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NARA INSTITUTE of
SCIENCE and TECHNOLOGY

2014

Graduate School of Information Science

Graduate School of Information Science

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Introduction
to the Graduate School of
Information Science

The Frontrunner in Pioneering Information Science Education

The Graduate School of Information Science (GSIS) undertakes high-level fundamental research in information science, while systematically training students to be pioneering researchers and engineers in the areas of information science and engineering. In 2011, three departments in GSIS were integrated into the Department of Information Science, which has three divisions: Computer Science, Media Informatics and Applied Informatics.

GSIS offers flexible systems, such as entrance examination by interview, accelerated admission and early course completion to accept and encourage excellent students. Through our acknowledged curriculum and research base, we educate students who will be leaders in a highly advanced information society.

Open-minded, active faculty members and diverse laboratory structure

- Division of Computer Science, Media Informatics and Applied Informatics
- Cooperative Laboratory with the Information Initiative Center
- Collaborative Laboratories in external institutions

Flexible research and education system

- Choice of research laboratory based on student's preference
- Quarter system with intensive training and varied curriculum, including archived lectures
- Fast-track system for graduation
- Received highest in Ministry of Economy, Trade and Industries university evolution

Support for outstanding students

- Teaching Assistant (TA) and Research Assistant (RA) program
- Support for international exchange activities

International Program

GSIS established the International Program (Master's) in April 2011 aiming to encourage enrollment of outstanding students from countries worldwide. The International Program is designed to mainly accommodate international students, offering research and education environments (lectures, research supervision, office help, etc.) in English, as well as opportunities for students to familiarize themselves with Japanese culture. A wide range of subjects are provided in information science and in such interdisciplinary topics as intellectual property and professional ethics.

Support Program for Improving Graduate School Education

The Graduate School of Information Science organizes the Educational Program to Promote Creativity and International Competitiveness in Information Science (CICP), which aims at developing research project planning and implementation skills, and increasing communication skills via group work. CICP is intended to solicit original research projects that students endeavor to work on in addition to their research activities supervised by professors. Students are required to write research proposals and budgets are assigned to accepted proposals based on their evaluation scores. Experience in writing research proposals promotes the skills essential in writing comprehensive and persuasive articles, while experience in leading projects helps students organize and lead group-based research.

Advanced research environment

- Integrated information processing system "Mandara"
- Digital library and lecture archives
- Wide range of advanced large-scale research facilities

Admission system valuing individuality

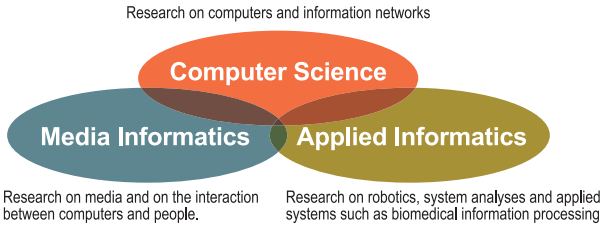
- Interview-based admission
- Cross-disciplinary admission and recruitment
- Fast-track admission for outstanding students

Special IT training programs

- IT Spiral: IT Specialist Program Initiative for Reality-based Advanced Learning and collaborative project to develop a common curriculum for teaching software engineering
- IT Keys: IT Specialist Program to promote Key Engineers as Security Specialists
- IT-Triadic: A leading education program for IT multi-specialists in a cybermedia society

Graduate School of Information Science

Divisions & Faculty



Computer Science

Laboratory	Professor	Associate Professor	Assistant Professor
Computing Architecture	Yasuhiko Nakashima	Jun Yao	Yuko Hara-Azumi
Dependable System	Michiko Inoue		Tomokazu Yoneda, Yuta Yamato
Applied Algorithmics	Hiroyuki Seki	Yuichi Kaji	Yuki Kato
Ubiquitous Computing Systems	Keiichi Yasumoto	Yutaka Arakawa	Morihiko Tamai
Foundations of Software	Minoru Ito	Naoki Shibata	
Software Engineering	Kenichi Matsumoto	Akito Monden	Akinori Ihara, Hideaki Hata
Software Design and Analysis	Hajimu Iida	Kohei Ichikawa, Yasushi Tanaka	Norihiro Yoshida, Toshinori Takai
Internet Engineering	Suguru Yamaguchi	Youki Kadobayashi, Takeshi Okuda	Shigeru Kashihara, Hiroaki Hazeyama
Internet Architecture and Systems	Kazutoshi Fujikawa	Atsuo Inomata	Masatoshi Kakiuchi, Kenji Ohira, Akira Yutani

Media Informatics

Laboratory	Professor	Associate Professor	Assistant Professor
Computational Linguistics	Yuji Matsumoto	Masashi Shimbo	Kevin Duh
Augmented Human Communication	Satoshi Nakamura	Tomoki Toda, Hiroshi Saruwatari	Sakriani Sakti, Graham Neubig, Hiromichi Kawanami
Network Systems	Minoru Okada	Takeshi Higashino	
Vision and Media Computing	Naokazu Yokoya	Tomokazu Sato	Norihiko Kawai, Yuta Nakashima
Interactive Media Design	Hirokazu Kato		Takafumi Taketomi, Goshiro Yamamoto
Ambient Intelligence	Norihiro Hagita	Norimichi Ukita, Masayuki Kanbara	

Applied Informatics

Laboratory	Professor	Associate Professor	Assistant Professor
Robotics	Tsukasa Ogasawara	Jun Takamatsu	Atsutoshi Ikeda, Masahiro Yoshikawa, Akihiko Yamaguchi
Intelligent System Control	Kenji Sugimoto	Kentaro Hirata	Kiminao Kogiso, Takamitsu Matsubara
Mathematical Informatics	Kazushi Ikeda		Takatomi Kubo, Tomoya Tamei
Computational Systems Biology	Shigehiko Kanaya	Tadao Sugiura, Md.Alaf-Ul-Amin	Tetsuo Sato, Naoaki Ono, Ming Huang
Large-Scale Systems Management	Shoji Kasahara		Jun Kawahara
Neural Computation (Visiting)	Kenji Doya	Junichiro Yoshimoto	

Affiliate Laboratories

Laboratory	Professor	Associate Professor
Communication (NTT Communication Science Laboratories)	Takeshi Yamada	Hiroshi Sawada
Computational Neuroscience (ATR International)	Mitsuo Kawato, Yukiyasu Kamitani	
Network-Human Interaction (Advanced Technology Research Laboratories, Panasonic Corporation)	Jun Ozawa	Katsuhiro Kanamori
Symbiotic Systems (C&C Innovation Initiative, NEC Corporation)	Keiji Yamada	Taku Konishi
Multimedia Mobile Communication (NTT DOCOMO, INC.)	Yukihiko Okumura	Takahiro Asai
Optical and Vision Sensing (Core Technology Center, OMRON Corporation)	Masaki Suwa	Yoshihisa Ijiri
Molecular Bioinformatics (National Institute of Advanced Industrial Science and Technology)	Yutaka Ueno, Kazuhiko Fukui	
Digital Human (National Institute of Advanced Industrial Science and Technology)	Satoshi Kagami	Kouichi Nishiwaki
Technology of Radiological Science (National Cerebral and Cardiovascular Center Research Institute)	Hidehiro Iida	Tsutomu Zeniya
Programming Science (National Institute of Advanced Industrial Science and Technology)	Yoshiki Kinoshita	
Network Orchestration (National Institute of Information and Communications Technology)	Kazumasa Kobayashi	Eiji Kawai

Laboratory

Computing Architecture

▶ URL: http://isw3.naist.jp/Contents/Research-en/12_lab-en.html


Prof.
Yasuhiko Nakashima


Assoc. Prof.
Jun Yao


Assist. Prof.
Yuko Hara-Azumi

E-mail { nakashim, yaojun, yuko-ha }@is.naist.jp

Research Areas

1. Co-processor Accelerator for High Performance and Low Energy
- Energy-aware Multimode Accelerator eXtension (EMAX)
  - Functional unit (FU) array based accelerators
  - Distributed memory for various access patterns
  - Energy-efficient instruction parallelism
  - Optimal acceleration of various domains of applications, including media processing and big data vector product

Fig.1 Processor architecture with high performance and low energy

2. Printable, Flexible Film Computer
- Emulator-oriented Minimal INstruction set computer (EMIN)
  - Extremely low-power/cost-efficient computers
  - Environment-friendly computers

Fig.2 Printable, flexible film computer

3. Hardware/software co-design for dependable embedded systems
- Dependable LSI designs
  - Dependability-aware optimizations in high-level and logic synthesis
  - Reliable LSIs with unreliable components
  - Partially programmable circuits
- Hardware/software Co-design
  - Cross-layer optimization
  - Timing variation-aware instruction-set architecture

Fig.3 Hardware/Software co-design for dependable embedded systems

4. Adaptive Processor Architecture
- Explicitly Redundant Linear Array (EReLA)
  - Reconfiguration for dependability
  - Self-adaptive instruction execution
- Dynamic Adaptive Redundancy Architecture (DARA)
  - Self-adaptive general-purpose fault-tolerant computer
  - Light-weighted fault coverage
- Linear Array Pipeline Processor (LAPP)
  - Reconfigurable functional unit array
  - Optimal power/performance efficiency for multimedia applications

Fig.4 Adaptive processor architecture

Key Features

In our laboratory, we study state-of-the-art technologies for next-generation computing paradigms. Our goal is to realize environment-friendly, high-performance, and robust computer systems under energy constraints. From wide viewpoints (from new theories to LSI implementations), we are promoting cutting-edge research and the highest degrees of education in various research themes, particularly: low-energy accelerators, functional unit (FU) array processors, high-level synthesis, hardware/software co-design, and acceleration of practical applications.

Laboratory Dependable System

▶ URL: http://isw3.naist.jp/Contents/Research-en/42_lab-en.html



Prof. Michiko Inoue
Assist. Prof. Tomokazu Yoneda
Assist. Prof. Yuta Yamato
E-mail dsl-contact@is.naist.jp

Research Areas

To overcome VLSI design and test challenges occurring due to scale enlargement, process miniaturization, high performance and low power, we are tackling various problems in VLSI design and testing, along with reliable and dependable systems.

