Graduate School of Informatics, Kyoto University

Informatics in Kyoto University is the study of information in natural and artificial systems.

Informatics studies the creation, recognition, representation, collection, organization, optimization, transformation, communication, evaluation and control of information in complex and dynamic systems.

Informatics has human, social, cognitive, biological, linguistic, computational, mathematical and engineering aspects. It includes systems science and communications engineering.

Informatics has close relations with a number of disciplines in the natural and human sciences. It is developed employing contributions from many different areas; in turn, it can contribute to their further development.

Interfaces to human and social areas, mathematical modeling, and information systems are the three pillars of Informatics in Kyoto University.

Contents

Graduate School of "Informatics": The Science of 21st Century

NAGAO Makoto, President

The 21st century is the era of information. Information technology (IT) is, and will be making, most rapid progress. Furthermore, IT will be changing from the current technology-oriented development to a user-centered development. Thus we have to capture correctly what is needed for the people who use information and for the society based on IT, and have to create such a technology that meets those requests.

Studies on computers and information processing have been developed dramatically in the last five decades. However, those studies are rather technology-oriented and we are at a very starting stage for studies from a different angle, namely, studies from the viewpoint of the characteristics and humanity of users. Also studies to clarify characteristics and structures of different kinds of information and to understand mutual relationships between them will be more and more important. What we have done so far is so-called "Information Science," and what we are going to establish should be one which is beyond "Science" and has more humanistic characters. It will be properly called "Informatics."

The Graduate School of Informatics at Kyoto University was founded from this standpoint in 1998, for the first time in Japan, as an interdisciplinary organization. Its goal is quite ambitious, which covers research and education of information processing mechanisms of individual human brains from the viewpoints of such disciplines as psychology, cognitive science and biological information processing, research and education of information structures in human's social activities including culture and economy, as well as those of the hardware/software technology in information systems and those of mathematical foundations of informatics such as mathematical science and complex systems. By integrating faculty members and research contributions that have been cultivated in several schools and departments of Kyoto University, we aim to build up a new leading graduate school of "Informatics" to support society in the 21st century.

We welcome all students in different fields who have a strong desire to contribute to the future IT society. We hope that the Graduate School of Informatics in Kyoto University will make a prominent contribution to this development.

Invitation to the Graduate School of Informatics

– To make the 21st century a century of creation –

IKEDA Katsuo, Dean, Professor

The 21st Century: the Century of the Information Civilization

To date, human society has experienced two big changes.

The first one was the Agricultural Revolution, about 10,000 years ago. People changed their ways of living from a hunting life, wandering in wild nature, to a farming life, settling down in a fixed place. A new civilization, represented by ironware, appeared.

The next change was the Industrial Revolution, extending from the latter half of the 18th century to the first half of the 20th century. Dreams that were impossible when we depended upon our muscular power did become true after the invention of the steam engine, and the material civilization of the 20th century was built up using machine energy.

Now we are experiencing a third big social and technical change, caused by the computer since the 1950s. A famous historiographer, Alvin Toffler, called this change “the third wave.” “...old patterns of power are fracturing along strange new lines.

...This crackup of old-style authority and power in business and daily life is accelerating at the very moment when global power structures are disintegrating as well.” (Powershift)

The information network on a world scale is developing rapidly today. And information is being transmitted all over the world in realtime. As a result, the system of human society and the mechanism of world economy are changing greatly. It is clear that the 21st century will become the century of the information civilization.

Issues in a Highly Developed Information Civilization Society

The computer is the most sophisticated artifact that human beings have ever invented, and the range of its applications seems limitless. The information system becomes more complicated and its scale becomes larger and larger because of its usefulness as a resource. As a result, if even a little breakdown in the computer or the network system occur the effect is widespread and serious. This is certainly a negative side of the new technology, but it is obviously impossible to stop using it. The civilization of the present age might not survive if the computer were removed out from this world. Given the various, sometimes contradictory, requirements of the society served by computers it is an urgent problem how to make a harmony of development in the new science and technology, bringing together various global systems and facilitating large scale and high speed circulation of information. This is the way of benefiting people's happiness, and suiting human society really, and the way to make the 21st century a century that ensures the continuous prosperity of the human race. Our standard of living has been improved by the advancement of science and technology in the 20th century. On the other hand, it was assumed that human beings were less efficient and less reliable than machines, and in pursuit of economy and efficiency workers were steadily replaced by machines. A serious social problem resulted. Though workers were certainly liberated from simple repetition work and other kinds of undesirable tasks, many people

now felt themselves to be of little value and importance in their society. We now recognize this problem of alienation, and realize that it is necessary to consider human beings first.

Problems such as the destruction of the natural environment, over-population, the using-up of resources, and widespread epidemics are serious today. These are problems, which we cannot pass by. It is now time to apply our wisdom based on a large amount of information available to us on computer to solve these difficult problems while defending the irreplaceable earth.

Graduate School of Informatics

The Graduate School of Informatics in Kyoto University was established in 1998 to create a new inter- and multi-disciplinary area to contribute to the development of the information civilization of the 21st century. This school is based on a totally new idea and is definitely not a simple extension of the conventional functions of the University. The purpose of this new Graduate School of Informatics is to establish a sound academic base from which to contribute to the healthy development of a highly developed information civilization society, to form and to develop the study of information as a fundamental science, to promote pioneering and original research, and to educate many young students who have a wide comprehension of the mechanism of information technology and a wide vision of how information science can and should best develop.

The development of computer-based technology has, as I said, caused a fundamental revolution in contemporary social and economic systems. It is necessary to elucidate and to establish the ideal way of collecting, assembling, and using information so that the change to an information society does not have an undesirable influence, and so our society has a human-centered standpoint. And it is necessary to construct an information support environment by which cultural intellectual work is promoted.

Our main goal is to establish an academic base by integrating contributions from the fields of information and communications sciences, mathematics, systems science, brain and nerve physiology, and the humanities, and to promote the education and research that will help us solve the various problems which will be faced in the coming information civilization century.

Many different talents are needed including the talent to clarify the ideal way of using information and making it accessible, the talent to determine desirable future directions for our information technology, the talent to use information available now and to judge appropriately, the talent to evaluate information problems from a wide point of view, and the talent to truly lead the world by original research. Moreover, it is also important to achieve exchange of researchers within Japan and abroad, as well as to train foreign students.

In the Graduate School of Informatics, a fundamental objective is to accept various ideas and ways of thinking and valuing by accepting students of various backgrounds, from all faculties. The curriculum of six majors assures a breadth of competence, while suitable subjects, which transcend the boundaries of the majors, are offered to encourage wider attainments in students.

To young students who challenge the future

Science and technology concerning information will affect greatly the system of society and economy of the world, and the natural environment of the earth as well as existence of all living things. It is timely to offer students this graduate school now. To make the 21st century a century of creations sunlit in hope we should collect every wisdom. We hope very much that a lot of young students who will resolutely ask hitherto unasked questions will join our new Graduate School of Informatics.

Departments

Department of Intelligence Science and Technology

Division	Group	Research and Education Topics
Biological and Cognitive Processing	Biological Information	The Basis of Information in Biological System
	Cognitive Science	Mechanisms of Information Processing in Human Thinking and Reasoning Processes
	Hearing and Speech Processing †	Techniques to Observe Speech Signal and Verbal Behavior, and Techniques of Speech Signal Processing
Intelligence Information Processing	Foundation of Software Science	Theoretical Approach for the Construction of Software
	Intelligence Information Processing Principles	Modeling and Methodologies of Intelligence Information Processing
	Applied Intelligence Information Processing	Realization of Processing Systems and Software to Extract, to Recognize, to Understand, and to Represent Intelligence Information
Intelligence Media	Language Media Processing	Several Issues in Natural Language and Information Processing
	Speech Media Processing	Speech Analysis, Recognition and Synthesis
	Visual Information Processing	Image Processing, Recognition, Understanding, and Generation
Application of Multimedia	Video Media	Human-Computer Interaction through Video Images
	Media Processing for Education of Information Processing	The Application of Media (Natural Language) in Education of Information Processing
	Language Studies	The Application of Multimedia to Linguistic Studies

†: Operated Jointly with Industry

Department of Social Informatics

Division	Group	Research and Education Topics
Social Informatics Model	Distributed Information Systems	Organization and Applications of Distributed Information Systems
	Digital Library	Organization of Digital Library
	Information Society †	Legal Protection System of Industrial Property and Copyright
Social Information Network	Global Information Network	Social Information Systems Utilizing Information Networks
	Information Security †	Theory and Application of Cryptography
	Market and Organizational Information Systems †	Enterprise Information Technology and Cyber Business Strategy
Biosphere Informatics	Bioresource Informatics	Observation and Evaluation of Earth Environment and Bioresource
	Environmental Informatics	Biological Informatics, Including Measurement, Monitoring and Modeling
Regional and Disaster Management Information Systems [1]	Integrated Disaster Management Systems	Development of Risk-adaptive Regional Information Systems Enhancement of Infrastructures
	Emergency Management for Disaster Reduction Systems	Understanding Disasters Processes and Simulating Mega-scale Disaster
	Psychology for Disaster Management	Disaster Ethnology, Reconstruction and Rebuilding Processes
Medical Informatics [2]	Transferring Hi-tech Engineering to Clinical Medicine	Imaging Technology for Visualization of Deep Human Organs and Robotics for Surgical Procedures/Nursing Care

†: Operated Jointly with Industry 1: Disaster Prevention Research Institute

2: Department of Medical Informatics, Medical School

Department of Applied Analysis and Complex Dynamical Systems

Division	Group	Research and Education Topics
Applied Analysis	Analysis of Inverse Problems	Inverse and Ill-posed Problems, Numerical Analysis, Analysis of Fractals, Theory of Dynamical Systems
	Nonlinear Analysis	Nonlinear Partial Differential Equations, Numerical Analysis, Analysis of Fractals, Probability Theory
Complex Dynamics	Nonlinear Dynamics	Nonlinear Dynamics, Fluid Dynamics, Structural Reliability, Computational Physics
	Nonequilibrium Dynamics	Nonequilibrium Statistical Mechanics, Statistical Theory of Turbulence, Ordering Process
Complex Systems Synthesis	Fundamentals of Complex Systems	Computational Models of Complex Systems, Computational Complexity, Parallel Computing Systems
	Intelligent and Control Systems	Control of Systems and Learning Models, Analysis and Synthesis of Intelligent Systems, Digital Systems

Department of Applied Mathematics and Physics

Division	Group	Research and Education Topics
Applied Mathematics	Applied Mathematics Analysis	Applied Mathematics, Applied Analysis, Differential Equations, Computational Mathematics
	Discrete Mathematics	Discrete Mathematics, Graph Theory, Algorithms
Applied Mathematical Systems	System Optimization	Mathematical Optimization and Queuing Theory
	Control Systems Theory	Linear System Theory, Control System Analysis and Design, System Identification
Mathematical Physics	Physical Statistics	Statistical Physics, Stochastic Processes, Computer Simulation and Dynamics of Many - Body Systems
	Dynamical System Theory	Mathematical Physics, Dynamical Systems Theory, Structures in Differential Geometry

Department of Systems Science

Division	Group	Research and Education Topics
Human Machine Symbiosis	Mechanical Systems Control	Theory and Application of Robust Mechanical Control Systems
	Human Systems	Mutual Cooperation between Human and Machine Systems
	Symbiotic Systems	Coordination and Symbiosis among Man, Systems and Environments
	Human System Interaction †	Systems that can grow, adapt and evolve with People through Interactions between Them
Systems Synthesis	Adaptive Systems Theory	Adaptive and Learning Theories for Intelligent Machines and Systems
	Mathematical System Theory	Mathematical Systems, Signal Processing, Artificial Neural Networks
Systems Informatics	Information Systems	Information Systems and Logical Systems
	Image Processing Systems	Image Processing and Quantitative Analysis from Multi-dimensional Images
	Biomedical Engineering	Signal Processing, Imaging and Multimedia Systems for Medical Field
Applied Informatics [3]		Super-Computer and Computer Network

