Ritsumeikan University

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RITSUMEIKAN

2017
Powering the Future

Graduate School of Science and Engineering
College of Science and Engineering

Message from the Dean

Kenichi KASAHARA, Ph.D

Dean,
Graduate School of Science and Engineering,
College of Science and Engineering
Ritsumeikan University

Information travels around the world in an instant, and economic activities that go beyond borders are becoming increasingly active. Our lifestyles are supported by many technologies, and quality of life continues to improve even to this day. However, becoming a society with a high standard of living has brought upon us problems related to the environment and energy, such as global warming. We now must think about technology in terms of a sustainable global society. For this reason, the abilities of high-level science and engineering experts are highly sought after.

Our Graduate School of Science & Engineering aims to foster personnel equipped with in-depth knowledge and skills that will act as leaders and work to resolve these issues, who will push forward with courage toward the creation of a new set of values, and make a difference on a global scale.

We offer programs in four majors: Advanced Mathematics and Physics; Advanced Electrical, Electronic and Computer Systems; Advanced Mechanical Engineering and Robotics; and Advanced Architectural, Environmental and Civil Engineering. Our graduate school is staffed with a team of professors that are capable of fulfilling our educational philosophy, and is characterized by its strong partnerships with the industrial sector and overseas universities in research collaboration. Our students present their research results not only here in Japan, but also at overseas academic conferences. After graduating, they find employment in companies and organizations in science and engineering industries that provide the backbone of global society, and play a central role in the front lines of innovation.

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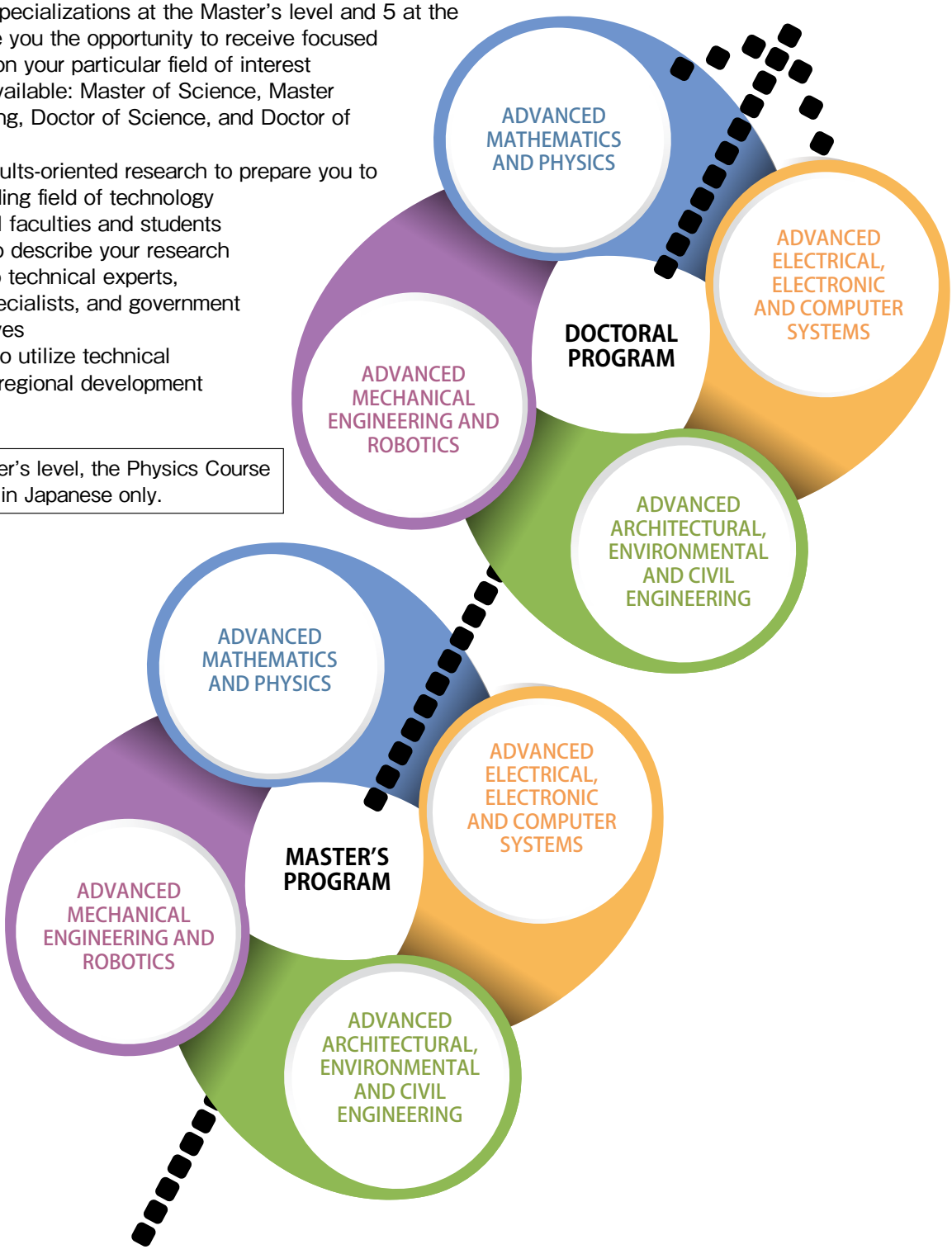
- Experience to utilize technical expertise to regional development perspective

※ At the Master's level, the Physics Course is available in Japanese only.



List of faculty members capable of supervising in English

Department of Mathematical Sciences

Research/Development Areas

Stochastic process and its application, financial mathematics and its application

Professor / AKAHORI, Jiro

My interest lies in probability theory, financial mathematics and the various fields that are related to them. This involves various subjects that include abstract mathematics as well as its applications; stochastic differential equation on topological groups, quadratic Wiener functionals and infinite dimensional Lie algebras, the pricing of financial derivatives, sustainable economic growth problems, and so on. These research projects also involve a number of postgraduate students. International exchanges take active place with guests frequently visiting my laboratory from all over the world, from whom we can all learn a lot. The number of foreign students at our laboratory is also increasing while some of our students occasionally get sent to foreign universities. We also frequently have the opportunity to travel overseas to attend academic society meetings. Graduates from our laboratory often enter professions in the banking industry.

Commemorative laboratory photo

Research/Development Areas

Structure analysis of von Neumann algebras

Associate Professor / AOI, Hisashi

As we live in a three-dimensional world the idea of “four-dimensions” can be quite challenging but it is considered quite routine in mathematics, with well developed arguments for it in place. However, contrarily enough five-dimension or six-dimension worlds appear to have been taken for granted.
My interest is in the “infinite dimensional” world that could be considered to exist at the beyond of “finite-dimensional” worlds where phenomena considered impossible in a finite-dimensional world could occur. The subject of “operator algebras” can be considered something that “acts” on this marvelous world. The study of this is classified as “analysis”; however, it is also closely related to algebra and geometry. In the real world quantum mechanics and knot theory etc are also related to it.
This field is comparatively new in mathematics and has a lot of unknown problems, thus making it a challenging research subject.

Research/Development Areas

Semi-classical Analysis of Schrödinger Equations

Professor / FUJIIE, Setsuro

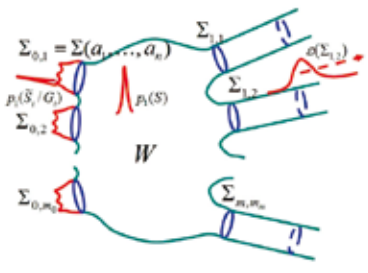
Semi-classical analysis is an asymptotic analysis where the Planck constant appearing in the Schrödinger equation is regarded as a small parameter. Under certain conditions, quantum mechanics is expected to approach classical mechanics in the semi-classical limit (Bohr’s correspondence principle). The asymptotic distribution of eigenvalues or resonances created by a bound or semi-bound state, respectively, is closely related to the existence and the geometry of “trapped” trajectories of the corresponding classical dynamics.
This problem is an extension of the famous question “Can one hear the shape of the drum?” (M. Kac), which examines the relationship between the geometry of a bounded domain and the asymptotic distribution of eigenvalues of its Dirichlet Laplacian.
The useful WKB method consists of constructing an asymptotic power series solution globally with respect to the Planck constant. This power series diverges and the asymptotic form changes discontinuously when passing through turning points or caustics. This so-called Stokes phenomenon is a key to solve the above problem.

Research/Development Areas

Application of gauge theory to V-manifolds and its three-dimensional manifold in the same boundary

Professor / FUKUMOTO, Yoshihiro

Homologically the same boundary groups configured with whole three-dimensional homological spheres are an important subject of research related to the unsolved expectation of triangles being divisible by high-dimensional manifolds, however, very little is known about the structure except the fact that it is a finitely generated Abelian group. My research involves homologically the same boundary invariants in seeking structures that particularly include the integer lifting of classic Rochlin invariants by applying gauge theory to V-manifolds. Gauge theory can be used to extract topology information from nonlinear partial differential equations describing the field (particle) on the manifold. I focus on the contribution made by the singular point of a V-manifold and configure the integer lift of an Ochanine invariant based on elliptic genus and unbound algebra related to the same boundary of the three-dimensional manifold and the functor in a certain type of zone with a commutative ring in order to consider the relationship between basic group, homological algebra and gauge theory more.



Application of gauge theory to topology

Research/Development Areas

Number theory, network algorithms, and cryptosystems

Professor / ISHII, Hidenori

Research within the number theory field undertaken at our laboratory involves the overall aim of researching automorphic L functions. Automorphic L functions are part of the Riemann zeta function family and are considered to be one of the most important of currently known L functions. Knowledge exists on various zeta functions and L functions throughout the world; however, it is no exaggeration to say that discovering a new L function or the relationship between L functions is the ultimate goal of number theory. Number theory plays an important role in cryptographic and authentication technology, both essential tools in our modern day advanced information network society. We are also involved in basic mathematical research on high-speed algorithms that related to networks.

Research/Development Areas

Amusing number theory

Professor / KAGAWA, Takaaki

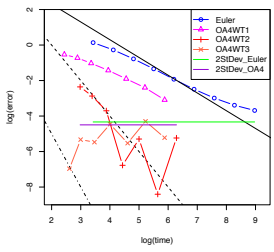
I specialize in number theory, and recently in particular classifying elliptic curves found in real quadratic fields. The cue to why I began to be interested in number theory was a book entitled “Fermat’s last theorem” that was written by my instructor Norio Adachi while I was at university (Waseda), and why I began to be interested in elliptic curves is that elliptic curve theory was used to solve Fermat’s last theorem. One of the great charms of number theory is its concreteness. Quadratic fields and elliptic curves are concrete and can be easily put into practice; however, they still involve lot of unsolved problems. My aim is to quickly solve those problems, and hence I hope students can be helpful.

Research/Development Areas

Stochastic Analysis, Monte Carlo Methods, Stochastic Differential Equations

Professor / KOHATSU-HIGA, Arturo

My research interests are centered on various applied and theoretical aspects of simulation for stochastic systems which evolve with time.
In particular, stochastic equations of different types. These equations may have various applications in finance, engineering and physics. One of the challenges consists in studying their theoretical properties and obtaining eficient simulation methods.
Therefore students working with me may do theoretical studies related with these problems or either simulation studies which have a strong mathematically oriented theoretical basis. We sometimes also try to test newly proposed simulation methods and find some theoretical basis to explain their behavior. The goal is to obtain fast and accurate methods that can be used in various practical problems and therefore there is a strive to achieve some generality over particularity.
Usually, students working on simulations will be proficient in C programming or other similar languages such as scilab or octave. On the theoretical side, we request basic knowledge and interest in either probability theory, stochastic process or Monte Carlo methods.
Our students, usually interact with the group of mathematical finance where they can also experience the direct feeling of applications to real problems. Therefore our group is very active, we encourage discussions between students, visitors and professors. We have frequent seminars, many times given by visitors from various countries and backgrounds therefore achieving a high scientific interaction which promotes learning and the spread of information.
We also encourage communication in foreign languages due to the multi-culturality of our group.



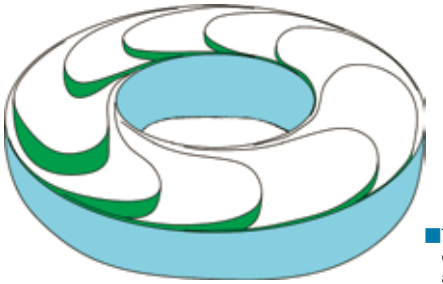
This graph shows the performance of various approximations schemes. The so-called Euler scheme is the traditional method. The other methods are the ones proposed by our team. The higher the slope the more accurate the method is.

Research/Development Areas

Differential topology, Foliation theory

Associate Professor / NOZAWA, Hiraku

A river can be regarded as a bundle of flow lines. Foliations are abstract generalization of such geometric structures. Namely, a foliation on a space is a decomposition of the space into spaces of smaller dimension. I am interested in the geometry and topology of foliations. They have been studied in these 50 years originally motivated by the research on partial differential equations and dynamics on 2-dimensional spaces. The relation of foliation theory to 3-manifolds, group actions and differential geometry is also actively studied. I am investigating global geometric properties of foliations from the viewpoint of cohomology and characteristic classes. The goal of my recent research is to understand mysterious phenomena on foliations called “rigidity”, which means that certain special foliations with large symmetry have distinguished dynamical properties.



The picture of a section of the Reeb foliation on a donut-like space.

Research/Development Areas

Operator Algebras and Operator Theory

Professor / OSAKA, Hiroyuki

Functional analysis which is the abstraction of mathematical models for use in revealing their essence is the main subject of this laboratory; however, recently, various graduate level research that includes mathematical physics, braid theory, topology, partial differential equations and probability theory are also taking place. We are also working on graduate level research linked to educational material for use in for junior high and high school education.

Operator algebras theory, which is known as “infinite-dimensional linear algebra”, is the research subject. Banach space theory was developed using the concept, and thought was given to functional spaces that can be configured with a vector space of functions rather than a function representing individual phenomenon, However, we are working on the classification problem of C*- algebras generated by inserting an algebraic structure within them.

Recently we have also been working on a problem connected to a monotonically increasing function that is applicable in economic theory and achieving a new result for Jensen’s inequality, which is a generalization of the arithmetic and geometric means that are presumably so familiar to high school students.

$$\varphi\left(\frac{\sum a_i x_i}{\sum a_i}\right) \leq \frac{\sum a_i \varphi(x_i)}{\sum a_i} \quad i = 1, 2, a_i = 1, x_i > 0, \varphi(x) = -\log(x)$$

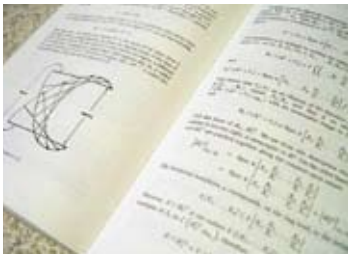
Both the arithmetic and geometric means can be derived using the above expression. Have a go at calculating them!!

Research/Development Areas

Algebraic geometry

Professor / TAKAYAMA, Yukihide

Dr Takayama’s main research interest is algebraic geometry in positive characteristic, which covers many interesting phenomena that are quite different from the phenomena covered by algebraic geometry in characteristic zero such as complex algebraic geometry and complex differential geometry. For example, Kodaira vanishing theorem and Bertini’s theorem of hypersurface intersection play important roles in complex algebraic geometry. However, these theorems do not generally hold in positive characteristic. In addition, we do not yet know how Hironaka’s theorem of resolution of singularities, which is also a fundamental result in complex algebraic geometry, holds in positive characteristic. This means that geometry in positive characteristic is much more complex or in a way richer than complex algebraic geometry and presents many interesting research problems. Dr. Takayama’s approach to this field involves the use of commutative ring theory and methods generally employed in algebraic geometry in characteristic zero.



Text used in seminars. Research on higher dimensional geometry that fully utilizes advanced algebra.

Research/Development Areas

Linear differential equations in complex domains/singular perturbation, spectrum, Stokes phenomenon

Associate Professor / WATANABE, Takuya

The subject of our research is to study the spectra (eigenvalues, quantum resonances etc) which relate the quantum mechanics and the classical mechanics.

Differential equations which describe typical phenomena have beautiful structures in a mathematical sense.

Hence the basic methods in analysis (complex analysis, functional analysis and Fourier analysis) play important roles for problems in Mathematical Physics.

The students of our laboratory learn deeply such basic techniques selected according to their interests.

Recently we investigate differential equations including a small parameter (singular perturbation).

Its keyword is “Stokes phenomenon”.

In order to understand it, we have to treat the differential equations in complex domains.

Therefore we can find here mathematical interests for studying natural phenomena.

A supernumerary bow can sometimes be seen inside rainbows.
This is explained by “Stokes phenomenon” of an Airy’s differential equation.

Research/Development Areas

Probability theory and numerical analysis

Associate Professor / YASUTOMI, Kenji

The study of modern probability theory.