- VLSI design for testability
- Design and testing for 3D-LSIs
- High quality testing (timing-related faults, low-power testing, low-temperature testing, etc.)
- Fault detection and diagnosis of VLSI
- Software-based self-testing for high performance micro-processors
- Test architecture for failure prediction
- Circuit and system mechanisms for high field reliability

We are also working on algorithms for distributed systems and parallel computers.

- Fault-tolerant distributed systems
- Wait-free distributed algorithms
- Parallel algorithms for multi-core processors
- Parallel algorithms for LSI CAD

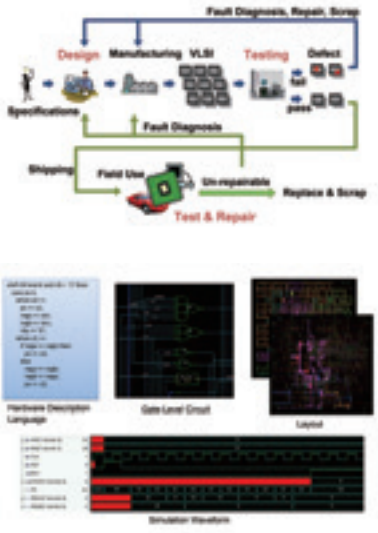


Fig.1 VLSI design and test flow

Key Features

Today's information society is supported by various levels of advanced technology such as applications, systems, computers and VLSIs. The Dependable System Laboratory is pursuing research on safe and secure systems including distributed systems with hundreds of computers and VLSIs with billions of transistors. "Dependability" is a concept from the user's point of view, when systems can be used reliably and securely.

In order to achieve dependable systems, we need to consider various aspects of these systems from the user's point of view. For example, if all the systems are completely tested and the bad systems have not been shipped, if the systems can work correctly in the presence of faults, if the systems can predict and avoid system failure caused by transistor aging, and if the system can handle malicious users. This laboratory is performing research to improve dependability from various approaches.

The Dependable System Lab also fosters skills for theoretical thinking, presentation, design and analysis of algorithms, traditional C/C++ and Java programming, advanced multi-thread programming, and Verilog/VHDL hardware programming through research.

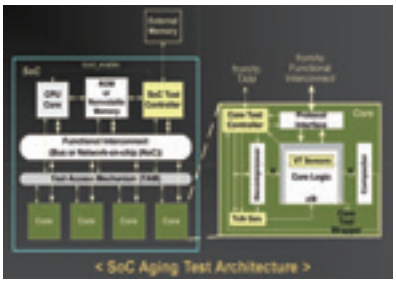


Fig.2 DART: Dependable Architecture with Reliability Testing

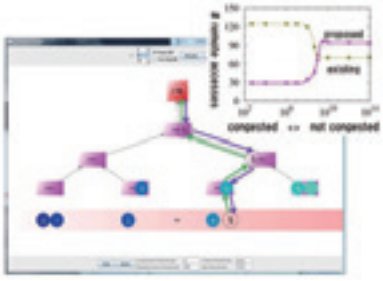


Fig.3 MUTEX algorithm Tree-Skip

Laboratory Applied Algorithmics

▶ URL: http://isw3.naist.jp/Contents/Research-en/01_lab-en.html


Prof.
Hiroyuki Seki


Assoc. Prof.
Yuichi Kaji


Assist. Prof.
Yuki Kato

E-mail { seki, kaji, ykato }@is.naist.jp

Research Areas

1. Information security

Two aspects of information security are focused on in this research. The first is the investigation of security mechanisms of tiny resource-restricted devices such as wireless sensor nodes, for which conventional techniques are not applicable. The other is to bring sophisticated security technologies to easily accessible applications for widespread use (Fig. 1).

Fig.1 Mutual authentication system utilizing visual secret sharing scheme

2. Automated software/database analysis and verification

Analysis and verification methods are developed for software and database systems, focusing on infinite state model checking, such as pushdown systems, and applying it to verification and synthesis problems in language-based security and privacy. We also deal with two topics in XML data transformation/queries. One is the verification of whether a given transformation preserves necessary information. The other is the verification of whether sensitive information in a database is safe against inference attacks, using authorized queries and their results. Our research also includes inquiries into related topics on security and privacy, such as k-anonymity, quantitative information flow and differential privacy.

Furthermore, we study formal language theory including mildly context-sensitive grammars, tree automata and tree transducers, which serve as the basis of the analysis and verification technologies mentioned above.

Fig.2 Ultra-density two-dimensional barcode with LDPC error-correction

3. Coding theory and error control

Algorithmic aspects of error-correcting codes are studied, together with the investigation of their practical applications such as ultra-density barcode systems (Fig. 2). Also, we examine coding schemes for non-volatile flash memory devices.

4. Bioinformatics

Sequence analysis is still an important task in bioinformatics, and we focus primarily on RNA analysis due to considerable attention being focused on the functions of RNAs that are related to their structure. Fast and accurate computational methods are being developed to predict a wide class of RNA secondary structures from sequence information alone (Fig. 3).

Fig.3 Screenshot of the Rtips web server (http://rna.naist.jp/)

Key Features

The Applied Algorithmics Laboratory (APAL) covers wide areas of information science by fully utilizing fundamental theories in information and computer sciences including information theory, theory of algorithms, formal language theory and optimization theory. We not only apply these theories to solve real world problems but also apply the results toward developing theories themselves.

The most important elements in APAL are students' creative ideas. Surrounded by thousands of books and facilities equipped with the newest technology, students can concentrate on their studies. Through this environment, many cutting-edge research results have been achieved.

Laboratory

Ubiquitous Computing Systems

▶ URL: http://isw3.naist.jp/Contents/Research-en/45_lab-en.html



Prof. Keiichi Yasumoto
Assoc. Prof. Yutaka Arakawa
Assist. Prof. Morihiko Tamai

E-mail { yasumoto, ara, morihi-t }@is.naist.jp

Research Areas

1. Context recognition and context-aware systems
- Indoor location estimation and tracking via sensors and wireless devices
- Estimation of physical load by smartphones for health-conscious walking navigation
- User comfort level estimation for various physical quantity values
- Context-aware home appliance control through social network services (Fig. 1)

Fig.1 Home appliance control system through social network services

2. Smart environment simulation
- Smartspace simulator to facilitate context-aware application development
- Simulator enhancement for collaborative smartspace applications development

3. Activity navigation
- Energy-saving activity navigation in home environment
- Emergency medical support system using electronic triage tags

Fig.2 Support system for emergency rescue operations

4. User interfaces for ubicomp systems
- Ambient user interface for activity navigation
- Vital sign visualization system for emergency medical support (Fig. 2)

5. Mobile networking and sensing
- Participatory sensing by mobile users (Fig. 3)
- Real-world recognition system using social data with users' locations
- Performance optimization for WLANs through AP association control
- Wi-Fi data offloading for outdoor mobile users using access points in vehicles

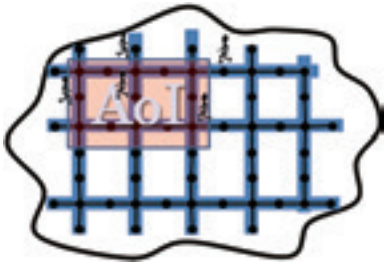


Fig.3 Participatory sensing by mobile users

Key Features

Each student selects research topics according to his/her own interests through several brainstorming meetings with advisers. Advisers provide students with kind and careful direction to advance their research as well as suggestions to improve their programming, writing, and presentation skills. Students receive many opportunities to present their research results at domestic / international workshops and conferences.

Laboratory

Foundations of Software

▶ URL: http://isw3.naist.jp/Contents/Research-en/02_lab-en.html

Prof.
Minoru Ito

Assoc. Prof.
Naoki Shibata

E-mail { ito, n-sibata }@is.naist.jp

Research Areas

1. Distributed computing
- Video multicast streaming and grid computing via P2P overlay networks
- Fault-tolerant and autonomous adaptive algorithms design

2. Mobile computing
- Portable terminal low-power-consuming video streaming (Patent granted)
- Cooperative downloading and streaming by multiple portable terminals in ad hoc networks
- Low-power-consuming information gathering in wireless sensor networks, optimal sensor deployment in 3-dimensional environments, and underwater sensor networks
- Delay tolerant networks applications
- Pedestrian and vehicle urban sensing

3. Ubiquitous computing
- UbiREAL, a simulator for virtual ubiquitous environments composed of sensors and consumer electronics (http://ubireal.org/)
- Consumer electronics intuitive remote controller with 3D graphic interface
- Power-saving support systems in smart homes
- Disaster emergency rescue support system using ad hoc networks (http://etriage.jp/)

4. Intelligent Transportation System (ITS)
- Efficient information delivery via vehicle-to-vehicle and vehicle-to-road communication
- Navigation system for tourists (http://ptour.naist.jp)
- Traffic jam reduction via mass vehicle scheduling in a whole city
- Pedestrians detection and alert system using directional antennas and vehicle-to-vehicle communication

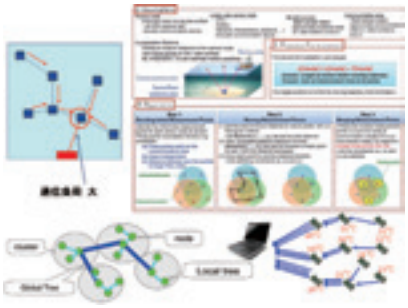


Fig.1 Optimal sensor deployment in 3-dimensional underwater sensor networks

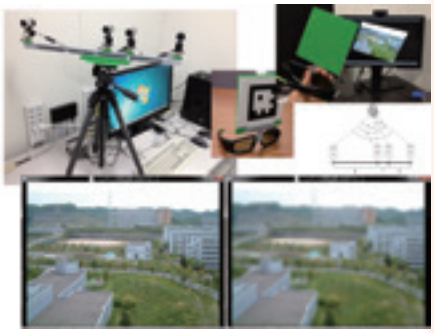


Fig.2 Adjusting parameters for stereoscopic 3D video playback

Fig.3 Cooperatively capturing and sharing video between vehicles

Key Features

We work on a variety of research topics to realize distributed pervasive systems. Each master course student starts his/her two year study by choosing an interesting research issue. Staff with different areas of expertise are happy to work with students to discover new perspectives on each problem. We move forward through cooperation in pursuit of novel research results.

