functions that have been difficult to achieve so far and support tasks performed by manual work, human intuition, and human wave tactics. These technologies also improve human capability, i.e., human augmentation, and contribute to the construction of new social structures, such as health care, medical support, business support, sports, entertainment, interface, and authentication.

In our laboratory, we develop technologies that enable computers to understand humans, transfer information appropriately to people, and efficiently manipulate computers by sensor information processing, machine learning, cognitive science, usability, system design, and so on.



Cutlery that recognizes foodstuffs with active acoustic sensing (left).



Method for estimating load position of sensors from time difference of ECG and PPG (right).

Eyewear to recognize silent speech movements for input manipulation (left).

Wristband to make illusion for manipulating subjective elapsed time sense (right).

Data-Driven Software Engineering Laboratory

Research/Development Areas

Flexible Software Development Support Based on Users' Understanding Level

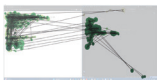
Head researcher: MAKIHARA Erina

We conduct research to uncover data-driven "tips" for deeply understanding the software that surrounds us in everyday life. In programming and software development, a wide variety of data can be collected, including not only source code and error logs, but also editing histories, developers' eye gaze, and communication logs. In our laboratory, we integrate and analyze these diverse data sources to model developers' thought processes and characterize errors, while also developing techniques to automatically generate individual feedback.

[Research Example 1: Analysis of Programming Platforms]
We analyze submission histories and interaction logs from online judge systems and Scratch to estimate users' programming proficiency. Based on these estimations, we recommend problems with appropriate difficulty levels and identify the causes of learners' struggle points, applying the results to more effective programming learning support.

[Research Example 2: Physiological Data and Program Comprehension]
We collect physiological data such as eye gaze and heart rate, along with communication histories during programming, using various sensors. These data are used to measure users' level of program comprehension in real time and to provide feedback to both learners and instructors. In recent years, we have also been working on constructing environments in which humans and AI can collaborate safely and effectively, based on physiological and behavioral data collected during AI usage.

Example 1: Error Classification Adapted to Proficiency Level



Example 2: Eye-Gaze Transitions Between Problem Statements and Source Code

Ubiquitous Intelligence Laboratory

Research/Development Areas

Technologies for Ubiquitous Intelligent Environments and Human Behavior Support

Head researcher: NAKAMURA Yugo

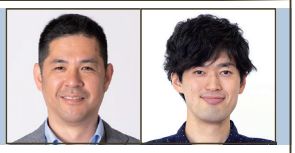
The Ubiquitous Intelligence Laboratory explores technologies that embed intelligence into everyday environments. Building upon the concept of ubiquitous computing, our research aims to realize "ubiquitous intelligence," where computational capabilities are seamlessly integrated into the physical world to support human cognition and behavior.
Recent advances in IoT devices, wearable technologies, edge AI, and generative AI are transforming computers from standalone information-processing tools into distributed components embedded in our living environments. In this context, our laboratory investigates the fundamental technologies required to build intelligent environments that understand and assist human activities.
Our research focuses on several key areas, including sensing technologies using embedded and wearable sensors, real-time environmental data processing with edge AI, and behavior modeling methods that analyze daily human activities and habits. By integrating these technologies, we aim to design environments that can gently support human actions while respecting human autonomy and well-being.
Through these studies, we seek to establish a technological foundation for ubiquitous intelligent environments in which humans and surrounding systems interact and co-evolve. Ultimately, our goal is to develop intelligent infrastructures that enhance human activities in domains such as health, learning, and everyday life.

Examples of our previous research on sensor- and AI-based technologies for human behavior understanding and support: (a) belt-type wearable for daily activity monitoring, (b) self-powered sensing using energy-harvesting elements, (c) interactive visualization of eating behavior, (d) olfactory-based taste experience design, and (e) behavioral interventions for regulating smartphone use.

Applied Cryptography Laboratory

Research/Development Areas

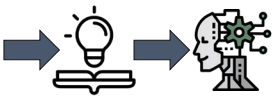
Privacy preserving technology using cryptography



Head researchers: NOJIMA Ryo, MIYAJI Hideaki

Cryptography has now become a technology that supports the society. Among cryptographic research, we focus on (1) security evaluation and designing of cryptographic primitives such as post-quantum cryptography and SSL/TLS, and (2) privacy preserving technologies. In (2), we have three sub-themes. (2-1) We evaluate what kind of privacy information leaks from a model that have been machine learned using data that contains privacy information. (2-2) Conversely, we aim to build a machine learning method that does not leak information of the data used for learning. (2-3) In order to improve the performance of machine learning, it is necessary to collect a large amount of data which may contain privacy information. To collect data that contain privacy information from multiple organization, a machine learning method while hiding information from each other is needed. We develop such a privacy-preserving machine learning method using the cryptographic technologies such as homomorphic encryption and differential privacy.

height	weight	age	health
163	58	31	yes
165	56	24	no
158	56	32	yes
153	60	54	yes
150	55	23	no
175	75	45	no
183	70	23	yes



Applied cryptography for:
- Learning while preserving private information secret
- Technology that does not leak private information from the trained model

Global Information Networks Laboratory

Research/Development Areas

Developing Cooperative Distributed Systems on Large-Scale Networks

Head researcher: NISHIMURA Toshikazu

Global Information Networks
On global information networks, all network entities such as data centers, fixed terminals, mobile computers and sensors, can be connected to interact with each other without a centralized mechanism. Our aim is to establish the next generation protocols for autonomous distributed cooperative communication to implement network applications and systems.

Next Generation protocols
In wireless communications such as mobile networks and Wi-Fi, quality degradation due to radio waves is inevitable. We are focusing on protocols that realize high-quality computer network by retransmission of missing data or by using multiple communication paths for single connection for example.

Overlay Networks
An overlay network is a computer network built on top of another network. Our Japanese patent No. 433200 employs overlay network technology to the mechannism for Wi-Fi Hotzone that covers a city with a wireless local area network.

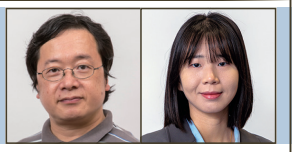
Mobile Networks and Internet Protocol
A virtual single cell is our solution that supports high-speed roaming and mobility by unifying neighboring micro-cells. We can realize broadband mobile networks by combining this idea with Internet Protocol over Wi-Fi Hotzone.

A router for satellite link (in the center of the photo) and its driving battery (a black equipment in the back of the router).

Cyber Security Laboratory

Research/Development Areas

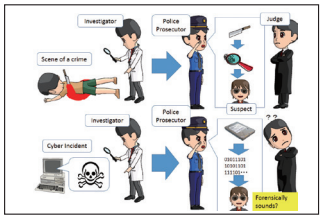
System Security and Digital Forensics



Head researchers: UEHARA Tetsutaro, Jingjing RAO

ICT has become crucial in our society. The social impact of failures that occur in critical information systems is quite serious. In particular, cyber crime has become a major obstacle threatening the safety and security of our society We are doing the research and development of technologies that will contribute to achieve stability of secure information systems as well as to fight against cyber crime.

[Digital Forensics]
Today, many pieces of evidence of frauds and crimes remain on various digital equipment in the form of digital data. However, this digital evidence is quite fragile and can be easily erased or tampered with. It is also quite difficult to understand and investigate for anyone other than professional engineers. Digital forensics is a set of related technologies to acquire and investigate digital evidence related to cybercrimes, frauds, system incidents, and failures. It is a new field of research, and we are developing a variety of techniques as pioneers in digital forensics.



In regular crimes, judges normally understand the evidence of the crimes. However, digital evidence is difficult to evaluate.