If the “result” that can be obtained is limited (two sides of a coin toss or the throw of a dice etc) the probability of each “result” primarily considered, however, the obtainable “result” will be non-countable and unlimited, in that the probability of each “result” in the limited case results in a contrariety, even if a value could be set for the probability.

Modern probability theory resolves this dilemma by abstracting the concept and measuring the size, thus enabling probability that is non-countable and has unlimited “results” to be considered. However, that abstraction does result in a new dilemma: the existence of an assembly for which the size cannot be measured.

As revealed above probability theory is an interesting research subject. It is also an interesting mathematical field that has the aspect of being actually applicable in various parts in society by being linked to statistical methods.

Mathematics can be pondered anywhere there is a blackboard and chalk or paper and pencil.

Department of Physical Sciences

Research/Development Areas

Structure formation and dynamics of soft matter

Professor / FUKAO, Koji

Soft matter involves systems with original structures and dynamics of the medium scale between macro scale and micro scale that have hierarchical structures in the rich time space of micro to macro. For example, macromolecules, colloids, liquid crystal, emulsions, and powders etc are all soft matter. Research on each of the type matters has been conducted for some time now, however, in recent years attempts are being made to collectively describe them as soft matter in understanding their physical phenomenon. We are promoting research with an interest in glass transformations, structural formations resulting from crystallization, glass dynamics, dewetting phenomenon, and the dynamics of ionic liquids etc of the macromolecules involved in the phenomenon.

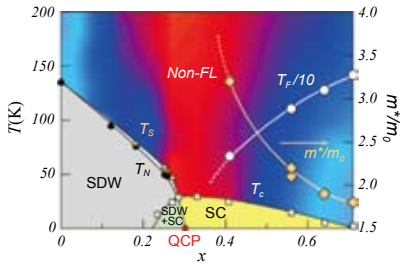
Impedance analyzer used in a dielectric relaxation spectroscopy method that enables dynamics measurements in wide time areas.

Research/Development Areas

Search for high-temperature superconductors and novel quantum phases

Professor / IKEDA, Hiroaki

In the technological development, designing innovative materials is crucially important. However, it remains difficult to design desirable materials from purely theoretical prediction. This is because complex physical systems may exhibit behavior that cannot be understood only in terms of the laws governing their microscopic constituents, as indicated by P.W. Anderson. For example, superconductivity is a phenomenon that shows quantum-mechanical effects on a macroscopic scale. Here we need its own fundamental principles, largely different from the laws governing individual electrons. In our group, we work on clarifying curious physical properties in some topical magnetic/superconducting materials based on the electronic structures, and constructing new theoretical concepts. In addition, we aim to make predictions of novel properties and new quantum phases, and design new high-temperature superconductors from the long-term perspective.



Phase diagram in the iron-based superconductor $BaFe_2(As_{1-x}P_x)_2$, discovered in 2008 (K.Hashimoto et al. Science 336, 1554 (2012)). Superconducting phase(SC) appears in close proximity to the spin-density wave phase (SDW). QCP indicates a quantum critical point.

Research/Development Areas

Electron spectroscopy and elucidation of materials physics related to electron spin

Professor / IMADA, Shin

Characteristics of a material are mostly decided by the characteristics of electrons in that material. For example, glass is transparent because electrons in glass do not absorb light. Electrons revolve around the nucleus as they rotate themselves. This rotation is called “spin”. The reason why iron becomes a magnet is that electrons in iron tend to have spin with the same direction. Electron spin causes many other interesting phenomena. For example, some metal becomes an insulator when its temperature is changed. The goal of our research is to elucidate the mechanisms of such phenomena related to electron spin.

In order to unveil the electronic states in materials, we perform experiments both at the campus and facilities such as SPring-8. Main experiment is “photoemission,” which measures the energy of electrons emitted from a material under application of ultraviolet light or x-ray.

High-resolution photoemission apparatus, which precisely measures electrons escaping from a sample.

Research/Development Areas

Earthquake source physics and seismic wave propagation

Professor / KAWAKATA, Hironori

Earthquakes are awful phenomena that may cause terrible damage to our infrastructures. On the other hand, however, plain fields and basins have been formed owing to faulting associated with earthquakes. Also, active faults provide us ground water. Beautiful nature in Japan has been partly made by activities of the earth such as earthquakes. Since we are living in Japan, where a lot of large earthquakes occur, we must survive earthquakes in exchange for great natural benefits. Then, it is essential to understand earthquakes and active faults.

When, where, how large and how do earthquakes occur? Are the earthquake sizes determined in advance? How do rocks in the earth behave when seismic waves pass through? In our laboratory, we are approaching to such fundamental problems on earthquake physics and seismic wave propagation by means of laboratory experiments, field observations and seismic waveform analyses.

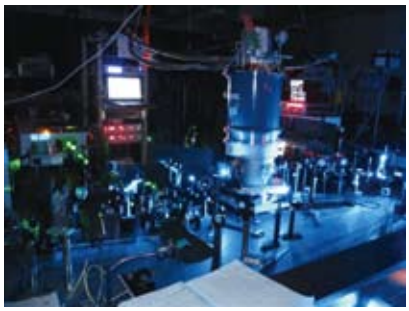
Granite sample on the way to fault formation. White part is a fault trace that will be a final rupture plane.

Research/Development Areas

High-precision laser spectroscopy on the elementary excitations in dielectrics/ ferroelectrics

Professor / KOREEDA, Akitoshi

In dielectrics, most of the energy is transferred by the motion of the atoms, or by the “phonons”, the quanta of the sound wave in matters. The phonons play important roles in ferroelectricity and in the thermal dynamics in dielectrics. In particular, some ferroelectric crystals allow the heat to become a “wave”, rather than to allow it only to diffuse as we experience usually. We use ultrafast laser sources to excite a “coherent wave of heat” in certain ferroelectric crystals. We also use an ultra-high (kHz) resolution stimulated Brillouin spectrometer to unveil the phonon linewidth in crystals and glass-forming materials at cryogenic temperatures. The high-resolution spontaneous Brillouin light scattering method is used, for example, to investigate the “fractal dynamics” in ferroelectric single crystals.



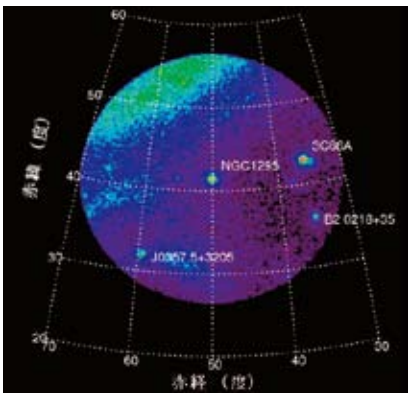
The optical system that excites the coherent wave of heat, and an optical cryostat for 0.3K spectroscopy.

Research/Development Areas

Particle acceleration in the Universe, Origin of cosmic rays

Professor / MORI, Masaki

We are exploring the high-energy Universe, which cannot be seen in optical light, with gamma-rays. Gamma-rays are emitted from high-energy objects in the Universe, such as supernova remnants, pulsars and pulsar nebulae, and active galactic nuclei. Electrons and protons are accelerated to high energies in these objects and produce gamma-rays via interaction with surrounding radiation and matter. Gamma-rays are the best probe of particle acceleration in the Universe since they travel straight and are not deflected by magnetic fields. In addition, the annihilation of dark matter particles could be detected by gamma-rays. Also we are operating a 60cm optical telescope in the BKC campus to explore time-varying astrophysical objects.



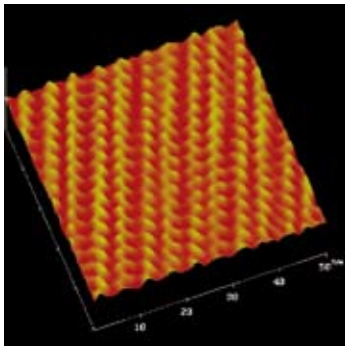
Gamma-ray intensity map around the Perseus cluster of galaxies observed by the Fermi Gamma-ray Space Telescope

Research/Development Areas

Phase transitions and interface phenomenon in the mesoscopic region

Professor / NAKADA, Toshitaka

Science in recent years has been clarifying a lot of enigmas, from the micro world that includes subnuclear particles to the macro world that includes cosmic space. However, in the medium that links micro to macro, or nanometer world (a few to several hundred arranged atoms or molecules) there is a lot of interesting phenomenon whose mechanisms have yet to have been clarified. At our laboratory we focus on how atoms and molecules gather together, break up or react in various materials, regardless of being organic and inorganic, or more concretely the phase transformation process and interface phenomenon. For example, we target metallic quantum dots created on semiconductors, ultra-thin films created using a single organic molecule layer, and the crystals of proteins etc. We research changes in atomic/ molecular alignment using the latest microscopes and analyzers by creating the materials ourselves.



Microscopic photograph of protein crystal. Molecules have a regular arrangement.

Research/Development Areas

Hypocenter-proximate monitoring to mitigate seismic risk

Professor / OGASAWARA, Hiroshi

During 2009-2015 I chaired a project “observational studies in South African mines to mitigate seismic risk” in a JST-JICA program for or Science And Technology REsearch Partnership for Sustainable Development (SATREPS). Having been appointed as a dedicated research professor, I spent lots of time in South Africa to monitor earthquakes (2>M) at the closest proximity at depths from 1km to 3.4km from the surface. These can be attempted only at South African gold mines in the world. We have worked with about 20 researchers from 5 universities and two research organizations in Japan, and more than 100 people in South Africa (researchers, mining houses and geotechnical consultant companies). Unprecedented arrays with a large number of sensors have been deployed, being ready to closely monitoring generation of target earthquake activities. We couldn’t foresee the 2011 M9.0 earthquake (Tohoku earthquake). We try our best to demonstrate how seismology can contribute to mitigate seismic risk in South Africa.

A shaft tower of the Mponeng mine of largest gold production in South Africa.

Research/Development Areas

Numerical Studies for Understanding Chaotic Motion of Atoms in a Nanoparticle

Professor / SHIMIZU, Yasushi

Every physical system is constantly changing its state both at a microscopic and a macroscopic level.
In the time evolution of the system, one can find wide varieties of dynamics. In particular, nonlinear dynamics often bring a highly complicated behavior to the system.
The main interest of our research group is to understand the complicated motion of atoms and molecules from the viewpoint of nonlinear dynamics with the help of numerical simulation. I have been investigating the dynamics of nano particles whose motion is dominated by a large fluctuation.
For instance, small Au particles are known to change their shape continuously even below melting point.
Such an isomerization process is a typical case where the nonlinearity in dynamics plays a primary role for the transition.
One of our goals is to give a firm theoretical basis to the understanding of chaotic motion, which can be experimentally observed for various nano-sized systems.

A visualization of a molecular dynamics simulation is often helpful for extracting characteristics in complicated behaviors in atoms and molecules

Research/Development Areas

Superstring theory and unification theory of elementary particles

Professor / SUGAWARA, Yuji

Elementary particle theory could be a field of science aiming at a unified description of elementary particles, which are the source of all matter and interactions, also searching for an answer to a fundamental question: 'how did our universe begin?'.
Establishing the unification theory for elementary particles is the long-held dream of theoretical physicists, however, the journey until completion remains long. Superstring theory has been expected to be the most hopeful candidate of unification theory including the quantum gravity, which is still incomplete. Therefore, Superstring theory has been actively researched as a cutting-edge area in theoretical physics all around the world.
At this laboratory, we are researching elementary particle physics, mainly focusing on Superstring theory, as well as deeply related topics in cosmology and the physics of black holes.

Laboratory seminar scene

Research/Development Areas

Synchrotron-radiation excitation physics

Associate Professor / TAKIZAWA, Masaru

We are exploring functional materials through atomic-orbital-controlled excitation by synchrotron radiation (SR) in the SR Center.
SR is very powerful light ranging from infrared light to ultraviolet light to x-ray. At the SR center in this campus, we easily access this useful light. Selecting an appropriate light through a beam line from SR, an element-specific excitation is realized, such as C, N, O in organic materials, Si in semiconductors, Mn, Fe, Co, Ni in magnetic devices, and so on. So, we can obtain the information of the element we want to know in the functional materials.
In addition, a polarization of SR light leads to an atomic-orbital-specific excitation. This enables us to know the orientation of the functional atomic-orbital.

Synchrotron radiation source (red building) and beam lines in the SR Center

Research/Development Areas

Biological and Nonequilibrium Physics

Professor / WADA, Hirofumi

Our group focues on understanding mechanisms underlying different forms and motions found in the natural world (including our daily life), with much emphasis on microbiology, plants, and other biological systems. Our research is mainly theoretical, and different physical approaches such as nonequilibrium physics, continuum mechanics of fluids and solids, softmatter physics, and pattern fomation dynamics, are all employed to understand biological systems and other macroscopic natural phenomena. Our research style finds a particular importance on a close link with experimental results, so we often work together with physical and biological experimetalists in other groups.

A unique structure in a twisted string or rubber band, called "plectoneme", encompasses the mechanics ranging from a telephone cable to morphologies of microorganisms to supercoiled DNAs in living cells.

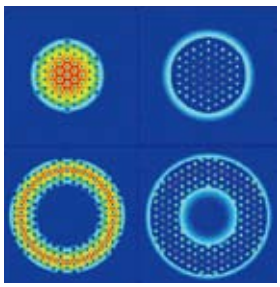
Research/Development Areas

Quantum field theory from micro to macro

Professor / YABU, Hiroyuki

Anywhere a physical quantity corresponds to a point of space such as an electric field or magnetic field is referred to as a field, and the motion described using quantum field theory. The theory is a basic way of understanding nature, from the micro world that includes nuclei, subnuclear particles and atomic molecules through to the macro world that includes the mechanism of the universe. Field theory is a basic method used in thinking about the symmetry of the natural world, and can reveal the beauty behind it.

It can also suddenly appear in the macro world through phenomenon such as superfluidity and superconductivity. At this laboratory the problem of symmetry in the world of subnuclear particles and nuclei and a new quantum state of matter such as the Bose condensation state of atomic gases are theoretically worked on using field theory and with basic research on application in new technology such as gamma lasers.



The vortex lattice (theoretical calculation) created by a number of quantum vortexes in a Bose-Fermi mixed condensate. The left one is the vortex of the Bose particle condensate and right one the Fermi particle trapped by the core of the vortex. In the below figure a huge vortex (Giant Vortex) has formed in the center.

Department of Electrical and Electronic Engineering

Research/Development Areas

Wireless Communications and Signal Processing for Wireless Systems.

Professor / ABREU, Giuseppe

Information is the commodity of the 21st century. With an average person consuming over 35 Gbytes of data per day, communications systems need to cope with the contrasting requirements of lower costs, higher speeds, lower power consumption, raising numbers of users, and increasing availability. Under such conditions, wireless communication is a key technology for the development of economies and societies the world over. My research in Wireless Communications and Signal Processing for Wireless Systems spans from theory to application, focusing on the improvement of data-rates, energy efficiency, user capacity, reliability, security and flexibility of wireless systems, both for large and small networks. Topics of interest include: Physical Layer Security, Interference Alignment, Small Cell Networks, Massive MIMO Systems, Cognitive Radio, Random Wireless Networks, Energy Harvesting Networks, Communication Theory, Information Theory, Compressed Sensing, Estimation Theory, High-precision Ranging Systems, Wireless Localization, Adaptive Antenna Arrays, Random Matrix Theory for Signal Processing and more.

■Energy-efficient wireless communication nodes with high-precision localization capabilities for Internet of Things applications, developed in partnership with ZigPos GmbH (Dresden, Germany).

Research/Development Areas

Cutting-edge semiconductor electronics for the 21st century

Professor / ARAKI, Tsutomu

The appearance of a new semiconductor known as gallium nitride resulted in blue light emitting diodes, white light emitting diodes and the Blu-ray Disc, completely changing our lives. If we can now extract the full potential of this semiconductor we will be able to create new optical/electronic devices that will solve important problems in the 21st century, which encompass energy, the environment, health and medical care etc. For example we can expect long-life light sources with less power consumption, solar cells of extremely high conversion efficiency, highly-efficient inverters that will support battery car technology, small and high power UV light sources for sterilization etc. Our laboratory is promoting global cutting-edge research from the fabrication of semiconductor materials through to evaluating their properties of and creating devices while obtaining support from the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry in order to realize semiconductor electronics that suit the 21st century.

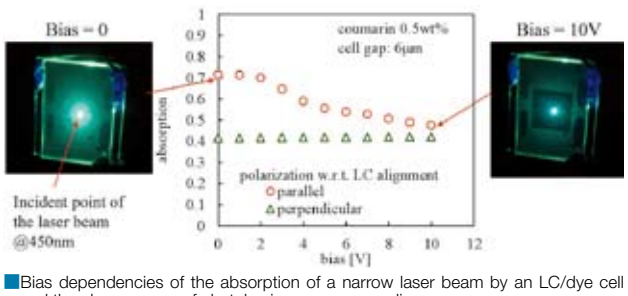
■Molecular beam epitaxy equipment for fabricating semiconductor materials being controlled at the atomic level.