Most master course students attend domestic and international conferences to present their achievements. We encourage students to take such opportunities to let people know how important, difficult and interesting their work is.

Laboratory Software Engineering

▶ URL: http://isw3.naist.jp/Contents/Research-en/13_lab-en.html




Prof. Kenichi Matsumoto
Assoc. Prof. Akito Monden
Assist. Prof. Akinori Ihara
Assist. Prof. Hideaki Hata

E-mail { matumoto, akito-m, akinori-i, hata }@is.naist.jp

Research Areas

1. Software data mining
- Software quality analysis and cost estimation
- Mass data processing and visualization
- Natural language processing in software development
- Data-driven software development

2. Open source software engineering
- Communication analysis in software development
- Software ecosystem analysis and user support
- Software repository mining and integration
- Global and collaborative software development support

3. Human factors in software development
- Measuring human brain activities to assess the program understanding process
- TaskPit: A software development task measurement system

4. Software protection
- Software obfuscation
- Software watermarking and birthmarking
- Software tamper-proofing

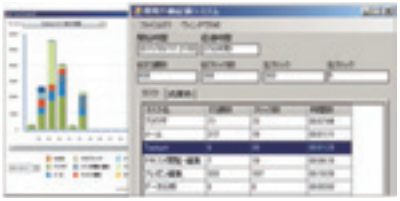


Fig.1 TaskPit: A software development task measurement system

Fig.2 Software engineering data analysis system

Key Features

The software engineering laboratory uses both theoretical and empirical approaches to address various problems related to software development, human computer interaction and software lifecycle management. We fully exploit the potential of students' curiosity and creative thinking together with conventional research theories and technologies to tackle new topics in software engineering.

While actual software development tends to rely on project managers' intuition without sufficient evidence, our goal is to develop an empirically-guided software development environment where the software process and product data are measured and decisions are made based on the data. We also address recent hot topics in software engineering such as open source software engineering, global software development and software protection.

Fig.3 Near-infrared spectroscopy system

Laboratory Software Design and Analysis

▶ URL: http://isw3.naist.jp/Contents/Research-en/19_lab-en.html


Prof. Hajimu Iida


Assoc. Prof. Kohei Ichikawa


Assoc. Prof. Yasushi Tanaka


Assist. Prof. Norihiro Yoshida


Assist. Prof. Toshinori Takai

E-mail sdlab-contact@is.naist.jp

Research Areas

1. Modeling and management / improvement of software development process
- Process modeling / analysis / improvement
- Visualization & management support of project information
- Social network analysis for open source projects
- Project re-player (virtual re-play of projects)
- Development process simulation

2. Repository mining
- History analysis of source code (code clone / design pattern)
- Infinitesimal grain degree process analysis of software maintenance
- Extracting topics in developers' mailing list

3. Software design & verification
- Super-upper process design
- Searching / detecting design patterns
- System and software assurance
- Software risk analysis

4. Cloud infrastructure design
- Virtual computing environments deployment
- Programmable control for virtual networks (software defined networks)

Fig.1 Software development history visualization tool using topic extraction method

Fig.2 Scatter plot for code clone analysis

Fig.3 Demonstration of project data analysis system (Open Campus, 2010)

Fig.4 Demonstration environment for international OpenFlow network

Key Features

In the Software Design & Analysis Laboratory, we conduct research on the methods and technologies which support the design / development of software and Cloud computing systems. Our main focus is on the analysis and improvement of the software development process. Software technology is increasingly present in our daily lives, including various software embedded machinery and electronic devices for home or mobile telephones and social infrastructures represented by Cloud computing systems.

Laboratory Internet Engineering

▶ URL: http://isw3.naist.jp/Contents/Research-en/04_lab-en.html


Prof.
Suguru Yamaguchi


Assoc. Prof.
Youki Kadobayashi


Assoc. Prof.
Takeshi Okuda


Assist. Prof.
Shigeru Kashihara


Assist. Prof.
Hiroaki Hazeyama

E-mail { suguru, youki-k, okuda, shigeru, hiroa-ha }@is.naist.jp

Research Areas

1. Making the internet a dependable infrastructure
- Information infrastructure attack prevention and mitigation techniques
- Reliable communication over mobile networks
- Trusted identity management for modern applications and services
- Smart responses to natural disasters via internet
- Workload measurements and characterization


Fig.1

2. Acceleration of evolution toward a novel internet architecture
- Wired and wireless networks integration and convergence
- Smart devices mobility support
- IPv6 transition and verification methodology
- Construction and management of resilient infrastructure
- Design and implementation of internet testbeds

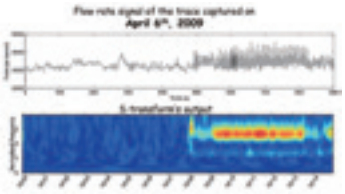


Fig.2

3. Considering our society and the internet
- Mission-critical service networks creation
- Information distribution based on user situation
- Ambient sensing system invention
- Learning effects on humanity
- Internet user experience quality improvement

Key Features

The Internet has become a vital infrastructure for our daily lives. We believe the Internet has to be trustworthy and more dependable as a core component for various services and applications in our society. To this end, we explore novel architectures of the Internet to harness sustainability and to overcome various challenges facing our society. We also consider the influence of technical innovations on humans. Our goal-oriented research employs a variety of methodologies, including those from the theoretical to the practical, and from simulation to demonstration.

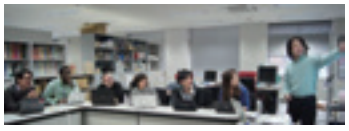


Fig.3

Laboratory Internet Architecture and Systems

▶ URL: http://isw3.naist.jp/Contents/Research-en/20_lab-en.html


Prof. Kazutoshi Fujikawa


Assoc. Prof. Atsuo Inomata


Assist. Prof. Masatoshi Kakiuchi


Assist. Prof. Kenji Ohira


Assist. Prof. Akira Yutani

E-mail inet-info@is.naist.jp

Research Areas

The objective of the Internet Architecture and Systems Laboratory (inet-lab) is to establish systems and applications in the following four noteworthy, Internet-wide areas from both theoretical and practical points of view:

1. Computer / network system management
- Nation-wide internet 4K video transmission
- Advanced digital library with multimedia
- Methodology for network traffic analyzation

2. Large scale sensor networks, overlay network technologies
- Large scale sensor network development and operation
- Overlay network based on geographical location (Fig. 1)
- Distributed publishing/subscription systems with in-network processing (Fig. 1)
- Delay Tolerant Network (DTN) using Android, Arduino and other actual devices

3. Mobile computing / networking
- Location aware services for vehicular communication systems
- IPv6 GeoNetworking stack development in compliance with worldwide ITS standards (Fig. 2)
- Information sharing mechanisms with geographical multicasting (Fig. 2)
- Privacy protection for vehicular communication systems

4. Information security: cryptography and network security
- Elliptic curve cryptography and its faster implementation
- Malware analysis on MWS datasets (Fig. 3)
- Privacy preservation and security risk management
- CTF (Capture The Flag) Competitions

Key Features

In our laboratory, students can study a variety of topics concerned with computer networks from the network layer to the application layer. The strength of our laboratory is that students have opportunities to perform their research using actual computer network environments because all faculty members are engaged in the Information Initiative Center (ITC) of NAIST (Fig. 4). Additionally, in some cases we develop devices to create appropriate research environments. Our laboratory welcomes students at all levels of expertise, because we provide seminars on basic theoretical and practical studies as well as advanced areas.

Fig.1 Distributed publishing / subscription systems on geography overlay networks

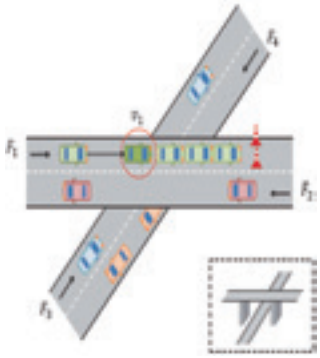


Fig.2 Communication method among vehicles in the same situation

Fig.3 Malware code

Fig. 4 ITC facilities

Laboratory

Computational Linguistics

▶ URL: http://isw3.naist.jp/Contents/Research-en/05_lab-en.html

Prof.
Yuji Matsumoto

Assoc. Prof.
Masashi Shimbo

Assist. Prof.
Kevin Duh

E-mail { matsu , shimbo , kevinduh }@is.naist.jp

Research Areas

1. Making natural language processing resources publicly available

We believe that publicly-available software and resources are important for the advancement of computational linguistics. Therefore, fundamental work in building essential resources such as dictionaries and annotated corpora is performed. Various widely-used software tools are also maintained for core natural language analysis. Examples include:

- Software: Japanese morphological analyzer ("Chasen"),
  Dependency parser ("Cabocha"),
  Predicate argument structure analyzer ("Syncha")
- Resources: NAIST text corpus,
  NAIST Japanese/English/Chinese dictionaries

Fig.1 Online demo of information extraction of restaurant reputations: Customer review positive / negative opinions extraction and summary

2. Learning-based natural language processing and knowledge acquisition

Machine learning approaches are investigated to acquire linguistic rules automatically from large-scale text data. This approach enables us to build highly accurate and robust statistical natural language taggers and parsers. We also perform research in lexical and common-sense knowledge extraction from the World Wide Web.

Fig.2 During a reading group session discussion

3. Applications

We explore novel applications that are enabled by computer processing of natural language. For example, our work in language learning assistance studies how computers can be used to help humans learn second languages.

Our Machine Translation effort focuses on statistical methods for building robust translation systems in any language. Also, we have researched textual entailment, sentiment analysis, and information extraction.

Key Features

Natural languages are highly complex systems embodying various kinds of exceptions and subtle linguistic phenomena among beautiful grammatical rules. They are also systems for representing and describing our knowledge. To analyse and interpret languages computationally, one needs various theories and tools. Our lab organizes many research projects and reading groups from fundamentals to applications. Each group presents surveys on up-to-date research topics and reads books and journals, and each project holds meetings on the research progress of project members. By participating in these reading groups and research projects, we encourage people to gain extensive knowledge on natural language processing that cannot be studied otherwise.