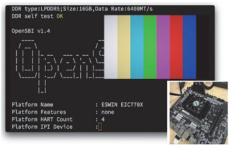
System Software Laboratory

Research/Development Areas

Aiming for a Software Revolution Using Cutting-Edge System Software

Head researcher: MOURI Koichi

I research system software, including operating systems (OSs) and hypervisors (virtual machine monitors/VMMs). System software plays a special role in managing computer hardware and applications. It is essential for application developers, computer users — it is what makes a computer usable as a computer. System software continues to evolve today, incorporating features such as software containers and security features to protect from cyberattacks and malware. Hypervisors enable a single physical PC to appear as multiple PCs (virtual machines/VMs), allowing separate operating systems to run on each VM. Furthermore, VMs running on one PC can be migrated to another PC over a network. This technology is indispensable in today's cloud computing environments. Beyond the search engines, shopping platforms, and social networks you use daily, future autonomous vehicles will also be built upon these technologies. Yet how many truly understand their inner workings? Our laboratory deepens the foundational knowledge of system software learned in courses, cultivating talent capable of acquiring and applying cutting-edge knowledge and technology to solve real-world problems. Become a software expert. Why not challenge yourself in this exciting field?



Hypervisor for RISC-V

Information Networking Laboratory

Research/Development Areas

Research and Development of Innovative Network Systems utilizing Internet-based Technology

Head researcher: YAMAMOTO Hiroshi

An IoT (Internet of Things) is the network system consisting of not only computers/smartphones but also various physical objects (or things) that have connectivity to the Internet. These things can be embedded with various devices and electronics (e.g., sensors, robots, cars) in the real world, hence the IoT is attracting attention in research/business fields for creating new network services. In our laboratory, we are focusing on greater value that can be achieved by interconnecting things through the Internet, so researching and developing enabling technologies for achieving the innovative network system which can improve quality of life in the real world.

【Topic 1: Social life support system using embedded system】
The embedded system is a small-sized, low-power, low-cost computer which can include various sensing capability and network interfaces. By utilizing the embedded system, we are researching and developing various social life support systems (Figure 1: snowplow support system for an area of heavy snowfall, Figure 2: victim detection system for a mountainous area).

【Topic 2: Highly reliable data management system utilizing "Blockchain"】
Behavior of the social life system is decided based on the "data" that are collected from the real world, so the system may cause critical issues if the data is tempered by attackers. Therefore, in order to guarantee reliability of the real-world data, we are researching a data management system utilizing "Blockchain" that is originally proposed for cryptocurrency such as Bitcoin, and designing/developing applications utilizing the system.

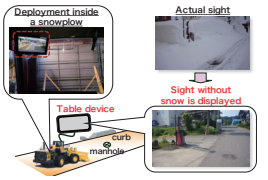


Figure 1: Snowplow support system using a table device

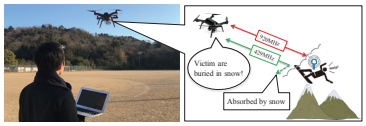


Figure 2: Victim detection system using a drone

Advanced Systems Laboratory

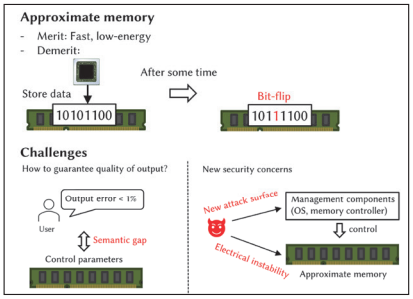
Research/Development Areas

Computing Systems for Sustainable Improvement of Software Performance

Head researcher: AKIYAMA Soramichi

Performance improvement of computer hardware has slowed down due to the slowdown of silicon manufacturing processes' refinement and the limited heat dissipation capabilities at runtime. This is leading us to an end of the good old age where the speed of underlying computers "automatically improve" from the software point of view. However, software domains such as AI, large-scale simulation, and big-data analytics keep requiring faster and faster computers.

To keep improving software performance, we focus on techniques that reside on the boarder of hardware and software. For example, a technique called Approximate Computing achieves time- and energy-efficient calculation by slightly sacrificing its integrity. However, gaining real benefit from this technique leaves us many challenges including which part of target software can be approximated (How do we know this? How do we control this?) and security issues that might stem from unconsciously modified data. We tackle these challenges with system software and computer architecture principles.



Overview of approximate memory and related research topics

Advanced Network Laboratory

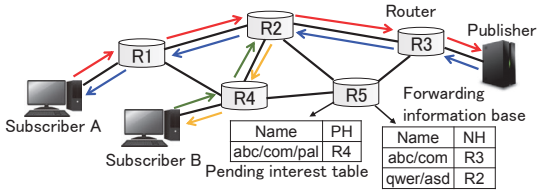
Research/Development Areas

Advanced Networks and Network Security

Head researcher: KAMIYAMA Noriaki

With the increasing definition of YouTube videos and the enrichment of web pages, the size of digital contents such as videos and images has increased, and the amount of data transmitted on the networks has continued to increase explosively. Furthermore, the patterns of data generation and consumption have diversified with the spread of IoT, which makes lives of people comfortable by analyzing the measurement data of sensors and smartphones installed in various places. Information-centric networking (ICN) is attracting attention as a new-generation network that replaces the current Internet in order to efficiently distribute large-capacity and diversified data. In our laboratory, we are engaged in research on various technologies of content delivery, e.g., router technology to realize a world-scale ICN and reliability technology to continue stable services even in the event of a disaster.

In addition, the Internet has become widespread as a social infrastructure that is indispensable for daily life of people. However, since the Internet is accessible to everyone, cyberattacks such as information leaks and denial of service (DoS) attacks that render Web servers inoperable occur on a daily basis. In our laboratory, we are also engaged in various research on network securities, e.g., defense technologies of various cyberattacks such as DoS attacks targeting network links, attacks targeting caches used to efficiently distribute content, and data management systems using blockchains.



Motion principle of ICN

Network Systems Laboratory

Research/Development Areas

Research for Advanced Network Technologies integrating Mobile Wireless Devices into the Internet

Head researchers: NOGUCHI Taku, YOSHIDA Masami

We are researching how to improve networks by integrating wireless technologies into the Internet. Our research interests include mobile ad-hoc networks (MANET) consist of mobile devices, e.g. smartphones, tablets and in-vehicle units, connected by wireless link, wireless sensor networks, which monitor the environment for any activities, and network coding theory, which is one of the most important breakthroughs in network communications. Through these researches, we would like to develop new generation network technologies to achieve a secure and reliable IT-based environment.

The photo shows concept of MANET, which is a self-configuring, infrastructure-less network of mobile devices connected by wireless links. MANETs are expected as an essential technology for an alternative communication networks after any large-scale disaster and vehicular communication networks connect vehicles because MANETs do not need any infrastructure support.

Concept of Mobile Ad-hoc Networks

Human-AI Education Laboratory

Research/Development Areas

Research to build an educational foundation by combining intelligence, educational data, and human understanding

Head researcher: Brendan John FLANAGAN

Advances in digital technology and artificial intelligence (AI) are dramatically transforming society. In the educational field, the spread of online classes, the accumulation of learning data, and the use of generative AI are advancing, leading to the emergence of new forms of learning. At the same time, new challenges are emerging, such as how to provide support tailored to each learner, how to design proactive learning while preventing overreliance on AI, and how to protect privacy.

In this laboratory, we begin our research by analyzing educational data to scientifically elucidate how people learn. We aim to build learner models that go beyond knowledge acquisition to include motivation, metacognition (the ability to reflect on one's learning), critical thinking, and social skills, thereby providing more effective and balanced learning support.

Furthermore, we explore mechanisms by which humans and intelligent systems learn collaboratively, developing support systems that can accommodate a variety of learning needs. Our goal is to appropriately adjust intelligent systems based on learning data and achieve "learning that truly builds students' abilities," rather than simply improving efficiency. We will redefine education as an "intelligent information system" and create a next-generation learning environment that connects learners, educators, and society.