Research/Development Areas

Electronic and photonic materials and devices

Professor / FUJIEDA, Ichiro

There is no need to reiterate the importance of electronic systems that handle images. Displays and image sensors are essential parts for human interfaces, contributing to the evolution of our social life of information. These devices are based on electronic and photonic materials, which also provide solid foundations for energy harvesting, optical communication, and other important systems. This laboratory focuses on such electronic and photonic materials, devices and systems. Our recent interests include liquid crystal (LC)/dye guest-host technology and its possible applications for displays and concentrator photovoltaics. For example, radiation pattern of such a device is altered by an external bias and so is its absorption as shown below. Understanding these phenomena is critical for designing efficient systems. For the latest news on our research activities, please visit us at: http://www.ritsumei.ac.jp/se/re/fujiedalab/index.html



■Bias dependencies of the absorption of a narrow laser beam by an LC/dye cell and the phenomenon of photoluminescence spreading.

Research/Development Areas

Intelligent vehicle systems and field robotics

Professor / FUKAO, Takanori

Autonomous or automated vehicle systems are aggressively researched in the world. As an example, autonomous driving of automobiles is not a dream. These systems are considered to make innovations and change the world. Our laboratory researches the key technologies on artificial intelligence, computer vision, control, and system integration for advanced vehicles because these technologies must be integrated closely and robustly to realize the systems. As applications, we have developed or are developing automated driving systems of automobiles including platooning and automatic parking, agricultural robots in farm field or orchard, unmanned aerial vehicles like outdoor or indoor blimps and VTOLs with multi rotors. In relation to these technologies, our laboratory also researches human support systems in walking, cycling, and driving a car to support humans naturally and safely.

■Our developed intelligent vehicles

Research/Development Areas

Machine intelligence for a safe and secure society

Associate Professor / FUKUMIZU, Yohei

Information processing systems with advanced intelligence technologies such as machine learning, as well as signal processing systems based on multimedia technologies, will contribute to a safe and secure society. In this laboratory, we conduct research on informatics technology that largely utilizes the power of software while still being based on hardware processing. Our research projects include a video processing system for a street- or storefront-mounted surveillance camera that provides a cognitive ability comparable to a human, making it possible to identify suspicious behavior; a non-invasive medical diagnosis system to process the inner body sound signals acquired with high-sensitivity microphones to detect signs of lifestyle diseases such as arteriosclerosis and heart disease in everyday life; and an image quality improvement system that uses computers to sharpen camera images degraded by darkness, backlight, mist, dust, and so on.

An experimental result of the intelligent camera finding the suspicious individual.

Research/Development Areas

Organic solar cell and molecular modeling

Professor / HARAFUJI, Kenji

Thin organic film solar cells that can utilize solar light, an extremely valuable energy source for the Earth, are expected to be a low-cost original source of electrical energy which takes the environment into consideration are alternative to silicon solar cells. In recent years developments in thin organic film solar cells have been amazing, however, issues remain with the low efficiency of the conversion of light to electricity. We are attempting to solve this problem through various approaches that encompass electrical and electronic engineering, physics, chemistry, biology, and mathematics, which are all based on experiments carried out by young original talents. Understanding the properties of organic molecular materials is very important in being able to improve the performance of thin organic film solar cells, and hence molecular simulations are being carried out using computing machinery. Our mission is to consider organic molecular materials using the behavior of the electrons in it or to research its thermal and mechanical properties at the atomic or molecular level.

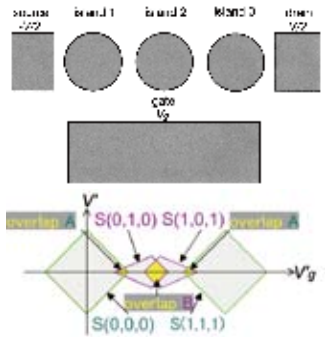
Thin organic film solar cells are created by evaporating organic molecular materials through being heated in the vacuum deposition equipment shown in the photo and then laminating it onto clear electrode substrates.

Research/Development Areas

Theoretical study on the behavior of single-electron devices

Professor / IMAI, Shigeru

Integrated circuits (IC) that perform advanced information processing in PCs are composed of a large number of transistors that are a few dozen nanometers in size and control the transfer of electrical charge bearing information. Single-electron transistors and other single-electron devices are ultimate devices that can control transfer of individual electrons with the smallest charge by means of their property of repelling each other. Single-electron devices can treat each electron as an information carrier and dramatically improve the degree of integration while reducing the power consumption of ICs. We are carrying out theoretical research on the behavior of multi-dot single-electron devices, each of which has a single-common-gate that can be easily fabricated.



The structure of a triple-dot single-electron device with a single-common-gate (top) and its stability diagram that represents the state of electrons within the device (bottom).

Research/Development Areas

Applications of power electronics in power systems

Associate Professor / KAKIGANO, Hiroaki

Electrical energy is essential for our society, and it is expected the electrification in various areas (e.g. electric vehicles and electronic books) is extended in the future. Power electronics plays an important role to use the electrical energy effectively because it is deeply related to the generation, storage, supply and use. Our laboratory researches the power electronics applications for stability, high quality and high efficiency of power supply systems. The examples of the concrete subjects are as follows: 1. Study on dc distribution (or supply) system, 2. Study on power converters to make good use of next-generation power devices, 3. Study on power hardware-in-the-loop simulation for power supply systems. Through the researches, you can learn engineering technique such as circuit design and controller programing, and it promotes your deep understanding of power electronics and power system engineering.

Power converter using next-generation power devices (SiC MOSFETs)

Research/Development Areas

Optic device for environmental measurements and network technology

Professor / KASAHARA, Kenichi

Both the environment and energy are global-scale problems, and hence fuel cells using hydrogen, biomass, and the development of technology to prevent global warming are being promoted. These solutions all involve various types of gas, and active type image monitoring technology that uses the light which enables high-sensitivity of those gases without making any contact will therefore be important from the point of view of security. This laboratory has been researching mid-infrared optical devices in order to realize that. Mid-infrared is the wavelength band that is longer than 1.5 microns which is used in optical communications but there has yet to have been an effective light source, however, in recent years a semiconductor light source known as a quantum cascade laser has appeared. We are promoting research revealing the technical advantages of this at our laboratory. Any environmental information obtained usually needs to be sent to the necessary point as quickly as possible, and therefore we are also promoting research on semiconductor lasers, highly sensitive light detectors, technology for directly amplifying light in fiber, and optical circuits.

■The spectrum width of a quantum cascade laser is measured to enable highly sensitive gas sensing.

Research/Development Areas

Intelligent power electronics

Professor / KAWABATA, Yoshitaka

Power electronics are essential in critical quality-of-life technology used in air conditioners, laundry machines, fluorescent lamps etc in addition to various industries, electrical power itself, new energy sources such as solar cells and fuel cells, and battery powered cars and trains. Power electronics concerns technology used to convert and control electric energy and ensure efficient use of it, thus contributing to solving energy and environmental problems, and hence you will be assured of having a worthwhile career after entering the workforce. In more detail we are involved in the following activities. (1) Studying the basis of electronic circuits through fabrication tests of the I/O peripheral circuits of microcomputers and electronic circuits such as drive circuits. (2) Studying the basis of real-time control while creating control software in the C-language in order to control inverters and electric motors using DSP and RISC microcomputers. (3) Studying the basis of control while establishing a system using the famous software of MATLAB and SIMULINK.

■The study of technology that can be utilized in society through research while carrying out experiments by operating the model of a few kW such as with inverters and electric motors using microcomputer control.

Research/Development Areas

Satellite positioning and applicable technologies

Professor / KUBO, Yukihiro

The positioning/navigation systems that use artificial satellites is known as GNSS (Global Navigation Satellite System), with the GPS mounted in car navigation systems or cell phones being a representative example. Various applications and ways of processing electrical satellite waves are being considered with regard to the launch and operation of the quasi-zenith satellite system (satellites that reinforce GPS) in Japan and Galileo (European GPS) in Europe etc. This laboratory is concerned with research on a method of improving the accuracy of satellite positioning systems, acceleration, and the positioning algorithm used in the compound positioning system that combines gyro sensors etc. We are also considering upgrading of the information communication system for mobile objects and application in ITS (Intelligent Transport System) in our research.

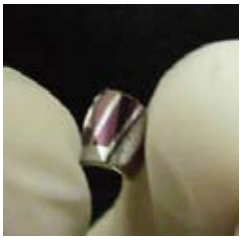
■Experimental mobile GPS positioning using a rail line scene (at the Hikone station of the Ohmi Railway)

Research/Development Areas

High efficiency solar cell and PV system

Professor / MINEMOTO, Takashi

Energy crisis and environmental pollution is now serious global concern in 21st civilization life. Photovoltaics have gathered much attention as clean energy. Solar cell is semiconductor device which convert sunlight directly to electricity. In our laboratory, we are working on thin-film compound solar cells which have great potential on low-cost fabrication and high energy conversion efficiency. Our research covers broad spectrum of solar cell development, such as theoretical device design (modeling), thin film deposition, crystal growth, and device fabrication. Our main task is “proof-of-concept” for new material and new device structure; especially we are working on chalcogenide material and earth abundant semiconductors. Also, our activity includes flexible and light weight solar cells by new fabrication approach. To realize further popularization of PV, we are working on field test of PV modules and also promoting collaborations with companies and government.



■Flexible Cu (In,Ga) Se_2 solar cell.

■Photovoltaic modules installed at Techno-complex.

Research/Development Areas

Ultrahigh-speed optical waveform/optical frequency control

Professor / MORIMOTO, Akihiro

Light is an electromagnetic wave, the same as a radio wave, however, the frequency is higher than that of a radio waveby three digits or more, and hence ultrafast measurements canbe made by creating a signal faster than that of a microwave. In the time domain, light signals at the time interval of a pico-second (1/1trillionth of a second)/femto-second (1/1000 trillionth of a second) are expected, and we are researching thecontrol of the light waveform. Also the expectation of a light signal at an interval of an atto-second (1/100 quadrillionth of a second) is increasing in recent years. These ultrahigh-speed signals have expanded the spectrum by a few terahertz or more, and their application in the fields of communication and measurement are therefore being studied. This laboratory aims at developing a new light source through shaping optical waveforms and optical frequencies, the generation of a broadband optical frequency comb through research that is based on optical modulation and laser oscillation control to manipulate light signals using electric signals.

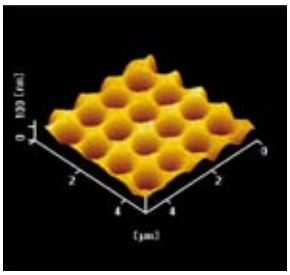
Scene of experiment using an optical fiber laser A light spectrum expanded to terahertz level by laser control and optical modulation.

Research/Development Areas

Application of interactions of light and electrons to engineering

Professor / NUMAI, Takahiro

Photonics/Quantum-Electronics is a research field that deals with interactions of electromagnetic waves and materials. The aim of our research is to create new devices and systems by controlling the interactions of light and electrons. Our major research themes are nano-scale process technology, semiconductor lasers, imaging devices, and optical fiber communication systems.In the research of the nano-scale process technology, we have developed room-temperature imprint lithography that allows us to copy fine patterns, which were formed on a mold, to a surface of resin on a substrate, at room temperature.
In the research of the semiconductor lasers, we have proposed and theoretically analyzed a new ridge structure, which can emit a laser beam with the fundamental transverse mode up to a high light-output. In the research of the imaging devices, we have discovered a structure, which can control the peak wavelength and spectral width independently. In the research of the optical fiber communication systems, we have proposed and analyzed several schemes to reduce four-wave-mixing noises, which are caused by the third-order optical nonlinear effect in the optical fibers.



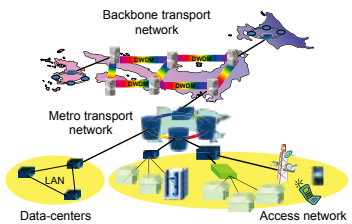
Fabricated pattern by room-temperature imprint lithography

Research/Development Areas

Optical fiber communications technology and its application

Professor / SANO, Akihide

Optical fiber communication is a key technology that supports the massive growth of Internet traffic. During the last three decades, transmission capacity per fiber has been increased five orders of magnitude. Our laboratory has been established on April 2017, and we are working on optical fiber communication system technologies and its applications. Our research target covers various aspects of optical communication systems such as long-haul optical transport networks, optical access networks and data-center networks. The transmission performance of long-haul transport networks has dramatically increased by digital coherent transmission scheme. However the attainable per-fiber capacity is fundamentally limited by fiber nonlinearity, and thus one of main topics in our laboratory is nonlinear compensation techniques to overcome this limitation. We are also focusing on advanced modulation-detection schemes to realize high-speed and low-cost interfaces, and working on optical performance monitoring technique that is indispensable for providing highly-reliable communication services.



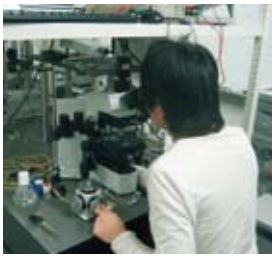
Configuration of optical communication networks

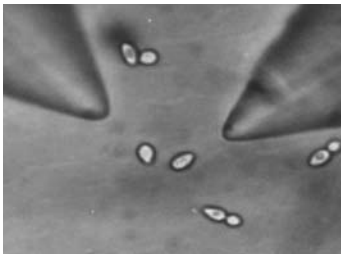
Research/Development Areas

Minute object laser trap using optical fiber

Professor / TAGUCHI, Kozo

Light has pressure. My laboratory is researching the control of minute objects without actually having to come in contact with them by using that pressure of light. We are currently developing a minute object light acquisition system using optical fiber and have confirmed that light acquisition of a few micrometers in size of a minute object can take place by irradiating the laser light from an optical fiber whose tip has been processed into a lens. This is known as “optical tweezers”. The two optical fibers shown in the photo can be used to move objects closer to each other or to separate them similar to how a human’s right and left hand handle objects. If the minute object were to be a cell it would contribute to the biotechnology field as a method of cell fusion and of replacing tissues in a cell.





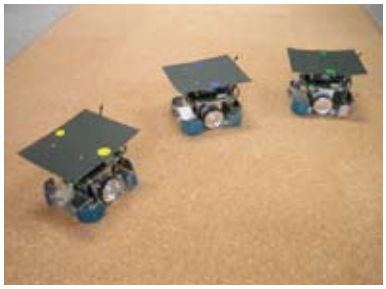
Scene where organism cells dispersed in pure water using laser light irradiated from an optical fiber are picked up by light.

Research/Development Areas

Systems and control theory and its applications
Modeling, estimation, and control of large-scale networked systems

Professor / TAKABA, Kiyotsugu

Dynamical systems arising in various engineering problems in modern society are getting increasingly huge and complex, and exhibit a large-scale network structure consisting of a number of sub-systems. Examples of such systems are power grids, sensor networks, formations of mobile vehicles, etc. Mathematical model-based methodologies are essential to guarantee stability and high performance of large-scale networked control systems under various constraints. Against this background, we conduct research and education on systems and control engineering aiming at the development of practical and expansible methods for modeling, estimation, and control of large-scale networked systems. Our research interests include robust design of networked control systems, synchronization of sensors or electro-mechanical systems, formation control of mobile vehicles, etc.



Formation control of a group of mobile robots

Research/Development Areas

Development of measurement systems by autonomous sensor node network

Professor / TAKAYAMA, Shigeru

Wireless sensing network systems is the key technology in advanced measurements in a wide range of fields, for measurement of multiple parameters, and under dangerous or destructive conditions. The system is designed as a remote, collaborative, cooperative system consisting of multiple sensors and measuring instruments, and communication devices. The aim of the sensing system laboratory is (1) to construct an autonomous sensing node, which integrates sensors, a micro-processor system and a communication device and (2) to realize a flexible, robust and dual communication sensing network. As concrete applications, the laboratory staff have been working on (1) forecasting landslides at hills around mountain areas, (2) monitoring the flow speed and direction of dangerous rivers, (3) monitoring the dynamical physiological parameters in daily life and (4) monitoring human flow in densely populated areas. From the viewpoint of social evolution, our staff work to design and construct practical systems and devices by combining the dual aspects of hardware and software.