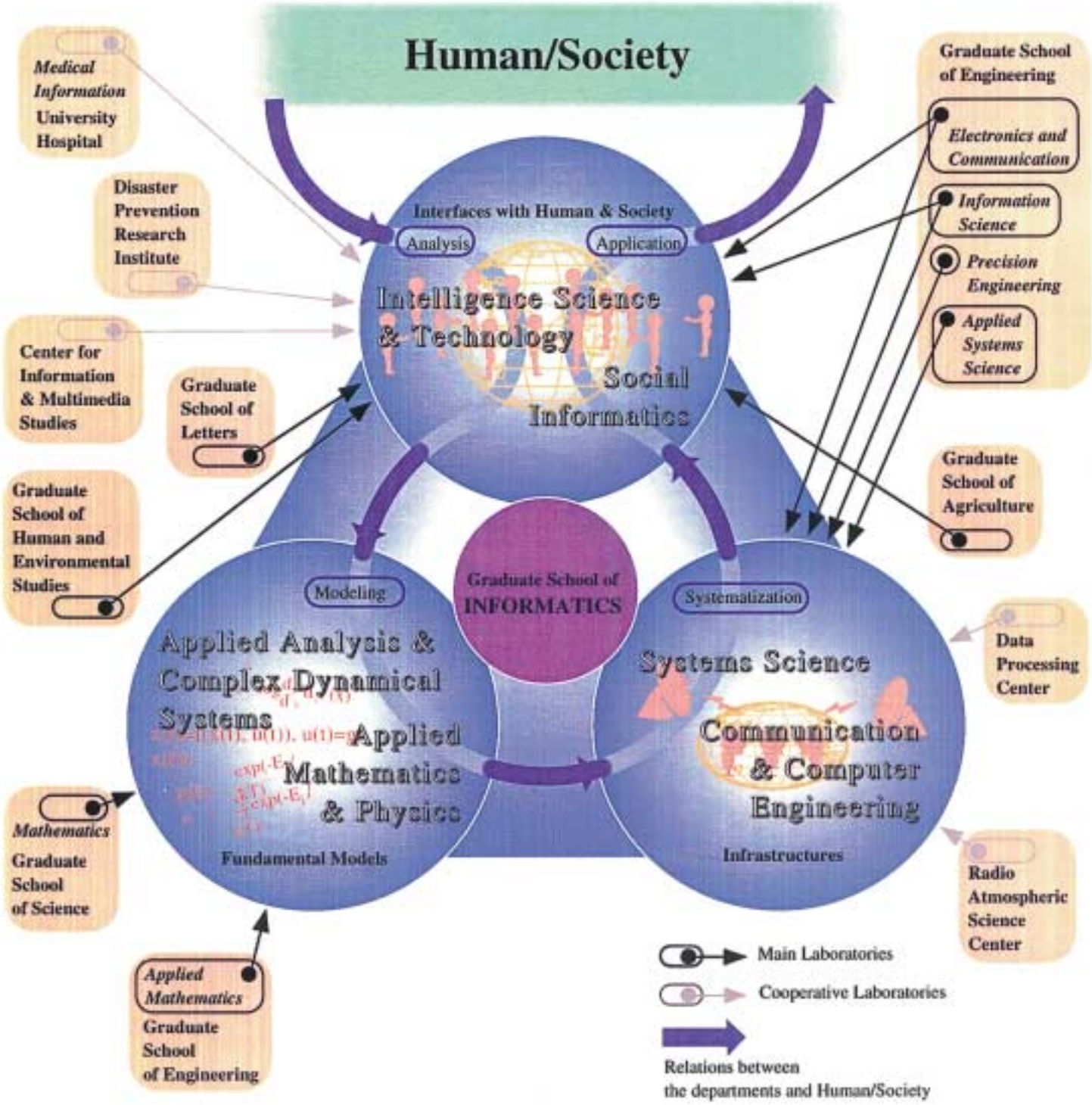
†: Operated Jointly with Industry 3: Data Processing Center

Department of Communications and Computer Engineering

Division	Group	Research and Education Topics
Computer Engineering	Logic Circuits, Algorithms and Complexity Theory	Logic Circuits, Discrete Algorithms, and Computational Complexity
	Computer Architecture	Novel Computer Architectures and Their System Evaluation
	Computer Software	New Computer Architectures and Their Fundamental Software
Communications Systems Engineering	Digital Communications	Highly Reliable and Secure Broadband Digital Communication Systems
	Integrated-Media Communications	Integrated Transmission System and Applications
	Intelligent Communication Networks	Design and Performance Analysis of Highly Efficient Information Networks
Integrated Systems Engineering	Processor Architecture and Systems Synthesis	Architecture for System LSI and High-Level Design Methodology
	Intelligent Circuit Design Engineering	Design Technology of High-performance Large-scale Integrated Circuits
	Advanced Signal Processing	Advanced Algorithms for Digital Signal Processing
Space Radio Engineering [4]	Space Radio Science and Engineering	Computation, Spacecraft Observation, and Wireless Power Transmission Using Intelligent, Informational, and Electrical Technologies
	Computer Radio Science	
Radio Atmospheric Sciences [4]	Remote Sensing Engineering	Atmospheric Measurement and Geophysical Environmental Information by Radio, Optical and Acoustic Soundings Using Electronic Engineering
	Atmospheric Observations	

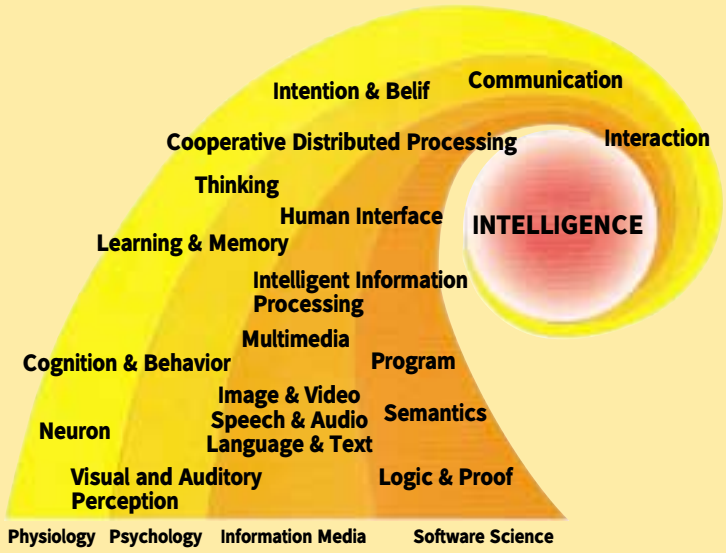
4: Radio Atmospheric Science Center

The Organization of Informatics



Department of Intelligence Science and Technology

Construction and Elucidation of Intelligence:
Realization of Flexible, Human-like Information Processing



In an advanced information-dense society, we seek flexible, human-like information capabilities. The information processing undertaken by biological organisms has been acquired through structural and functional adaptation to the environment through the process of evolution, and there is no other high-level processing capacity. Department of Intelligence Science and Technology is a multidisciplinary field which has the purpose of clarifying the mechanisms of biological, particularly human, information processing for the development of high-level information-processing applications.

Divisions and Groups

Division	Group
Biological and Cognitive Processing	Biological Information
	Cognitive Science
	Hearing and Speech Processing
Intelligence Information Processing	Foundation of Software Science
	Intelligence Information Processing Principles
	Applied Intelligence Information Processing
Intelligence Media	Language Media Processing
	Speech Media Processing
	Visual Information Processing
Application of Multimedia	Video Media
	Media Processing for Education of Information Processing
	Language Studies

Graduate Curriculum

Subjects for Master's Program

Advanced Study on Intelligence Science and Technology 1,2
Neural Basis of Intelligence
Computational Neuroscience
Foundation of Software Science
Intelligent Information Processing, Advanced
Intelligent Information Software, Advanced
Language Information Processing, Advanced
Speech Information Processing, Advanced
Image Understanding

Subjects for Doctoral Program

Advanced Seminar on Biological and Cognitive Processing
Advanced Seminar on Intelligence Information Processing
Advanced Seminar on Intelligence Media
Advanced Seminar on Application of Multimedia
Advanced Seminar on Intelligence Science and Technology

Staff

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KOBAYASHI Shigeo, INUI Toshio, KATAGIRI Shigeru (ATR)
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NAKAMURA Motonori †, FUJII Yasuo †

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FUJIKAWA Kenji, TOKAI Shogo, KAMEDA Yoshinari †, YAGI Keisuke †
WATANABE Masako †, TSUJI Hitoshi †, NAKASHIMA Yasuhiko †, SHIMIZU Masaaki †

†: Center for Information and Multimedia Studies

Biological and Cognitive Processing

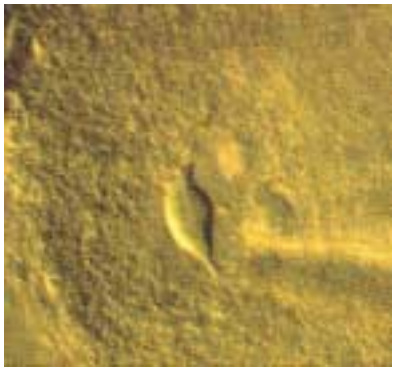
We aim to investigate both the cognitive and the physiological mechanisms of advanced biological, especially human, information processing and to explore possible applications of such mechanisms. For this purpose, we plan to analyze the information processing mechanisms of the nervous system at the molecular, biochemical and physiological levels, to elucidate the underlying principles, and to develop new artificial information processing systems. Moreover, we will analyze the processes of human sensation, perception, Learning, memory, thought and inference from both a cognitive perspective and a computational neuroscience perspective in order to clarify the mechanisms of human information processing.

Biological Information

– Elucidation of the Format of Biological Information and Its Application to Artificial Systems –

Information systems of animals have evolved over long periods of natural history, and are quite sophisticated. The systems may be useful to create new artificial systems that are more intelligent and sophisticated than those we have now. We investigate structures and functions of biological systems with techniques of physiology, histochemistry, and molecular biology. Current topics are (1) to identify the ionic and genetic basis of temperature-sensitive neurons in the brain and skin, (2) to make functional neural networks from neurons cultured on multi-channel electrode dish, (3) to clarify mechanisms of communications between nervous system and immune system, and (4) to elucidate epigenetic control of gene expression. By these investigations, we aim to clarify the format of biological information and to apply it for the creation of new artificial systems.

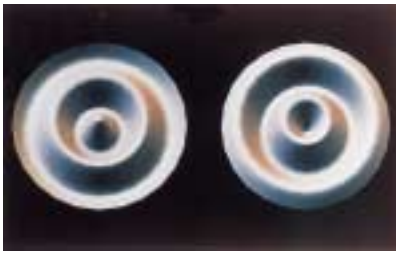
(Professor: KOBAYASHI Shigeo, Associate Professor: MATSUMURA Kiyoshi, Research Associate: SHIRAKI Takuma)



A neuron in a brain slice. How does this cell communicate with other cells? What is the genetic basis for the communication?

Cognitive Science

– Toward a System-level Understanding of the Human Brain –



Please look at this upside down.

In order to obtain a systematic understanding of the human brain, research on the higher cognitive functions has progressed both experimentally and theoretically. Specifically, we have undertaken studies involving both psychological experiments and neural network simulations to determine how various higher-1evel functions are realized in the brain, such as visual pattern recognition, the integration of sensory information from various modalities, verbal and nonverbal communication. We have also measured human brain activity using brain-imaging techniques.

(Professor: INUl Toshio, Associate Professor: SAIKI Jun, Research Associate: MORISAKI Ayako)

Hearing and Speech Processing

(Operated Jointly with Industry)

– Mechanisms of Human Hearing and Computational Models of Hearing –

This figure shows the fMRI signals of the human brain for binocular depth perception.

Speech is one of the most fundamental communication channels. We aim at clarifying the mechanisms of hearing and speech perception through a trans-disciplinary approach based upon psycho-acoustics, physiology, and information engineering. Our research topics include 1) the analysis of timing perception, 2) computational auditory modeling, 3) the development of speech recognition algorithms, and 4) the analysis of spoken language acquisition.

(Professor: KATAGIRI Shigeru, Associate Professor: TSUZAKI Minoru)

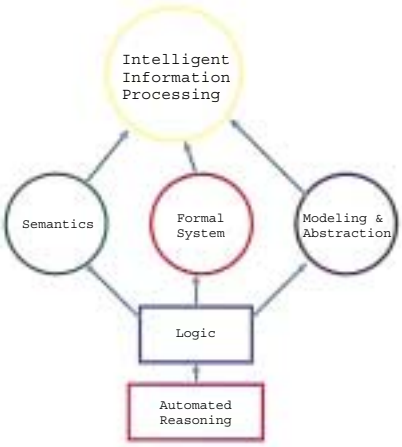
Intelligence Information Processing

Our goal is to realize flexible and intelligent information processing. We identify basic components and structures of information, and study extraction, recognition, understanding, and representation of information. We also study theoretical foundation of computer software in which modeling and abstraction play important roles.

Foundation of Software Science

– Theoretical Approach for the Construction of Software Supporting Human Mental Activities –

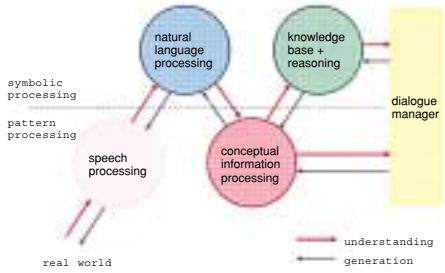
In order to realize computer software that can perform intelligent information processing done by humans, it is necessary to abstract and formalize the problems in question. With this objective in mind, we study the mathematical semantics of both the problems and software, and also study methods to reason about properties of software. We also design and implement software that supports high-level reasoning.
(Professor: SATO Masahiko, Associate Professor: KAMEYAMA Yukiyoshi, Research Associate: TAKEUTI Izumi)



Intelligence Information Processing Principles

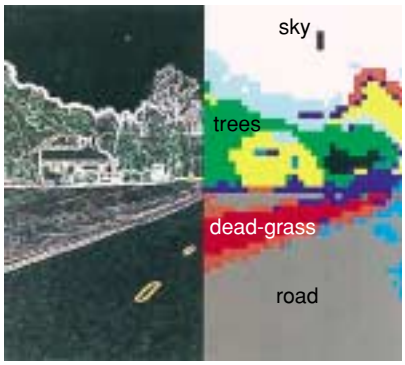
– Toward Intelligent Agent with Spoken Dialogue Interface –

Our ultimate goal is to realize an intelligent agent system that understands human intentions and processes information with self-organized knowledge bases. We study modeling of intelligent information processing based on statistical and logical reasoning as well as concept and knowledge representations. We also design and implement a spoken dialogue system by integrating speech understanding with planning and problem solving mechanism.
(Associate Professor: KAWAHARA Tatsuya)



Applied Intelligence Information Processing

– Intelligent Information Processing to Support Human Intellectual Activities –



Recognition of natural scene images.