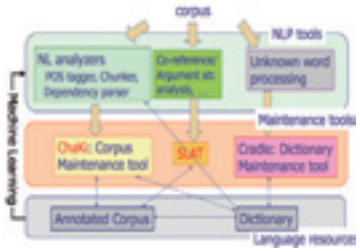


Fig.3 Overview of corpus management and annotation tools

Laboratory Network Systems

▶ URL: http://isw3.naist.jp/Contents/Research-en/14_lab-en.html

Prof.
Minoru Okada

Assoc. Prof.
Takeshi Higashino

E-mail { mokada, higa }@is.naist.jp

Research Areas

1. Digital TV on mobile receivers

In Japan, high-definition television (HDTV) is provided using digital terrestrial television (DTTV) broadcasting. In addition to HDTV, a narrow band digital television service dedicated to handheld terminals, also known as "One-Seg TV", is popular now. After the termination of analog TV services, multimedia broadcasting services have started using the vacated VHF analog TV band. However, it is difficult to improve reception reliability in mobile and handheld environments. This laboratory is working to develop low power-consumption and reliable handheld digital TV receivers using array antennas and radio signal processing techniques.

Fig.1 Highly reliable wireless communication system research and development

2. Mobile communication systems

Thanks to recent research and development activities, the bit rate provided by mobile communication systems, such as cellular systems and wireless local area networks (W-LAN), is growing rapidly. However, its reliability is not satisfactory for error intolerant purposes, such as surveillance, networked robots, etc. In order to solve this problem, our laboratory studies key technologies including OFDM (Orthogonal Frequency Division Multiplex), MIMO (Multiple Input Multiple Output), diversity, and multi-hop mesh networks. We are working on implementing these technologies into specific systems such as W-LAN, WiMAX, and Zig-Bee.

Fig.2 Photo 1. Wireless sensor network container yard in Tarragona

3. Radio on fiber and distributed antenna systems

Recently, various radio wireless and broadcasting systems are available, for example, LTE, WiMAX, mobile multimedia contents broadcasting, etc. Radio on Fiber (RoF) is a promising technology to construct a heterogeneous radio infrastructure. The distributed antenna system (DAS) performs sophisticated radio processing for multi-user, MIMO communication systems.

4. Wireless sensor networks

Although radio wave-based sensor systems, such as radar and GPS, are capable of measuring positions over a wide area, their function is limited. To enhance their applicability, we propose various kinds of sensing networks using radio waves. For example, rain rate estimation using millimeter-wave mesh links, intruder sensing in leaky coaxial cable infrastructure, and positioning sensors for medical applications using RFID tags.

Fig.3 ESPAR antenna assisted receiver

Key Features

We do not only evaluate systems in theoretical analysis and computer simulation, but also implement them onto hardware using FPGA (Field Programmable Gate Array) and embedded systems. Students learn theories on signal processing and communication systems. In addition, they experience embedded system programming and digital circuit design.

Laboratory

Augmented Human Communication

▶ URL: http://isw3.naist.jp/Contents/Research-en/43_lab-en.html

Prof.
Satoshi Nakamura

Assoc. Prof.
Tomoki Toda

Assist. Prof.
Sakriani Sakti

Assist. Prof.
Graham Neubig

E-mail { s-nakamura, tomoki, ssakti, neubig, sawatari, kawanami }@is.naist.jp

Research Areas

"Going beyond the communication barrier"

With the ultimate goal of enhancing human communication ability, the AHC Laboratory performs research and education on various technologies that support human-to-human and human-to-computer communication. Research includes multilingual speech translation, human-machine dialog systems, communication quality of life (CQoL), voice conversion, silent speech interfaces, user-adaptive speech recognition/synthesis, and brain analysis.

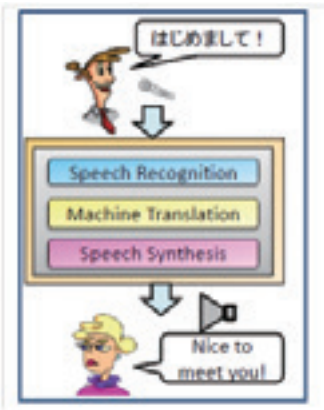


Fig.1 Speech-to-speech translation

・Speech-to-speech translation

Speech-to-speech translation has been a long-standing dream, allowing for the possibility of seamless communication with people that speak other languages. Speech-to-speech translation recognizes the user's speech, translates it, and synthesizes a voice in the target language. Our current research project focuses on simultaneous speech translation of news and lectures.

・Speech recognition/speech synthesis

Speech recognition: We study multilingual spontaneous speech recognition applicable in real, noisy environments via statistical modeling and machine learning.

Speech synthesis and voice transformation: Our speech synthesis techniques synthesize more informative speech from given texts by controlling voice quality and prosody. We also study voice transformation/morphing systems to convert arbitrary speakers' voices to the desired voice quality.

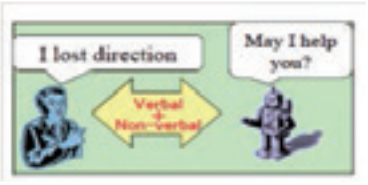


Fig.2 Spoken dialogue system

・Machine translation

We focus on the integration of syntactic/sentence structure information to statistical machine translation over a wide variety of languages. Furthermore, we are developing methods to extract syntactic or semantic information from large-scale text corpora.

・Dialogue systems with verbal and non-verbal information

Our spoken dialogue system research aims to develop a computer avatar/agent that communicates with humans intelligently and naturally. We focus on new statistical dialogue models for persuasive dialogue via intonation, emotion, personality, face and gesture information, as well as verbal information.

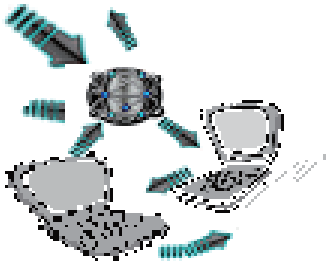


Fig.3 Web information analysis

・Multimedia web information analysis

Huge amounts of multi-media information have been accumulated on the web. We conduct research on technology to analyze multi-language and multi-modal information and utilize this information to enhance communication.

・Technology to improve quality of life

Communication Quality of Life (CQoL) is technology to improve the users'

Assoc. Prof.
Hiroshi Saruwatari

Assist. Prof.
Hiromichi Kawanami

Research Areas (Cont'd)

quality of life regardless of age, gender, or capability. We perform research to help users who have lost their voice through accidents or diseases by reproducing their voice using speech synthesis and voice conversion.

Fig.4 Voice generation for the disabled

・Cognitive communication / brain analysis

Our research on cognitive communication analyzes brain activity to detect communication difficulty in real time using Electroencephalograms (EEG). We are also performing research on education and support for people with communication disabilities such as Autism.

Fig.5 EEG measurement system

・Individuality modeling

Individuality modeling is the study of what makes each person different. We study the individuality present in the human voice, face, expression, and dialogue modalities.

・Multi-modal concept learning

Computers need to understand not only language but also objects, motions, and their connection with the words in language. Our research covers the study of allowing computers to link speech, language, image and motion, and the learning linkages of concepts between them.

・Microphone/speaker array signal processing and blind source separation

Microphone array signal processing estimates directivity patterns to effectively extract distant speech signals or canceling noise. We also study unsupervised adaptive array signal processing such as blind source separation based on independent component analysis.

Our research on sound field reproduction uses multiple loudspeakers to faithfully reproduce natural sound fields in a controlled setting.

Fig.6 Blind source separation DSP

・Silent speech recognition and silent speech telephone

We perform research on non-audible murmurs (NAM), that can be detected via a special body-conductive microphone. This new communication medium may lead to silent speech recognition and silent speech telephones.

Key Features

Being a Super Research Group, SRG, we collaborate with other research laboratories inside NAIST and international research laboratories. We participate in the interACT consortium with 8 research universities including CMU and KIT. http://interact.anthropomatik.kit.edu/index.php

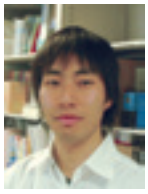
The AHC-lab provides an international research environment where all students can experience interaction and collaboration with students and faculty from all over the world.

Laboratory Vision and Media Computing

▶ URL: http://isw3.naist.jp/Contents/Research-en/15_lab-en.html


Prof.
Naokazu Yokoya


Assoc. Prof.
Tomokazu Sato


Assist. Prof.
Norihiko Kawai


Assist. Prof.
Yuta Nakashima

E-mail { yokoya, tomoka-s, norihi-k, n-yuta }@is.naist.jp

Research Areas

Our laboratory mainly focuses on technologies which handle visual information using various sensors and display devices. Our research interests include computer vision, mixed reality, and virtual reality (Fig. 1). Representative research projects are listed below (Fig. 2):

1. Computer vision: Inferring real world from images and videos
- 3D reconstruction from video sequences
- Image/3D shape inpainting based on patch similarities
- Position estimation of near light sources using clear hollow spheres
- Camera pose estimation for ground-view images using aerial images
- Detection of visual attention induced by videographers' intentions

2. Mixed reality: augmenting the real world through virtual objects containing useful information
- Augmented telepresence for aerial views
- Markerless augmented reality using natural features
- Diminished reality for marker hiding

3. Virtual reality / Augmented virtuality: Reconstructing natural and realistic scenes in a virtual world via real images
- Interactive 3D modeling
- Free viewpoint image generation using view dependent geometry

Fig.1 Vision and Media Computing Lab's research fields

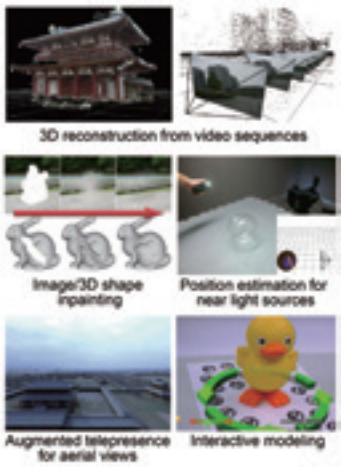


Fig.2 Example research projects

Key Features

The main feature of our laboratory is that we make full use of opportunities to do collaborative work with other universities, institutes, etc., as well as having off-campus demonstrations and exhibitions of our research results.