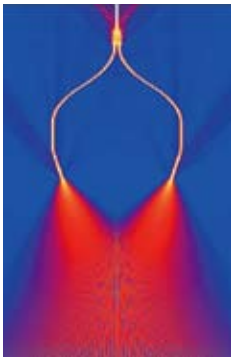
Example of configuration of sensory node that is the constituent element of a slope failure monitoring network

Research/Development Areas

Optical signal processing and its application to optical communication and sensing

Professor / TAKIGUCHI, Koichi

The capacity of optical communication is being steadily increased, which brings significant benefits to our lives including broadband services of the Internet. However, the signal processing utilizing electronic circuits causes the limit of processing speed and large power consumption in the optical communication. The information photonics laboratory was just established in April 2012, where we aim at research on optical signal processing based on photonic nanotechnology, diffraction, interference, and non-linear optical effect in optical waveguides and fibers. We pursue technology that can process optical signals directly in the optical domain at high-speed and without increasing power consumption. The lightwave also has a feature that enables us to carry out sensitive detection of biological objects and environmental information without disturbing them. By use of this feature and above-mentioned optical signal processing technology developed for the optical communication, we pursue sensitive metrology for biotechnological, medical and environmental fields, and information photonics for multiplexing or fusion of optical sensors.



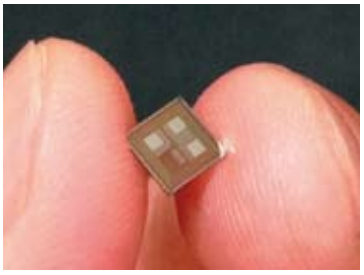
Result obtained with simulation of integrated photonic device.

Research/Development Areas

Nanoelectronics and its applications for bio-chemical sensors

Professor / UNO, Shigeyasu

Nanotechnology and biotechnology. These disciplines have achieved remarkable progress independently, and now they collaborate to form a new interdisciplinary research area, namely, nanobiotechnology. We aim to contribute to advances in nanobiotechnology through our expertise in electronics. Our research interests include (a) nanoscale integrated CMOS devices and circuits for advanced sensors, (b) biosensors for biochemical molecules and physiological activities, (c) biochemical energy generation and storage. We stress international collaboration with research groups all over the world, and laboratory members are international as well. We enjoy exciting collaborations with experts from wide variety of disciplines not only physics but also chemistry, biology, and medical science. Interested? Then just contact me for more details!



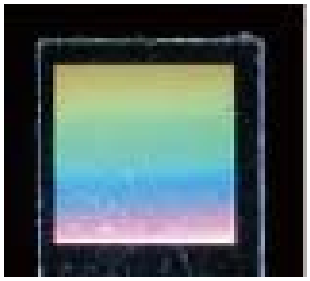
CMOS LSI chip for biochemical molecular sensing.

Research/Development Areas

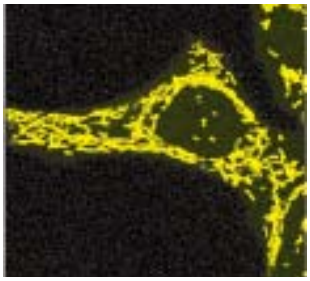
Photonic application for optical information technology and biomedical imaging

Professor / WATANABE, Wataru

Light is used in a wide variety of applications including communications, information processing, data storage, energy, healthcare, medicine, and manufacturing. The group engages in fundamental and applied study on photonics, focusing on nanophotonics and nonlinear optics with the aim to harness light. Our research involves optical device fabrication and advanced optical microscopy for minimally invasive medical diagnostics. The group is engaged in interdisciplinary areas of education and research, spanning optics, photonics and electronics.



Diffraction image of the embedded grating in polymers by ultrafast laser pulses



Visualization and manipulation of organelles in a biological cell

Department of Electronic and Computer Engineering

Research/Development Areas

Design of battery-less system and its application

Professor / DOUSEKI, Takakuni

Systems that do not require any batteries would be more convenient in that they would not require any maintenance and can be installed where people cannot reach such as in sensor networks and implantable computers. At our laboratory we are aiming at the research, development and application of a battery-less system that obviously does not require any batteries. In order to realize this research needs to cover the three points of the generation of energy (electricity generation technology), conversion (power supply conversion technology) and consumption (low-power LSI technology). As energy resources the natural energy existing around us such as light, thermal and motion energies need to be utilized. With regard to LSI-related research we are researching new power supply conversion circuit technology to enable stable electricity to be supplied from unstable natural energy sources to internal CPUs and extremely small circuit electric power technology. We have succeeded up to the creation of system but are now promoting the research in cooperation with external companies.

<Example of battery-less system>

■Hanger electric generation

■Body temperature electricity generation

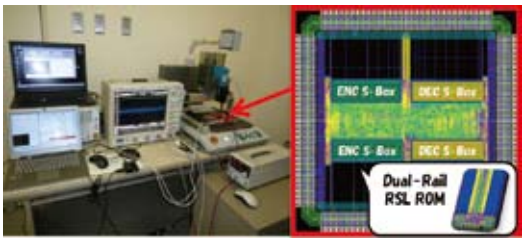
Research/Development Areas

Electronic Devices for Network Application — Security & Application Specific LSI —

Professor / FUJINO, Takeshi

The networking of electronic devices is the key technology for safe and comfortable society. High-security and low-power consumption are required for these electronic devices. Cryptography is used for realizing high security, in the contact-less smart cards, which keep money and personal information, or sensor nodes, which handle privacy information.

Cryptography is mathematically safe, however, the attacker reveal secret information by analyzing the side-channel information such as power consumption and electro-magnetic field. Furthermore, the attacker could clone security LSIs by analyzing physical information. In our laboratory, we are researching tamper-resistant LSI which protect secret information, and Physically Unclonable Function for anti-cloning. In addition, we are developing networking and high security systems by using programmable LSIs and high-performance low-power processors.



■Side Channel Attack and tamper-resistant cryptographic LSI

Research/Development Areas

Optimization Technique for Analog Integrated Circuits

Professor / FUJITA, Tomohiro

At the analog integrated circuit laboratory we are promoting research that focuses on two points: information processing technology utilizing analog circuits and how the analog circuits are created. With regard to information processing technology we are researching information processing that utilizes complex dynamics such as in a neural network. We wish to realize the information processing doctrine of the brain on an analog circuit. For the problem of how the circuits should be created we aim at establishing automatic design technology carried out by computer. We wish to automate the design flow, which used to rely on the experience of the designer, using an optimization program on a computer. We are also carrying out research on simulation technology that cannot be easily realized using existing technology such as high-frequency circuits used in cell phones and a large-scale digital circuit mixed system.

Research/Development Areas

High-performance, highly-reliable and low-power VLSI system design technology

Professor / FUKUI, Masahiro

VLSIs (very large scale integration), which have been so successfully used in information appliances, have now entered an era of more diversified applications such as on-vehicle and ultra-small medical use systems, and are therefore undergoing new development. In this era mastering the optimization of the system according to the application has the tendency to heighten its added value, and thus be a resource of large competitive power. In the case of medical treatment robots that can be used inside people's bodies, for example, ultralow-power operation is necessary. In the case of safety controlling vehicles and positioning the space shuttle, high-speed and ultra-high reliability are also required. This laboratory is working on low-power design technology at the system level and ultralow-power, including the battery and power supply circuit, in order to solve these requests of the era. As the reliability operation with the shift to LSI is also needed in addition to the aspect of the system, we are emphasizing the establishment of a design optimization method that takes into considering heat and timing with miniaturization physics.

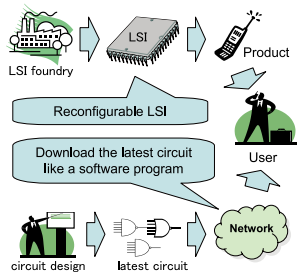
■Design of algorithm of lane recognition system, and its electronic implementation which performs high-speed low-power

Research/Development Areas

Flexible hardware and its application

Professor / IZUMI, Tomonori

Electronic information equipments, such as cell phones, vehicles, artificial satellites, etc., are implemented as complicated systems with hardware and software.
In the traditional sense, hardware (implies a rigid matter) is an electronic circuit which offers the best performance and software (implies a flexible matter) is a computer program whose functionality can be changed by re-loading another program.
Our research theme concerns “reconfigurable hardware” which realizes both the high performance of electronic circuits and the flexibility of computer programs. Reconfigurable hardware would realize adaptive systems such as mobile phones, TV receivers, or wireless network appliances which could be reconfigured automatically to fit multiple standards. It would also realize evolutional hardware which would change autonomously according to the environment and usage. Furthermore, it would contribute to safety maintenance of the systems in dangerous place such as space, deep sea, nuclear facilities, by reconfiguring hardware for update or repair. It might also contribute to ecology by reconfiguring and re-using the system, i.e. reducing the waste.



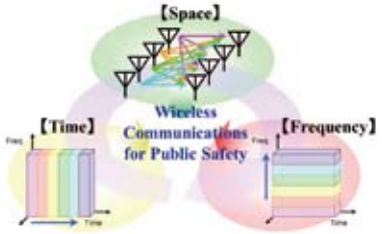
■An electronic board equipped with “flexible hardware” (top-right photo) and an example of application “downloadable hardware” (above figure)

Research/Development Areas

Wireless Communication Systems for Public Safety

Professor / KUBO, Hiroshi

Wireless communications play important role not only for broadband data transmission but also for public safety. Our laboratory is making research on digital signal processing technologies for wireless communications with high quality and reliability in fast vehicle environment and in low received signal power environment. Using digital signal processing technologies in “Time”, “Frequency” and “Space” domains, we focus on robust wireless communication systems for high-speed trains and airplanes at a speed of several hundredsof km’s per hour and communication satellitesat a height of several ten thousands of km’s. We are also making research on visualization technologies for wireless communications in order to support robust wireless communication systems. In addition, we are expanding these digital signal processing technologies not only to wireless communications but also to wired communications (optical communications, metallic communications) and acoustic sensing.



■Wireless digital signal processing technologies in “Time”, “Frequency” and “Space” domains

Research/Development Areas

Massively parallel LSI architectures for multimedia systems

Associate Professor / KUMAKI, Takeshi

Recently, our multimedia environment is developing and changing rapidly.
Furthermore, mobile devices have spread with the rapid development of embedded LSI architecture.
For contributing to the further development of above technologies, our laboratory focuses several novel massively parallel LSI architectures and its applied multimedia systems.
The proposed massively parallel LSI architectures are based on a Content Addressable Memory (CAM), a Single Instruction Multiple Data (SIMD) hardware, etc.
The applied multimedia systems are deal with image data, sensing data, etc.
Latest research topics for realizing effective multimedia data processing are multi-ported and process variability-used CAM, intermittent-sensing image sensor node, highly implementable watermarking, human-like digital image forensics, spy-photo prevention system, hardware Trojan detection and more.

■Demonstration scene: international conference and domestic exhibition.

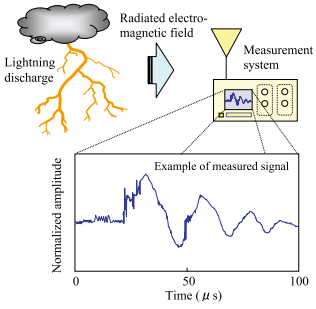
■ARM-core and FPGA evaluation board for multimedia system and security camera prototype system.

Research/Development Areas

1. Signal analysis in atmospheric electricity and bioengineering fields
2. Bio-electromagnetic engineering

Professor / MASUGI, Masao

Our laboratories deals with two research topics: one focuses on the signal analysis in atmospheric electricity and bioengineering fields, and the other focuses on bio-electromagnetic engineering related to the effect of transient electromagnetic waves on bio-systems.
Regarding the former research topic, we measure electromagnetic waves caused by lightning discharges whose occurrence rate is strongly related to global warming effects. The weather data sets are also used to assess the measured data and actual global warming effects. Regarding the atmospheric electricity, we also measure fluctuations of broadcasting waves, which can be effective data for forebodings of big earthquakes. In addition, we analyze the biological signals (e.g., EEG) for the health care management in our daily life.
Then, in the latter research topic, we evaluate effects of transient electromagnetic waves on bio-systems such as plants and yeast fungus. Artificial nerve-cell models are also used to analyze their responses by external electromagnetic waves. We believe that these new approaches will provide a new quantitative measures in revealing the actual effect of electromagnetic waves on bio-systems.



■Concept of measuring electromagnetic field caused by a lighting discharge

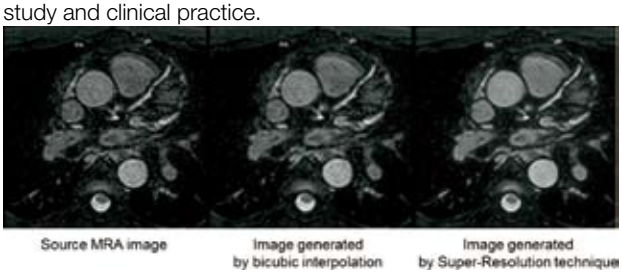
Department of Electronic and Computer Engineering

Research/Development Areas

Development of techniques of medical image processing/analysis for clinical practice

Associate Professor / NAKAYAMA, Ryohei

Our major research efforts have been focused on computer vision and human-computer interaction for medical images. The goal of our researches is to let computers help physicians in the image interpretation process. In computer vision, we have been developing image processing techniques such as a filter bank for enhancing lesions in medical images, a subtraction technique for visualizing lesions, and a super-resolution technique for improving image resolution and image quality. In human-computer interaction, we have been developing a computerized scheme for evaluating the likelihood of malignancy and/or histological classifications on lesion by using pattern recognition and artificial intelligence. We also investigate if the proposed methods are useful for improving the diagnostic accuracy and for reducing the interpretation time in observer study and clinical practice.



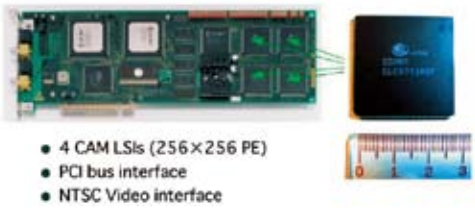
■Example of 512x512 source image and 512x512 generated images from the 256x256 input image by a bicubic interpolation and by super-resolution technique.

Research/Development Areas

Intellectual processing through SSoC (Search System on Chip)

Professor / OGURA, Takeshi

With typical memory data uses an address with input and output. However, memory that can have data input and output using a part of the data itself is known as association memory. You could say that association memory is the realization of the intellectual memory that forms the basis of human's intellectual functions. It is known that association memory LSI that can realizes that has various parallel processing functions in addition to the storage function. SSoC (Search System on Chip) is a system model that can use association memory as the key technology. We are analyzing and taking into consideration the target process to be realized by SSoC from the initial point and studying the algorithm and constitution method of SSoC so as to realize the processing in the most efficient manner. We will promote our research with the aim of realizing intellectual processing using video processing, network security and robot control etc as the main targets.



■An example of SSoC in intellectual image processing

Research/Development Areas

Design methodology for systems-on-chip and embedded systems

Professor / TOMIYAMA, Hiroyuki

Our vision is to conduct leading-edge theoretical and applied research in design methodology for Systems-on-Chip (SoCs) and embedded systems. Embedded systems are computer systems, which are embedded in various electronic products such as digital TVs, blu-ray encoders/decoders, mobile phones, game machines, cars, and aircraft. SoCs are semiconductor chips on which multiple processors, memories, accelerators, and peripheral circuits are highly integrated, and are the key component in the embedded systems. Our current research focuses are on, but not limited to, high-level synthesis of SoCs and system-level design optimization of mobile phones and automotive control systems.

■Weekly meeting in our laboratory

■Hardware/software co-design of an image processing embedded system

Research/Development Areas

Parallel heterogeneous computing and hardware software co-design

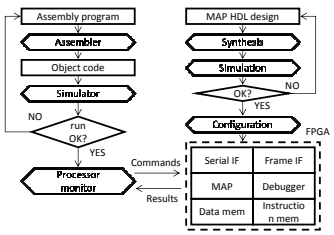
Professor / YAMAZAKI, Katsuhiro

Parallel Heterogeneous Computing

GPUs and FPGAs have improved very rapidly, and it is very important to acquire parallelization mechanisms and fully utilize these devices for a wide range of applications. Currently, we are developing a recognition system of oracular bone inscriptions by template matching and deep learning on GPUs. We are also interested in pipelining BLOB detections. Dual and quad pipelining systems of BLOB detections have been implemented on FPGAs, and we are applying these systems to front vehicle detection.

Hardware Software Co-design

We have been studying Multi-ALU Processor (MAP) s on FPGAs. MAP has two, four, and eight ALUs, thus both parallel operations and chaining operations are available. The objectives of this project are not only to design, implement, and actually run the processor on FPGAs, but also to investigate the possibilities of operation level parallelism. Students can acquire processor designing capabilities and FPGA utilization techniques by designing MAP on FPGAs with Verilog HDL.



■Structure of the multi-ALU processor system

Department of Mechanical Engineering

Research/Development Areas

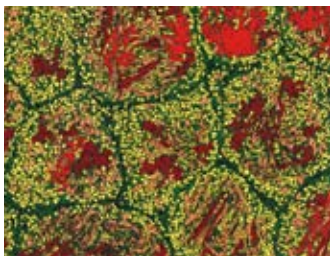
Development of materials for use in highly-functional/high-performance structures

Professor / AMEYAMA, Kei

Conventional material developments have emphasized ultrafine-grain refinement and homogenization. However, “nano- and homo-” materials do not usually satisfy the need to be both strong but ductile, which are of course rather contradictory characteristics.