Activity Information Engineering Laboratory

Research/Development Areas

Estimation of "mind state information" from human activity data

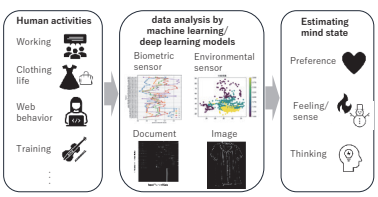
Head researcher: HARADA Fumiko

Our research focuses on the services to optimize human activities by estimating invisible mind state information from behavioral and/or biometric data observed during past life and activities. We especially deal with (1) preference, (2) feeling/sense, and (3) thinking as the mind state information.

In (1), various AI models, including machine learning and deep learning models, are used to estimate the individual preferences and the trend of preference of population from evaluation behavior and resource posting behavior on the web. Based on the estimated results, we aim to develop services to recommend items agreeing with the preferences and/or adjust the preferences.

In (2), based on the time-series data analysis of wearable sensors and sensors present in the environment with various AI models, we aim to realize an application that optimizes the activity environment by estimating mental states such as pleasant discomfort, concentration, and comfort in specific situations, and so on.

In (3), image and text data generated in the process of intellectual activities are analyzed to estimate the thoughts during the activity, such as "what was the emphasis on design?" By doing so, we aim to develop an environment that supports intellectual activities, such as the reuse of development assets in industrial activities.



Collaboration Design Laboratory

Research/Development Areas

Designing Human Society based on Multi-Agent Systems

Head researcher: HATTORI Hiromitsu

As human society is getting highly-developed and complicated, it becomes hard to design suitable social systems for the society. Social simulation has been regarded as a promising method to understand complicated human society and predict probable social problems. The research objective in this laboratory is to explore technologies to design systems, mechanisms, services for human society in the future. The core technology is Multiagent-based simulation (MASim) which has been focused as a promising form of micro-simulation because it is suitable to reproduce complex phenomena in human societies.

We have conducted MASim in various domain such as traffic, energy, disasters, and internet communities. Especially, in the traffic domain, we have developed massively multi-agent simulator on which each agent can make its own decision every few seconds. Then, we successfully reproduced traffic flows under conditions applied for social experiment held in Kyoto City in 2007.

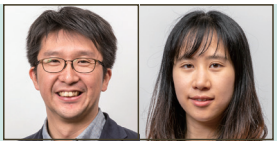
Simulation is not a technology to accurately predict the future, but a tool to find or point out possible form of the future. We will try to develop MASim-based technologies which can promote collaborations among humans and machines/softwares to solve diverse issues in human societies through interactions among them.

User Experiment with Urban Design Simulator

Social Intelligence Laboratory

Research/Development Areas

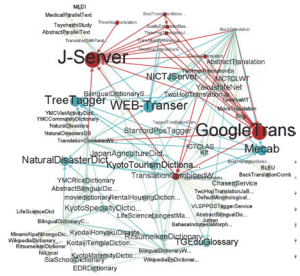
Developing a Service-Oriented Platform for Social Intelligence



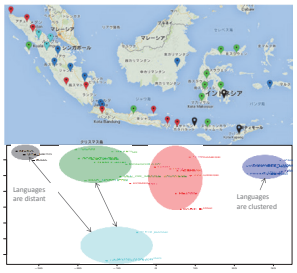
Head researchers: MURAKAMI Yohei, Mondheera PITUXCOOSUVARN

Social problems increasingly become too complex to be solved within one discipline. To address such problems, it is necessary to collect intelligence from a whole society. Our laboratory aims at forming social intelligence based on services computing technologies. Especially, by interconnecting web services of human/machine intelligence, we are developing a service-oriented platform that accelerates the construction of social intelligence.

For example, to overcome language barriers caused by globalization, we are operating the Language Grid, a platform to customize a multilingual service according to a community's context by combining various language resources. Also, to save endangered languages, we are driving Indonesia Language Sphere project that comprehensively creates bilingual dictionaries of low-resourced languages by combination of automatic generation and multiethnic crowdsourcing.



Language service network on the Language Grid

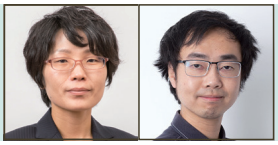


Clustering Indonesian ethnic languages and their distribution

Communication and Interaction Design Laboratory

Research/Development Areas

Communication Support via Information Extraction and Visualization

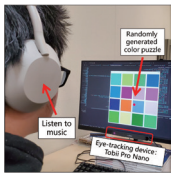


Head researchers: NISHIHARA Yoko, Junjie SHAN

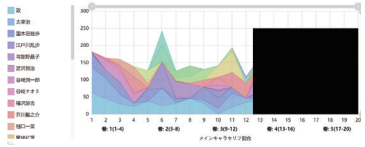
The objective of the research is to support human communication. The laboratory is researching methods of information extraction and visualization.

[Communication Chatting Bot]
We are developing chatting bots that enhance communication among people and provide communication topics. The chatting bots increases the number of physical communications among people. The increase of the physical communications reduces loneliness and prevents isolation.

[Nonverbal Information in Communication]
We are developing a system that estimates the colors that users imagine and feel by the eye-tracking device.



[Comic and Anime]
We are developing an information retrieval system on comic contents. Users do not need to use language query, so they rarely encounter comic's spoilers. We are also developing a listening practice support system using anime dialogues with estimated levels and features.



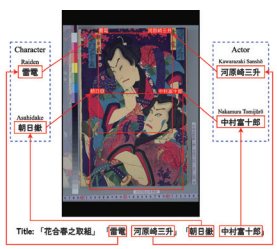
Digital Library Laboratory

Research/Development Areas

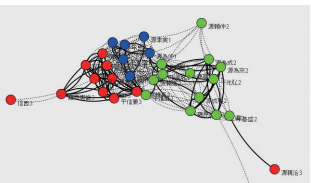
Information Access Technology for Digital Libraries

Head researcher: MAEDA Akira

We are doing research mainly on information access technologies to facilitate the organization and use of a vast amount of text media information. In recent years, an increasing amount of information has become available online, but it is becoming difficult to find the desired information from it. In order to support users in accessing information that matches his/her needs, we research techniques for information retrieval, which is the basis of information access technologies, as well as data mining techniques to discover useful knowledge hidden in a vast amount of information, information recommendation techniques that recommends useful information according to the user's interests, search and mining techniques for valuable historical materials that have been increasingly digitized, and multilingual information retrieval which enables access to information written in various languages in the world.



Automatic matching of parts of an ukiyo-e image with names in the title



Interpersonal relationship diagram obtained by analyzing a historical document

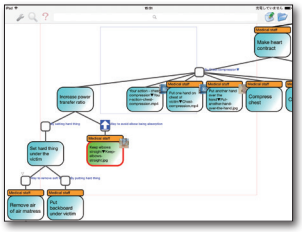
Knowledge Computing Laboratory

Research/Development Areas

Semantics-based Knowledge Support Systems

Head researcher: KITAMURA Yoshinobu

In recent information society, it is necessary to use diverse knowledge and information in different areas, organizations, and disciplines. Our research aims to facilitate access to knowledge-supported by computers-and its semantic-based use of knowledge computing. The key technologies cover "ontology engineering," i.e., semantically defined concepts, and "semantic technology," i.e., interlinking heterogeneous resources on the web. In previous research, one of the implemented systems included ontology-based procedural activities to describe nurses' expertise, developing a tablet-computer application for education and training of novice nurses. This system has successfully been used in real-world applications. In other research effort, for the manufacturing industry, design-support systems based on the models of artifacts, material and faults have been developed and deployed. This laboratory conducts fundamental research, development of application systems, and research applied in the real-world containing a variety of disciplines and domains.



Tablet-based learning application software for nursing activities (left) and a situation of its real use in a hospital (above).