Students are encouraged to make presentations and publish their research results at international conferences and in journals. Especially, Ph.D. students are urged to participate in internships at foreign research institutions. In addition, we actively invite lecturers and accept intern students from foreign institutes to cultivate international perspectives and competitiveness.

In our research projects, we make use of various cutting-edge research facilities for interacting and sensing the real world (Fig. 3):
- Unmanned airship for outdoor sensing from the sky
- Immersive display with omnidirectional treadmill
- Outdoor environment for omnidirectional 3D measurement vehicle
- Omnidirectional sensor Internet vehicle
- Omnidirectional laser range finder

Fig.3 Example research facilities

Laboratory

Interactive Media Design

▶ URL: http://isw3.naist.jp/Contents/Research-en/09_lab-en.html


Prof.
Hirokazu Kato


Assist. Prof.
Takafumi Taketomi


Assist. Prof.
Goshiro Yamamoto

E-mail { kato, takafumi-t, goshiro }@is.naist.jp

Research Areas

Interactive media is one of the key technologies that facilitates a usable and comfortable ubiquitous computing environment. Our laboratory researches not only future interactive media itself but also the media technologies, human-computer interaction and data engineering necessary for creating innovative interactive media.

1. Media engineering
- Upgrading augmented reality technology (Fig. 1)
- Augmented reality assistance systems based on sensing
- Projection-based augmented reality technology (Fig. 2)
- Medical image processing

2. Data engineering
- Next generation highly accurate information retrieval system (Fig. 3)
- Database processing in the era of multicore processors
- Context-aware information recommendation

3. Human interface
- Augmented reality based human-human communication
- Interface technology for ubiquitous display environments (Fig. 4)
- User characteristics analysis

Fig.1 Upgrading augmented reality technology

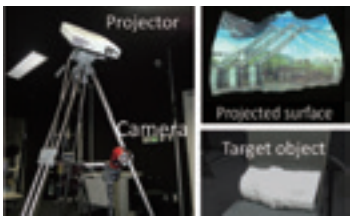


Fig.2 Projection-based augmented reality technology

Fig.3 Next generation highly accurate information retrieval system

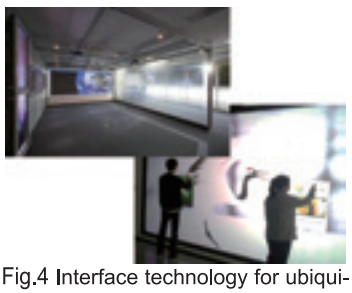


Fig.4 Interface technology for ubiquitous display environments

Key Features

Our laboratory has a rich international flavor, with many foreign students and visiting foreign researchers gathering from every corner of the world. Therefore we communicate in English for some meetings and other events.

We have various custom systems and special equipment, and we are actively pursuing creative research.

Dissertation supervision is carried out through frequent discussion in each research group as well as in weekly general meetings. In addition to supervising dissertations, we have weekly lunch talks about topics of interest and occasionally have study sessions.

Research Equipment

- Ubiquitous display system
- 270 inch display with touch interface, the world's largest
- Augmented reality experiment environment
- Head mounted display system
- Moving projector system
- 3D digitizer

Laboratory

Ambient Intelligence

▶ URL: http://ambient.naist.jp

Prof.
Norihiro Hagita

Assoc. Prof.
Norimichi Ukita

Assoc. Prof.
Masayuki Kanbara

E-mail { hagita, ukita, kanbara }@is.naist.jp

Research Areas

Ambient intelligence is a kind of intelligent environment and space corresponding to the real world, which helps and facilitates our daily life. Our lab aims to create core technologies of ambient intelligence for a safe, secure and comfortable life based on real world sensing, knowledge structuring and interaction for humans.

1. Real world sensing

In order to acquire real world information for ambient intelligence development, information from real scenes is measured by various sensors. Human behavior is especially important information for human life support with ambient intelligence platforms. Our laboratory is trying to analyze human behavior by integrating various kinds of data through various measuring sensors installed in real environments.

Fig.1 Experimental environments: human and robot positions are measured using laser range fingers or invisible markers.

2. Knowledge structuring

For a service robot to support human activity, it is necessary to structure the knowledge (position or behavior of human, status of actual area, etc.) of the environment in advance. This knowledge of the environment is structured from huge amounts of data by real world sensing and information on the internet through analyzation with pattern recognition techniques and configuration structures, etc.

Fig.2 Interaction Robots

3. Interaction

Ambient intelligence provides users with appropriate multimodal interaction which is determined by structured knowledge in order to support the user's activity. Our laboratory is not only developing augmented reality interaction, which is an intuitive visual information display technique, but also Human-Robot Interaction (HRI) which can provide visual, audial and physical stimulus. User's reactions after the interaction are also observed to update the knowledge of the ambient intelligence.

Fig.3 Human motion and behavior understanding in various scenarios.

Key Features

By cooperating with communication media and objects, like robots for human support, and giving useful and helpful information of the environment to them, ambient intelligence significantly contributes to novel and useful services. Additionally, because we carry out user studies not only in experimental rooms at NAIST but also at actual scenes, like real shopping malls etc., the development of more practical and reliable services is expected.

Fig.4 Examples of Human-Robot Interaction (HRI) research

Laboratory Robotics

▶ URL: http://isw3.naist.jp/Contents/Research-en/18_lab-en.html


Prof.
Tsukasa Ogasawara


Assoc. Prof.
Jun Takamatsu


Assist. Prof.
Atsutoshi Ikeda


Assist. Prof.
Masahiro Yoshikawa


Assist. Prof.
Akihiko Yamaguchi

E-mail { ogasawar, j-taka, atsutoshi-i, yoshikawa-m, akihiko-y }@is.naist.jp

Research Areas

1. Visual interfacing

Understanding environments and generating appropriate robot motion play important roles in the intelligent interaction among people, robots, and computers. We are developing methods to recognize environments using cameras and laser sensors to assist the activities of people and robots.

- Measurement of Bio/gaze information and its interface …(A-1)
- Environmental modeling and mobile robot navigation …(A-2)
- Human-robot interaction …(A-3)
- Motion synthesis and reinforcement learning …(A-4)

2. Human modeling

We measure, analyze, and model human beings to understand human skills, as well as their policies and strategies while carrying out various activities. Our research topics include a human-size robotic hand, the evaluation of usability based on musculoskeletal model, power assistance, haptic devices, and the evaluation of surgical skills.

- Sensorimotor control in manipulation …(B-1)
- Forearm and hand musculoskeletal models …(B-2)
- Multi-finger robot hand and its applications …(B-3)
- Tactile modeling and haptic devices …(B-4)

3. Applications

We construct various robot systems for applications in real-world environments. And we employ outputs on visual interface and human modeling as fundamental components.

- Humanoid robot: HRP-4 …(C-1)
- Upper body humanoid robot: HIRO …(C-2)
- Android robot: Actroid …(C-3)
- Wheel-chair robots …(C-4)

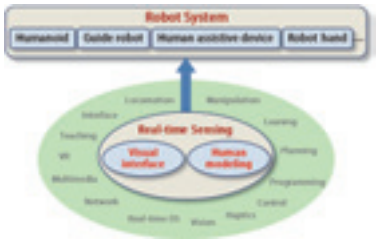


Fig.1 Overview of our research

Fig.2 Visual interface research areas

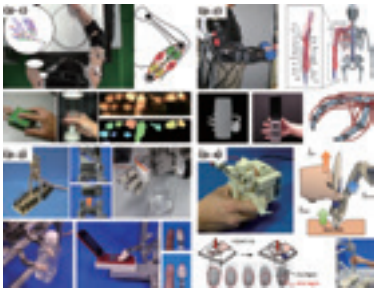


Fig.3 Human modeling research areas

Key Features

The members of the Robotics Laboratory have various backgrounds which enable us to deal with multiple technologies that intelligent robot systems require. By devoting our specialists to solve particular problems in the robotics field, we aim to transform our members' skills into improved intelligent robot technologies. Furthermore, a considerable number of students often have the opportunity to perform demonstrations of our robots in different places, including stays in other research facilities. We always welcome new students to join our laboratory and its cooperative and friendly environment.

Fig.4 Robots in the laboratory

Laboratory

Intelligent System Control

URL: http://isw3.naist.jp/Contents/Research-en/16_lab-en.html


Prof.
Kenji Sugimoto


Assoc. Prof.
Kentaro Hirata


Assist. Prof.
Kiminao Kogiso


Assist. Prof.
Takamitsu Matsubara

E-mail { kenji, kent, kogiso, takam-m }@is.naist.jp

Research Areas

1. Control systems design

- Advanced mechatronics control (Figs. 1, 2, 3)
  We investigate control theory for periodic motions (such as repetitive and delayed feedback control) and its application to power-assisted control for electric bicycles and analysis of passive dynamic walking.
- Vehicle control using robust control theory (Fig. 3)
  We conduct theoretical and experimental studies on motion control for vehicles

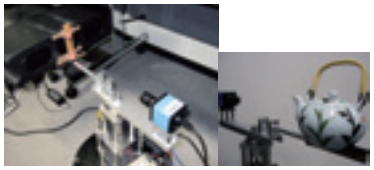


Fig.1 Entertainer robot "SOMENOSUKE"

2. Sensing & signal processing

- Visual feedback and sensor networks
  By regarding sensing technology as a component of a control system, we work on visual feedback control and sensor networks for mobile robots.
- Learning/Adaptive theory applied to various systems (Fig. 5)
  We study intelligent signal processing such as independent component analysis and feedback error learning. We also study their applications to system identification for control.

Fig.2 Power assist control for electric bicycles

3. Machine learning for robotics

- Motor skill learning for humanoid robots (Fig. 4)
  We are developing novel methods that enable robots to learn complex motor skills (e.g., biped walking, T-shirt wearing and clothing assistance) by optimal control and reinforcement learning.
- Constructing practical myoelectric interfaces for robot control (Fig. 5)
  We construct a myoelectric interfaces robust to postural changes, sweating, and muscular fatigue, using a surface electromyograms (sEMG) via modern machine learning methods.