The computer is able to aid us well to present and to represent information. Further the computer can raise the processing ability to more abstract level of intention or of concept. By utilizing such higher level capability of the computer our daily activities and eventually our lives become more satisfying. We pursue the realization of systems and software for such intelligent information processing 1) To aid in perception of the external world and in collection of information, 2) to ease human's understanding of the collected information by recognizing and discriminating the information, thus 3) to promote better communications between people, and 4) to support appropriately our daily activities.

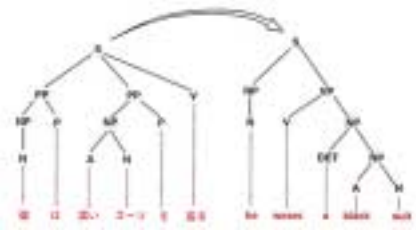
(Professor: IKEDA Katsuo, Research Associates: MUKUNOKI Masayuki, and FUJIKAWA Kenji)

Intelligence Media

The Intelligence Media Division deals with language, speech, and visual information which are the fundamental media to represent, accumulate and communicate information. Research and teaching at the Division covers a wide range of topics in theory and application, including analysis, recognition and understanding of information contents represented in these media, and media generation/editing to represent and communicate information contents effectively.

Language Media Processing

– Toward Automatic Language Understanding –



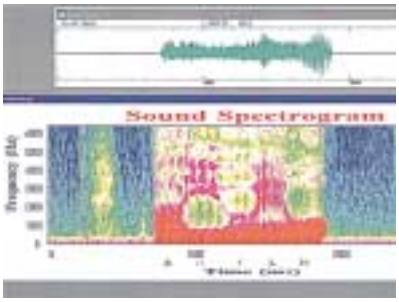
Machine translation through phrase structures of sentences

Language is the most useful and reliable media of human intelligent activities. Our objective is to establish an academic discipline and technologies of handling and understanding language by machine. These include text corpus analysis (mono-lingual/bi-lingual), automatic dictionary construction, morphological and syntactic analysis of Japanese texts, syntactic/semantic disambiguations, discourse analysis, text generation, machine translation and information retrieval.

(Lecturer: KUROHASHI Sadao)

Speech Media Processing

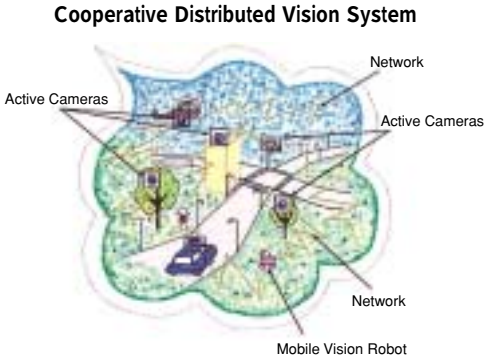
– Toward Spoken Dialogue System –



Speech is fundamental media for human communication. Intelligent processing of speech will provide friendly human-computer interfaces and novel ways for multi-media information systems. We are studying automatic speech indexing, recognition, understanding and dialogue systems based on signal processing, pattern recognition, language modeling and artificial intelligence technologies.
(Associate Professor: INAGAKI Kousaku)

Visual Information Processing

– Toward Image Understanding Systems –



Human beings are endowed with highly flexible visual perception capabilities to recognize objects and understand dynamic situations. The goal of our research is to realize image understanding systems enough capable as human beings. We study a wide spectrum of hardware and software technologies for image processing, recognition, understanding, and generation. Currently, the Cooperative Distributed Vision project is being conducted, where a group of network-connected Observation Stations (real time image processor with active camera(s)) and mobile robots with vision are embedded in the real world to realize 1) wide-area dynamic scene understanding and 2) versatile scene visualization.
(Professor: MATSUYAMA Takashi, Associate Professor: WADA Toshikazu, Lecturer: SUGIMOTO Akihiro, Research Associate: TOKAI Shogo)

Application of Multimedia

Multimedia processing with computer devices has great potential for expression, information gathering, realtime dialogue processing, and so on. We aim to teach and study the technology of multimedia application through the construction of educational environments in which we can make use of multimedia consisting of images, texts, sound, and so on. In this way, students can engage themselves in their studies while creating something of practical use in universities.

Video Media

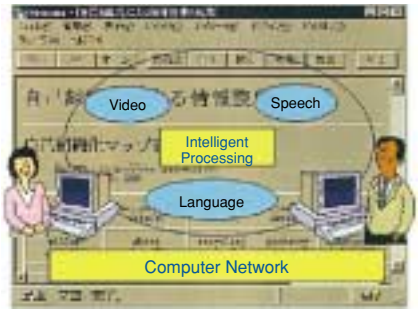
– Human-Computer Interaction through Video Images –

Real-time reconstruction of a classroom in virtual space using video image processing and computer graphics. The position of the lecturer is estimated from video images.

Video image understanding for a human to interact a computer via 3D world. Technologies related to video image processing and video image generation are studied. Concrete research topics are: human factors in the interaction system, real time interaction through video images, interaction via virtual 3D world, distance learning system with computer network, i.e internet. Based on the research on these topics, the mechanism and principle to utilize a computer as media technologies are considered.
(Professor: MlNOH Michihiko, Associate Professors: KAKUSHO Koh, and NAKAMURA Motonori, Research Associates: KAMEDA Yoshinari, YAGI Keisuke, and WATANABE Masako)

Media Processing for Education of Information Processing

– Supporting Education with Network Communication Technologies –



Schema of supporting education with network communication technologies.

Communication technologies using computer network are studied, and the results are applied to support various fields of education. For example, by integrating intelligent processing technologies for language, speech, and video, which are media of network communication, and by applying them to presenting and gathering information over computer network, intelligent education support system will be developed.
(Professor: NAKAMURA Jun-ichi, Associate Professor: FUJII Yasuo,Research Associates: TSUJI Hitoshi, and NAKASHIMA Yasuhiko)

Language Studies

– The Application of Multimedia to Linguistic Studies –

Speech analysis on a personal computer.

We understand natural language, culture, and education comprehensively through making a scientific analysis of language. Language plays a basic role in communication, and culture is based on it. There exist large numbers of languages in the world, and their constructions and systems are varied. We aim to prepare phonetic and linguistic databases and apply them to language teaching and to education for communicative skill.
(Professor: DANTSUJI Masatake, Research Associate: SHIMIZU Masaaki)

Department of Social Informatics

Harmonizing Society and Information Technology

Due to the recent development of world-wide network and very large databases, our society will change drastically. The major purpose of the Department is to conduct research and education for problems caused by such dynamic society utilizing various computer science-based technologies including distributed artificial intelligence and databases. Electronic commerce, environment observation, bioresources, disaster privation and medical information processing are considered to be important application areas. Network security and intellectual property are also included.

Divisions and Groups

Division	Group
Social Informatics Model	Distributed Information Systems
	Digital Library
	Information Society
Social Information Network	Global Information Network
	Information Security
	Market and Organizational Information Systems
Biosphere Informatics	Bioresource Informatics
	Environmental Informatics
Regional and Disaster Management Information Systems	Integrated Disaster Management Systems
	Emergency Management for Disaster Reduction Systems
	Psychology for Disaster Management
Medical Informatics	

Graduate Curriculum

Subjects for Master's Program

Advanced Study on Social Informatics 1, 2
Distributed Information Systems
Mathematical Social Model Theory
Biological Environmental Information Systems
Crises Management
Social Information Systems
Database Systems
Bioresource Information Systems
Disaster Information Management
Medical Informatics

Subjects for Doctoral Program

Advanced Seminar on Social Informatics
Advanced Seminar on Social Informatics Network
Advanced Seminar on Medical Informatics
Advanced Seminar on Social Information Model
Advanced Seminar on Biosphere Informatics
Advanced Seminar on Regional and Disaster Management Information Systems

Staff

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ISHIDA Toru
MORIYA Kazuyuki
KAWATA Yoshiaki
TANAKA Yuzuru (Hokkaido Univ.)
KOYAMA Kenji (NTT)
SAKAI Tetsuro
HAYASHI Haruo
OHSETO Takeshi (ASTEM/Kyoto)
SHINOHARA Takeshi †
KAMEDA Hiroyuki
TAKAHASHI Takashi

Associate Professors

TARUMI Hiroyuki
ISHIGURO Hiroshi
ARAI Nobuaki
MATSUDA Tetsuya
SATO Satoshi ‡
SHIRAYANAGI Kiyoshi (NTT)
NUMATA Kunihiko
YAMADA Atsushi (ASTEM/Kyoto)
YOKOZAWA Makoto †
NISHIGAMI Kinya

Lecturers

TAKAKURA Hiroki (Graduate School of Engineering)
KOMORI Masaru

Research Associates

YOKOTA Yusuke
KOBA Keisuke
OGINO Hiroyuki
TANAKA Satoshi
YOSHIMURA Tetsuhiko
TAKAHASHI Tomoyuki

Part Time Lecturers

AJISAKA Tsuneo (Wakayama Univ.)
HOSHINO Hiroshi (Graduate School of Economics)

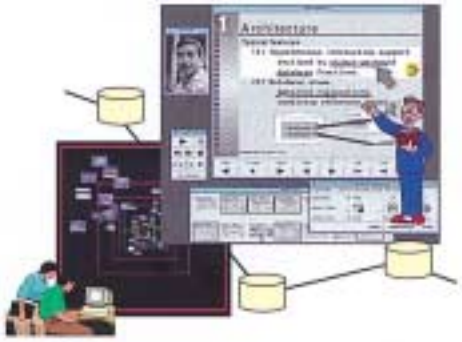
†: Nomura Research Institute, Ltd. ‡: JAIST (Japan Advanced Institute of Science and Technology)

Social Informatics Model

Due to the development of information networks, it became possible to utilize information-bases distributed all over the world. Organization of such distributed information-bases, applications for digital libraries, intellectual property and copyright protection and various problems caused by such global distributed systems are covered by this division.

Distributed Information Systems

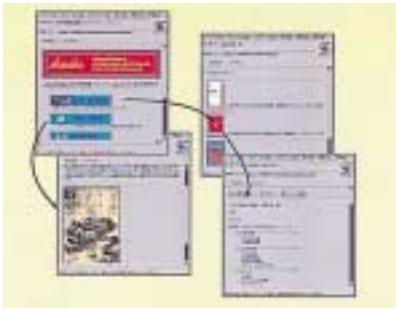
Since database is one of the key technology for organizing large systems, data engineering including database design, query processing, transaction processing, and security are studied. As one of the important applications of database technologies, distributed cooperative systems are developed. Together with computer supported cooperative work (CSCW) and distributed systems research, applications to virtual organizations are investigated.
(Professor: KAMBAYASHI Yahiko, Associate Professor: TARUMI Hiroyuki, Lecturer: TAKAKURA Hiroki, Research Associate: YOKOTA Yusuke)



A system based on distribution and sharing of data.

Digital Library

This group has been conducting three R& D projects. The first aims at establishing 2D and 3D media architectures for the editing, world-wide distribution, and management of intellectual resources, including multimedia contents, documents, and software systems. The second is pursuing new technologies for document image libraries, including the compression, editing, and retrieval of document images. The third is focusing on automated editing of information, including text filtering, text categorization and text summarization.
(Professor: TANAKA Yuzuru, Associate Professor: SATO Satoshi, Research Associate: OGlNO Hiroyuki)



Digital library ARIADNE.

Information Society

(Operated Jointly with Industry)

Legal protection system of information, including industrial property and copyright systems is studied and computer systems for copyright management, copy protection, and security are developed.
(Professor: OHSETO Takeshi, Associate Professor: YAMADA Atsushi)

Social Information Network

Computer networks have made the integration and use of information resources ubiquitous. At present computer networks covering the world enable us to communicate by various means while overcoming temporal and spatial constraints. With global computer networks, we will realize new social information systems that will transform societies across the world.

Global Information Network

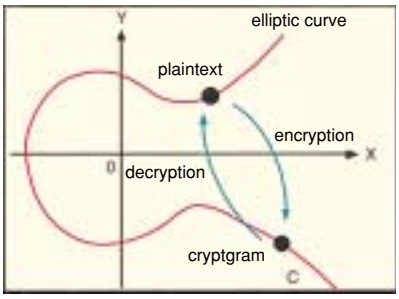
Meeting in virtual 3D space.

This group supports worldwide communication and collaborative activities among people by exploiting computer network technologies. We monitor the relationship between human society and computer technologies and explore promising directions for the progress of our information-oriented society by developing social information systems, analyzing their effectiveness and influence on society, and performing social experiments. More concretely, our themes are (1) civic life and computer networks and (2) the economy and computer networks. With these themes in mind, we educate and conduct research on fundamental technologies, such as artificial intelligence, the Internet, community computing, the information market, and so on.

(Professor: ISHIDA Toru, Associate Professor: ISHIGURO Hiroshi)

Information Security

(Operated Jointly with Industry)



Cryptography based on elliptic curves.

For secure electronic commerce via Internet, we need keeping of privacy and detection of illegal modification. Cryptography is indispensable to realize secure computer communication. Public-key cryptosystems are used for high secrecy and easy digital signature. We study efficient and secure cryptography from the viewpoints of mathematics and social applications.

(Professor: KOYAMA Kenji, Associate Professor: SHIRAYANAGI Kiyoshi)

Market and Organizational Information Systems

(Operated Jointly with Industry)

Experiment on digital cash.

Enterprise Information Technology, including intranet, management technology and business object is studied and technology for cyber business, including electronic commerce, electronic money and extranet is developed.