Cognitive Engineering Laboratory

Research/Development Areas

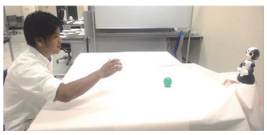
Interaction design between human and human, objects based on cognitive engineering

Head researchers: IZUMI Tomoko, YASUO Megumi

Cognitive engineering is a research field that designs artifacts and systems by considering human cognition and behavior, based on findings from cognitive science and psychology. It examines interactions among people, between people and objects, and between people and computers, and explores mechanisms that support human activities and evoke positive emotions such as happiness and enjoyment. The main areas are as follows:

1. Memory Engineering: Research focusing on personal memories and their use in supporting mental well-being through reminiscence and promoting interpersonal communication
2. Communication Support: Proposes interaction mechanisms that facilitate smooth, comfortable communication and enhance a sense of social connectedness.
3. Disaster Prevention: Evacuation support and information presentation that fosters disaster awareness.
4. Tourism Support: Research on systems that encourage voluntary sightseeing and exploration to make tourism more enjoyable.
5. Driving Support: Research on driver-friendly information presentation and mechanisms that promote safe driving.

Verification of a driving support system using the drive simulator



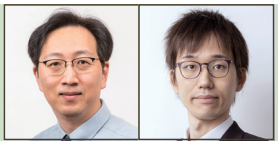
Interaction support via playing catch with a robot

Location sharing that fosters a sense of social connectedness

Advanced Intelligent System Laboratory

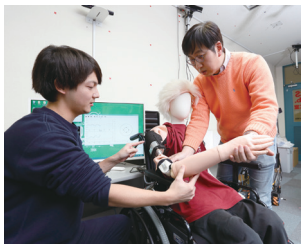
Research/Development Areas

Solving various problems with Intelligent Systems - Intelligent Space, Intelligent Robots, Artificial Intelligence

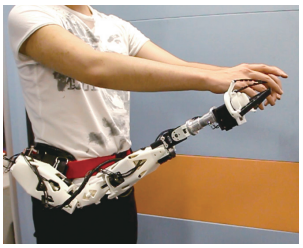


Head researchers: Jooho LEE, HOSODA Yuya

We are conducting research to solve various problems by integrating various IT and related technologies mainly robots to take action, computer vision to see events, artificial intelligence to judge the situation and instruct actions doing.
For example, in Intelligent Space research, data obtained from sensors distributed in space are processed to retrieve useful information then the space will provide comprehensive support; physical support by robot and informative support by image and voice for people in space.
In addition to this, a wide range of researches in various fields such as a wearable robot arm that supports human work, an elderly care assistance robot, a on water environment monitoring system, and a medical behavior recognition technology are performed widely in this laboratory.



A nursing care support robot that quantitatively measures nursing care movement and teaches the correct nursing care movement

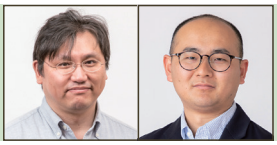


Assistance Oriented Arm (Wearable Robot Arm)

Interaction Laboratory

Research/Development Areas

Developing Interfaces and Robots Supporting Human Life by Interactive Intelligence

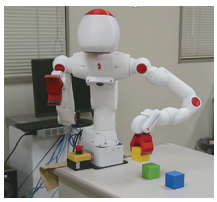


Head researchers: SHIMADA Nobutaka, FUJII Yasuyuki

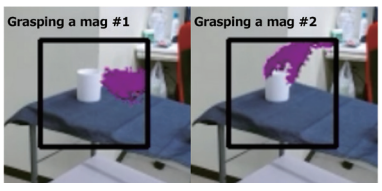
Computer Vision for Service Robot
Service robot has ability to move around autonomously, identify human faces/gestures, and engage in verbal conversations. It behaves as a physical agent mediating between a user and the indoor surveillance system. It also automatically learns and recognizes the usage of new tools by observing daily human activities. Our vision-based intelligent interfaces including real-time object detection and gesture estimation enable the robot to operate devices like human.

Indoor Surveillance System
This system visually captures human activities in indoor scenes and recognizes them with computer vision. It can automatically detect objects a person places on or removes from a table. A user can ask "Who left this?" or "Who took the book from here?" through verbal and gestural interaction.

Food Processing Automation
Methods and system which enables robots to handle foods for factory automation and food processing at home.



Object operation by observing human demonstrations



Robotic Imagination for grasping a mag (Deep learning)

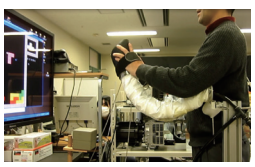
Biorobotics Laboratory

Research/Development Areas

Emotion, Perception and Motor Control
Pneumatically Controlled Soft Mechanism

Head researcher: MITSUDA Takashi

The Biorobotics Laboratory has developed wearable robots and soft mechanisms actuated by air pressure. In addition to these studies, the laboratory has recently started to study cognitive psychology dealing with human emotion, perception and motor control. Human emotions and decisions are unconsciously affected by the environment. Human perceptions also vary according to the environment. Understanding the relationship between the environment and the human mind contributes to the development of human-friendly systems. Current research interests include preference formation, proprioception, haptic sensation and pneumatically controlled machine elements that change the rigidity.



Force display system

Odor preference judgments

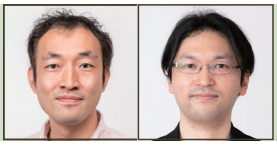
Force display by the use of constrictive pressure on forearms

Variable stiffness sheet

Playful Laboratory

Research/Development Areas

Research and practice on playful interaction design.



Head researchers: MATSUMURA Kohei, TAKAHASHI Haruki

We use human-centred design and tackle challenges real world problems in playful way. We are more than just researchers; As engineers, designers, practitioners, artists and geeks, we create digital technologies to solve real world problems.

Examples of our human-computer interaction (HCI), human-robot interaction, and digital fabrication research:

Service robot experiment at shopping mall

Research on "harmonious" service robot within a real situation. We do study on intelligence of a robot as well as interaction between human and robot.

Emoji input by drawing a curve

Research on "Face." We develop a variety of novel user interfaces that utilizes Emoji such as questionaire with Emoji and Emoji input method by drawing a curve.

3D printing hair-like object

Research on "novel 3D printing" techniques. We are keen to seek a novel way to use digital fabrication machines.

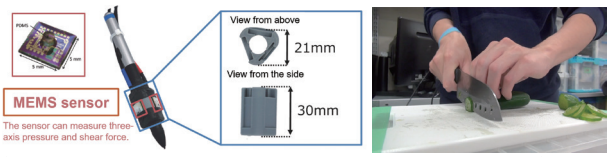
Media Experience Design (MxD) Laboratory

Research/Development Areas

Applied media technology for our daily life

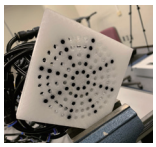
Head researchers: NOMA Haruo, ANDO Mitsuhito

MxD lab are exploring new experiences provided by the media technology for contributing to our real life. Our research target covering all fields such as daily life, education, transportation, medical care, games. Starting from actually observation and understanding the our activity, we try to find essential problems at the real site and then solve them with media technology.

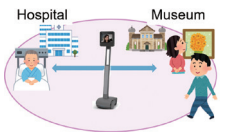


Signature recognition system and cooking procedure system using MEMS sensor.

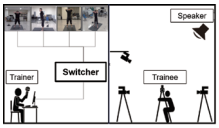
Procedure training system for NCPR



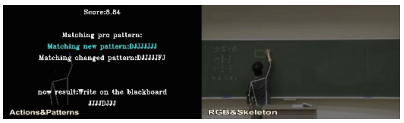
Cluster digital air cannon



Telepresence robot for social inclusion



Remote exercise support system

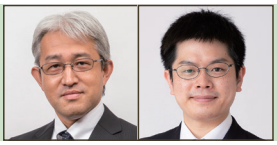


Visualization system of trial class

Mobile Computing Laboratory

Research/Development Areas

Research for Enhanced Information Space Using Mobile Devices



Head researchers: SHIBATA Fumihisa, NAKAMURA Fumihiko

"Mobile computing" is a key technology for creating an enhanced information space integrating the real world and the virtual world. We are conducting research by using mobile devices which are equipped with various sensors to improve our daily lives in the near future. The functions of mobile devices are further refined every year, and which is enabling us to develop common core systems using mobile devices that cleverly, casually, and gently support various activities in our daily lives.