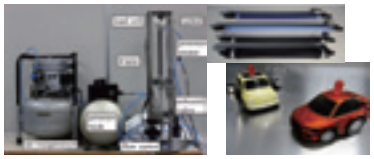


Fig.3 McKibben pneumatic artificial muscle system and collision avoidance of vehicles

Key Features

We welcome motivated students from various fields including mechanical/electrical engineering, mathematical/physical science, as well as computer science. The faculty staff guides students individually, taking into account their backgrounds, and assists them in mastering mathematical system approaches by the end of their course. Thereby they acquire a wide range of technical skills from fundamental theories to applications. The students in our lab are highly-motivated hard-workers, cooperative and eager to learn from others. We anxiously await such students, both from Japan and from abroad.

Fig.4 Dual arm/hand robot and electromyographs

Fig.5 Acquired table-tennis skills and two-link manipulator

Laboratory Mathematical Informatics

▶URL: http://mi.naist.jp

Prof.
Kazushi Ikeda

Assist. Prof.
Takatomi Kubo

Assist. Prof.
Tomoya Tamei

E-mail { kazushi, takatomi-k, tomo-tam }@is.naist.jp

Research Areas

We study methods for solving problems in various areas using mathematical models. Our research topics include the development and analysis of machine learning methods and their applications to science and engineering.

1. Machine learning
- Statistical learning theory
- Statistical signal processing based on Bayes theory
- Neural network theory
- Information geometry and information theory
- Factor analysis and sparse models

2. Brain informatics
- Eye movement and attention
- Motion control modeling
- Non-invasive brain-activity measurement
- Adaptive training-support systems
- Systems biology

3. Adaptive systems
- Advanced driver assistance systems
- Adaptive signal processing theory and applications
- Reinforcement learning theory and applications
- Non-invasive human-machine interfaces
- Brain-computer interfaces

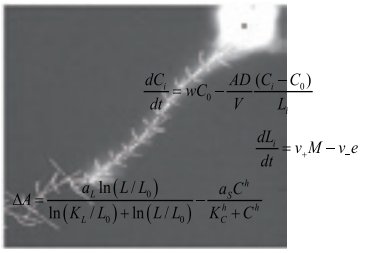


Fig.1 Mathematical models of biological phenomena

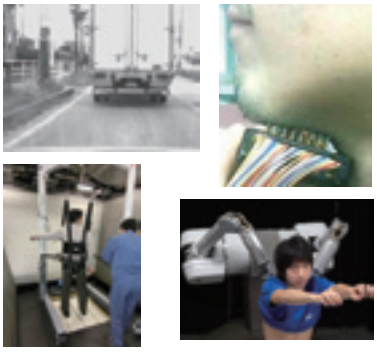


Fig.2 Mathematical models applied to various fields

Key Features

Mathematical informatics is interdisciplinary; faculty and students in our lab have a variety of backgrounds, such as mathematical, electric, electronics, information, and mechanical engineering, statistical science, physics, psychology, and medical science. We have two lab seminars per week to pool our knowledge toward future progress, and we also host seminars organized by students.

Fig.3 Discussion seminar to develop new ideas

Laboratory

Computational Systems Biology

▶ URL: http://isw3.naist.jp/Contents/Research-en/27_lab-en.html


Prof. Shigehiko Kanaya


Assoc. Prof. Tadao Sugiura


Assoc. Prof. Md. Altaf-Ul-Amin


Assist. Prof. Tetsuo Sato


Assist. Prof. Naoaki Ono


Assist. Prof. Ming Huang

E-mail { skanaya, sugiura, amin-m, tsato, nono }@is.naist.jp

Research Areas

1. Systems biology

Biology has been significantly advanced by reductive approaches. Huge biological data sets, such as more than 1,000 genome sequences, have caused a paradigm shift into a holistic approach to understanding living things as systems. We study these approaches by modeling several biological systems to elucidate cellular mechanisms.

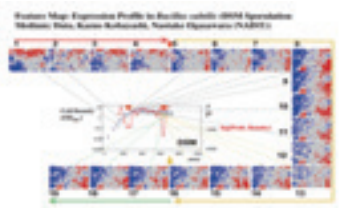


Fig.1 Feature Map: Expression Profile in Bacillus subtilis

2. Network analysis

With the development of omics technologies, it has become imperative to systematically analyze all biological components (genes, mRNA, proteins and metabolites). To meet this challenge, we have developed a clustering algorithm (DPClus) to extract highly connected clusters.

3. Transcriptomes

A transcriptome is defined as a total set of transcripts in an organism. To elucidate transcriptome networks, we study transcriptome analyses using microarrays and new generation sequencers with the use of BL-SOM and novel methods.

4. Metabolomes

Cells consists of a few thousand molecules. Of those, metabolites are mainly produced by enzymatic reactions. The objective of metabolome analysis is to comprehensively identify which particular metabolites affect cellular networks. As a metabolome analysis platform, we have developed a species-metabolite database, KNApSAcK, covering almost all reported metabolites. To date, 50,048 metabolites and 101,500 species-metabolite relationships have been accumulated.

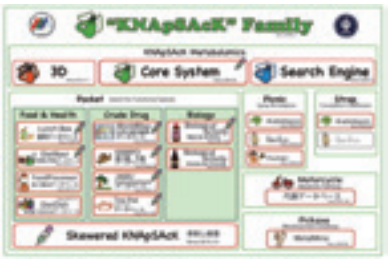


Fig.2 Main page of "KNApSAcK Family" (http://kanaya.naist.jp/KNApSAcK_Family/)

5. Bioimaging and informatics

Bioimaging has become an essential tool for understanding biological phenomena at the micrometer scale and also for medical diagnostics. Due to significant progress in microscope and detection technologies in the last decade, advanced observation methods have been realized, such as three-dimensional observation at the micron scale and super-resolution microscopes with resolution of several 10nm. We develop various microscope and analysis systems based on such emerging technologies.

- Three-dimensional and super-resolution microscopes
- Micro-nano manipulation system with optical tweezers
- fN force measurement and cell palpation systems

Research Areas (Cont'd)

6. Medical Imaging

Cardiac MRI in clinical imaging for coronary arteries and decision support technology for motion compensation have been developed. Diffusion Tensor MRI (DT-MRI) and tractography techniques are investigated for the analysis of human brain cognitive functions.

- MRI
- Medical image analysis

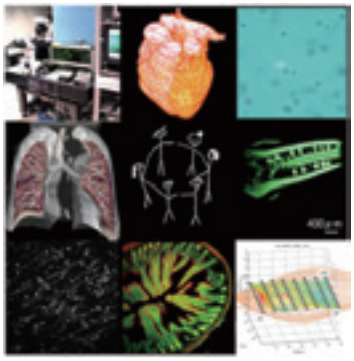


Fig.1 Examples of biomedical imaging taken by various imaging schemes

7. Volume Visualization in Biology

We developed a high speed volume rendering method for visualizing high resolution microscopic 3D images such as two-photon microscopy techniques.

- Volume graphics
- Neuron tracing
- Microscope image analysis

8. Medical Engineering and Informatics

In collaboration with medical hospitals and other institutions, we develop various medical engineering technologies based on information technology.

- Electromyogram and motion analysis
- Rehabilitation engineering
- Hospital information systems

Fig.2 Development of a surgical simulation system

Key Features

We work in an interdisciplinary field between information technology and bio-medical science. Our aim is to further both bio-medical science and information technology. Students study a wide variety of technologies, such as signal and image processing, imaging technology, optics, and nanotechnologies. We have developed techniques to identify gene function and disease mechanisms at high resolution.

Our members, who have a wide variety of backgrounds, aim to elucidate the robustness and diversity of biological systems by chemo- and bio-informatics. In our lab, students study a wide range of areas and attain broad perspectives. We always discuss important issues regarding research to enhance each other's knowledge.

Laboratory Large-Scale Systems Management

▶ URL: http://isw3.naist.jp/Contents/Research-en/46_lab-en.html

Prof. Shoji Kasahara

Assist. Prof. Jun Kawahara

E-mail { kasahara, jkawahara }@is.naist.jp

Research Areas

1. System analytics
- Large-scale systems modeling
- Discrete event systems
- Markov analysis
- Risk analysis

2. Theory of information systems, network science
- Decentralized cognitive MAC protocols
- Task scheduling for cloud computing
- Queueing theory
- Networking theory

3. Service science
- Service modeling
- Large-scale call center design and management
- Medical service design

4. Simulation tools and techniques for large-scale systems
- Large-scale network systems simulation
- Rare-event simulation
- Simulation visualization techniques

5. Algorithm theory and application
- Online algorithms
- Mechanism design, auction theory
- Large-scale data processing

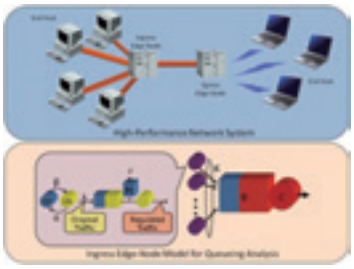


Fig.1 Network system analytics

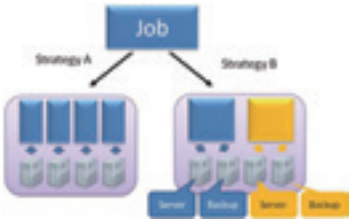


Fig.2 Cloud computing architecture

Key Features

The Large-Scale Systems Management Lab aims to develop mathematical modeling and simulation techniques for design, control and architecture of large-scale systems such as computer/communication networks, with which the resulting systems achieve high performance, low vulnerability and highly efficiency energy. Our research focus is on network-science oriented design frameworks, fundamental technologies and highly-qualified services, particularly for large-scale computer/communication network systems. The laboratory was established in June 2012, and we welcome students from abroad who have strong interests in theories and simulation skills for designing smart services over large-scale complex systems including data centers, cognitive radio networks, and energy-harvesting networks.