Our research group has succeeded in creating a “Harmonic-Structure Material” that is both a “nano- and harmonic” material which has overcome that antinomy through the use of one of the non-equilibrium powder metallurgy (PM) processes called the severe plastic deformation PM process (Figure shows an EBSD grain size image of Ti-6Al-4V Harmonic Structure Material) .Target materials are not only metallic materials but also hard materials such as ceramics.The harmonic structure design improves toughness as well. This also means that a whole new paradigm of materials design has been created.

Alongside material development, we are also working towards practical application of the materials by carrying out demonstrative experiments, various assessments,and design optimizations.



An EBSD grain size image of Ti-6Al-4V Harmonic Structure Material

Research/Development Areas

MEMS devices for technology of evaluation/observation

Associate Professor / ANDO, Taeko

The mechanical properties of various structural materials in the microscale and nanoscale domain are the research focus of the Ando Group. Microscale materials such as silicon, metals, and polymers are useful for micromachined applications in MEMS devices. We have developed a new method to evaluate the mechanical properties of silicon chips in various environments such as high or low temperature, high humidity, and vacuum. Our research targets include the development of a novel MEMS device for evaluating various phenomena in nanotechnology, biotechnology, and medical fields.

Research/Development Areas

Strength of materials under multiaxial loading

Professor / ITOH, Takamoto

This laboratory is carrying out many fatigue tests under multiaxial loadings for various materials, such as heat and corrosion registrant alloys used for high temperature component, light weight alloys and super alloys used for aircraft, low melting alloys used for electronic devices, etc. The fatigue tests were mainly performed under multiaxial loading at room and high temperatures. Based on the obtained test results, deformation and fracture behaviors are evaluated. Observations of crack and microstructure, analyses and evaluations of results and numerical analyses are also carried out, and then evaluation of strength and development of design criteria for fatigue strength are studied. For the multiaxial fatigue test, since special test equipment is needed, almost all the machines are the originally designed and fabricated testing equipment. New testing machines are also developed. Thus, the students can study not only materials and strength of material, but also programing of test controlling and hydraulic control system. In this laboratory, most important thing is to enjoy the research work.

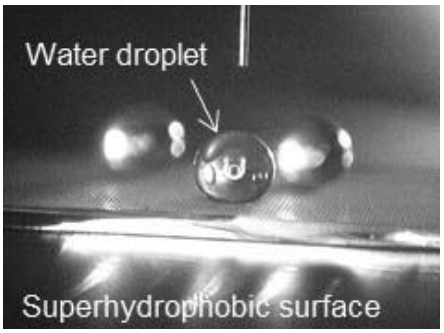
Multiaxial low cycle fatigue test of heat resistant steel using electro-hydraulic servo testing machine

Research/Development Areas

Mechanical–electrical material properties of advanced functional thin films

Associate Professor / KOBAYASHI, Taizo

Our study focuses on the fabrication and investigation of advanced functional surfaces/interfaces through a combination of micromachining technology and mechanical–electrical thin films. Surface properties have higher impact on physical and chemical phenomena at the micro-scale than on those at the macro-scale. Functional surfaces/interfaces have a wide range of potential applications. The design and fabrication of topological surface structures based on micromachining and thin-film growth of advanced functional materials through thermal evaporation, reactive sputtering, and electroplating are studied to fabricate new functional surfaces/interfaces. For example, we are currently working on wettability for microliquid manipulation.



A figure shows water droplets on a superhydrophobic surface with a micromachined topological structure

Research/Development Areas

Creation of new functionality of small machines (MEMS) and their application

Professor / KONISHI, Satoshi

LSIs (integrated circuits) are incorporated computers and the computers are connected to networks, thus linking information, humans and objects. Small machines originating in LSI technology MEMS (Micro Electro Mechanical (= machine) Systems, called MEMS) are now being spotlighted. My subject of research is MEMS and the world that can be treated using MEMS. MEMS involve an acquisitive field where mechanical and other information that includes biochemical information is dealt with utilizing the minute structure of the LSI chip. Applications have continued to expand: a number of small mirrors that turn ON/OFF the image signal of a display by swinging it, and biotips for catching cells, boring holes, and assembling cells etc. We are recently working on medical applications of MEMS with the aim of contributing to medical care that less burdens patients. An endoscope robot with soft hands has been developed, and we would like to continue working on this field with you.

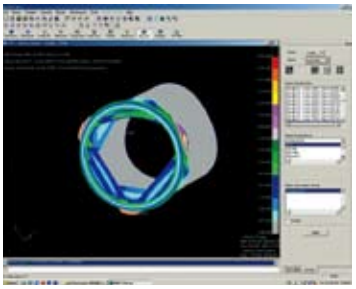
■Remote operation by data glove of micro hand: under deployment in medical application

Research/Development Areas

Strength design and soundness evaluations of machine structures

Professor / KUSAKA, Takayuki

We are involved in the structural design and structural evaluations of the safety and functionality of rapid transportation such as vehicles and aircraft. The crash safety of vehicles and damage detection of aircraft etc are both representative examples of this theme. In particular we are carrying out research using the keyword of “impact phenomenon” and researching the impact resistance of new materials such as carbon fiber reinforced composite materials and shock absorbers that put a folding structure to practical use. We frequently carry out inspections using CAE (a type of computer simulation) in addition to various intensity experiments in our research, and develop test productions. Recently we have also been emphasizing damage diagnosis of architectural constructions and developing a system that can be used to evaluate the generation status of cracks in real time. We have a lot of themes of research that are being promoted in cooperation with car and aircraft manufacturers etc.



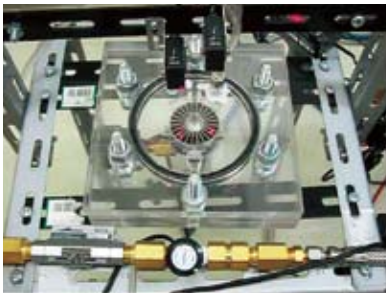
■Plastic buckling simulation of shock absorber for vehicle. We are developing a highly-efficient shock absorber using CAE.

Research/Development Areas

Application of nonlinear science to machine systems

Professor / MIYANO, Takaya

Phenomenon where exceeds something can be represented by “1+1=2”, or, that is to say, the situation where a new characteristic appears when two systems are combined, which could not be expected when each system individually existed, could be described as “emergence”. The science that studies emergence is nonlinear science. The word “nonlinear contains the nuance “it is not a world where 1+1=2”. At our laboratory research is being carried out the “emergence” new functions of a machine system by applying nonlinear science to machine systems, or by using a lot of parts and having them cooperate can lead to a mutual effect. For example, it is possible to rotate the same machine at a constant pace or to rotating it irregularly by slightly changing the operating conditions.



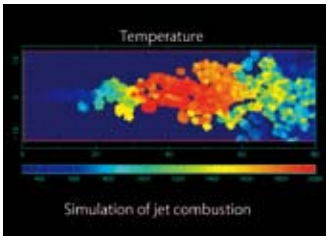
■Chaotic waterwheel: form of chaotic gas turbine I am collaborating on with Professor Toshiyuki Toriyama.

Research/Development Areas

Development of efficient computational codes and their technological applications

Professor / OGAMI, Yoshifumi

With the advances in computer technology and development of computational codes for fluid dynamics, solving complex equations has become mainstream. However, there is room for improvement in computational accuracy and time. For example, simulation of combustion in turbulent flows needs to solve hundreds of chemical equations simultaneously, which leads to a huge computational load. Therefore, efficient computational methods are required. In our laboratory, we are developing efficient computational codes for analyzing flow around fixed physical objects (Eulerien method) and as well as flow around moving physical objects (Lagrangian method).
In addition to the development of efficient computational codes, we are working on application of these codes to technological studies such as “noise-reduction of turbulent flow from jet nozzle,” “development of micro gas turbine,” “development of artificial heart with magnetically suspended impeller,” and “flow analysis of moving animals as swimming fishes and flying birds.”



■An example of computational code for the Lagrangian method combined with the thermal equilibrium method. With this code, accurate calculation is possible without using hundreds of chemical equations.

Research/Development Areas

MEMS informative communication laboratory

Professor / SUZUKI, Kenichiro

We are carrying out research and development on wireless/optical components utilizing Microelectromechanical Systems (MEMS) technology. As the dimensions of the machine's element can be miniaturized to the same level of electromagnetic waves, the possibility that a new doctrine for controlling the phase and amplitude of electromagnetic waves with those machine elements is emerging. The expectation is that this research will lead to the development of a new research area which will initiate the fusion of electromagnetic waves and machine vibrations in the micro area. It is also expected that this research will realize even higher functionality of mobile wireless communications and sensing system and contribute to the construction of the infrastructure for the next-generation ubiquitous network society.

■Background of fabrication of MEMS device

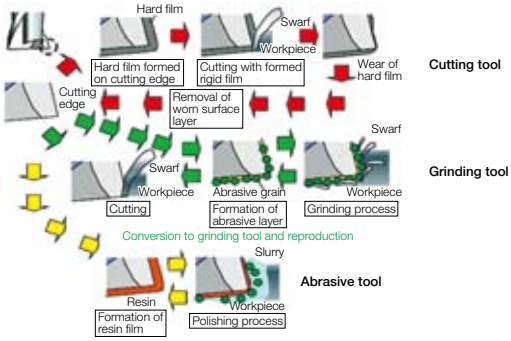
■Electrical characterization scene with MEMS device

Research/Development Areas

Development of easy reforming technology for machining tools

Professor / TANI, Yasuhiro

We utilize various industrial products around us, many of those parts are produced in removal process using machining tools. The tools gradually wear out and need to be replaced. Only the surface layer of a tool is used in processing, and hence replacing the entire tool is a waste of resources. Attachments can change with each replacement that can cause variation in the accuracy of processing. This laboratory is therefore working on the development of technology for reforming machining tools on the machine tool. The technology will help workers involved in processing to select the optimal tool, and improve their ingenuity. We are developing support technology and equipment at our laboratory to aid processing engineers in fabricating machining tools with a simple shape in addition to this research.



■Concept of reforming technology for machining tools
Technology used to reform only the surface layer of a machining tool used in processing.

Research/Development Areas

Analyses and applications of rhythmic system in science and technology

Professor / TOKUDA, Isao

Rhythmic phenomena, characterized as regular recurrence of pattern in time, are observed in a variety of systems in nature. Examples include rhythms in speech communications, rhythms in music plays, rhythmic walking, rhythmic heart beat, 24 hours biological rhythm, rhythmic flashing of fireflies, firing patterns of neuronal activities, planetary motion, and many others. Ensemble of such rhythmic elements leads to a rich collective behavior such as synchronization. In mechanical engineering, development of mechanical oscillators that can generate stable and precise rhythms provides one of the most fundamental technologies. In our laboratory, we construct mathematical models and experimental devices for rhythmic systems. Our aim is to develop basic theories and advanced applications in science and engineering. Our subjects cover a broad range of research fields from mechanics, robotics, computer science, neuroscience, and circadian rhythm to acoustics and music.

■Physical model of vocal folds that can produce voice as human.

Research/Development Areas

Micro machine design that puts the micro mechanics of solid fluids to practical use

Professor / TORIYAMA, Toshiyuki

We are aiming at the realization of a micro power source of an ultra-small turbo machine etc. by putting micro machine system technology to practical use. The micro power source has been assumed to be a propulsion engine loaded on an ultra-small flying object. We are implementing element design and test production of centrifugal compressor, a can type premixing hydrogen combustor, a radial flow turbine and gas bearing etc configured with an impeller diffuser based on the thermodynamic cycle required for the propulsion engine. We are also implementing structural fluid design by dealing with the centrifugal force, thermal stress and heat conduction problems from the point of view of solid mechanics and the transonic fluid problem of the low Reynolds number from the point of view of aeromechanics. We are also aiming at resolving the electronic/dynamic behavior of piezoresistant material in which the application of a micro mechanical rate sensor like an acceleration sensor is expected, by applying micro mechanics to it.

■Silicon splitter impeller blade/reaction turbine blade of 10mm in diameter and fluid sealing structure (design point performance of rotation number of 900000rpm: pressure ratio 2, heat-insulating efficiency 0.5) that was experimentally produced by the processing technology with the micro machine system.

Research/Development Areas

Fracture controlling in localized regions of engineering materials

Professor / UENO, Akira

It is very important to produce reliable industrial products, including MEMS products. One effective method for preventing product failure is the early detection of small-scale damage or fracture. In our laboratory, we study an advanced fracture controlling technique for application in early fracture detection.
Another field of study we have recently embarked on is the study of practical uses of fuel-cell vehicles, as part of the effort in addressing the issues of global warming and resource shortages.

■Our team of undergraduate student in the laboratory

■Fine hole electrical discharge machine

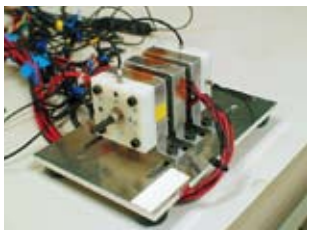
Research/Development Areas

Development of magnetic levitation/ magnetic bearing system

Professor / UENO, Satoshi

Magnetic levitation/magnetic bearings are used in systems that support objects or rotating shaft without contact through use of magnetic force. It has various favorable characteristics: no friction or abrasions, supports high-speed rotation, low loss, long lifetime, usable in vacuums or in ultralow temperature environments, and supports advanced active control. Currently it is actually being utilized in magnetic suspension trains, turbo-molecular pumps, flywheel energy storages, clean pumps, and blood pumps for artificial hearts etc. We are working at the development of a magnetic bearing smaller than those already existing, the development of a self-bearing motor that integrates magnetic bearings and an AC motor, and the development of a non-contact displacement sensor for use in magnetic levitation etc. We are also developing a magnetic bearing system using a superconductor in addition to the magnetic suspension that uses a normal conduction magnet.

■Scene of experiment



■AC motor using small magnetic bearing

Research/Development Areas

Clarification of high-speed impact phenomenon accompanying shock waves

Professor / WATANABE, Keiko

The high-speed impact accompanying the shock waves is a very interesting research subject in physics because unique phenomena that can never happen under the static and dynamic loading are induced. The main subject is the clarification of fracture and propagation behavior of waves induced by the impact. In particular, we recently focus on the high-speed penetration phenomenon into geological particulate materials such as sands. Since particles are heterogeneity and instability, both behaviors as solid and liquid exist and the three states of matter (solids, liquids and gases) are mixed, phenomena are so complicated and less understood. This is not only basic research of high-speed impact phenomena but research of engineering significance, such as the product development using a non-Newtonian phenomenon, the establishment of planetary exploration technology, the establishment of protection technology against high-speed scattering objects and the development of new excavation technology and geological survey technique.

■Behavior of ejecta during high-speed penetration into sands

Research/Development Areas

Clarifying biomechanics through mechanical engineering

Professor / YAMAMOTO, Noritaka

We are clarifying the mechanism of vital functions using the material mechanics required in designing vehicles and aircraft that avoid damage in mechanical engineering. In addition we are aiming at developing new medical treatments for disorders that have been untreatable using the accomplishments obtained. We mainly carry out research on tendons and ligaments of the articulatio genus.
Tendons and ligaments are made up of collagen fibers and have a very complicated structure. We are researching the relationship between minute structures and mechanical properties by harvesting fiber fascicles of approximately 100 micrometers in diameter and very fine fibrils of approximately 200 nanometers in diameter obtained the tail tendon of the mouse for use in conducting tensile tests. We also obtain mechanical properties from the relationship between force and extension at that time by capturing the change in shape of the patella tendon that bears the load using ultrasonic diagnostic equipment in order to measure the mechanical properties of the patella tendon in the human articulatio genus.

■Ultrasonic diagnostic image of human patella tendon

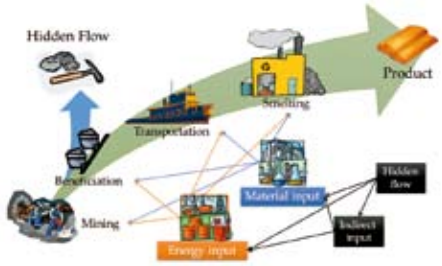
■Electron microscope photograph of fiber fascicle from mouse tail tendon

Research/Development Areas

Materials Science and Process Engineering supported by Industrial Ecology towards Sustainable Material Supply Chains (Material Logistics)

Associate Professor / YAMASUE, Eiji

The research interests of our group may be encapsulated as "Sustainable Materials, Processes and Production". Our laboratory is grappling with the development of materials and processes, and their environmental impact assessment from multidimensional (present, past and future; local, domestic, and global) viewpoints. More academically, our research fields consist of natural science (materials science, thermodynamics and transport phenomena, etc.) supported by industrial ecology (material flow analysis, life-cycle assessment, environmental system engineering, etc.), and sometimes experimental archaeology. Current targets are metals (iron, nickel, zinc, copper and related scarce metals), phosphorus and foods, and related processes. With regard to these particular products, we focus not only natural mines but also urban mines that were thought of as waste.