(Professor: SHINOHARA Takeshi, Associate Professor: YOKOZAWA Makoto)

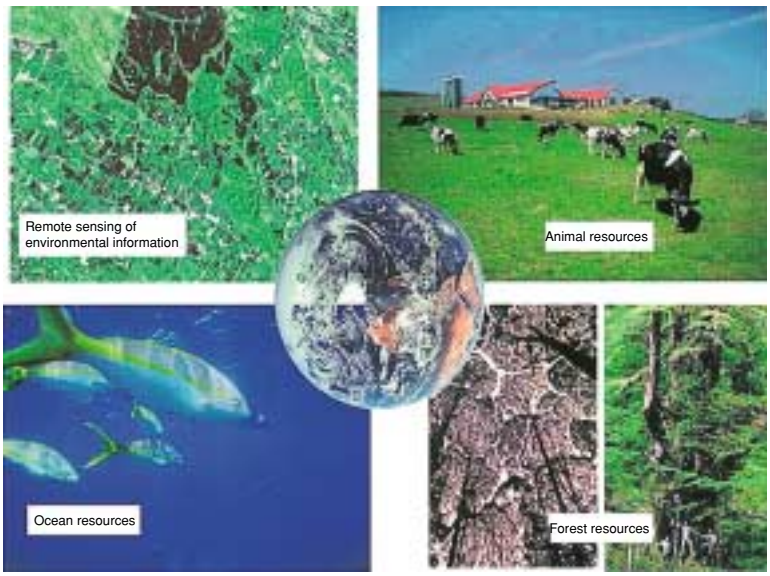
Biosphere Informatics

Living things on the earth have close interrelations through food chain or energy circulation and they are essential as food resources for us and as environmental resources to maintain the global environment. Our purposes are to find and analyze valuable information on the environment and bioresources in biosphere and to clarify the potential value and significance of biospheric information. Moreover, we also aim to overcome food crisis and conserve the global environment by studying the methods of utilizing biospheric information and the effects of such information on our lifestyle.

Bioresource Informatics

While mineral resources, such as oil or coal, can no longer be reproduced, bioresources can be sustainable for generations. In fact, we have utilized bioresources continually by hunting or cultivation since ancient times and, thanks to the existence of such bioresources, the global environment have been maintained well so far. In terms of resources and the environment, our life conditions will be more serious in the 21st century. In order to achieve a stable food supply as well as environmental conservation, we are trying to establish the system, in which bioresouces are effectively utilized, by using LCA (life-cycle assessment), monitoring and conserving bioresources, making a huge database and analyzing the bioresource information worldwide.

(Professor: MORIYA Kazuyuki, Associate Professor: ARAI Nobuaki, Research Associate: YOSHIMURA Tetsuhiko)



Various information on resources and environment in biosphere.

Environmental Informatics

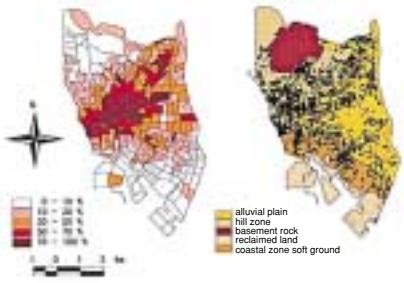
With rapid modernization and industrialization since the Industrial Revolution, many problems, such as a population explosion, environmental degradation, reduction of agricultural lands due to urbanization, have occurred and had negative impacts on biosphere, that is, the base of our lives. In order to solve problems, such as global warming, overcutting forests, desertification, sea pollution, acid rain and ozone depletion, we are conducting scientific researches by monitoring and modeling the global environment, analyzing the environmental information using RS (remote sensing), GIS (geographical information system) and GPS (global positioning system), and applying environmental economics to the natural environment and scenic landscape.

(Professor: SAKAI Tetsuro, Associate Professor: NUMATA Kunihiko, Research Associate: KOBA Keisuke)

Regional and Disaster Management Information Systems

(Disaster Prevention Research Institute)

Disaster is an abrupt and large-scale environmental change. Natural, artificial and social environments, especially the balance among them, that have been achieved by regional communities are forced to change. Large-scale disasters often make us unable to recover the balance of the community we had before the disaster, and urge us to create a new form of balance. This aspect was dramatically demonstrated by the gigantic damage by the Great Hanshin-Awaji (Kobe) Earthquake Disaster and societal difficulties that have hitherto been sustained. Information processing is a key issue in the efforts in disaster mitigation. The Division of Regional and disaster Management Information Systems is aimed at establishment of information systems that will be useful for minimizing the effects of disasters and realizing quick recoveries. The issue requires collaboration from various fields. The Graduate School of Informatics, a multi-disciplinary forum is believed to function profitably for this goal.



Collapse rate of wooden houses in the 1995 Hyogoken-nanbu (Kobe) Earthquake

Failure of water distribution pipes in the 1995 Hyogoken-nanbu (Kobe) Earthquake

Integrated Disaster Management Systems

Improvement of "Quality of Infrastructure" -Safer societies are studied in terms of the "physical world," "social world," and "information world;" i.e., focus is placed on reliability enhancement of infrastructure including life line systems and key facilities for disaster management. From this perspective, utilizing GIS and other information processing techniques, risk adaptive disaster information systems are developed for a systematic diagnosis of cities.

(Professor: KAMEDA Hiroyuki, Research Associate: TANAKA Satoshi)

Emergency Management for Disaster Reduction Systems

Both on the similarities and differences among various urban catastrophic disasters are studied to make clear the unpredictable and unforeseeable matters. A multi-media disaster simulation system which utilizes the disaster information we have gained from urban catastrophic disasters at the community level, at the regional level, and at the national level, has been developed.
(Professor: KAWATA Yoshiaki, Research Associate: TAKAHASHI Tomoyuki)

Psychology for Disaster Management

As the bases for establishing loss reduction, disaster management measure will be established. The necessity of helping the victims as well as the disaster stakeholders understand what they have experienced is emphasized as well as the necessity of promoting the study of reconstruction and rebuilding processes following urban catastrophic disasters. It is a long complex, and difficult process to which little attention has thus far been paid.
(Professor: HAYASHI Haruo, Research Associate: NISHIGAMI Kinya)

Simulation of earthquake and tsunami in 1944 east-south sea earthquake.

Medical Informatics

(Department of Medical Informatics, Medical School)

Transferring Hi-tech Engineering to Clinical Medicine

One of the focuses of ongoing research and education in our group is the application of advanced high-tech engineering to the problems encountered in the clinical medicine. There are three areas of particular interest to us: medical imaging technology, robotics, and information systems for telemedicine as well as informatics supporting both medical decision making and medical economics. We focus on VR technology which integrates both imaging technology for enhancing visualization of deep human organs and robotics giving new surgical procedures and nursing care.
(Professor: TAKAHASHI Takashi, Research Associate: MATSUDA Tetsuya, Lecturer: KOMORI Masaru)

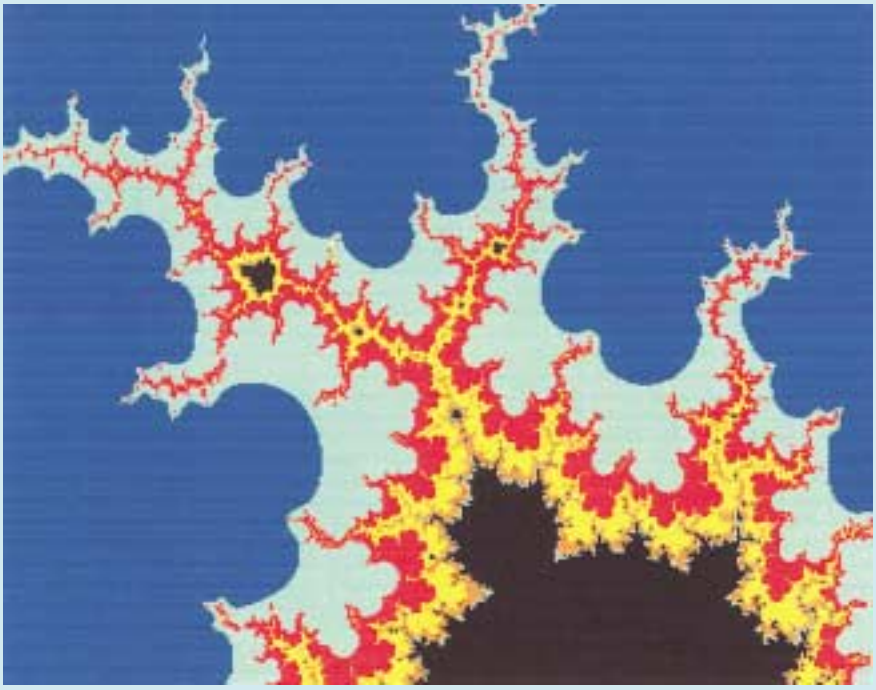
Rehearsal of operation by VR.

Generation of dynamic maps according to usage and purpose.

Meeting in 3D space using Free Walk.

Department of Applied Analysis and Complex Dynamical Systems

Toward the Analysis and Synthesis of Varied Behavior of Complex Systems



Complex systems refer to such systems that consist of a large number of elements and exhibit, as a whole, a variety of mechanisms and interesting behavior such as self-organization, chaos with a large degree of freedom, learning and associative memories through nonlinear large-scale interactions among those elements. This department aims at clarifying the fundamental principles and structure in such phenomena, as well as utilizing and synthesizing the knowledge derived from them. Emphasis is placed upon general backgrounds in diverse fields as well as a more in-depth grasp of specific branches such as applied and numerical analysis, nonlinear dynamics, nonequilibrium dynamics, parallel computing, intelligent control systems.

Divisions and Groups

Division	Group
Applied Analysis	Analysis of Inverse Problems
	Nonlinear Analysis
Complex Dynamics	Nonlinear Dynamics
	Nonequilibrium Dynamics
Complex Systems Synthesis	Fundamentals of Complex Systems
	Intelligent and Control Systems

Graduate Curriculum

Subjects for Master's Program

Advanced Study of Applied Analysis and Complex Dynamical Systems 1, 2

Analysis of Inverse Problems
Complex Dynamics
Complex Systems Synthesis
Intelligent and Control Systems
Nonlinear Analysis
Nonlinear Dynamics
Fundamentals of Complex Systems
Formation of Dissipative Structures

Subjects for Doctoral Program

Seminar on Applied Analysis, Advanced
Seminar on Complex Dynamics, Advanced
Seminar on Complex Systems Synthesis, Advanced
Seminar on Applied Analysis and Complex Dynamical Systems, Advanced

Staff

Professors

ISO Yuusuke, KIGAMI Jun, FUNAKOSHI Mitsuaki
FUJISAKA Hirokazu, NOGI Tatsuo, YAMAMOTO Yutaka
NISHIDA Takaaki (Graduate School of Science)

Associate Professors

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Lecturers

HlNO Masanori, KUBO Masayoshi, MIYAZAKI Syuji

Research Associates

WAKANO Isao, KANEKO Yutaka, TUTU Hiroki
HARADA Kenji, WAKASA Yuji

Applied Analysis

One important object of Mathematics is to make existing theory deeper and deeper. At the same time, to keep Mathematics alive, one should seek out new frontiers and try to widen the scope as well. The aim of our group is to try to pursue new ideas in Mathematics through applications in various areas, for example, Physics, Engineering and Biology. In particular, from the viewpoints of Analysis and Probability, members are working together to understand mathematical models used in applications and the deeper mathematical structures which lie behind them.

Non-linear Analysis and Inverse Problems

– Toward Establishment of New Mathematics –

Faculty Members and Their Research Interests

ISO Yuusuke (Professor)
Numerical Analysis of (partial) Differential Equations,
Numerical Analysis of Ill-posed Problems,
Inverse problems

KIGAMI Jun (Professor)
Analysis on Fractals,
Fractal Geometry,
Mathematical Biology

NISHIDA Takaaki (Professor, Graduate School of Science)
Non-linear Partial Differential Equations,
Numerical Analysis of (partial) Differential Equations,
Bifurcation Theory

KUMAGAI Takashi (Associate Professor)
Stochastic Processes on Fractals,
Analysis of Stochastic Models

KUBO Masayoshi (Lecturer)
Inverse problems, Numerical Analysis of (partial) Differential Equations,
Non-linear Partial Differential Equations

HINO Masanori (Lecturer)
Stochastic Analysis on Infinite Dimensional Spaces,
Functional Analysis related to Dirichlet Forms

WAKANO Isao (Research Associate)
Numerical Analysis of (partial) Differential Equations,
Analysis of Fracture Mechanics

Complex Dynamics

The dynamical behavior of nonlinear extended systems is attracting the attention of scientists and technologists in the relevant and related multidisciplinary and interdisciplinary fields. The subject of this section is ranging from the specific complicated nonlinear system to the common features such as chaos and pattern formation. Computer simulations as well as theoretical analyses are used for the research.

Nonlinear Dynamics

– Studies on a Variety of Behavior of Nonlinear Dynamical Systems such as Fluid Systems –

An efficient mixing of fluids is attained if two eccentric cylinders are rotated alternately so that each fluid particle moves chaotically. This is called a chaos mixing.

We aim at the understanding and utilization of a variety of complicated behavior of nonlinear dynamical systems such as fluid systems, many body systems, and structural systems. Nonlinear behavior of fluid systems and coupled dynamical systems, such as chaos, pattern formation, nonlinear waves and interaction of vortices, is examined using computer simulations and the theories of dynamical systems, solitons, and perturbation. We also aim at the development of reliability analysis methods for structural systems based upon the theory of stochastic processes or random fields. Furthermore, the dynamics of liquids and crystal growth are examined using computer simulations.