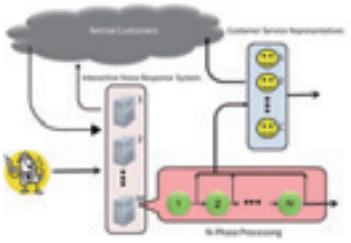


Fig.3 Call center management model

Laboratory

Neural Computation

▶URL: http://isw3.naist.jp/Contents/Research-en/29_lab-en.html

Prof.
Kenji Doya

Assoc. Prof.
Junichiro Yoshimoto

E-mail { doya, juniti-y }@is.naist.jp

Research Areas

1. Bayesian inference and reinforcement learning

An outstanding feature of the brain is its ability to recognize environmental characterisitics with uncertainty and dynamically change behavior to adapt to the current environment. Computational frameworks used to explain these functions of the brain include Bayesian inference and reinforcement learning, which are believed to be implemented in the cerebral cortex and basal ganglia.

To verify this hypothesis, we are analyzing neural activities recorded from rodents and humans undertaking decision-making tasks. Also, we develop novel computational algorithms based on Bayes' theory to identify hidden variables and parameters in dynamic systems. We then apply these computational algorithms to estimation problems such as the determining of the value functions expected in the brain and defining rate constants of intracellular molecular cascades involved in synaptic plasticity.

Fig.1 Rat behavioral experiments

2. Learning, evolution and communication

Two of the most fundamental constraints for living organisms are self-preservation and self-reproduction. A nervous system, especially a reward-related system, strongly reflects these constraints. To help understand the design principles of such a reward-related system, we developed "Spring Dog", capable of self-preservation through capturing batteries and self-reproduction by exchanging gene-like programs through an infrared communications port. We use these Spring Dogs to investigate learning, evolution, and communications mechanisms required for adaptation in various environments.

Fig.2 "Spring Dog"

3. Neuroinfomatics towards understanding emotion-regulatory system

Emotion is strongly associated with basic behaviors such as feeding and danger avoidance, and plays a critical role in animal survival. Recent findings support the hypothesis that emotion is involved in neural plasticity via monoamine neuromodulators. In this study, we are developing a database system to manage the comprehensive knowledge on phospholyration reactions triggered by neuromodulators. The database is also used to develop a kinetic model of intracellular signal cascades in an emotion-related circuit.

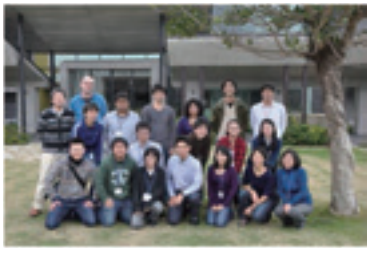


Fig.3 Laboratory members

Key Features

We share a dream of completely understanding brain mechanisms from the viewpoint of computation and using this to create autonomous robots who act as if they had real brains. To realize this dream, we have gathered members from various fields: neurophysiology, robotics, machine learning, economics, cognitive psychology, etc. Our base at the Okinawa Institute of Science and Technology is located on the west coast of Okinawa island with an exotic view of the East China Sea. Half of the researchers and students in the Institute are from foreign countries and many events are held in English, creating a truly international environment.

Affiliate Laboratory Communication

(NTT Communication Science Laboratories)

▶ URL: http://isw3.naist.jp/Contents/Research-en/30_lab-en.html

Prof.
Takeshi Yamada

Assoc. Prof.
Hiroshi Sawada

E-mail yamada.tak@lab.ntt.co.jp

Research Areas

1. Data mining from large and complex networks

We study the basic technologies for understanding huge, irregular and ever-growing complex networks, such as the Web, and then make effective use of them for knowledge navigation.

2. Understanding real world situations through sensor networks

We are interested in observing and interpreting the real world through a variety of sensing devices such as acceleration sensors, light sensors, GPS, cameras, and microphones.

Key Features

Our research activities include various phases, such as proposing new theories and modeling, developing effective algorithms and data structuring, and applying techniques to new interesting applications. We are interested in processing various data, for example Web and language data, speech sounds, images, and sensor data. Our everyday efforts are aimed at the world's first proposal and verification of new techniques, or the world's best performance of certain tasks. Each researcher has a booth in a broader room where discussions occur naturally. More heated, in-depth discussions with several researchers are conducted in the discussion room.

Affiliate Laboratory Computational Neuroscience

(ATR International)

▶ URL: http://isw3.naist.jp/Contents/Research-en/31_lab-en.html

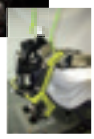
Prof.
Mitsuo Kawato

Prof.
Yukiyasu Kamitani

E-mail { kawato, kmtn }@atr.jp

Research Areas

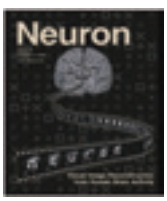
A profound idea in this course is that in order to really understand human brain function, you need to reconstruct a human being. To clarify any brain function such as sensation, movement, communication, emotion or language we take the viewpoint of information processing and integrate experimental means like neurophysiology, psychology, brain imaging and robotics into a computational framework. Taking this approach, ATR is internationally recognized as a leading center for computational neuroscience, aiming at cutting edge research.



Key Features

1. Humanoid robot development

Our goal is to develop a "Brain-Robot-Interface" (BRI), interfacing a human brain to a robot controller, so that we can operate robots using extracted brain signals (as we "thought" without moving our body). We also have been developing very unique research platforms. For example, the high-performance humanoid robot-named "CBi" is designed to tackle control problems underlying such a complicated system based on machine learning approaches and control theories.



2. Decoding brain signals

Neural decoding allows us to predict mental contents from measured brain signals. Our group develops computational techniques for the decoding of human brain signals, and studies information coding in the human brain. Our goal is to establish novel communication technology that directly connects the brain and machines using decoded neural information.

3. From mind-reading to brain-machine interface

Brain signals can be seen as the ‘codes’ that encode our mental experience. To decipher these codes, we combine neuroscience and machine learning methods. We aim to develop decoding techniques that capture the subtlety of our mental experience, and to apply them to build brain-machine interfaces that control machines using decoded information.

Affiliate Laboratory

Network-Human Interaction

(Advanced Technology Research Laboratories, Panasonic Corporation)

▶ URL: http://isw3.naist.jp/Contents/Research-en/32_lab-en.html

Prof. Jun Ozawa
Assoc. Prof. Katsuhiro Kanamori

E-mail { ozawa.jun, kanamori.katsuhiro } @jp.panasonic.com

Research Areas

1. Integrated brain signal sensing technology for quantification of human cognitive status
2. Interactive robot control technology for human-occupied areas
3. Learning-based teaching methods of manipulators with sensory feedback

Key Features

"Humanware" is the core concept of this laboratory. It essentially refers to the capacity and dispatch of information results in humans. It aims to achieve human-like intelligent information processing, five-sense communication, and soft-flexible robotics/mechatronics.

The basis of conventional information and communication technologies is mathematics, and the main R&D targets are computers and information equipment.

In the near future, R&D of total systems and frameworks will be necessary, and this laboratory explores new research areas concerning information technologies combined with human, social, and physical science.

Affiliate Laboratory

Symbiotic Systems

(C&C Innovation Initiative, NEC Corporation)

▶ URL: http://isw3.naist.jp/Contents/Research-en/33_lab-en.html

Prof. Keiji Yamada
Assoc. Prof. Taku Konishi

E-mail kg-yamada@cp.jp.nec.com, t-konishi@jv.jp.nec.com

Research Areas

We research symbiotic technologies to link society, environment, objects, information and energy with people. Also, we design new system architectures to realize a safe and rich society and more comfortable lifestyles.

Now we create new elemental technologies such as

1. Open community co-creation systems
2. Work-flow analysis with various sensor data
3. Intellectual productivity measurement and support systems
4. Sensing of individual emotion and behavior characteristics
5. Wearable bio-sensing
6. Behavior diffusion simulation based on social dynamics
7. Systems for enhancing community activity

Fig.1 Human behavior data analysis system for intellectual productivity measuring

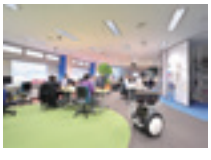


Fig.2 Laboratory devices such as remote communication systems, behavior sensors, etc, to accelerate co-creation

Key Features

1. Inter-disciplinary collaboration

We are pursuing new technology through collaboration with experts in informatics, psychology, cognitive science, sociology, library science, economics, business management, media design, interactive arts, media science, etc.

2. Open and global research environment

We invite many researchers and internship students from Europe, Oceania and Asia to the open laboratory at NEC. Students of our laboratory learn about various research fields and foreign languages, while gaining a global point of view.

Affiliate Laboratory

Multimedia Mobile Communication

(NTT DOCOMO, INC.)

▶ URL: http://isw3.naist.jp/Contents/Research-en/35_lab-en.html

Prof.
Yukihiko Okumura

Assoc. Prof.
Takahiro Asai

E-mail

Research Areas

Broadband multimedia mobile wireless communication systems

- Variable bit rate transmission techniques
  Power and bandwidth efficient resource allocation schemes for variable bit rate transmission, which is required for multimedia communication systems
- Radio relaying scheme for MIMO wireless networks
  Radio repeaters to expand the coverage area without degradation in power and frequency utilization efficiency performance

Key Features

Our laboratory is located in Yokosuka, Kanagawa. Students who plan to join our laboratory complete course work provided by the Network Systems Laboratory in the first year of the master's program. In the second year, students move to our laboratory in Yokosuka to start working with us.