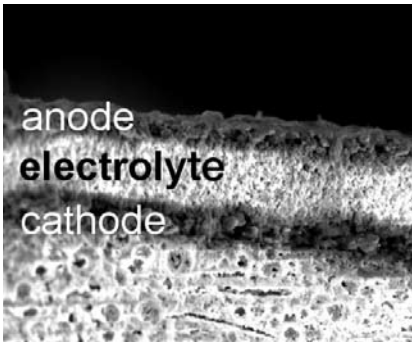
Concept of material logistics. We optimize the entire material and energy inputs in various different ways through basic natural science supported by industrial ecology.

Research/Development Areas

Development of energy conversion technology that will contribute to the establishment of a resource recycling society

Professor / YOSHIHARA, Yoshinobu

Prevention of global warming is currently a pressing issue, making the establishment of a system that ensures a constant supply of energy while reducing CO_2 emissions necessary, along with the promotion of energy saving, recycling of resources and the conversion to new fuels. Because of this we are developing highly efficient technology for use in gasoline engines and purification technology for harmful substances from the point of view of energy conservation, because diesel engines have higher thermal efficiency than gasoline engines but do have the tendency to discharge a lot of nitrogen oxide (NOx) and particle matter (PM) such as smut. We are also developing technology for utilizing biomass resources and Solid Oxide Fuel Cells (SOFCs) as a new fuel.



Porous solid electrolyte cell developed at the laboratory
Used to purify exhaust gas from diesel engines and the development of a quick start SOFC

Research/Development Areas

Environment restoration technology by fluid engineering

Associate Professor / YOSHIOKA, Shuya

The environment has recently been damaged by human activity. In our laboratory, we study two technologies: environment restoration technology and the technology for the reduction of environmental impact, by means of fluid engineering. Our main focus is to develop such technologies by using a large quantity of micro scale bubbles. This technology makes it possible to efficiently dissolve oxygen in water in the environment on a massive scale. Dissolved oxygen restores the ecological systems and material cycle systems, providing the water environment strong environment-restoration ability. Our field experiments are carried out at testing sites such as lakes and water-storage dams, in cooperation with the local government authority. To support and verify our fieldwork, we perform experiments in our laboratory on campus, which attempt to predict the process of water environment restoration by simulating heat, fluid flow, diffusion, and chemical reaction in the environment.

Water containing micro bubbles, with the appearance of milky liquid

Field experiment at Sounoseki-dam (Miyagi Pref.)

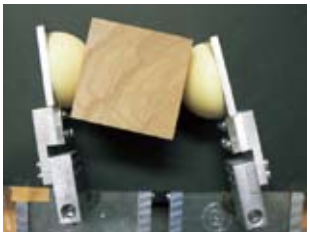
Department of Robotics

Research/Development Areas

Making a mechanical system intelligent using dynamics

Professor / HIRAI, Shinichi

Soft Robotics Laboratory is investigating robots with novel functions brought by soft materials and its related technologies including soft sensors and actuators. So far, hard materials are mainly used in robotic systems. Contrary, creatures are made of hard and soft materials, suggesting us introducing soft materials into robotics will realize novel functions as creatures. Research topics are 1) soft-bodied robots including soft-fingered hands and tensegrity robots, 2) soft tactile sensors that can detect normal pressure, slippage, and proximity, 3) micro pneumatic valves and their applications to soft-bodied robots, 4) modeling of human tissue and organs such as vitreous and flatfoot, 5) handling of soft objects such as food and wires, and 6) aerial manipulation performed by hands equipped with multi-rotor robots.



■Soft finger operation
An object can be skillfully operated by a robotic hand with soft fingers

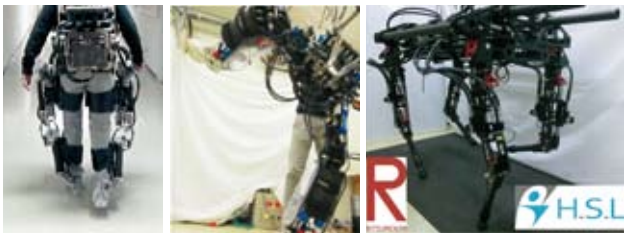
■Aerial robot with a robot hand for aerial operation

Research/Development Areas

Humanoid systems

Associate Professor / HYON, Sang Ho

We contribute to our society by creating humanoid (human-like) intelligent systems, focusing on high-performance motion control.
To obtain the better control, learning, prediction and monitoring performance, we integrate wide range of knowledge from control theory, dynamical system theory, machine learning algorithms and electro-hydraulic technologies.
Ongoing projects include hydraulic biped humanoid robots capable of fast and compliant full-body motions, pneumatic/electric hybrid exoskeletons capable of compliant motion assist, quadruped robots for tough field application, robotic excavator, and high-precision pneumatic/hydraulic servo press.



■Hybrid exoskeleton robot ■Hydraulic biped/quadruped robots

Research/Development Areas

Motion intelligence of robots and humans

Professor / KAWAMURA, Sadao

Our research focuses on the motion science of multi-joint structure common to both humans and robots, and its application. Due to multi-joint structure, the control of this motion becomes difficult. However, by developing innovative mechanisms and control systems, very efficient motion can be realized. In 2010, we are focusing on the following research projects:
(1) Realization of a Highly Energy-Efficient Robot based on Resonance Principles.
Theoretical and practical research is being carried out based on the resonance of mechanical stiffness devices. From a theoretical viewpoint, resonance for linear systems is developed to the nonlinear dynamics of robots.
(2) Development of a Human-size Underwater Robot with Dual Arms and its Testing in Biwa Lake.
We are focusing on the dexterity of an underwater robot with dual arms. A movable floating blocks system and a new type of controller for an operator have been developed. Experiments are conducted in both a pool on campus and in Biwa Lake.
(3) Realization of Muscular Structure Robots and High Performance Control.
A muscular structure robot resembling a human body has been developed using rubber actuators. Robust visual feedback control systems are being developed.

■Small underwater robot

Research/Development Areas

Understanding the dynamic phenomena of life's intelligence of motion and developing environmentally-adaptive robots with novel morphology and functionality

Professor / MA, Shugen

Nature systems behaving a body with a large number of degrees of freedom are often considered as the ultimate model for intelligence. To confer the performance advantage of animal systems on robotic machines, at this laboratory, we are carrying out the studies on a thorough understanding of the biological systems at both biomechanical and physiological levels and the developments of biomimetic intelligent machines, biologically-inspired robots and environmentally adaptive mechanisms with the keywords, 'biological system', 'intelligence', 'environmental adaptation', 'flexibility' and 'energy-saving'. Our research topics include - but not limited to - studies and developments of new types of robots such as snake-like robots and quadruped robots that have a similar body with animals and show the correspondent intelligence, and studies and developments of rescue robots such as crawler-driven robots that behave polymorphic motions and show better impact absorption ability.
http://www.malab.se.ritsumei.ac.jp/

■Upper left: A crawler-driven robot, upper middle: An in-pipe robot, upper right: A snake-like robot, lower left: A wall-climbing robot, lower middle: A quadruped robot, lower right: An omni-directional robot

Research/Development Areas

Development of medical welfare robot and ultra high-speed robot

Professor / NAGAI, Kiyoshi

1) Rehabilitation robot (international collaborative research with the University of Reading in England)

We are promoting the rehabilitation robot R4 used for the upper extremities that can be applied during rehabilitation in the acute stage after having suffered apoplexia cerebri in an intercultural exchange with researchers from the University of Reading in England where some of my graduate students and I visit.

2) Medical robot (collaborative research with Shiga University of Medical Science)

In order to realize a master-slave robot that can support surgery under MRIs etc we are working on research regarding a motion transfer mechanism that does not get affected by magnetic fields.

3) Assist robot

We are promoting the design of a mechanism for an assist robot for support in preventing lower back pain, the design of a control system and research on a distributed force sensor.

4) Ultrahigh acceleration robot

We are working on research on the ultrahigh acceleration parallel mechanism NINJA with the aim of realizing 100G and a parallel mechanism that can accelerate equipment on which electronic components are mounted.

Rehabilitation robot R4 (1st model)

Parallel mechanism NINJA

Research/Development Areas

Highly Functional Small Medical Robots/ Equipment

Professor / NOKATA, Makoto

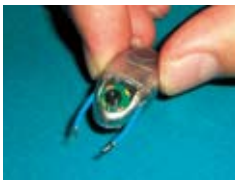
We carry out research into medical robots, highly-functional small medical equipment, and rehabilitation equipment in order to improve the quality of our daily lives.

[Capsule-Robots for diagnostic treatment]

We design and develop Capsule-Robots that can carry out inspections and provide medical care in the body cavity for a long time. Capsule-Robots move along the surface of internal organs driven by external magnetic fields. We research mechanisms that enable correct positioning in soft internal organs, a diagnosis function, a medical treatment function. We also develop a system that generates a magnetic field for the robots' movement in the body, and analyze the behavior of the Robots by use of movement simulation.

[Tool for minimally invasive medical treatment]

We develop tools for use in surgically treating internal organ with minimal damage. We design and fabricate a vascular catheter that includes micro forceps of 1mm in external diameter and a multi-functional endoscopic instrument for laparoscope assisted surgery. Our medical tools have multi-degrees of freedom and rigidity required in surgery even though very small size.



Capsule-Robot for diagnostic treatment with 30x15x8[mm] CCD camera and two forceps

Micro forceps of 1mm in external diameter mounted on the tip of vascular catheter

Research/Development Areas

Biological and Physiological Engineering / Engineering in Medicine and Biology

Associate Professor / OKADA, Shima

We have been devoted to biological and physiological engineering. We have five main themes, 1) Development of biomedical sensors, 2) Healthcare monitoring, 3) Brain machine Interface and 4) Development of Sports instrumentation. Additionally, Dr. Shima Okada is an expert on sleep research. We should approach the sleep monitoring with the ambulatory, unconsciousness, noninvasive and long-term monitoring in daily life. Newly critical sensor has to be developed. We focused on the relationship to assess the sleep quality and investigated the body movement measurement technique using video analysis. We successes to monitor sleep stages only using the body movement date obtained from this technique. We applied this technique for assessment of Obstructive Sleep Apnea Syndrome (OSAS) therapeutic efficacy. Apply our technologies for clinical and commercial products. Many of our research area include sleep, but not are limited to only sleep research. Our research key words are Medical, Welfare, Healthcare, Sports and so on.

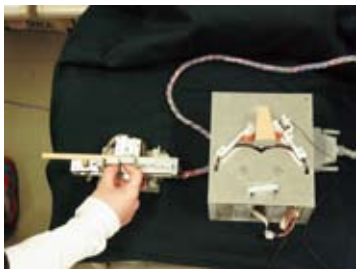
We propose an advanced motion classification method combined arm-shape-changes with sEMG to classify the detailed motions which is difficult motions to classify using only sEMG signals and to improve the classification accuracy of various hand motions as compared with previous methods.

Research/Development Areas

Development of motion control of robots and mechatronics robot system

Professor / OZAWA, Ryuta

The main interests of the manipulation laboratory are to design controllers of robotic hands and arms to enable dexterous motion such as grasping and reaching, and to develop robotic systems such as tendon-driven mechanisms. The tendon-driven mechanism is one of the technologies used in robotic transmission systems to drive a linkage mechanism with the use of wires, and is often used to perform features of the musculoskeletal system. We are currently analyzing tendon-driven mechanisms to understand the important characteristics of musculoskeletal systems, such as variable stiffness properties and the connected motion shown at the interphalangeal joints of the index finger. We are also developing other mechanical systems such as a new mass measurement system, an ankle-foot orthotic system, and a tele-operation system.



Tele-operation of finger robot

Full/under-actuated tendon-driven finger robots

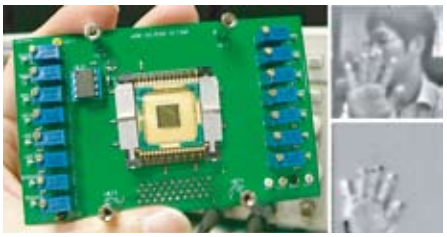
Research/Development Areas

Intelligent vision system for autonomous robots

Associate Professor / SHIMONOMURA, Kazuhiro

We are studying intelligent sensing systems for autonomous and adaptive robotic systems. Our research topics include an intelligent vision sensor with a design inspired by the biological vision system (neuromorphic vision sensor), a real-time robotic vision system with VLSI technology, and a device for integration of sensory information obtained from different types of sensors (sensor fusion). In addition, we are applying the vision-based sensing systems to robotic controls, such as mobile robot navigation and target tracking with active vision.

Stereo vision based target tracking



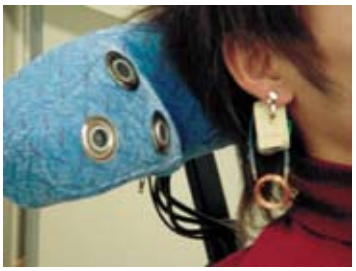
Neuromorphic vision sensor

Research/Development Areas

Research and development of assistive technologies for persons with disabilities and the elderly

Professor / TEJIMA, Noriyuki

We are developing assistive technologies (AT) for use by persons with disabilities and the elderly and doing basic research. We are proud that our laboratory has the most different commercially-available AT found in science and engineering laboratories in Japan and students commence learning from first experiencing the superior points and problems of AT by using and comparing them as research that does not include any hands-on experience frequently becomes merely paper theory. This laboratory is a part of the robotics department; however, we aim at developing useful equipment, even if it is rather low-tech and regardless of high-tech mechatronics equipment. The themes of research includes the development of a safety mechanism for rehabilitation robots, the development of a more comfortable cushion for a wheelchair, basic research on amusement equipment for the elderly, and the development of an earring type input device for tetraplegics etc.



Experimentally produced earring type input device

Scene of experiment where elderly people interact with a radio control toy

Department of Civil Engineering

Research/Development Areas

Environment Management and Disaster Mitigation in Forested Areas

Associate Professor / FUJIMOTO, Masamitsu

The number and scale of sediment disasters are increasing due to climate change. Frequent heavy rain and huge typhoons may cause severe disasters such as shallow and deep landslides, and debris flows as well as natural landslide dams across a wide area and they would seriously harm human life and activity. To protect our life and activity, we must understand the risks of sediment disasters and the countermeasures, especially in mountainous areas. In our laboratory, we conduct research on landslide phenomena using several methods, including onsite measurement of subsurface water (soil and groundwater) movement, laboratory landslide experiments, and numerical simulations of rain infiltration/groundwater movement/landslide processes. We are also seeking for effective countermeasures against sediment disasters that consider both conservation of the natural environment and the protection of human life.

■Laboratory experiment and numerical simulation of landslide

Research/Development Areas

Ground disaster-prevention engineering and geomechatronics

Professor / FUKAGAWA, Ryoichi

At this laboratory we are researching (1) ground disaster-prevention engineering, (2) geomechatronics, and (3) environmental geotechnical engineering. With (1) we are handling research on ground disasters (slope disasters in particular) to prevent disasters from destroying our cultural heritage as a member of COE or G-COE. We are also working on a wireless slope disaster prevention system in cooperation with information system and sensor system researchers. We are planning to work at helping to conserve the world heritage sites in Viet Nam in the future. With (2) we are carrying out research on the mutual action of machine systems and the ground in a resource development on the moon in cooperation with researchers from JAXA (Japan Aerospace Exploration Agency) etc. Geomechatronics is the name of a research field that concerns the automation and robotization of operating machines for the ground. With (3) we are carrying out research on the spreading of ground pollution due to heavy metals and oil and a method of controlling it.

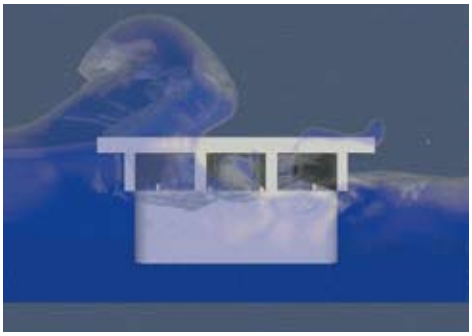
■Long-term measurement implemented at Kiyomizu Temple using the slope disaster prevention monitoring system. A tensiometer that measures the water volume of the surface layer of the slope is the center of the sensor.

Research/Development Areas

Earthquake disaster mitigation of infrastructures

Professor / IZUNO, Kazuyuki

The critical responsibilities of the engineering discipline in helping to ensure the safety of people and society have much in common with the role played by medicine in protecting and preserving human life. Our laboratory promotes research aimed at protecting people, communities and their cultural assets against the effects of earthquakes and other natural disasters. Destruction of one or more bridges can significantly compromise logistic operations, not only having a major impact on daily living activities but also delaying resumption of pre-disaster conditions. We conduct experiments and numerical analysis in response to the need to ensure design and construction of safe, robust bridges with designed-in resistance to seismic vibrations and to tsunami forces in the case of coastal areas.