(Professor: FUNAKOSHI Mitsuaki, Associate Professor: TANAKA Hiroaki, Research Associate: KANEKO Yutaka)

Nonequilibrium Dynamics

– Study of Complex Dynamical Systems from the Viewpoint of Nonlinear Nonequilibrium Physics –

Nonlinear chemical reaction systems yield spontaneously spiral structure and its complex motion, which can be reproduced by use of a mathematical model of the nonlinear oscillating field. Spatial pattern obtained from the numerical solution is depicted.

It is often said that the law of nature is simple. The world around us are, however, filled with a variety of complex systems such as fluid, coupled electric circuits, chemical reaction, spin systems, liquid crystal, and biological systems. Oversimplified models or viewpoints cannot serve any more to understand such systems. With the help of computer simulation, we aim to elucidate the common principles and their mathematical expressions in the formation of complicated structure and in the emergence of motion observed in the extended nonlinear complex systems.

(Professor: FUJISAKA Hirokazu, Lecturer: MIYAZAKI Syuji, Research Associate: TUTU Hiroki)

Complex Systems Synthesis

Complex systems exhibit a wide variety of interesting phenomena such as self-organization and learning through complex mutual connections and interactions among the components. We aim at clarifying their emergence schemes, modeling and control principles, with the objective of utilizing such complex system phenomena for engineering. The two divisions are specifically devoted to the study of parallel computation and control systems, with emphasis upon the general understanding of the principles of complex systems.

Fundamentals of Complex Systems

– Study the World from the Viewpoint of Mathematics for Complex Systems and Parallel Computational Engineering –

Being grounded upon studies of mathematical models, computational models and solution algorithms for complex systems, this division aims fundamental studies of complexity of parallel interaction, principles of self-organization and grasp of global aspect, as well as development of new parallel computing systems, automatic parallelizing compilers and problem solvers with high intelligence and their application on brain systems, global environment systems and others.

(Professor: NOGI Tatsuo, Research Associate: HARADA Kenji)

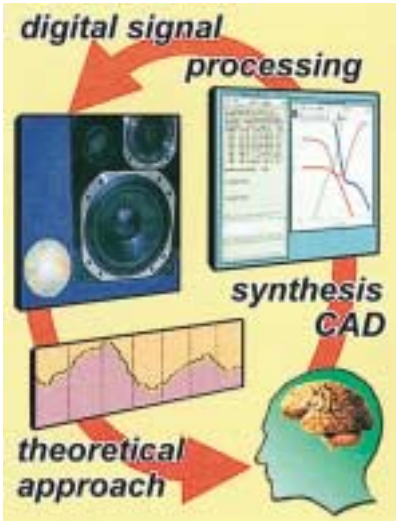
Parallel computer system ADENAs (2 sets) produced in collaboration with Matsushita Electric Industry Co.. They are useful for simulation studies of global environment, brain system and others, as well as study of parallel algorithms.

Intelligent and Control Systems

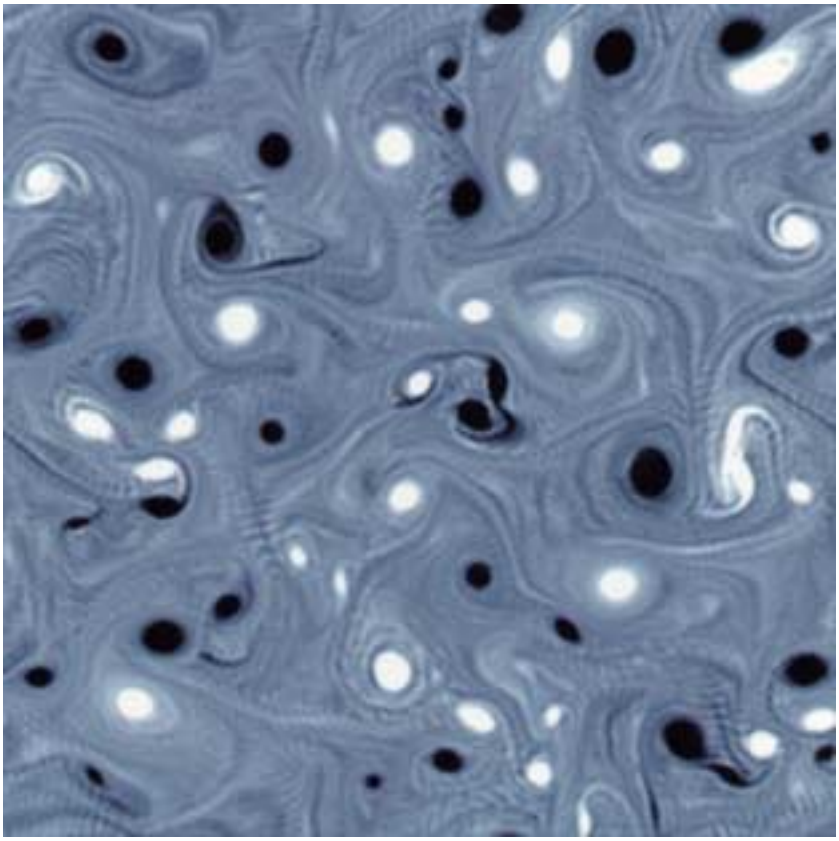
– Study of Intelligence and Control of Systems –

We are surrounded by a vast number of systems in the daily life--natural systems such as water circulation, meteorological systems, to artificial systems ranging from artificial satellites, robots, to production systems, computer networks and small-scale electric appliances, just to name a few. In order that they function properly, some kind of control mechanisms are indispensable, and they are required to work in more and more advanced and intelligent ways. This division aims at studying digital and robust control, learning control and CAD systems, signal processing, neural networks, especially in connection with their control, self-organization and intelligent functions.

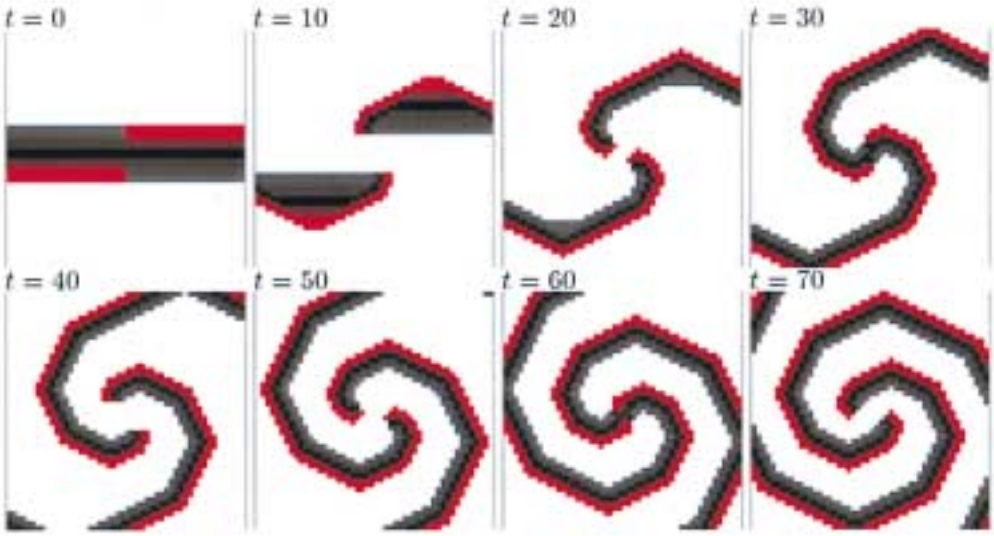
(Professor: YAMAMOTO Yutaka, Associate Professor: FUJIOKA Hisaya, Research Associate: WAKASA Yuji)



The new signal model via lifting and a CAD program introduced with it leads to a new horizon in digital signal processing.



Vortex structure in the two-dimensional turbulence.



Two-arm spiral wave computed by Wiener-Rosenblueth model (Red: exited, Black: inactive, White: quiet).

Department of Applied Mathematics and Physics

Engineering/Natural Systems:
Modelings, Analyses, Operations, Designs and Solutions

The systems in this modern information society become more complex and large-scaled. In order to model, analyze, design, control and operate such systems, it is necessary not only to have individual expert knowledges in specific areas but also to acquire flexible ways of thinking and sharp insights, which are based on general understanding of the underlying phenomena. This Department aims at clarifying the structures of large-scale systems through the study of advanced mathematical sciences, thereby establishing a new field that supports the backbone of this advanced information-dense society, and producing scientists and engineers who are able to cope with various emerging problems by applying their systematic and logical thinking.

Divisions and Groups

Division	Group
Applied Mathematics	Applied Mathematical Analysis
	Discrete Mathematics
Applied Mathematical Systems	System Optimization
	Control Systems Theory
Mathematical Physics	Physical Statistics
	Dynamical Systems Theory

Graduate Curriculum

Subjects for Master's Program

Advanced Study on Applied Mathematics and Physics 1, 2

Applied Mathematical Analysis	Discrete Mathematics, Advanced
Operations Research, Advanced	Control Systems Theory, Advanced
Optimization Theory, Advanced	Mathematical Physics
Physical Statistics and Probability Theory	Dynamical Systems Theory, Advanced

Subjects for Doctoral Program

Seminar on Applied Mathematics and Physics, Advanced
Seminar on Applied Mathematics, Advanced
Seminar on Applied Mathematical Systems, Advanced
Seminar on Mathematical Physics, Advanced

Staff

Professors

IBARAKI Toshihide	FUKUSHIMA Masao	KATAYAMA Tohru
MUNAKATA Toyonori	IWAI Toshihiro	

Associate Professors

TARAMA Shigeo	NAGAMOCHI Hiroshi	TAKINE Tetsuya
TAKABA Kiyotsugu	IGARASHI Akito	UWANO Yoshio

Research Associates

SHIOZAKI Yasutoshi	YAGlURA Mutsunori	YAMASHITA Nobuo
TANAKA Hideyuki	AOYAGI Toshio	YAMAGUCHI Yoshiyuki

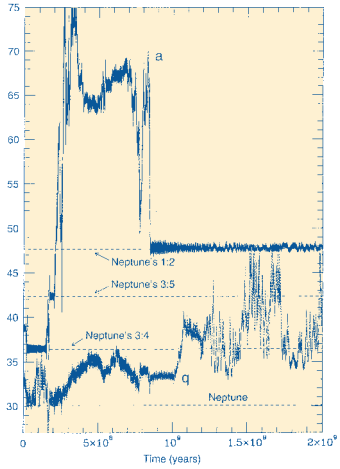
Applied Mathematics

The division consists of two subdivisions of Applied Mathematical Analysis and Discrete Mathematics, and studies mathematical models of natural and social phenomena and engineering systems. The first subdivision emphasizes the point of view of analysis and partial differential equations, while the second subdivision deals with combinatorial optimization problems, graph and network problems and logic functions. Not only is the general formulation of the new mathematical models aimed at, but education and research in the computational complexities, algorithms, and system modeling are also conducted.

Applied Mathematical Analysis

– Researches on Phenomena in Natural Science and Engineering from the Point of View of Mathematical Science –

Many phenomena in Natural Science and Engineering are described by differential (partial and ordinary) equations. The properties inherent in these equations are clarified from the point of view of mathematical analysis, and for concrete problems the phenomena are investigated by computational mathematics. In particular, emphasis is laid on the time development of the solutions of partial differential equations. It is also encouraged to develop new paradigms in the related fields.
(Associate Professor: TARAMA Shigeo, Research Associate: SHIOZAKI Yasutoshi)



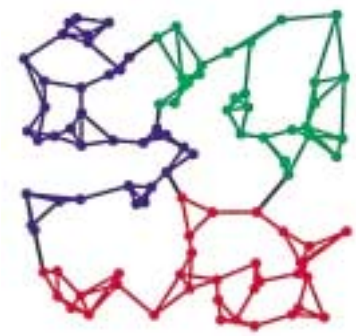
An example of chaotic behavior in the solution of a dynamical system. Semi-major axis a and q=a(1-e) are plotted, where e stands for the eccentricity.

Discrete Mathematics

– Exploring the Complexity and Algorithms of Discrete Problems –

Topics of discrete mathematics are closely related to applications; e.g., graphs and networks used to represent systems, scheduling problems to improve productivity, and logical analysis to handle large data. We try to clarify the complexity of such problems and to develop novel algorithms, including those meta-heuristic algorithms such as tabu search, genetic algorithms and simulated annealing.
(Professor: IBARAKI Toshihide, Associate Professor: NAGAMOCHI Hiroshi, Research Associate: YAGIURA Mutsunori)

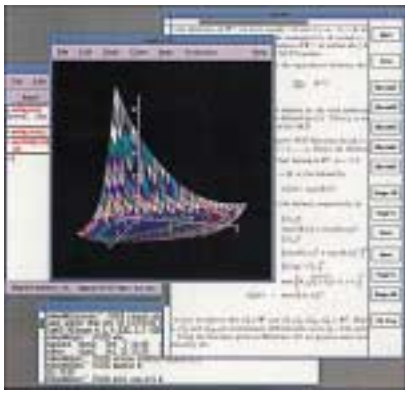
Computation of a minimum cut that separates a network into two components (i.e., the most fragile part of the network). A cut with size two can be found around each red cluster.



Computation of a minimum cut that separates a network into three components with the same number of vertices.