Affiliate Laboratory

Optical and Vision Sensing

(Core Technology Center, OMRON Corporation)

▶ URL: http://isw3.naist.jp/Contents/Research-en/36_lab-en.html

Prof.
Masaki Suwa

Assoc. Prof.
Yoshihisa Ijiri

E-mail joyport@ari.ncl.omron.co.jp

Research Areas

Vision sensing technology for factory automation, social systems and consumer products

1. Physics-based vision
3D sensing, vision-based 3D measurement/object detection, camera calibration

2. Computer vision
Object detection/recognition, character recognition, machine vision algorithms

Key Features

Students in our laboratory:

- Extract research topics that are closely linked to product commercialization: Research topics are derived from customers' problems in each application field
- Frequently discuss ideas with company engineers
- Collaborate with overseas internship students

Affiliate Laboratory

Molecular Bioinformatics

(National Institute of Advanced Industrial Science and Technology)

▶ URL: http://isw3.naist.jp/Contents/Research-en/37_lab-en.html

Prof.
Yutaka Ueno

Prof.
Kazuhiko Fukui

E-mail uenoyt@ni.aist.go.jp, k-fukui@aist.go.jp

Research Areas

1. Interacting protein molecule simulation using atomic coordinates
2. Bioinformatics tool integration for workflow analysis
3. Biological molecule structural analysis from electron microscopy images
4. A domain specific language for molecular model scripting animations

Key Features

1. Graduate students' individual research projects and collaboration studies in bioinformatics areas are hosted at laboratories in the National Institute of Advanced Industrial Science and Technology (AIST)
2. Experiencing a wide variety of methods and techniques, working with researchers in both biology and informatics
3. Various software systems for bioinformatics research projects developed in AIST in the last decade demonstrate the computational studies required for future problem solving

Other Topics

1. Software development for modern high performance computing
2. Applications of haptic user interface device for molecular modeling

Affiliate Laboratory

Digital Human

(National Institute of Advanced Industrial Science and Technology)

▶ URL: http://isw3.naist.jp/Contents/Research-en/38_lab-en.html

Prof.
Satoshi Kagami

Assoc. Prof.
Kouichi Nishiwaki

E-mail s.kagami@aist.go.jp

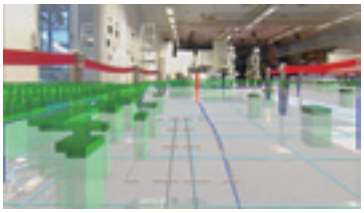
Research Areas

1. Digital Human Modeling
- Modeling of the human body and human motion
- Mapping of human environments and human behavior

2. Smart Assist Technology
- Perceive, plan, and control functions of smart assist robots
- Dependable system design and development

Key Features

Our laboratory is part of a national institution under METI, and is located in Odaiba, Tokyo. An over 2000m^2 laboratory field has been prepared for human and human environmental measurements. "Application driven research" is our basic strategy, and NAIST students tackle practical problems here with us.



Affiliate Laboratory

Technology of Radiological Science

(National Cerebral and Cardiovascular Center Research Institute)

▶ URL: http://isw3.naist.jp/Contents/Research-en/39_lab-en.html

Prof.
Hidehiro Iida

Assoc. Prof.
Tsutomu Zeniya

E-mail

Research Areas

We develop image-based diagnostic tools to investigate the pathophysiology of diseases both in the brain and in the heart, using Nuclear Medicine (Positron Emission Tomography: [PET], Single Photon Emission Computed Tomography: [SPECT]) and Magnetic Resonance Imaging (MRI) techniques. We aim to develop advanced high-performance imaging techniques/devices and new image processing programs based on computer science, to quantitatively assess physiological functions in clinical application and pre-clinical animal studies

1. Clinical diagnostic imaging
- Rapid and quantitative PET systems
- Quantitative and standardized SPECT imaging
- MRI and its data analysis

2. Molecular imaging for pre-clinical studies
- Evaluation of new therapies and drugs
- Development of animal models of diseases

3. Key technology development for diagnostic imaging
- Image processing: Image reconstruction, tracer analysis, motion correction, image registration
- High spatial-resolution SPECT
- Computer simulation

High-resolution SPECT
We aimed at developing a new generation high-resolution, highly- sensitive clinical SPECT device, which can provide functional parametric images in clinical service.

Key Features

Our laboratory is in a national center for advanced and specialized medical care and research, with scientific researchers working on a variety of fields such as computer science, physics, medicine, pharmaceutics and chemistry. We collaborate with clinical doctors, medical equipment companies, pharmaceutical companies, and domestic and international researchers.

Affiliate Laboratory

Programming Science

(National Institute of Advanced Industrial Science and Technology)

▶ URL: http://isw3.naist.jp/Contents/Research-en/41_lab-en.html

Prof.
Yoshiki Kinoshita

E-mail yoshiki-ml@aist.go.jp

Programming Science is the mathematical science of syntax and semantics of descriptions, which ranges from computer programs and system specifications to industrial standards regulations and law. It also covers comprehensive research on information processing systems from programming aspects, including computer hardware, software and human-beings as operators.

Research Areas

1. **Science of computer programs**
- Programming language Semantics: Mathematical models of programming languages
- Mathematical and formal specification of programs and information systems
- Verification and validation
- Model based testing

2. Engineering of information processing systems
- Assurance cases: logical study on documented bodies for validation
- Open Systems Dependability: study on ability to perform as and when required for ever-changing systems

Key Features

We consider the communication between student and mentor as essential.
1. Students start with a reading seminar to understand basic concepts and theories.
2. Student projects are started as early as possible with themes chosen by themselves.
3. Use of Agda programming language/proof assistant is highly encouraged.

Affiliate Laboratory

Network Orchestration

(National Institute of Information and Communications Technology)

▶URL: http://isw3.naist.jp/Contents/Research-en/44_lab-en.html

Prof.
Kazumasa Kobayashi

Assoc. Prof.
Eiji Kawai

E-mail tblab-info@is.naist.jp

Research Areas

1. Virtualization technologies for network infrastructure

- Switch/router virtualization
- Software Defined Networking (SDN)
- Networking for cloud computing

2. Next- and new-generation network infrastructure technologies

- IPv6 and beyond-IPv6 technologies
- Infrastructure technology for service-oriented networks such as mobile networks, sensor networks, content-centric networks, etc.

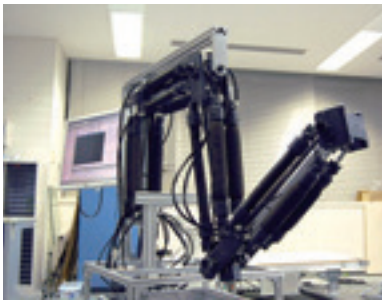
3. Orchestration technology for large-scale network infrastructures

- Management of wide-area and virtualized networks
- Wide-area and virtualized network advanced traffic engineering
- Multi-domain networks

Key Features

The Network Orchestration Laboratory is a collaboration with the National Institute of Information and Communications Technology (NICT). In particular, we are developing the JGN-X network testbed, a nation-wide experimental network infrastructure founded by NICT. JGN-X provides high-speed international connectivity to the United States, China, Korea, Singapore, and Thailand, and forms part of a global R&E network infrastructure. Those students who are interested in real-world ICT infrastructure technologies find great opportunities to conduct research not only utilizing the facilities of JGN-X but applying their products to JGN-X.

Cutting-edge Research Facilities



7-DOF manipulator controlled by pneumatic artificial muscles
(Mathematical Informatics Lab)

Multi-tilt camera system
(Ambient Intelligence Lab)

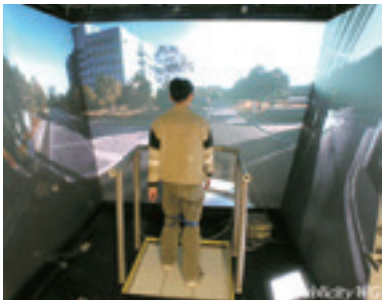
Advanced dual robot arm-hand system
(Intelligent System Control Lab)

Omnidirectional 3D measurement vehicle
(Vision and Media Computing Lab)

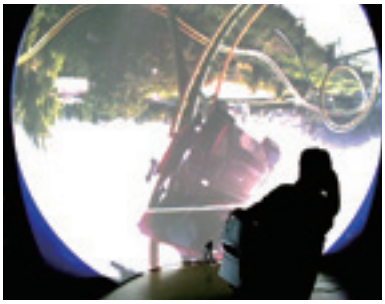
Interaction robot
(Ambient Intelligence Lab)

Tele-presence transmitter
(Network Systems Lab)

Internet vehicle with omnidirectional sensors
(Vision and Media Computing Lab)

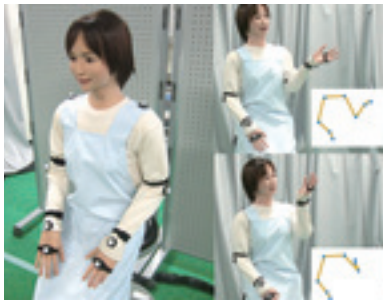


Immersive display with omnidirectional treadmill
(Vision and Media Computing Lab)



Dome screen with motion base
(Vision and Media Computing Lab)

HIRO-NX
(Robotics Lab)



Behavior media system
(Robotics Lab)

4K ultra high definition display (270 inches)

Unmanned airship for outdoor sensing
(Vision and Media Computing Lab)

Computation server
(Information Initiative Center)

Container server room
(Information Initiative Center)

Experimental system for wide area networks
(Internet Architecture and Systems Lab)

Humanoid robot HRP-4
(Robotics Lab)

Eye movement measurement device
(Mathematical Informatics Lab)

Large-scale simulation/ verification equipments
(Computing Architecture Lab)

Large-scale document processing system
(Computational Linguistics Lab)

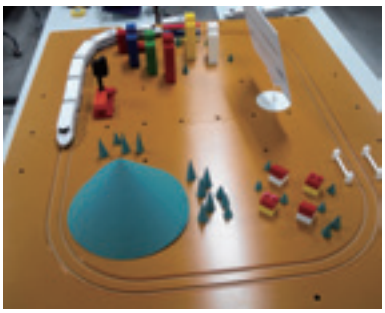
Ubiquitous display
(Interactive Media Design Lab)

Near-infrared Spectroscopy System
(Software Engineering Lab)

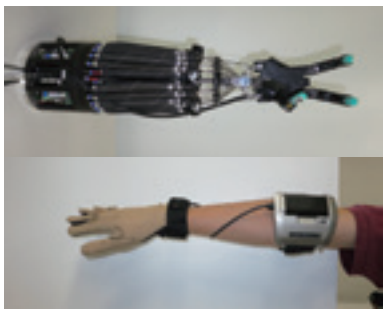
Software engineering data analysis system
(Software Engineering Lab)

High-speed storage server
(Augmented Human Communication Lab)

Electroencephalogram (EEG)
(Augmented Human Communication Lab)



Wireless power transfer system
(Network Systems Lab)



Shadow hand and CyberGlove
(Intelligent System Control Lab)

Graduate School of
Information Science