We are concentrating our energies into our research to develop a distributed framework for mobile mixed reality (MR) systems that enable users to experience the real world enhanced with electronic information provided through mobile devices. We have developed mobile MR applications based on the developed framework: a campus guide, a wiring and facilities inspection system, and so on.

In the future, we will expand the range of research into automobiles and UAV (Unmanned Aerial Vehicle)to think extensively about "mobile computing".

Experiencing MR campus guide using mobile devices

Reality Media Laboratory

Research/Development Areas

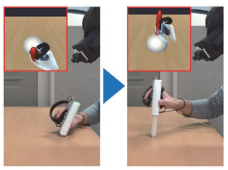
Mixed Reality and Human Interfaces Technology for Next Generation

Head researcher: KIMURA Asako

We are conducting research on next-generation human interfaces (HIs) using Virtual Reality (VR) and Mixed Reality (MR) technologies. VR allows users to experience a simulated world, while MR merges the real world with the virtual world. Our studies focus on how intuition and experience can enhance these interfaces. We also investigate human perception and cognition in these environments. Our research includes gesture user interfaces, similar to those seen in science fiction movies. We explore haptic devices and pseudo-haptic feedback systems that let users touch or feel the weight of virtual objects. We also study body augmentation and collaborative avatars in virtual worlds. Additionally, we examine how experiences in VR and MR spaces affect users' sense of self-motion, body perception, sense of body ownership, and sense of agency.

The effects of experiences in VR and MR spaces on users' sense of self-motion, body perception, body ownership, and sense of agency

Gesture user interfaces using hands, foot, eyes etc…



ExtickTouch: Interactive haptic device for getting contact-feeling of virtual objects

Acoustics & Signal Processing Laboratory

Research/Development Areas

R&D into the analysis, understanding, reproduction, and synthesis of acoustic sound environments.

Head researchers: NISHIURA Takanobu,Yuting GENG

We are researching the analysis, understanding, reproduction, and synthesis of acoustic sound environments using media technology for building a more pleasant living environment. In particular, we research on daily basis topics in the area of "Acoustic Sound", such as "Audio Spots" based on spotlights of acoustic sound, "Acoustic Sound Sensors" based on abnormal sound detection techniques, "Hands-free Voice Interfaces" based on the distant-talking speech capturing techniques, "Optical Laser Microphone" based on the sound reproduction techniques by scanning from vibration objects with laser, "3D Acoustic Sound Field Reproduction" based on highly realistic acoustic sound field reproduction techniques, "Active Control of Sound for Comfort Acoustic Environment" based on superposition of sound and auditory masking, and "Acoustic Planetarium" based on the design techniques of sound images with parametric loudspeakers.Furthermore, we also try to actively contribute to R&D for new acoustic systems based on the auditory scene analysis of human beings.

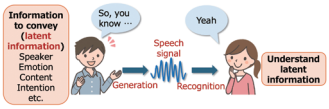
Spoken Language Laboratory

Research/Development Areas

Speech recognition and generation and their applications.

Head researchers: TAKASHIMA Ryoichi, NAGASE Ryotaro

Humans communicate their thoughts, feelings, and intentions to one another through speech. In our laboratory, we are researching speech recognition technology, in which a computer recognizes various information from speech like the human hearing, and speech generation technology, in which a computer generates speech based on the information to be conveyed, like the human speech. While current speech recognition technology can accurately transcribe speech, it still struggles to recognize complex information such as who is speaking, when, with what emotion, and with what intention. Similarly, speech generation technology faces challenges in generating speech that accurately reflects the various types of information mentioned above. Our goal is to develop advanced speech recognition and generation technologies capable of capturing the various types of information latent in speech. We also aim to develop technologies that contribute to the realization of a safe and secure society by applying these technologies to; for example, speech input interfaces for the physically disabled people, communication assistance for people with speech or hearing difficulties, and anomaly detection and safety monitoring by analyzing environmental sounds by expanding the target range from speech to all sounds.



Computer Graphics Laboratory 1

Research/Development Areas

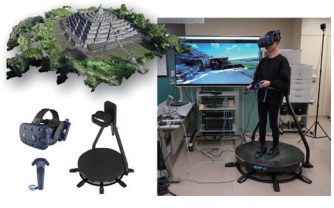
Visualization, VR, AI, and their application to science and culture

Head researchers: Liang LI, Jiaqing LIU

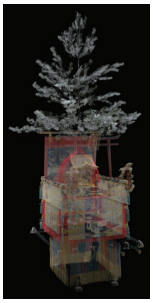
We are developing a range of state-of-the-art methods in computer visualization, virtual reality (VR), artificial intelligence (AI), and three-dimensional (3D) computer graphics. At the same time, we are advancing numerous interdisciplinary research projects that apply these developed techniques to the creation of digital twins for various tangible and intangible cultural heritage sites both in Japan and abroad.

In the field of tangible cultural heritage visualization, our projects include recreating, preserving, and analyzing the Gion Festival in Kyoto within a virtual space, as well as developing high-speed, high-quality visualization techniques for large-scale point cloud data obtained through 3D scanning of heritage sites such as Indonesia's Borobudur Temple and Kyoto's Nijo Castle, both recognized as UNESCO World Heritage sites.

In the field of intangible cultural heritage digital archiving, we are engaged in projects such as developing a learning support system for Japanese traditional dance.



Borobudur Temple VR
Thanks: National Research and Innovation Agency (BRIN), Indonesia Borobudur Conservation Office, Indonesia



Hachiman-yama float in the Gion Festival, Kyoto
Thanks: Hachiman-yama Preservation Society

Computer Graphics Laboratory 2

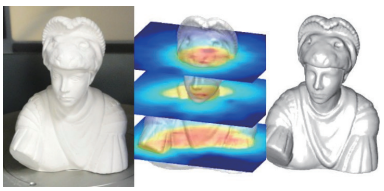
Research/Development Areas

Computer graphics and simulation of physical phenomena

Head researcher: NAKATA Susumu

The main research topic is computer simulation of physical phenomena like deformation of solids, flow of fluids and propagation of electromagnetic waves. Our approach is to combine the simulation with the techniques of computer graphics (CG) in order for accurate expression of three-dimensional geometry, intuitive operation and high visibility. We developed original techniques for shape representation of three-dimensional surfaces that contribute to accurate and efficient computation of physical phenomena. Some of our simulation techniques allow users interactive manipulation during the simulation. In fluid simulation, users can modify obstacles in three-dimensional domain and, in electromagnetic simulation, users can change shape and material parameters of objects located in the space. In addition, our shape representation is designed for effective parallel computation and efficient visualization.

Fluid simulation



Three-dimensional shape modeling

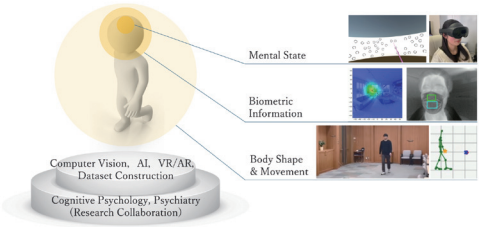
Computer Vision Laboratory

Research/Development Areas

Computer Vision Research for Estimating People's Mental States

Head researcher: MITSUGAMI Ikuhisa

With our eyes, we can not only perceive the shape, color, texture, and other physical characteristics of objects, but we can also perform sophisticated recognition and inference of what the object is, who the person is, and what situation he/she is in. Computer vision is a research field that realizes such advanced recognition capabilities through cameras and computers. Computer Vision Laboratory focuses on computer vision in general, but we are particularly interested in the development of techniques for estimating mental states such as a person's intentions, emotions, and level of understanding. Specifically, we are working on methods to measure a person's body shape and movement, to acquire biometric information such as gaze and respiration, and to use this information to estimate the person's mental state. Furthermore, we aim to develop new knowledge and innovative technologies by taking a cross-disciplinary approach, such as using VR/AR technology to present visual information to people, and developing collaborative research to analyze and interpret human behavior in cooperation with experts in psychology, brain science, and psychiatry.