Applied Mathematical Systems

We conduct education and research on mathematical theory of analysis, planning, management and evaluation of diverse complex systems that arise in highly informatized societies and modern production systems. Particularly we aim to develop solid theories and efficient solution methods in mathematical programming, applied probability, network theory, modern feedback control theory, estimation and identification of stochastic systems, and robust control theory.

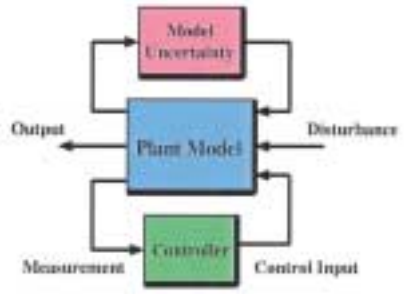


3-D graph of a merit function for a complementarity problem.

System Optimization

– Optimization is the Key Word for Problem Solving –

We conduct education and research on the theory and methods of system optimization that play an important role as a mathematical methodology to resolve diverse problems. In particular, we develop efficient mathematical optimization approaches to actual large-scale systems, complex nonlinear systems, and systems with uncertainty, as well as basic research on mathematical programming and queuing theory.
(Professor: FUKUSHIMA Masao, Associate Professor: TAKINE Tetsuya, Research Associate: YAMASHITA Nobuo)



A general framework of robust control system.

Control Systems Theory

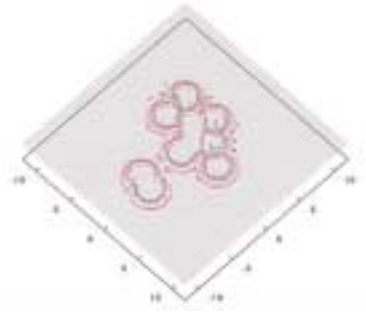
– Mathematical Approaches to Modeling and Control –

Aiming at developing theories applicable to practical control systems, we conduct active programs of teaching and research in the area of the mathematical methods of modeling, analysis and design of control systems. In particular, our research interests include robust control theory, descriptor systems, spectral factorization, Riccati equations, stochastic realization and system identification. We have also been working on the cooperative research on modeling and control of chemical processes with some private companies.
(Professor: KATAYAMA Tohru, Associate Professor: TAKABA Kiyotsugu, Research Associate: TANAKA Hideyuki)

Mathematical Physics

From the viewpoint of dynamical systems, mathematical models arising in physics, chemistry, biology, and engineering are investigated on the basis of statistical physics, dynamical systems theory, differential geometry, probability theory, and stochastic process theory, through computer simulation method on occasion, in order to analyze the mathematical structure of those models and thereby to set up fundamental theory along with its applications.

Various coupled many-element systems.



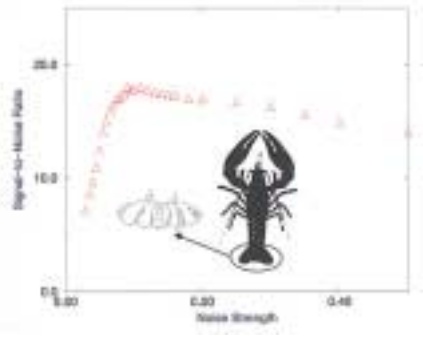
Polymer in solvents.

Physical Statistics

– Mathematical Physics of Coupled Many-element Systems and Information Processing –

Unified understanding, based on mathematical physics, of various complex phenomena resulting from strong coupling of many elementary units and applications thereof to information processing are the main areas of efforts. More explicitly, dynamical properties of some biomolecules (folding, motor,...), neural networks, complex liquids and chemical reactions are investigated with use of statistical mechanics, computer simulation, theory of stochastic processes and dynamical system theory.
(Professor: MUNAKATA Toyonori, Associate Professor: IGARASHI Akito, Research Associate: AOYAGI Toshio)

Neural networks.

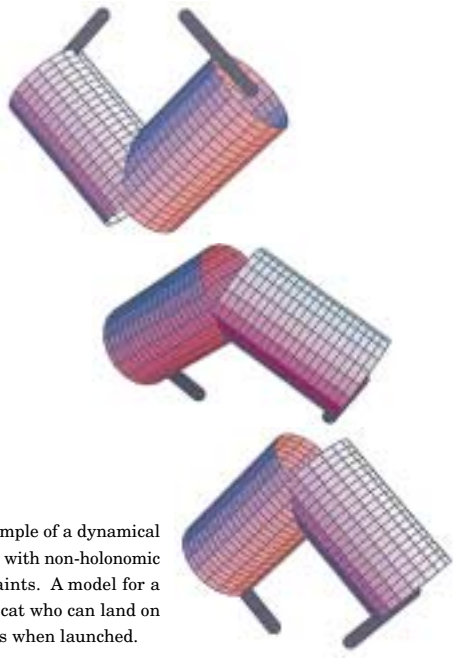


Stochastic resonance in mechanoreceptor cells of the tail fan of a crayfish.

Dynamical Systems Theory

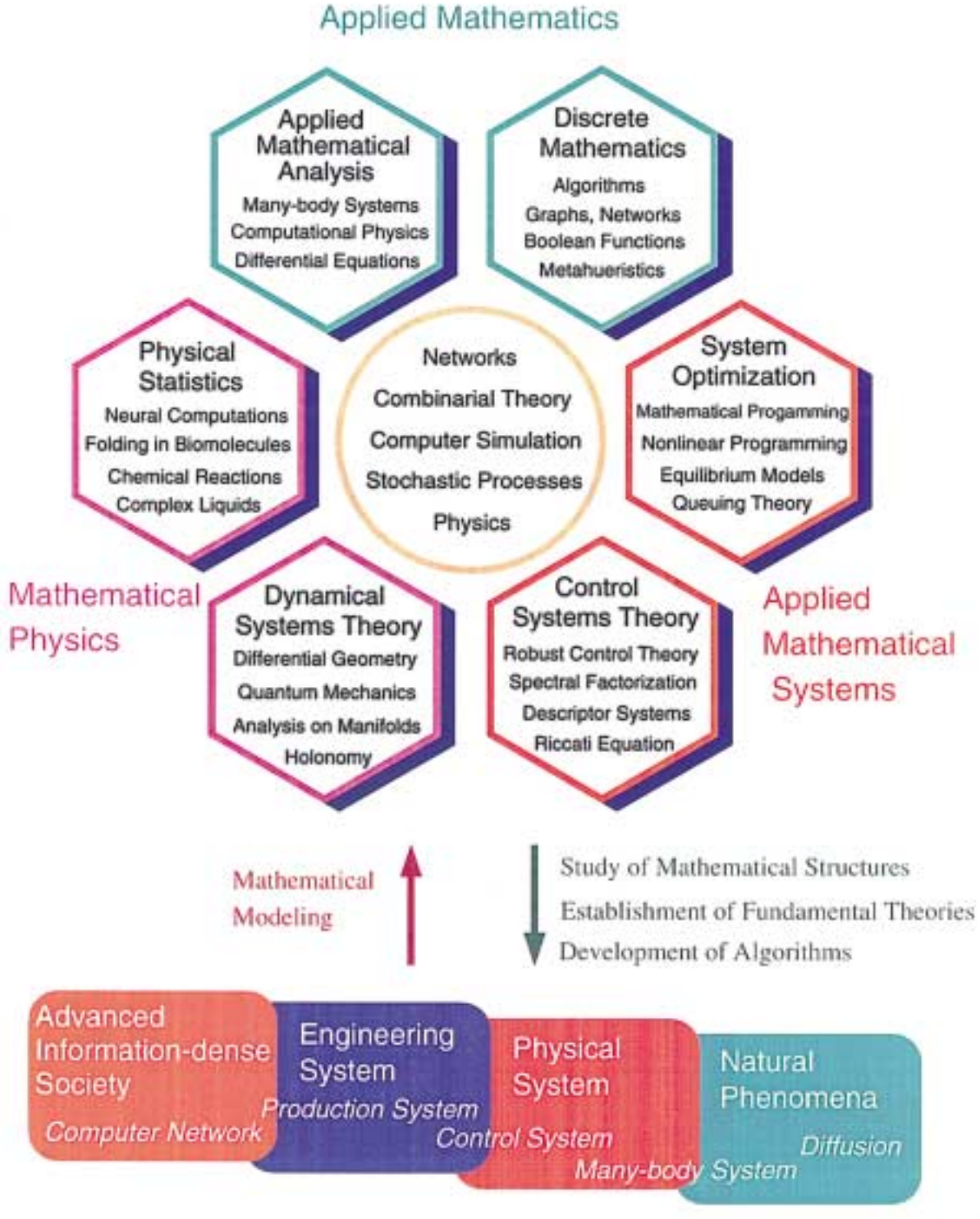
– Investigation into Systems through Dynamical Systems Theory –

Dynamical systems are studied from the viewpoint of differential geometry and of mathematics for dynamical systems. Subjects to be treated in the scope of mathematical physics in this laboratory are bifurcation theory of dynamical systems, differential-geometric structures of many-particle systems, correspondence between classical and quantum mechanics, group actions on dynamical systems and so on. Differential-geometric study of dynamical systems is applied to a control problem for dynamical systems with non-holonomic constraints.
(Professor: IWAI Toshihiro, Associate Professor: UWANO Yoshio, Research Associate: YAMAGUCHI Yoshiyuki)



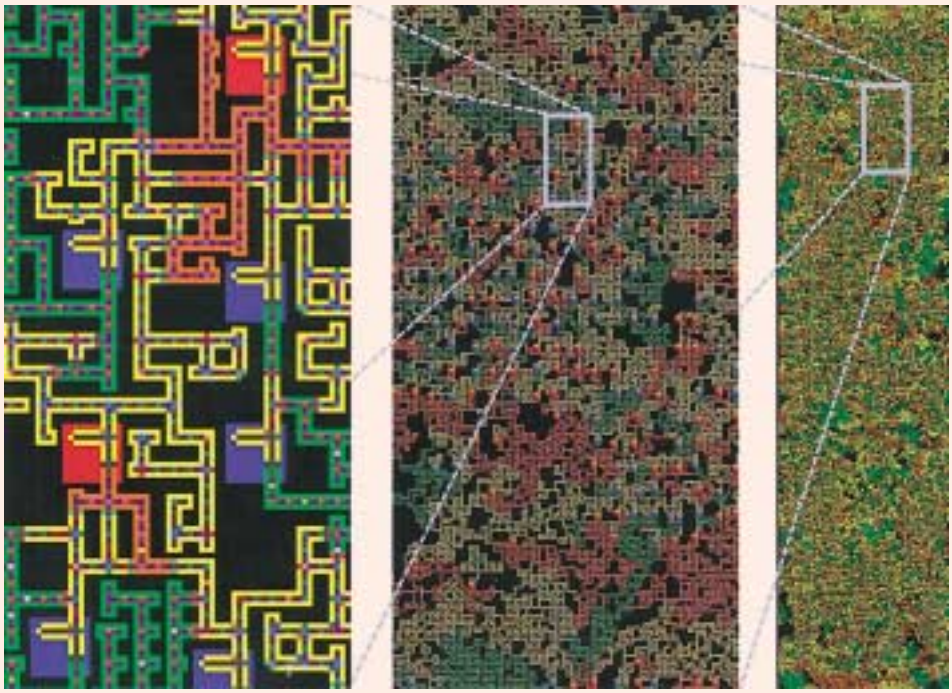
An example of a dynamical system with non-holonomic constraints. A model for a falling cat who can land on her legs when launched.

Department of Applied Mathematics and Physics



Department of Systems Science

New Frontier in Informatics and Systems



Research and education in the Department of Systems Science deal with a new and unified approach to a variety of technological problems from the standpoint of systems science. In particular, the approach requires the study of complex systems in the light of self-regulation, self-organization, and self-production. Emphasis is also placed upon the understanding of complicated mutual interactions, hierarchical systems, distributed or parallel self-determination, human-machine interfaces, biomedical engineering, and medical information systems.

Divisions and Group

Division	Group
Human Machine Symbiosis	Mechanical Systems Control
	Human Systems
	Symbiotic Systems
	Human System Interaction
Systems Synthesis	Adaptive Systems Theory
	Mathematical System Theory
Systems Informatics	Information Systems
	Image Processing Systems
	Biomedical Engineering
Applied Informatics	

Graduate Curriculum

Subjects for Master's Program

Advanced Study of Systems Science 1, 2
Theory of Human-Machine Systems
Adaptive Systems Theory, Advanced
Systems Synthesis, Advanced
Image Processing Systems, Advanced
Logical Systems, Advanced
Medical Information Systems
Theory of Mechanical Systems Control
Theory of Intelligent Collaborative Systems
Statistical System Theory, Advanced
Informatics in Systems
Theory of Information Systems, Advanced
Medical Image Media
Applied Informatics, Advanced

Subjects for Doctoral Program

Seminar on Human-Machine Symbiosis, Advanced
Seminar on Systems Informatics, Advanced
Seminar on Systems Science, Advanced
Seminar on Systems Synthesis, Advanced
Seminar on Applied Informatics, Advanced

Staff

Professors

SUGIE Toshiharu
SHIMOHARA Katsunori (ATR)
TAKAHASHI Yutaka
KANAZAWA Masanori (DPC)
KUMAMOTO Hiromitsu
ADACHI Norihiko
EIHO Shigeru
KATAI Osamu
SAKAI Hideaki
MlNATO Kotaro (Nara)

Associate Professors

OSUKA Koichi
OKADA Michio (ATR)
OSHIRO Osamu (Nara)
NISHIHARA Osamu
KAWANO Hiroyuki
YASUOKA Koichi (DPC)
KAWAKAMI Hiroshi
SUGIMOTO Naozo
SAWADA Atsushi (DPC)

Lecturers

OGlNO Katsuya
IKEDA Kazushi

Research Associates

FUJIMOTO Kenji
SOGO Takuya
SEKIGUCHI Hiroyuki
HIRAOKA Toshihiro
FUKAO Takanori
KAWAHARA Minoru (DPC)
IDA Masaaki
MIYAGI Shigeyuki

DPC: Data Processing Center Nara: Nara Institute of Science and Technology
ATR: Advanced Telecommunications Research Institute International

Human Machine Symbiosis

In the ages of information and network societies, the relationships among Artificial Systems such as machines and Man or Environments (natural or social) become more and more complex and are hard to be coordinated. The division searches for effective coordination among them by theoretical, methodological and technical approaches based on Systems Theory, Control Engineering, Artificial Intelligence, Cognitive Science, Human Interface and Media Technologies, Robotics and Reliability Engineering thus yielding harmonious Symbiosis among them.