■Simulation of tsunami surging toward a bridge

Research/Development Areas

Materials and structures for sustainable infrastructures

Associate Professor / KAWASAKI, Yuma

Our laboratory is researching (1) Non-destructive testing of materials such as concrete, metal and rubber, (2) Porous concrete for sustainable environment, (3) Development of new materials or structures. (1) In order to use infrastructures long term, the maintenance technique with high accuracy is needed. (2) Porous concrete are known as good materials for improvement of water quality. We are researching to apply in any other application. (3) We are researching development a new material for sustainable infrastructures.

■Acoustic Emission measurement which is one of the non-destructive testing of laminated rubber bearing.

Research/Development Areas

Soil investigation and its application to intelligent earthworks and geo-disaster prevention

Professor / KOBAYASHI, Taizo

We are working on practical engineering studies related to “Ground” based on our two fields, “Soil mechanics” and “Soil investigation.” Our recent activities include (1) hazard assessment of slope disaster using an in-situ investigation system, (2) development of intelligent earthwork equipment, (3) implementation of testing tools to maintenance of soil structures and (4) studies on interactions between robots and lunar/planetary surfaces in space exploration. What and how shall we obtain information of the ground with high uncertainty and heterogeneity? How shall we use that information for construction and maintenance? These are challenging researches that demand deep knowledge of soil mechanics, expertise in testing and sensor technologies, and among others, unique creative power.

■Subsurface soil strength measurement using a miniature borehole testing tool

■Quality assurance testing of soil compaction using a ground penetrating radar

Research/Development Areas

Strength of steel structures, maintenance of steel bridges

Professor / NOZAKA, Katsuyoshi

At the bridge engineering laboratory we mainly carry out research on the design of steel bridges and their maintenance. For use as data needed to design steel bridges economically we are clarifying the strength of members through experiments and analyses. Through experimental tests, it is possible for us to see and feel the strength of steel members and to get to know a bit about the strength of the structures our lives depend on. Many structures around us have been in public use for long time and some of those have some structural damages. Hence we are researching a method of safely using them for longer through maintenance and strengthening. As one possible method, we are studying the use of carbon fiber reinforced polymer (CFRP) plates. CFRP is light but has much strength and rigidity than steel material, and it has begun to attract attention as an effective material for strengthening and maintenance use in the future.

■Experiment on the strength of a steel girder
(Heavily deformed shape indicates the ductility of steel)

Research/Development Areas

Travel behavior analysis and traffic phenomenon analysis for urban transport planning

Professor / OGAWA, Keiichi

We are carrying out research on urban transport that encompasses the movement of people in cities along with the movement of bicycles and vehicles on roads. In order to ease traffic congestion in cities and thus traffic jams and accidents the behavior of people moving in cities and the behavior of people driving cars need to be analyzed, and appropriate traffic management policies and road safety practices then considered.
Travel behavior such as with work trips, commuting to school and shopping is implemented by everyone on a daily basis, and thus is a field that involves behavior in everyday life, and therefore a target of research that can take place anywhere in people’s daily lives.

■Video recording image used to analyze the movement of vehicles at a crossroad

Research/Development Areas

Creation and management of sustainable cities

Associate Professor / OKAI, Yuka

It is anticipated that due to depopulation and global environmental issues cities will shrink instead of expanding continuously.In this context, the modern city planning methodologies need to be reviewed to reflect the current status of urbanization, which can therefore contribute to creating rich, dynamic,and sustainable cities.
Our study focuses on the techniques for measuring the shrinking cities and the maintenance technologies in the advanced urbanized societies and advice on how to achieve sustainable cities, which can take advantage of the regional characteristics. We conduct research on the city systems, regional planning, and management systems of the cities that fully utilize participation and consultation offered by diversified bodies, including national and local governments, citizens, and NPOs. We also carry on comparative research on European cities and especially refer to the French cities.

■Lille (France)

Research/Development Areas

Design and city planning for environmental preservation and fire disaster mitigation of wooden cultural heritage and historic cities with regional natural water and communities

Professor / OKUBO, Takeyuki

The aim of our research is to design the safe and beautiful cities and regions in a composite study field, which incorporates the conservation of cultural heritage and disaster mitigation planning for cities, two areas that have traditionally been implemented separately. In particular, we are carrying out planning research for the revitalization and disaster-mitigation of historic areas related to the activities of "Institute of Disaster Mitigation for Urban Cultural Heritage". We are also committed to making a contribution to society in the creation of beautiful environments with abundant space and water that can be utilized even in case of post-earthquake fires. This includes the creation of regional disaster mitigation plans for historical city-scapes with the participation of the local communities, the discovery of traditional knowledge of disaster mitigation in history, and effective evaluation by modern science. For example, we are also involved in the water resource development plan for disaster mitigation in the flammable and historical region around Kiyomizu-dera Temple, which is being put into practice by Kyoto-city. Through these kind of projects in Japan and overseas, we are taking part in practical research for making disaster mitigation plans and evaluations by inhabitants and the government for sustainable social services.

■Developed Easy Hydrant System using Stocked Rain Water: it can be operated by single person and equipped in Kiyomizu Historic District by Kyoto Fire Department.

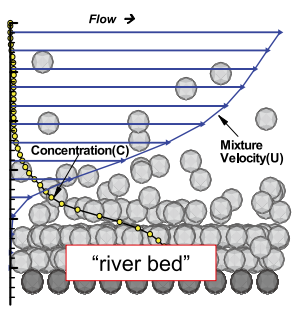
Research/Development Areas

Dynamics of riverbeds during flooding

Professor / WELLS, John C

Recently flooding damage due to hurricanes (typhoons) has been increasing due to changes in the global environment. Hence river engineering, especially forecasting of flooding and sediment disasters, have been growing in importance. In the fluid mechanics laboratory, we perform research on turbulent flow in rivers, and on the basic processes of sand particle motion on river beds.

The "bedforms" on a river-bed (for example the "sand wave" known as a "dune") is formed by erosion and deposition of particles by flowing water. Dunes are important, because they can block the flow of floodwaters, causing the river to overflow its banks. To better understand how dunes form, we are developing a computer simulation of erosion and deposition at a riverbed. The method is similar to the computer simulations of the airflow in the atmosphere that are used in weather forecasts. We are also developing advanced measurement technology to check the simulations.



■World's first "bedload DNS" developed at Ritsumeikan University.
In order to clarify bedload phenomenon a "direct" numerical simulation method that can handle heavily-concentrated solid-liquid two-phase turbulent flow, Direct Numerical Simulation; ("DNS") was developed.

Research/Development Areas

Seeking the ideal situation of a river basin

Professor / SATOFUKA, Yoshifumi

Rivers are not just for channeling precipitation (rain and snow) down to the mouths of rivers but also for the cycle of various substances. Landslides carried by the flow of a river have generated changes in landforms and created various natural environments through the organic substances that form in mountainous areas and forests. However, people have evolved using the sustenance of rivers since early times and have changed river basins according to their wishes while being occasionally faced by disasters such as floods and sediment disasters. In recent years catchphrases such as protection and conservation of the natural environment have become in vogue and the opinion that the approach to rivers by humans should be controlled as much as possible is growing stronger. At this laboratory we are researching the outflow phenomenon of water and landslides in river basins and how it can change the form of the land. We are also researching a method sophisticatedly balancing human society with the river environments by confirming the effect of such phenomenon on ecological systems and past river development transitions etc.

■Checking the outflow process of water and landslides at the Kusatsu river basin where a new river road was constructed.

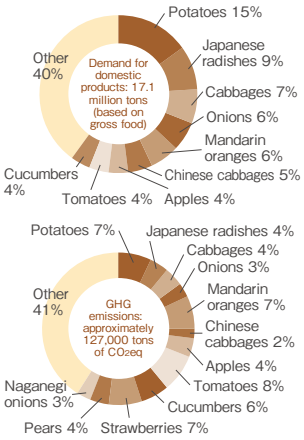
Department of Environmental Systems Engineering

Research/Development Areas

Relationship between environmental problems and the social economy

Professor / AMANO, Koji

With the environment you cannot just say “Clear up the water!” or “Recycle waste!” Because humans do live on the earth the water has become polluted and waste discharged. The important thing is to think about maintaining a good balance. An important concept here is the Life Cycle Assessment (LCA) that can be used to evaluate various problems with consideration given to the whole life cycle (or from the cradle to the grave). Global environment problems are especially complicated and you are damned if you do and damned if you don’t. This environmental system laboratory is a “convenience store for environmental problems” that promotes research using the abovementioned LCA method. Characteristic of it is that we are carrying out research in accordance to the demands of society by importing all the possible academic fields that could be necessary, regardless of specific expertise.



■Emission of greenhouse effect gas (GHG) caused by the demand for domestic fruit and vegetables and their consumption

Research/Development Areas

Assessment and design of sustainable resource and waste management systems

Professor / HASHIMOTO, Seiji

Development of a socioeconomic system that cyclically uses limited earth resources at an appropriate level is an important task to achieve a sustainable society, given an increasing and increasingly wealthy global population. Our laboratory intends to conduct research that contributes to the development of such a socioeconomic system from the viewpoint of a systems analysis approach. Our work will answer the following questions confronting Japan and the world:

- What is sustainable resource and waste management? How should progress to a sustainable resource and waste management be measured and assessed?
- What is the status of material cycles in our society? What will it be in the future? What technological systems of resource and waste management should be developed?
- What are people’s attitudes related to sustainable resource and waste management? What social systems such as regulations and incentives should be developed for the formation of sustainable resource and waste management?

■Waste and resource issues are increasingly convergent.

Research/Development Areas

Evaluation and control of air quality/ malodors

Professor / HIGUCHI, Takashi

Measurement techniques to evaluate air quality and odors, especially using human sense of smell, is studied. In Japan, the use of “olfactory measurement” to assess malodors has been established by legislation, and the purpose of this study is to find the way of its application to comprehensive evaluations of air quality in the environment.

And, a biological treatment system is being developed for use in removing gaseous organic compounds (VOCs or Volatile Organic Compounds), which are major air pollutants currently, and odorants. This equipment is generally known as “biological deodorization” or “biofiltration,” and our research is focusing on high efficiency of pollutants removal and on fine control of microbial activity and biomass growth to achieve its practical use.

■Air sample at a spot of roadside is collected. Pollution level of the target air is evaluated using both human noses and instruments.

■A pilot apparatus of biofiltration system for the preparation of its practical use. Unique structures are equipped in gas-flow and filter material (patent has been approved)

Research/Development Areas

Phenomenon analysis for use in formulating environmental management plans and a policy analysis method

Professor / ICHIKI, Atsushi

Lake Biwa, for example, has a vast water catchment area with 100 or more large and small rivers flowing into it, thus making comprehension of the contaminant outflow and outflow characteristics of the water catchment area necessary in formulating appropriate water management policy to conserve water quality and carrying out concrete facility developments to controlling the outflow load of contaminants. We are therefore clarifying the existing characteristics of contaminants, their behavior characterization that includes generation, accumulation and outflow, and the mechanism of pollution, and working at making inspections and suggestions of appropriate water management policy using policy simulations and an environmental management model. Some concrete research themes are given below.

- Dynamics analysis of contaminating substances/small amounts of harmful substances in urban or agricultural land
- Existing evaluations of urban activity-derived air-pollution substances
- Ecological risk evaluations of small amounts of harmful substance that exist in the environment
- Development of a contaminant outflow management support system for the water catchment area of Lake Biwa and evaluation of its availability
- Water quality formation process for Lake Biwa and its model

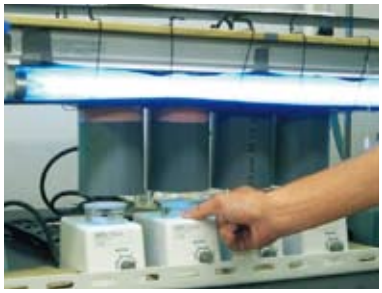
■Scene of river water quality survey from a ship in the Kapuas river in Indonesia

Research/Development Areas

Physicochemical processing method for safe tap water

Professor / KAMIKO, Naoyuki

Running water is essential in our lives as we are use it for cooking, doing the laundry, bathing, and for drinking.
However, it has recently been discovered that a disease organism called cryptosporidium could be threatening the safety of water. Cryptosporidium gets discharged from infected warm-blooded animals to survive and propagate in another warm-blooded animal within a shell that is immune to disinfectant like chlorine.
Something that cryptosporidium is not immune to though is water being irradiated with ultraviolet light. However, if the amount of ultraviolet light is too small the disinfection process can be insufficient, but if too much is used the equipment or operation can be uneconomical. We are carrying out various inspections for use in the appropriate design and operation of ultraviolet disinfection.



A Petri dish containing micro-organisms is sterilized using an ultraviolet lamp.

Research/Development Areas

Landscape planning for creating sustainable regions

Associate Professor / SASATANI, Yasuyuki

We are carrying out fieldwork in cooperation with the inhabitants, companies, and elementary school students etc around our university in rediscovering the attractive resources that are inherent to the region and proposing the creation of environmental towns and landscapes etc. As one method we are trying to make presentations to the general public so that they can comprehend the future image of their region easier by combining and registering photos, videos, animation and audio etc on computerized maps and creating the content mixed with media. More concretely we are reproducing the past landscape of the town using old maps or photos and the current landscape with three-dimensional graphics and displaying the landscape of a sustainable society for the future in three dimensions using those characteristics. We are also proposing circulative composite space utilization as a supply center of food and energy, conservation of national land such as through recharging water sources, conservation of life's diversity, the economic base of regions, and fields for recreational activities in the countryside and mountains near towns that have various values.

Registration of a future images drawn by elementary school students is supported.

Research/Development Areas

1. Impact assessment to water resource and ecosystems by global climate changes
2. Model development and field application of an Integrated Lake Basin Management method
3. Vulnerability analysis of sea level rise, storm surge, and tsunami

Associate Professor / SATO, Keisuke

There are serious water resource problems in the world. With forecasts of global warming and climate change intensifying in the future, safe and steady water supply will become more difficult for people and industries. It is therefore necessary to propose effective management techniques in our country that rely on the import of food and energy resources. In our laboratory, field investigation from lake Biwa and the Aso basin and experimental measurement of pollution loads are carried out. Moreover, an Integrated Simulation Model of atmosphere-soil-water-sediment has been developed. We use information technology, such as the latest global information obtained from GIS and satellites RS as an applicable method all over the world. Problem structures of water resource are comparatively analyzed in various regions. Additionally, by considering the limitation and environmental capacity in each region, new environmental policies are designed and evaluated quantitatively. Our final goal is to suggest more sustainable water resource management techniques.

A Bird's eye view of lake Baringo basin with GIS and Remote sensing, and a photo of the field investigation

Research/Development Areas

Implementation of intelligent transport systems for sustainable society

Associate Professor / SHIOMI, Yasuhiro

Transportation systems are one of the most essential infrastructures for our social activities and daily life. However, in densely populated area, traffic congestion, air pollution, traffic accidents and delayed public transportation annoy our daily life, while, in rural area, city area has been widely spreading due to motorization and the city center has been empty. It causes our society to decline sustainability, livability, and eco-friendliness. Our mission is to come up with smart and optimal transportation systems with "intelligence" and to achieve livable society. The fundamental research consists of the following three steps; i) getting better knowledge about the nature of transportation network dynamics, ii) developing methods to acquire these in sights, and iii) using this knowledge to come up with innovative traffic management approaches. The current research topics cover the following area: modeling traffic flow and driving behavior, developing traffic data collection technique and active traffic management systems, and analyzing traffic safety and travel behavior.

(Left) Active traffic management in the Netherlands,
(Right) Traffic survey in Makassar, Indonesia

Research/Development Areas

Wastewater treatment and resource recovery by using microorganisms and aquatic plants

Professor / SODA, Satoshi

The purpose of our laboratory is to develop technology for wastewater treatment and resource recovery by exploiting the abilities of microorganisms and aquatic plants.

A lab-scale membrane bioreactor for removing persistent chemicals

Landfill leachate treatment using lab-scale constructed wetlands

(1) Design and control of the biological wastewater treatment process

A variety of approaches are used, including the design and operation of the bioreactor, the gene analysis of the microbes, and mathematical models for removing persistent chemicals and toxicants.

(2) Wastewater treatment and biomass production using constructed wetlands

We are surveying the constructed wetlands for treating landfill leachate in Southeast Asia. We are also testing the approach of converting the plant biomass that grows in a constructed wetland into biofuels and biomaterials.

(3) Environmental assessment for developing sustainable wastewater treatment processes

By the introduction of a variety of energy-saving and energy-generating technologies, we are exploring the design of future sustainable wastewater treatment process.