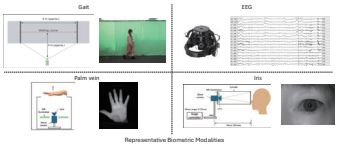
Visual Recognition Laboratory

Research/Development Areas

Visual Recognition for Biometrics and Human Analysis

Head researcher: Chi XU

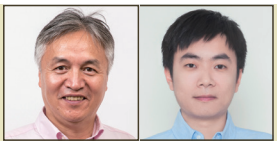
Computer Vision is a research field that develops techniques to extract and understand information about objects, people, and scenes from images and videos. In our laboratory, we focus on visual recognition technologies that analyze and interpret human-related information from visual data.
Our primary research theme is biometric authentication using human biological and behavioral characteristics. In addition to conventional biometrics such as fingerprint and face recognition, we study a variety of biometric modalities including iris and palm vein recognition, gait recognition based on individual walking patterns, and emerging authentication methods using brain signals (EEG). We also investigate multimodal biometric authentication that integrates multiple biometric cues, as well as robust recognition techniques designed to prevent spoofing and impersonation.
Furthermore, we conduct research on human analysis and behavior understanding from visual data. By developing techniques such as motion analysis using 3D human models and methods for estimating human behaviors and states from visual observations, we aim to apply these technologies to socially important fields including security, healthcare, and safety monitoring. Ultimately, our goal is to establish intelligent information technologies that enable deeper understanding of humans by integrating visual recognition with diverse biometric information.



Intelligent Image Processing Laboratory

Research/Development Areas

Intelligent Image Processing, Image Understanding and Image Recognition

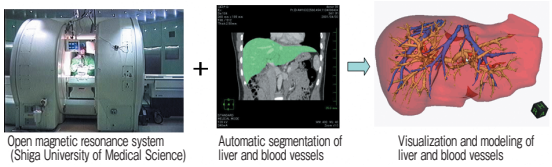


Head researchers: Yen-Wei CHEN, Yinhao LI

Medical Image Processing and Computational Anatomy
In recent years, computational anatomy has become a hot topic in medical image analysis research fields. We are working on the construction of a digital atlas of human anatomy such as the liver. The digital atlas can capture an organ's variability, such as its position, shape, and voxel intensity (texture) from a training set, and then be used for computer assisted diagnostics.

Automatic Image Annotation and Image Indexing
With the development of digital imaging technology, more and more information is nowadays conveyed in the form of digital images or video clips. We are developing an automatic image annotation method/system in which computer vision and pattern recognition techniques are used to understand the semantic meaning of an image. Metadata, such as captions and keywords can be automatically annotated to the image for image indexing.

Facial Image Processing and Beautification
Quantitative characterization of facial appearance is an important issue in many fields and applications including cosmetic foundation design. We have constructed a multi-angle view, illumination, and cosmetic facial image database (Ma-VIC) for appearance studies. Several morphing techniques have also been developed for beautification studies.



Surgical navigation system for treatment of liver tumors

Vision and Imaging Laboratory

Research/Development Areas

Computer Vision and Computational Imaging

Head researchers: TANAKA Kenichiro, KUSHIDA Takahiro

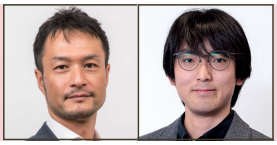
We develop new technologies of visual information acquisition and understanding. We do this by building computer vision and computational imaging systems that tightly couple sensing hardware and computational algorithms. Specifically, we have three main pillars of research topics: 1. Computational imaging technology to acquire new visual information by co-designing hardware and software, 2. Optical sensing device development to acquire and analyze light transport, and 3. Physics-based computer vision framework that estimates scene information including 3D shape and materials by incorporating the properties of light.

Imaging is fascinating.

Computational Neuroscience Laboratory

Research/Development Areas

Elucidating Brain Information Processing Mechanisms Using Mathematical Methods



Head researchers: KITANO Katsunori, KANEMURA Itsuki

The brain contains cells called neurons which number in the tens of billions, and which are thought to enable various functions through the trading of electrical signals called action potentials, but the mechanism itself is still not well understood. We are researching this brain functions mechanism using mathematical methods such as theoretical analysis and computer simulations. By modeling the electrophysiological characteristics of neurons, the aim is to clarify the informational processing mechanisms of the neural circuits comprising groups of neurons, and the mechanisms of information transmission at the level of the individual neurons. If this explication of the brain's information processing mechanisms advances, we hope to be able to apply it to developing methods of treating brain injuries and in interfaces that enable the brain to be accessed directly.

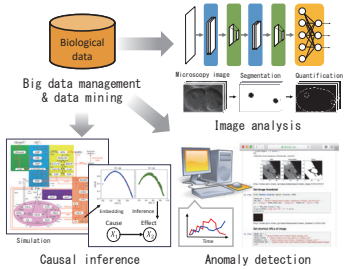
Computational Biology Laboratory

Research/Development Areas

Computational Analysis and Modeling for Biological Dynamics Data

Head researcher: TOHSATO Yukako

In the field of life sciences, advances in sophisticated measurement technologies, such as microscopes, has enabled us to obtain highly precise spatiotemporal data of cells, tissues, and organisms. In our laboratory, we are engaged in research on information technologies to uncover new knowledge from these large amounts of data. Specifically, we are working on "image analysis" methods to accurately and robustly recognize the shapes of objects in images taken under different experimental conditions, and "anomaly detection" methods to automatically identify abnormalities in new images by training models on images of normal states. Additionally, we are exploring "causal inference" to analyze data that changes over time and to infer the cause-and-effect relationships in biological phenomena. By applying these methods, we aim to realize "data-driven science" that uncover biological insights from data related to development, aging, and diseases—insights that are difficult to discover using traditional methods.



Neural Information Processing Systems Laboratory

Research/Development Areas

Understanding the key mechanism of neural information processing and development of methods for measuring and analyzing neuronal data

Head researcher: TSUBO Yasuhiro

The brain is considered to use relatively small amount of energy for its efficient information processing. The goal of our researches is to clarify the principle of information processing in the brain: a flexible and energy-saving computer with low power consumption. In particular, we focus on stochastic information processing on a characteristic architecture "cortical local circuit", which is commonly observed among various cortical areas. To this end, we construct electrical measurement systems for cortical activity, record neural activities by physiological experiments, analyze the data using statistical techniques, construct mathematical models, and extract rules for cortical information processing and nonlinear dynamics. We expect taking various approaches to "cortical local circuits" gives new perspective to physics, engineering, and neuroscience.

[Current research interests]

* Stochastic information processing by neurons in the cortical local circuit
* Nonlinear dynamics of neuronal population
* Information analysis of physiological experimental data
* Statistical properties of dynamical systems of complex network

Biological Information Engineering Laboratory

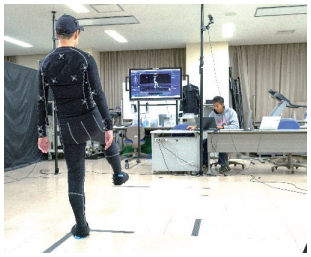
Research/Development Areas

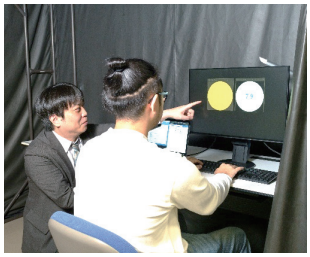
Evaluation of advanced brain activity and autonomic nervous activity by biological measurements

Head researcher: KASHIHARA Koji

The main theme of this laboratory is advanced brain activity (e.g., working memory) during cognitive processes, based on the time-frequency analysis of EEG and MEG recordings. The activation patterns of brain activity can be investigated by wavelet analysis and 3D-mapping data in a specific frequency band. In particular, we focus on the appearance of theta waves (i.e., EEG of 4–8 Hz) as neuronal activation in the frontal lobe because they indicate short-term memory and attention/concentration.