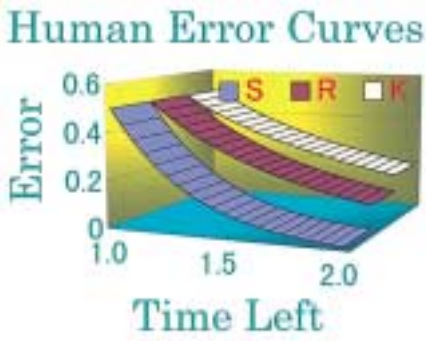
Mechanical Systems Control

Current research activities cover the various fields of control of mechanical systems. In particular, we focus on the research on advanced control theory and robotics. The individual research subjects include (i) robust control theory, (ii) system modeling for control, (iii) nonlinear systems control, (iv) development of various mechatronics systems, (v) dynamics based control of robots, (vi) mechanical speech synthesizer, and (vii) rescue robot projects.
(Professor: SUGIE Toshiharu, Associate Professor: OSUKA Koichi, Research Associate: FUJIMOTO Kenji)

Magnetic levitation system.

Human Systems

Mutual cooperation between human and machine is vital for any engineering systems. Our group clarifies scientific as well as engineering approaches to maximizing positive aspects of human and machine, while minimizing negative ones. Current research targets include automobile, high-risk plants, dynamic systems, all involving humans as organic elements.
(Professor: KUMAMOTO Hiromitsu, Associate Professor: NISHIHARA Osamu, Research Associate: HIRAOKA Toshihiro)



To err is human.

Symbiotic Systems

Autonomously moving robot by ecological information exchange with environment.

We investigate key issues and methodologies for the Coordination and Symbiosis among Man, Systems and Environments by referring not only to the traditional system design methodologies yielding rational and efficient coordination but also to the Complex Systems characteristics of man and environments which might be utilized to yield harmonious symbiosis among them based on Ecological and Bio-informatic systems approaches together with Intelligent Information Processing techniques, Media technologies and Artifacts Engineering.

(Professor: KATAI Osamu, Associate Professor: KAWAKAMI Hiroshi, Research Associate: IDA Masaaki)

Human System Interaction

(Operated Jointly with Industry)

Communicating autonomous creatures,Talking Eye.

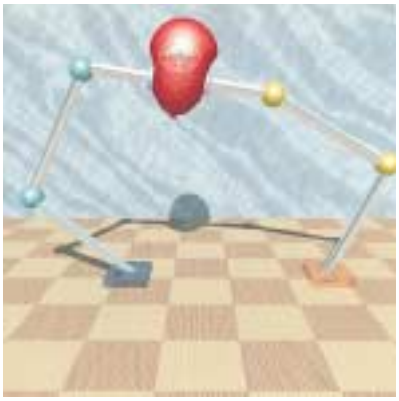
The human being wishes for relationships with others and hopes to find meaning in these relationships. Postulating communications as “forms of relationships with others,” we are aiming to create human-system interactions through which people can find diverse relationships. Currently we are conducting the following research projects; Evolutionary systems for creative communications and Ecological architecture for communication agents: Talking Eye system.

(Professor: SHIMOHARA Katsunori, Associate Professor: OKADA Michio)

Systems Synthesis

For intelligent systems, the acquisition of information about themselves and their surroundings is prerequisite to attain their self-stabilization and to enhance their own functions. The division performs the education and research from the standpoint of applied mathematics for solving a variety of problems in Systems Synthesis: the artificial realization of adaptive and learning abilities in humans and the living things as well, and the modeling and information processing for exploring systems advanced functions.

Adaptive Systems Theory

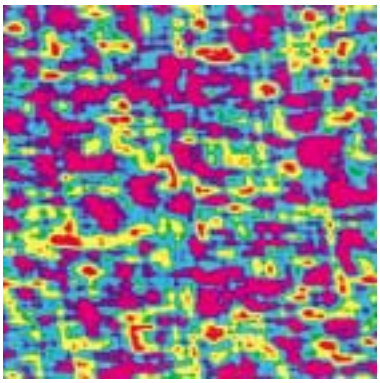


Cooperative two-arm robot.

– Adaptive and Learning Theories for Intelligent Machines and Systems –

The group is concerned with the education and research for pursuing intelligent systems associated with the adaptive and learning aspects. Specifically, we are looking at various problems in the adaptive control theory, iterative learning control, reinforcement learning, anthropomorphic biped walking robot, and theory of decision making.
(Professor: ADACHI Norihiko, Lecturer: OGlNO Katsuya, Research Associates: SOGO Takuya, and FUKAO Takanori)

Mathematical System Theory



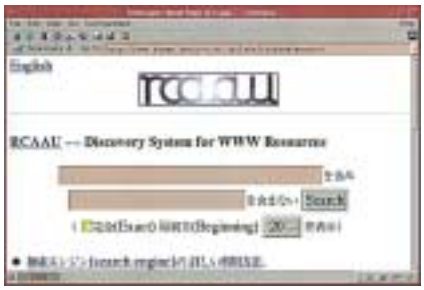
An example of generated random image with two dimensional ARMA spectrum.

Our research and teaching concern analysis and synthesis of mathematical models for probabilistic and statistical problems appearing in many systems, and development of efficient algorithms in practical implementations. Current research projects include time series analysis, various adaptive algorithms in digital signal processing, neural networks and computational learning theory, texture analysis in statistical image processing.
(Professor: SAKAI Hideaki, Lecturer: IKEDA Kazushi, Research Associate: MIYAGI Shigeyuki)

Systems Informatics

The division performs the education and research from the standpoint of systems science and information science for solving a variety of problems in various kinds of practical systems. Current education and research program is concerned with information and communication systems, image processing systems, and systems in biomedical engineering. We have concerns about not only practical systems but also theoretical approaches.

Information Systems



mondou: Web search engine using association rules.

Research interests in the group include mathematical modeling and theoretical analysis of information and communication systems, transportation systems, and manufacturing systems. Current activities are concerned with the following and related topics:

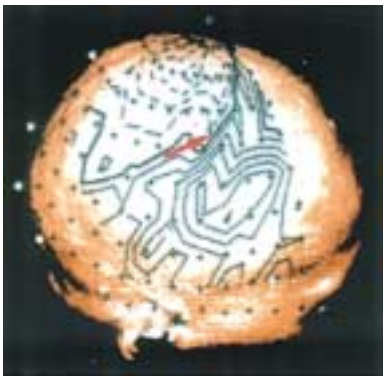
1. Modeling and performance analysis of information and communication systems
2. Queuing (Trafiic) theory and its application to computer communication systems
3. Integration of database mining and statistical analysis for network management

4. Stochastic analysis of discrete event systems.
5. Performance evaluation of multi-media communication networks.
(Professor: TAKAHASHI Yutaka, Associate Professor: KAWANO Hiroyuki)

Three-dimensional reconstruction and display of a beating heart from MRI.

Image Processing Systems

The current research activities cover image processing systems, biomedical engineering, and medical informatics, as follows:
1. Digital image processing for practical systems
2. Biomedical image processing to obtain biomedical information from various medical images
3. Knowledge based systems for image analysis and diagnosis
4. Motion analysis for multi-dimensional image processing.
(Professor: EIHO Shigeru, Associate Professor: SUGIMOTO Naozo, Research Associate: SEKIGUCHI Hiroyuki)



Human brain functional mapping with SQUID superimposed on a MRI brain image.

Biomedical Engineering

The current research activities in the group cover signal processing, imaging and multimedia systems for medical field.
The individual research subjects are:
1. Human brain mapping and imaging with PET/functional MR
2. Measurement and analysis of human organ elasticity with MR/US
3. Three-D visualization of human organ/tissue using VR/AR technology
4. Tele-medicine systems via Internet
5. Evolutionary theory of the media genetics.
(Professor: MlNATO Kotaro, Associate Professor: OSHIRO Osamu)

Applied Informatics

(Data Processing Center)

The current research activities cover large scale systems theory.
1. Operating systems for computer centers
2. Complex computer networks
3. High performance computing and communications
4. Data mining and distributed database system.
(Professor: KANAZAWA Masanori, Associate Professors: YASUOKA Koichi, and SAWADA Atsushi, Research Associate: KAWAHARA Minoru)

Department of Communications and Computer Engineering

Towards the Establishment of Fundamental Technologies
in the Information Age

Advanced information processing and digital communications are key technologies for our society in the 21st century. For information processing, both hardware and software which are high-performance, high-functional and small-size are required. For communications, we should be able to enjoy, anytime and anywhere, the high-speed and reliable transmission of a vast amount of multimedia data. Our department is for the people who wish to study these technologies.

Divisions and Groups

Division	Group
Computer Engineering	Logic Circuits, Algorithms and Complexity Theory
	Computer Architecture
	Computer Software
Communications Systems Engineering	Digital Communications
	Integrated-Media Communications
	Intelligent Communication Networks
Integrated Systems Engineering	Processor Architecture and Systems Synthesis
	Integrated Circuits Design Engineering
	Advanced Signal Processing
Space Radio Engineering	Computer Radio Science
Radio Atmospheric Sciences	Atmospheric Observations

Graduate Curriculum

Subjects for Master's Program

Advanced Study on Communication and Computer Engineering 1,2

Logic Circuits and Algorithms, Advanced
Computer Architecture, Advanced
Programming Languages, Advanced
System Programs, Advanced
Information Networks
LSI Devices
High-Level Design Methodology for System LSIs
Electronic Circuits, Advanced
Space Radio Engineering
Computer Simulation of Electrodynamics
Logic Circuits and Complexity, Advanced
Parallel Computer Systems, Advanced
Formal Language Theory
Digital Communications Engineering
Integrated Circuits Engineering, Advanced
Digital Signal Processing, Advanced
Electromagnetic Wave Theory, Advanced
Remote Sensing Engineering
Atmospheric Environmental Sciences

Subjects for Doctoral Program

Seminar on Computer Engineering, Advanced
Seminar on Integrated Systems Engineering, Advanced
Seminar on Radio Atmospheric Science, Advanced
Seminar on Communication Systems Engineering, Advanced
Seminar on Space Radio Engineering, Advanced

Staff

Professors

IWAMA Kazuo	TOMITA Shinji	YUASA Taiichi
YOSHIDA Susumu	MORIHIRO Yoshiteru	NAKAMURA Yukihiro
ONODERA Hidetoshi	SATO Toru	MATSUMOTO Hiroshi (RASC)
HASHIMOTO Kozo (RASC)	FUKAO Shoichiro (RASC)	TSUDA Toshitaka (RASC)

Associate Professors

OKABE Yasuo	MORI Shin-ichiro	KAWAI Makoto
NORIMATSU Seiji	KOJIMA Hirotsugu (RASC)	USUl Hideyuki (RASC)
OMURA Yoshiharu (RASC)	YAMAMOTO Mamoru (RASC)	NAKAMURA Takuji (RASC)

Lecturers

YASUGI Masahiro	HIROSE Shouichi

Research Associates

MIYAZAKI Shuichi	GOSHIMA Masahiro	KOMIYA Tsuneyasu
MURATA Hidekazu	UMEHARA Daisuke	IZUMI Tomonori
KOBAYASHI Kazutoshi	MATSUO Toshio	KASAHARA Yoshiya
SHlNOHARA Naoki (RASC)	HASHIGUCHI Hiroyuki (RASC)	HORINOUCHI Takeshi (RASC)

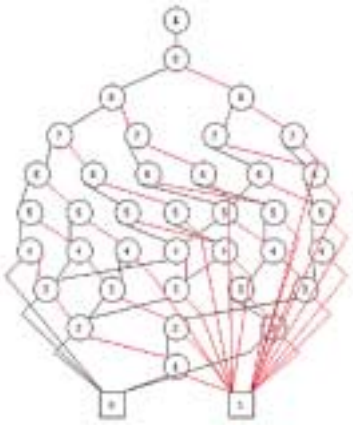
RASC: Radio Atmospheric Science Center

Computer Engineering

Enhancing the performance of computers is an obvious request for the advanced information age. Our goal is to answer this request by means of research and education on advanced technologies of computer systems, including those for computer architectures for parallel information processing, for discrete algorithms, and for fundamental software such as operating systems.