Research/Development Areas

Development of technology in the field of construction and its application to other fields

Professor / TATEYAMA, Kazuyoshi

We are carrying out research on the development of technology for use in the field of construction, centering on civil engineering works, and in the field of architecture, and are working at the utilization of these research accomplishments in other fields such as agriculture. More concretely, we are developing intelligent construction technology for implementing sophisticated, but flexible construction and management according to the relevant field conditions. We are doing this by introducing the latest information and communication technology into construction practices, minimizing the energy and resources needed for the construction work, by developing technology for use in constructing cavities such as tunnels under the ground instantaneously using impact waves, by researching ways to predict the subsidence due to the ground failure of family homes and how to prevent it from taking place, by suggesting environmentally friendly plant factories that make maximum use of solar energy, and by researching the utilization of management methods applied in the field of construction for agriculture and food supply, etc. In addition, we are creating academic material in order to introduce the amusingness of science courses to elementary, junior high, and high school students using topics from the field of construction starting this year.

Carrying out a ground investigation in order to predict the subsidence of a building in a housing lot

Department of Architecture and Urban Design

Research/Development Areas

Architecture/urban environmental engineering, architectural equipment, environment coexistence

Professor / CHIKAMOTO, Tomoyuki

We are carrying out research on the design of architecture and cities/city blocks that can coexist with the environment, clarifying humans comfort/physiological phenomenon, and the establishment of a low-carbon society.

(1) Human-clarification of comfort/physiological phenomenon:
We clarify the comfort and physiological phenomenon people experience through architecture and various spaces in cities in studying the architecture and urban spaces people feel comfortable with.

(2) Architecture-energy saving efforts:
We are promoting the development of next-generation air-conditioning/heat source systems that balance energy saving with comfort and an eco-campus in addition to making suggestions on and evaluating new merchant houses in Kyoto utilizing traditional knowledge and environmental coexistence type architecture.

(3) City-safe city blocks/city designs that take the environment into consideration:
We are evaluating and researching urban greening and city block designs that lead to control of the heat island affect.

(4) Earth-aiming at a low-carbon society:
We are aiming at the realization of being a low-carbon society by establishing a model that incorporates traffic and transportation in addition to architecture and cities.

■Researching reduction of heat island affect by reproducing a city in an experimental wind tunnel laboratory

Research/Development Areas

Architectural design process

Professor / HIRAO, Kazuhiro

The concept and academic field of a “design process” exists with architecture and product design. It is a concept that evolved in the US and Germany in the 1960s, with researches on it having been carried out in the fields of industrial and architecture design.

Design cannot be promoted without a plan and is generally implemented with targets: (1) efficient allocation of time, (2) generation of ingenious ideas, (3) smooth formation of agreement with client/transmission of the intent of the design, (4) expressive presentation etc according to the plan. Performance can be improved by intentionally following these processes toward a specific result. From the methodology given above we focus on the expression technique such as in making sketches and invocation via the means of the imagination that are evolving in the planning field etc and carrying out research on verifying the efficiency of the processes using actual projects and competitions.

■Project model

Research/Development Areas

Analysis of hygrothermal environment of buildings, Evaluation of human sensations

Associate Professor / LEE, Myonghyang

In recent years, the demand for a highly efficient and comfortable hygrothermal environment has increased. Therefore, it is necessary to consider the heat insulation, air-tightness performance, the indoor residential environmental performance and the equipment efficiency, etc. of the building at the planning phase. In order to create an energy-saving and comfortable living environment, we are researching on the durability of the building, the human health, the energy conservation and the thermal comfort.

The main research themes are as follows;

(1) Effective utilization of the natural energy of the passive and active methods
(2) Proposal of the high performance building for the energy conservation
(3) Dynamic prediction and evaluation of the hygrothermal environment of the whole buildings
(4) Development of the building envelope system for high durability (evaluation of moisture condensation proof)
(5) Evaluation of thermal comfort of the human body
(6) Coupled analysis of the building environment and human sensation of thermal comfort
(7) Optimal operation and installation of high efficiency equipment

■The high performance building utilizing hygrothermal property of red pine plank

Research/Development Areas

Buildings Production, Construction Materials and Structural design

Professor / MOCHIDA, Yasuhide

In a design process and the construction process of the building, we perform the original actions that are specialized in each. And we continue working hard to adapt to the demand of the times enough. I contribute to the society by building the convenient facilities and unprecedented huge space. Lately, we do not only construct new buildings. The preservation of an old building, the creation of the long-lived building and the consideration to natural environments become important. My present studies relate to the communication and management in the construction. For example, the research and development on method of the earthquake reinforcement including seismic Isolation retrofit. The maintenance by the dry crazing control technology of concrete structures. The development of relays such as a carbon fiber rod using the thermoplastic resin or the high-strength fiber composition laminated lumber. Application of information and communication technology in the quality control of the ground improvement body using electric ratio resistance investigation.

■Production scenery of the carbon fiber rod specimen of the impregnation in thermoplastic resin

■Visit scenery of concrete placing work

Research/Development Areas

Providing new design methodologies for architecture and working on practical architectural projects

Professor / MUNEMOTO, Shinsaku

The purpose of our laboratory is to provide design methodologies for architecture that are based on human senses and behavior. For many designers it is difficult to explain these ideas clearly. Even though there are already many basic, established theories on architectural planning and design, the conceptualization of a design is primarily based on one's personal sense and knowledge base without obvious evidence. In response to this, our laboratory is trying to incorporate the modeling of human feelings, eye motion and brain activities into design methods for the solution of such problems. We are also working on practical architectural projects and international competitions as another avenue towards developing methodologies for the design of new architecture.

■Discussion of projects making models and drawings

Research/Development Areas

Morphological Analysis and Planning of Architectural/Urban Space

Professor / OIKAWA, Kiyoaki

We are developing theories for use in objectively describing, analyzing and evaluating the characteristics of spatial forms and structures in built environments such as cities and buildings from the point of view of morphology and geometry. We are also researching methods of applying it in actual urban planning and architectural design. The research themes we are currently working on are given below.

(1) Architecture/urban space analysis: We are attempting to portray the spatial characteristics of buildings, urban facility allocation, land use, urban landscape, the flows of people and cars, and visible areas etc.

(2) Research and analysis on traditional dwellings and cities of the world: We are carrying out field investigations on the dwellings inherent to regions in comparing the correspondence between natural and social environment conditions and mutual spatial composition and positively researching the characteristics of dwelling culture.

(3) Practice of spatial planning: We are continuing to design houses, schools and commercial buildings, and with our involvement in a reorganization project of urban space.

■Scene of various activities such as the creation of a research article, creation of architecture/urban project drawing/model

Research/Development Areas

Landscape Architecture-planning/design of outdoor space

Professor / TAKEDA, Shiro

Landscape Architecture involves the planning and design of outdoor spaces, and include small scale spaces such as gardens and large scale spaces such as green areas in parks and street landscape etc. Differing to architecture plants are important material in those plans and design, and particularly in the case of large-scale outdoor spaces, it is frequently accompanied by public use. In modern society the system of belonging to a community, which is deeply rooted in a place, being lost because of the effect of urbanization and environmental problems etc. can be seen, and what is more there is no such system of voluntary green space management such as that in agricultural societies. Because of this we are researching how public outdoor spaces that everybody can feel to be their own space should be planned, with maintenance and management being important issues. Also, we are actively participating in design contests as a laboratory as a practical concrete design planning activity.

■Fabrication scene. At the landscape design laboratory presentation of projects using drawings and models is also carried out in addition to research articles.

Research/Development Areas

Logical structural design method based on principles of mechanics

Professor / YOSHITOMI, Shinta

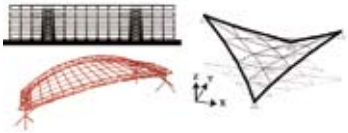
The structural design is not only related to the external form or internal space of buildings but also connected directly with the safety to various turbulences such as the winds or earthquakes, usabilities, and the construction costs.

Especially, the necessity ofadequate evaluation of the aseismic capacity for the built structure has risen caused by receiving the influence of the large earthquakes that happen frequently in recent years.

In our laboratory, the technique based on the structural mechanics principle is researched in order to support a logical structural design that appropriately considers such various actual conditions.

Logical structural design methods are proposed based on optimization of cost minimization or performance miximization considering various phase of structural design such as determination of the shape of building structure and the size of each material, or designing aseismatic and the vibration control system.

Moreover, to evaluatethe aseismic capacity of actual buildings, it researches concerning the system identification approach that clarifies the performance of structure based on the vibration measurement in the building.



Graduate School Application Information

Important Dates

	Regular Admission	Scholarship-Based Admission	
		Monbukagakusho Scholarship (MEXT)	Joint Japan/World Bank Scholarship (JJWBGSP)
Application Information Available	Early February	Mid-October	Late January
Application Deadline	Late May	End of November	Mid-February
Admission Results Released	Early June	Early February	Mid-March
Scholarship Results Released	Mid-July	Late June	Late June
Classes Begin	Late September		

Regular Admission: http://www.ritsumei.ac.jp/gsse/eng/fs/apply/application.html/
MEXT: http://www.ritsumei.ac.jp/eng/html/admissions/finance/host/fin_01_1.html/
JJWBGSP: http://www.ritsumei.ac.jp/eng/html/admissions/finance/host/fin_01_2.html/

Pre-Enrollment Scholarship Details

Scholarship Provider	Key Qualifications	Benefits	Period
MEXT (2016: 38 Awardees)	Age: Under 35 Level: Master or Doctoral Compelling Research Topic	Full tuition covered Round-trip ticket to Japan JPY 143,000-145,000/month stipend. The amount is subject to change.	Master: 2 years* Doctoral: 3 years* Research: 1.5 years *Cannot be extended
JJWBGSP (2016: 1 Awardees)	Nationality: World Bank borrowing member country Age: Under 45 Level: Master Experience: At least 3 (preferably 5) years work experience in development	Full tuition covered Round-trip ticket to Japan Travel allowance ¥170,000/month stipend	2 years* *Applicants must return to home country to work in development after graduation

For full details on scholarship eligibility and benefits, please see the pages above. Information is current as of February 2017, but subject to change without notice.

Admission Fee (Academic Year 2017 Entry)

(JPY)

Category	Type of fee	Fee
Admission Transfer Admission	Admission Fee	300,000

Notes: Payment of the admission fee is required in the year of admission only.

Tuition for Graduate Schools (Academic Year 2017 Entry)

(1) Master's Program (JPY)

Graduate School			1st Year		2nd Year	
			1st Semester	2nd Semester	1st Semester	2nd Semester
Science and Engineering (except for Mathematics Course)		Tuition	575,000	575,000	575,000	575,000
		Annual Sum	1,150,000		1,150,000	
	Mathematics Course	Tuition	537,500	537,500	537,500	537,500
		Annual Sum	1,075,000		1,075,000	

Notes: Of the third-year after the tuition fee will be the same amount as the second year.

(2) Doctoral Program (JPY)

Graduate School		1st Year		2nd Year		3rd Year		4th Year and after
		1st Semester	2nd Semester	1st Semester	2nd Semester	1st Semester	2nd Semester	Per Semester
All Graduate Schools	Tuition	250,000	250,000	250,000	250,000	250,000	250,000	250,000
	Annual Sum	500,000		500,000		500,000		

* Tuition fees may be revised when social factors, such as rapid inflation, have a significant impact on the University.

Application FAQ

Q1. What are the application requirement?

Requirements differ based on the application processes. Please review the links listed on the previous page for the appropriate eligibility criteria, required documents, and deadlines.

Q2. What is the minimum TOEFL Test®, etc., score required to apply ?

There is no minimum requirement, but all applicants are required to submit a certificate from an English language testing agency such as TOEIC Test®/ TOEFL Test®/ IELTS Test® so we can evaluate your language ability.

Q3. I studied in English for my undergraduate degree, do I really need to submit TOEFL® / etc. scores ?

Yes. All applicants must submit scores from an internationally recognized, standardized English language proficiency test, regardless of their previous academic experience or official language in their home country.

* For those who gained the credits in English on their previous program, the designated form of "Certificate of credit earned in English" with the signature of registrar and university official seal may replace above scores.
* Above certificate shall be considered as a judging material for application qualification. However, the English score for screening of Scholarships will be zero point.

Q4. Must I specify my desired advisor before applying ?

Yes. All applicants must choose a desired advising professor and write their name in the application form, regardless of their application type.

Q5. How can I view your list of researchers / professors ?

Please consult the Ritsumeikan University Research page at: http://www.ritsumei.ac.jp/eng/html/research/

Q6. How can I contact researchers / professors ?

If a researcher / professor does not release their own personal Email on the website, it is possible to make a request to get in direct contact with them by emailing the administrative office, Graduate School of Science and Engineering at: se-admw1@st.ritsumei.ac.jp

Q7. What is the screening procedure like ?

Screening is conducted primarily based on submitted materials. But an interview via email / telephone / etc. may be conducted if necessary.

Q8. Do you have spring semester admission ?

The English-language curriculum starts in September. Therefore we cannot accept applicants in English-language programs in the spring. For details, please see the Admissions Countdown page.
http://www.ritsumei.ac.jp/gsse/eng/fs/apply/admission.html/

Q9. Is Japanese language ability required ?

Since lectures are conducted in English, students are not required to have Japanese language training. However, some knowledge of the Japanese language would make it easier to transition into living in Japan. Students may also take various Japanese language course to orient them to day-to-day life in Japan and to aid interaction with other students within their research laboratories.

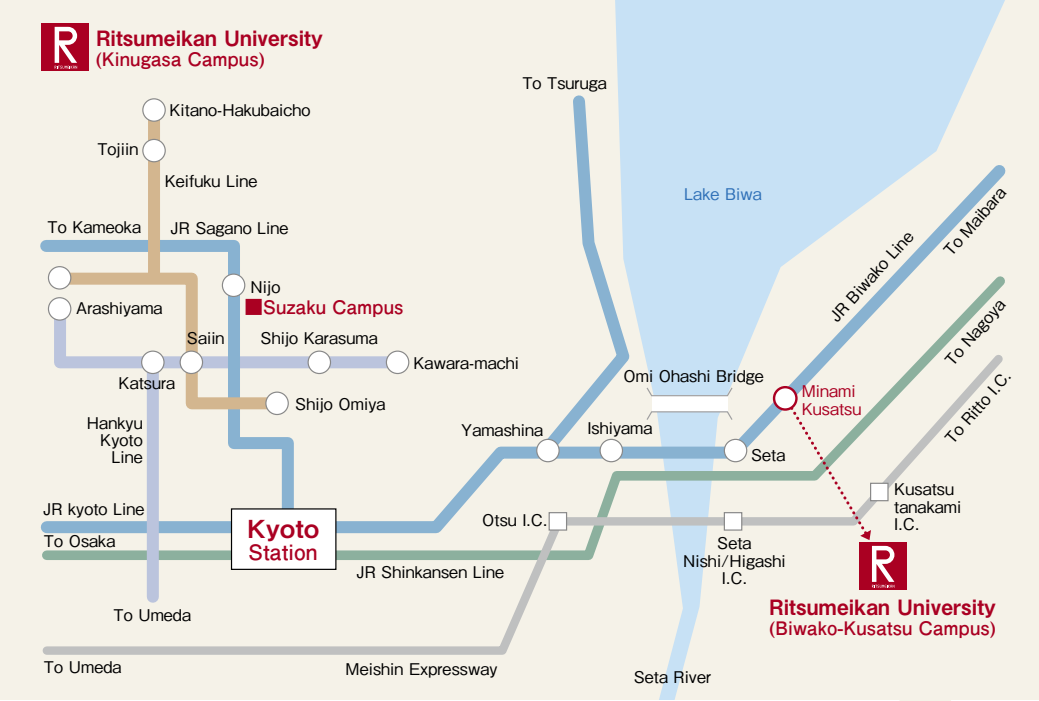
Q10. Can I review what graduates have researched in the past ?

Please consult the Past Research Topics page here.
http://www.ritsumei.ac.jp/gsse/eng/academics/past.html/

Q11. If I have other inquiries, who should I contact ?

Please send an email to: se-admw1@st.ritsumei.ac.jp

Access to Ritsumeikan



To Get to the Biwako-Kusatsu Campus of Ritsumeikan University

From Osaka or Kyoto

Take the JR to Minami Kusatsu Station (50 minutes from Osaka, 20 minutes from Kyoto). Exit the station on the south side (turning right after passing through the ticket gates). Take an Omi Railways Bus designated as either "Ritsumeikan Daigaku yuki（立命館大学行き）" or "Ritsumeikan Daigaku keiyu Tobishima Green Hill yuki (立命館大学経由飛島グリーンヒル行き)" and get off at "Ritsumeikan Daigaku（立命館大学）"(8 minutes).

For More Information

Please refer to the homepage for the latest information on scholarships, housing and other assistance.

HP: http://www.ritsumei.ac.jp/gsse/eng/

RITSUMEIKAN

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