We also develop a feedback system to prevent accidents, analyzing the features of operators' attention/concentration and autonomic nervous activity (the pulse wave and ECG). Furthermore, we construct the human interfaces that reflect individual preferences and facilitate nonverbal communication, abstracting the emotional changes from microsaccadic activity and event-related potentials.





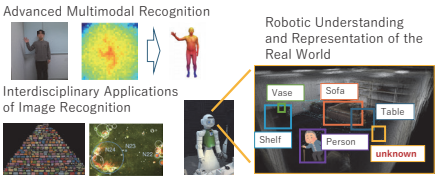
Perception and Intelligence Laboratory

Research/Development Areas

Advancing Intelligent Systems through Multimodal Perceptual Integration

Head researcher: KAWANISHI Yasutomo

Humans perceive their surroundings through the five senses and understand the events and situations around them. Inspired by this mechanism of human perception, our laboratory aims to develop intelligent systems that achieve advanced recognition by integrating diverse sensory information obtained from various sensors.
Among the various modalities, vision provides especially rich information. Therefore, we place particular emphasis on computer vision as a core technology in our research. In addition, we study multimodal perceptual integration, combining heterogeneous sensory data such as temperature, distance, and audio signals. By fusing these complementary sources of information, we enable robust perception and understanding that would be difficult to achieve using a single modality alone.
Our technologies extend beyond information science, such as robotic systems and smart environments to other scientific disciplines, including astronomy and archaeology. Through these interdisciplinary applications, we seek to contribute to society by developing intelligent systems that support new discoveries and expand the frontiers of knowledge.



Intelligent Systems Optimization Laboratory

Research/Development Areas

Intelligent Systems Optimization and Robotics Using Artificial Intelligence Techniques

Head researchers: NISHI Tatsushi, Jiayi LI

As fundamental technologies to support the ICT era, we conduct research on intelligent systems optimization such as intelligent robot systems, supply chain management, scheduling, and systems optimization, as well as new modeling, optimization, and artificial intelligence methods based on these theories, as well as optimization methods for large-scale systems. (1) Development of efficient robot system optimization techniques, including flexible motion planning using mobile manipulators and multiple robots, interference avoidance control, layout design, and integration with generative AI for equipment selection, placement planning, motion planning, and task planning. (2) Development and evaluation of new data-driven artificial intelligence and system optimization techniques that integrate data science and artificial intelligence techniques, including optimization using deep neural networks, integration of machine learning and optimization, automatic generation methods of optimization models from input/output data, neural architectures inspired by biological nervous structures, long-term time-series prediction models, and AI applications in the fields of drug discovery, medicine, and energy. (3) Development of a cyber-physical system platform for inter-company collaboration and optimization in smart supply chains, encompassing production planning, scheduling, and inventory management from parts supply to production, inventory, and sales.

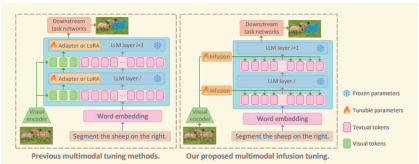
Computational Intelligence Laboratory

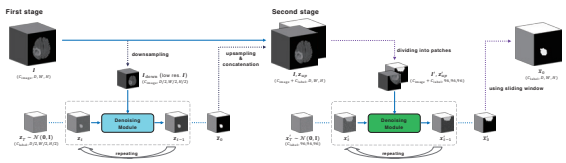
Research/Development Areas

Development and Application of Computational Intelligence

Head researchers: NISHIKAWA Ikuko, Yu SONG

Machine learning and optimization are developed for data recognition/generation, and system analysis/optimization. Deep neural networks are trained by the past data to recognize the future data or to generate required data, moreover, those are combined in a framework for the anomaly detection, domain adaptation, fine tuning of the huge general foundation model etc. The present research topics include 'Medical image segmentation based on diffusion models' to detect the small and complex shaped tumors; 'Fine tuning of the multi-modal foundation model' to train the adapters of the general backbone model for specialized complicated tasks; 'Universal domain adaptation' to transfer the acquired knowledge to other new domains. Different applications are based on common modelling and formalization frameworks which enables the training or optimization techniques. New challenges arise every year.





Human Vision & Color Science Laboratory

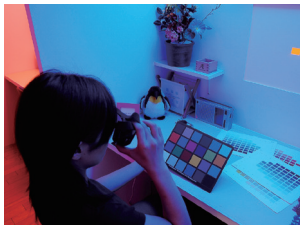
Research/Development Areas

Research on Human Visual Information Processing and Color Science using Psychophysics

Head researchers: SHINODA Hiroyuki, AKASHI Yukio

https://hvcs.is.ritsumei.ac.jp/

We investigate the characteristics and information processing mechanisms of the human visual system, and apply the findings to color science, visual environment engineering, and forensic psychology. Since light, which is the input to vision, is "physics," and perception and recognition, which are the final output, are "psychology," we use psychophysical methods to study the functions and characteristics that link the two. In color science and visual environment engineering, we have contributed to the commercialization of many products, such as UDColor, software that supports color vision diversity, ColorRecoverySystem, a lighting system for the elderly, and Feu, new space brightness index. In forensic psychology, our findings are also used in actual trials to evaluate the credibility of witnesses. Many other themes are currently underway, including the creation of VR environments that provide visually induced self-motion perception and new visual experiences, research into methods for quantifying individual differences in color vision and color vision diversity, the development of a visual quality index for images that takes into account the visual environment, and color analysis of painting preferences.



Affective Engineering and Computer Arts Laboratory

Research/Development Areas

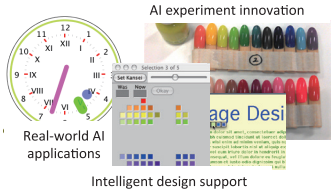
Affective Engineering, Artificial Intelligence, Computer Art Research

Head researchers: Eric W. COOPER, Alarith UHDE, Djedje Didier GOHOUROU

Affective Engineering and Computer Arts Lab (AECAL) researches and develops models to infer human affective, emotional, or sensual responses and applies these models to specific objectives. When a person is exposed to a stimulus, the experience may be associated with quantifiable internal and external responses. Because the objective systems are to satisfy specific, practical objectives, the models applied range from statistical models to methods of soft computing and intelligent systems (also known as artificial intelligence, or AI). AECAL develops new methods to meet those needs.

There are many areas where affective responses are central to the functioning of essential systems. In security, for example, user feelings lead to behaviors that may either protect or endanger data, systems, and people. In education, how students feel has a direct influence on how they. In healthcare, patient affect influences recovery and improving how patients feel is also a major final goal. In these and other areas, intelligent systems are discovering novel solutions to problems once considered beyond the scope of engineering.

AECAL also applies affective engineering and intelligent systems to the arts. Computers have often been tools for the arts but, more and more, intelligent systems are becoming full partners in the creation process in every media. In the past, many developments for the computer arts have become technologies we use every day. Computer arts today will become the innovative technologies of tomorrow because the arts have no borders.



Digital Governance Systems Laboratory

Research/Development Areas

Use of ICT and AI/ML in the public sector, applied to e-participation and e-government systems

Head researchers: Uwe SERDÜLT, Mate KOVACS, Shady SALAMA

In the Digital Governance Systems Lab we are mainly interested in how ICTs can be used to improve public services and ultimately the quality of living in a broad sense. Taking ethical considerations into account, students can either study the design of such systems or work with the data they are generating.