Logic Circuits, Algorithms and Complexity Theory

– Challenge to Hard Computational Problems –

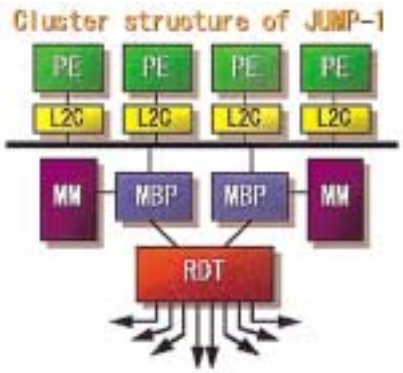


Our main theme is design and analysis of discrete algorithms. An algorithm is a procedure for solving problems automatically on computers. Computing the value of π is a typical example in which computers can fully achieve their performance. On the other hand, scheduling problems, such as time schedules for schools, are known to be computationally hard problems, for which even most advanced computers cannot achieve a good performance. We challenge such hard computational problems to make it possible for computers to make more and more contribution to our society.

(Professor: IWAMA Kazuo, Associate Professor: OKABE Yasuo, Research Associate: MIYAZAKI Shuichi)

Computer Architecture

– To Achieve High Speed Computer Systems –



To achieve high performance computer systems, we have to make an individual research on hardware technology, computer organization, compiler/ OS techniques and application specific features and to combine them all from a view point of system integration. Since parallel processing will be a key technology for high performance computing in the future, we are focusing our research activities on a wide spectrum of parallelism from instruction level parallelism within a single processor to massive parallelism attained by thousands of microprocessors.

(Professor: TOMITA Shinji, Associate Professor: MORI Shin-ichiro, Research Associate: GOSHIMA Masahiro)

Computer Software

– Principles and Practice of Programming –

We do research on computer programming in terms of programming languages and related issues, including algorithms, programming paradigms, language systems, and computer architectures. We pursue new language designs for more functionality and better performance, and we also develop practical language systems for the proposed languages. In addition, we develop languages, processing systems, algorithms, and hardware for parallel computing.

(Professor: YUASA Taiichi, Lecturer: YASUGI Masahiro, Research Associate: KOMIYA Tsuneyasu)

Communications Systems Engineering

This division aims at performing education and research on the state-of-the-art technologies towards the goal of highly advanced multi-media information networks. Topics include fundamental technologies realizing integrated wired, wireless and satellite information networks such as coding/modulation, adaptive digital signal processing, intelligent network protocols, highly flexible and secure information network design, etc.

Digital Communications

– Towards the Realization of Key Technologies for the Multi-media Digital Mobile Radio Communications –

The subjects of education and research include fundamental digital communication techniques which enables high-speed, highly reliable and secure multi-media information transmission over wireless channels which are likely to be noisy and heavily interfered. Examples are coding/modulation, radio access schemes, adaptive digital signal processing, dynamic resource allocation, information security, etc.

(Professor: YOSHIDA Susumu, Lecturer: HIROSE Shouichi, Research Associate: MURATA Hidekazu)

Integrated-Media Communications

– Toward Flexible Communications System for Multimedia Network –

Multimedia means the integration of services(medium), for example, voice, video, text, etc. Various kinds of networks are constructed and used for each individual service, now. For the future multimedia era, it is very important to integrate networks, in order to realize the efficient use of contents and minimize the commnications cost. In addition, mobility, reliabil-

ity and quality are the important functions of the communications networks. For this purpose, researches on the integration of wired and wireless systems, and terrestrial and satellite systems including low earth orbit satellite systems will be carried out. The fundamental research and education fields include network integration, network and circuit control, data transmission, modulation and demodulation, forward error correction technologies, and other related technologies.
(Professor: MORIHIRO Yoshiteru, Associate Professor: KAWAI Makoto, Research Associate: UMEHARA Daisuke)

Intelligent Communication Networks

– Toward the Highly Intelligent Information Networks –

The topics of education and research for information networks of 21st century includes the techniques of optimal design of high-speed broadband backbone information networks and access networks, multi-media network protocols, and their performance analysis.

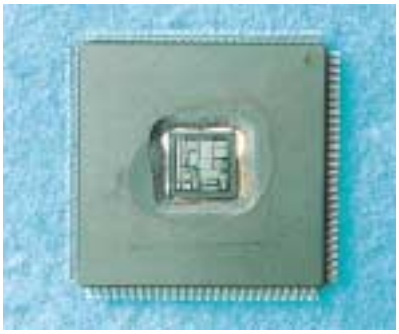
Integrated Systems Engineering

Lectures and researches on fundamental technologies to implement systems for multi-medias, computers, and communications, including architectures, circuit configurations, algorithms for high-speed signal processing /highly parallel processing, and advanced LSI design technologies.

Processor Architecture and Systems Synthesis

– Seeking for Various Processors of Higher Performance –

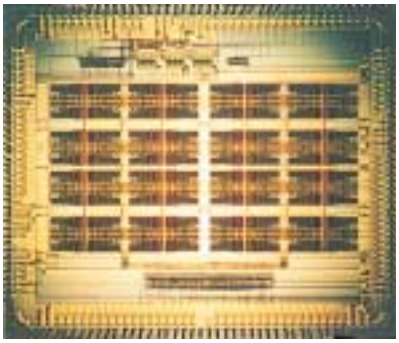
Processor architectures and design methodologies are key factors to meet the requests for more various and higher-performance processors. We proceed practical researches as followings:
1. Highly Parallel Computer Architecture and its Design Methodology.
2. Non-Von Neumann Computer Architecture and its Design System.
3. Design Methods for Key-Processors in Harmonized Environments between Multimedia and Communication.
4. High-Level Synthesis Design for Submicron Process.
5. Hardware/ Software Co-design.
(Professor: NAKAMURA Yukihiro, Research Associate: IZUMI Tomonori)



An MPEG2 decoder LSI synthesized by PARTHENON system.

Integrated Circuits Design Engineering

– Researches on Design Technology for Advanced LSIs –



An image compression LSI with 64 processors.

An integrated circuit is a key device that enables functionality enhancement, performance increase, and cost reduction of an electronic system. Starting from an integration of several devices in 1959, an integrated circuit today can accommodate more than ten million devices. An entire system can be realized on a single silicon chip. With this vast increase of the integration scale, important technical challenges arise such as how to utilize/design such a large scale integrated circuit (LSI) and how to automate/assist its design process, which are the main topics of our research and education. In particular, we are working on LSI architecture suitable for large scale integration, design methodology and CAD for performance and productivity improvement.

(Professor: ONODERA Hidetoshi, Research Associate: KOBAYASHI Kazutoshi)

Advanced Signal Processing

– Extract Essence of the Information in Signals –

Scattering of electromagnetic wave from a body embedded in an inhomogeneous medium.

Method of the signal processing heavily depends on the user's definition of what are the desired and undesired signals. It is thus required to have a systematic understanding of the given signal and the system in order to construct the optimum procedure. We try to develop fast and accurate signal processing algorithms which overcome the current limits by making full use of a priori information. The current topics covered in the group include; Radar signal processing, Optical communication systems, and Plasma wave phenomena in space.

(Professor: SATO Toru, Associate Professor: NORIMATSU Seiji, Research Associates: MATSUO Toshio, and KASAHARA Yoshiya)

Space Radio Engineering

(Radio Atmospheric Science Center)

The Space Radio Engineering focuses on the study and education on the radio science through plasma wave observations in space, and computer experiments and on the radio application through space communication and wireless power transmission.

Space Radio Science and Engineering

– Radio Science and Space Exploitation Using Technologies of Radio Waves and Computers –

The activities of Space Radio Science and Engineering involve studies and education of radio science, radio engineering, and electrical engineering in association with space science and space development. The main research subjects are the development of wireless power transmission system and devices with the target of space power stations, plasma wave observations in space by scientific spacecraft, and studies of nonlinear plasma physics and spacecraft-environment interactions using computer experiments.
(Professor: MATSUMOTO Hiroshi, Associate Professors: KOJIMA Hirotsugu, and USUI Hideyuki, Research Associate: SHINOHARA Naoki)

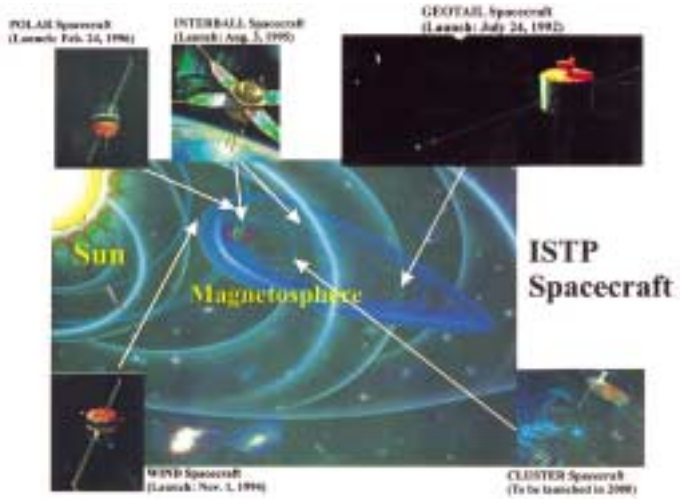
The construction of space power station is the final target of the study on wireless power transmission in laboratory and space station.

Computer Radio Science

– Space Research with Computers and Radio Waves –

The activities of Computer Radio Science involve studies and education of radio science, electronics, and information/communication engineering in association with space science. The scientific focuses are on the observation of plasma waves with scientific satellites and the associated data analysis, the development of plasma wave instruments for the planetary space by applying signal-processing technologies, the development of efficient information network used in the space communication, computer simulations of non-linear plasma dynamics with super parallel computers, and the application of communication technologies to wireless power transmission.
(Professor: HASHIMOTO Kozo, Associate Professor: OMURA Yoshiharu)

Computar simulation of wave-particle interaction in space plasmas.



ISTP fleet: International Solar Terrestrial Program(ISTP) is being conducted under the collaboration of Japan,US,Europe and Russia. The ISTP objective is the comprehensive understanding of plasma phenomena in solar-terrestrial space using multi-spacecraft.

Radio Atmospheric Sciences

(Radio Atmospheric Science Center)

The division of Radio Atmospheric Sciences covers study and education in radio science, radio engineering, electronics and information communication engineering related to geophysical environmental information and atmospheric physics. Subjects of our studies are the development of different kinds of radar systems with sophisticated electronics and computer technology, radar signal processing, and radar observations of atmospheric waves. Also included are remote sensing techniques, which are in the fields of radio applied engineering and the information processing.

Remote Sensing Engineering

– Explore the Earth's Atmosphere by Using Radars –

The atmosphere surrounding the earth produces disasters such as typhoons and severe storms. We explore the atmosphere using radar techniques which provide vital information with high time and altitude resolutions. Our research field covers studies of radar techniques for atmospheric observations, processing of radar signals, and the engineering development of atmospheric radars at many different wavelengths, including VHF, UHF, microwave and shorter. Examples of atmospheric radars based on our studies are the MU radar, boundary layer radars operating in the L- and S-bands, and millimeter-wave (35GHz) Doppler radar. By using these radars we study atmospheric physics over the full altitude extent of the atmosphere, from the ground up to the ionosphere.

(Professor: FUKAO Shoichiro, Associate Professor: YAMAMOTO Mamoru, Research Associate: HASHIGUCHI Hiroyuki)

Atmospheric Observations

– Development of New Observational Techniques to Obtain Atmospheric Environmental Information –

The earth's atmosphere, which protects the biosphere, is divided into three regions: the troposphere (below 10 km altitude), where meteorological phenomena occur, the middle-atmosphere (between 10 and 100 km), the region most sensitive to global environmental change, and the upper atmosphere (above 100 km) which extends into interplanetary space. Each atmospheric region also is a medium for the propagation and interaction of radio waves, light and acoustic waves. We study the physics of these interactions and carry out electronic engineering work to develop and improve observational techniques. Collection and processing of the observational data are included in this subdivision as well as distribution of global atmospheric environmental information to the scientific community.

(Professor: TSUDA Toshitaka, Associate Professor: NAKAMURA Takuji, Research Associate: HORINOUCHI Takeshi)

Academic Programs

The Graduate School of Informatics provides graduate programs of study leading to the Master's and Doctoral degrees. Taking the varied aspects of Informatics into consideration, the interdepartmental education is encouraged to the students by setting several compulsory credits other than the students' own department.

Requirements for the Master's Program

To receive the Master's Degree, every student is required to take at least 30 credits, to submit a thesis in the fields of specialization, and to pass an examination on the thesis. To cultivate a wide scope, the student is asked to take subjects offered not only by his or her major department but also by other departments.

Requirements for the Doctoral Program

A Doctoral degree requires original research of high grade in an individual field. To receive the Doctoral Degree, he or she is required to take at least 6 credits of subjects offered in this school and to pass an examination on the thesis submitted.

The Number of Students to be Admitted

Department	Master's Program	Doctoral Program
Department of Intelligence Science and Technology	28	13
Department of Social Informatics	27	13
Department of Applied Analysis and Complex Dynamical Systems	24	10
Department of Applied Mathematics and Physics	21	9
Department of Systems Science	30	13
Department of Communications and Computer Engineering	35	16
total	165	74

Either a foreigner or a person involved in social activities may be admitted as a graduate student. The students of the doctoral courses may enroll to this Graduate School as part time student without resigning their occupation.

Entrance Examination

The Academic Year starts in April. In general the Master's degree requires two academic years of study and the Doctor's degree three years. Admission to graduate program is granted to those who have passed the entrance examination of the Graduate School of Informatics by the respective departments. The examination is taken place in August, and there may be another examination in February to fill up a vacancy.

For further information, contact

Graduate School of Informatics
Kyoto University
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Tel. +81 75-753-5429
Fax. +81 75-753-4796
http://www.i.kyoto-u.ac. jp