Key research topics in the lab include:

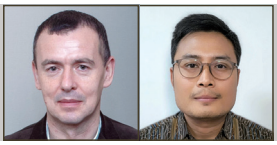
- Online voting advice applications (VAA), the lab experiments with and runs its own VAA;
- Internet voting systems design and usability studies, the lab is involved in further developing an open source internet voting application with a storage of votes in a blockchain;
- e-Petition systems, adding AI elements to make them more efficient for users and their administrators, analyzing petition signature dynamics;
- The use of distributed ledger technology and distributed autonomous organizations to enhance digital participation, and the analysis and visualization of time-stamped event participation network data in public administration;
- Applying NLP techniques like language modeling, automatic summarization, topic modeling, etc., to analyze and potentially improve digital governance systems, and e-petition platforms;
- Applying operations research methods and machine learning algorithms to optimize processes in industrial facilities and aid decision-making in the energy sector, a key pillar of Society 5.0.

The lab maintains research and educational contacts in Japan (Kobe, Kyoto and Waseda University) as well as internationally in Austria, Cyprus, Germany, Hungary, and Switzerland.

e-Society Laboratory "ICT for Human Enhancement"

Research/Development Areas

Simulation and Modeling, Social Media Analysis, IoT, e-Society, Smart City, Smart Agriculture, Business Intelligence

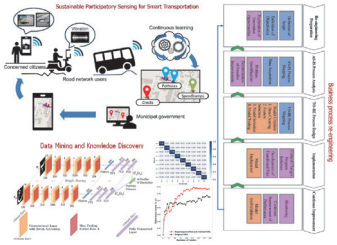


Head researchers: Victor KRYSSANOV, Valentinus Roby HANANTO

The e-Society Laboratory is a multi-disciplinary, international research and learning space centering its work around individuals, social groups, organizational networks, as well as public administrations in the age of digitalization. Classical IT projects are envisaged in a broader environmental and social perspective, encompassing the exchange with experts from urban planning, mariculture and farming, management, linguistics and sociology, but also from engineering and physics. One of the distinctive features of the laboratory is its international character. The working language is English.

Student members of the Laboratory are typically expected to discuss results of their work at professional meetings, including international conferences, while graduate research projects are to produce results that would be reported in international journals. Graduate student work is often coupled with overseas partners of the laboratory that include research groups from Universitas Brawijaya, Universitas Dinamika (STIKOM Surabaya), and The Technische Hochschule Nürnberg Georg Simon Ohm.

Laboratory social events include birthday tea-and-cake parties, cross-cultural picnics, and city tours.



Intelligent Computer Entertainment Laboratory

Research/Development Areas

Intelligent Techniques for Increasing the Value of Computer Games & Human-Centered Assistive Robotics

Head Researchers: Ruck THAWONMAS, Wenbin LIU, Ibrahim KHAN

We divide our research into three themes as follows.

Our research in Themes 1 and 2 emphasizes applying artificial intelligence and other intelligent methods to computer games for well-being games, live video game streaming, and digital humanities. Related basic research is conducted on a case-by-case basis as needed.

Theme 1: As part of this commitment to inclusive gaming, we also investigate accessible sound design to create engaging, non-visual interfaces for visually impaired players. By leveraging deep reinforcement learning "Blind AI" agents and human evaluation frameworks, we explore how to effectively convey complex game states through audio in fast-paced genres such as fighting and first-person shooter games. This includes developing adaptive background music systems and establishing evidence-based design principles, such as strategic audio minimalism, to prevent cognitive overload.

Theme 2: We are currently pursuing the potential of generative AI, including large-scale language models, and prompt engineering. These technologies will enable us to provide more realistic and engaging, serious or non-serious game experiences. These studies will also help game developers explore new game mechanics and create more engaging games for players.

Theme 3: We also conduct research in human-centered assistive robotics, spanning human-robot interaction, intention recognition, intention-driven control, and human-multi-robot collaboration. By leveraging state-of-the-art AI techniques together with robot control theory, we enable robots to infer user intent and provide safe, predictable assistance in real-world environments. Current projects include a multi-robot assistance system for daily living, haptic-feedback-enabled UAV teleoperation for safer operation, and rehabilitation robotics that artificially generate movement and kinesthetic sensation. Ultimately, we aim to deliver deployable helper robots that enhance human independence, safety, and quality of life.

Visual Information Engineering Laboratory

Research/Development Areas

Visual information analysis, coding, and processing; quality assessment; perceptual modeling; image/video compression, enhancement, restoration; natural-scene statistics

Head researchers: Damon CHANDLER, Nicko CALUYA

Research in the Visual Information Engineering lab broadly concerns analysis, coding, and processing of visual information. These days, there are many sources of visual information, including digital images, video, 3D images/video, computer-generated content, and composited versions. Our research explores how these sources of information can be utilized to help society. Our overarching goal is to research and develop software and systems to: (1) make fast and reliable decisions from visual sources, and/or (2) to assess/improve the appearance, security, and usefulness of the visual content. A key theme of our research is to consider both the computational perspective and the perceptual perspective; this approach allows us to engineer models and algorithms that are aware of how the visual information is perceived by humans, and how that perception is altered based on changes to the source content, the viewing environment, and the task at hand.

Our key research topics include:

- Image/video enhancement, restoration, and compression via perceptually guided and/or machine-learning based methods
- Quality assessment of natural and synthetic images, video, 3D content
- Traditional and AI-based analysis, including detection, segmentation, and classification
- Computational modeling of the human visual system using natural-scene statistics and visual psychophysics
- Real-time analysis and processing

Some applications of our work including automatic detection and scoring of streamed visual content, perceptually lossless compression and watermarking, visual guidance for the blind, and detection, segmentation, and correction of driving video.

Core Education Program Coordinators

Jeremy WHITE

Mobile assisted language learning, Mobile learning, Digital literacy

SUGINO Naoki

Theories of second language acquisition, English language teaching

SUGIMORI Naoki

Corpus linguistics, English language teaching

Barry Christopher CONDON

Applied Linguistics, Second Language Acquisition Studies, Educational Technology

TANIMURA Midori

English language teaching, Communication research

KATO Masaki

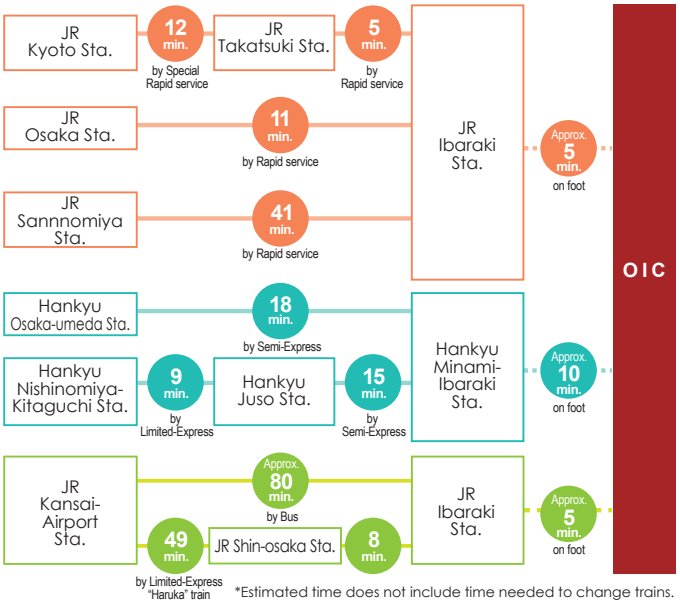
Special functions

HIRAOKA Takahiro

Number theory: Arithmetic theory in quadratic form using Clifford algebra

YOSHIKAWA Toru

Japanese language education, Theories of second language acquisition



College of Information Science and Engineering Ritsumeikan University
2-150 Iwakura-cho, Ibaraki, Osaka 567-8570 Japan; Tel.: 072-665-2075

College of Information Science and Engineering
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Graduate School of Information Science and Engineering
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