College of Science and Engineering
Research Information

Aoyama Gakuin University

PREFACE

New master's program starting Fall 2017

All lectures and assignments in English

First program at the graduate schools of Aoyama Gakuin University

Cultivate solid abilities in our well-developed research environment

When I was in the third grade, I was deeply impressed by *Fabre's Book of Insects* and dreamed of becoming a biologist. However, when I reached my preteen years, my interest shifted to assembling radios. This hobby led me to studying RF engineering as a major in college. Though I changed my path, what is needed both in biology and engineering is the same—gathering data from objects, systematizing it, and finding out the truth.

The Graduate School of Science and Engineering at Aoyama Gakuin University was founded in 1969. We are home to 135 faculty members and offer well-developed education and research programs. In each course, students can not only develop expertise but also build up accomplishments and communicative abilities through interactions with students and faculty from other courses.

We have furthermore established the Center for Advanced Technology (CAT) and advanced a wide range of research and development projects aspiring to the basic philosophies of conducting "world-leading research" and "research open to the public." We have achieved numerous results including acceptance into the 21st Century COE Program. Our graduate students who are the product of such a fertile research environment, are now active in a wide range of fields, playing important roles throughout society.

We apply great passion to nurturing scientists and engineers capable of working globally. We hope you will be able to cultivate solid abilities as well as expand your realms of possibility through the variety of experiences available at our campus.

Professor **Osamu Hashimoto**
Dean of the Graduate School of Science and Engineering
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Department of Physics and Mathematics

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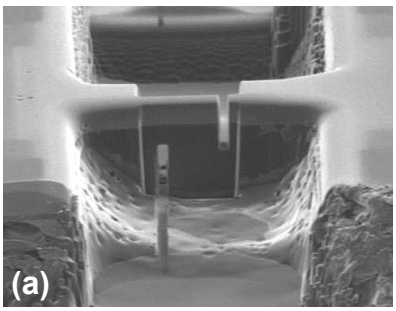
Research field	Solid State Physics, Superconductivity, Microwave Properties in Solids	
Keyword	Macroscopic quantum tunneling, Josephson effects, High -temperature superconductivity, Charge-ordered state in strongly-correleted systems	

Research content

My research is primarily focused on “superconductivity”, which is characterized by a sudden disappearance of electrical resistance below a low temperature. Superconducting materials are industrially applied to strong and compact magnets for magnetic resonance imaging (MRI) equipment and magnetically levitated (Maglev) trains. In my research, microwave techniques play an important role to elucidate unresolved phenomena observed in the superconducting state. Such techniques are also used in the recent information technology in our daily life. For instance, a central processing unit (CPU) in PCs is operated at 1-3 GHz in the microwave frequency range.

The quantum tunneling between two superconductors (Josephson effects) is expected to accelerate the processing speed of electronic devices. I aim for the application of Josephson effects occurring in cupper-oxide superconductors with layered-structure to the future quantum information processing technology (See also Figure). In my laboratory, graduate and undergraduate students go ahead with fundamental and application researches emerged from a combination of Josephson effects and microwave measuring techniques.



Recent Publication

[1] **H. Kitano**, Y. Takahashi, D. Kakehi, H. Yamaguchi, S. Koizumi, S. Ayukawa, “*Increase of phase retrapping effects in the switching rate from the finite voltage state of the underdamped intrinsic Josephson junctions*”, J. Phys. Soc. Jpn. 85, 054703 (2016).

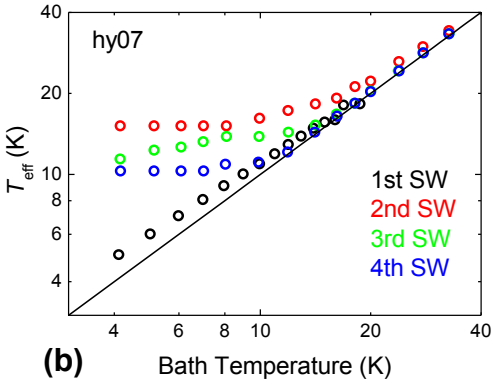


Figure caption (a) Scanning ion microscopy image of the intrinsic Josephson junction (IJJ) devices, (b) Plots of effective phase-escape temperature versus bath temperature, which are obtained from the analyses of phase switches in IJJs

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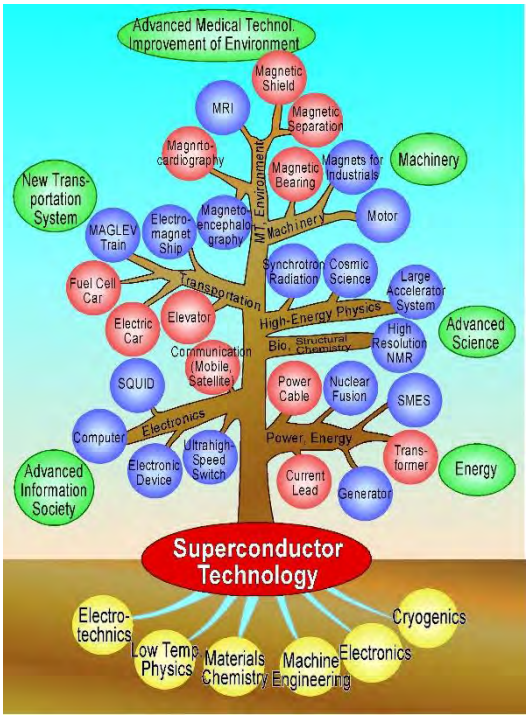
Research field	Materials Science of Solids	
Keyword	Functional oxide, Defect control, New superconductor, Superconducting properties, Superconducting materials	

Research content

Solid-state materials, such as metals, ceramics and glasses, had been developed to improve quality of life in very old days. Since the middle of former century when details of substances and materials were almost clarified, numerous artificial compounds with various functions have been developed. Various types of materials with functions, such as conductors/insulators, magnetism, dielectric properties, high-strength, catalytic activity and energy conversion, are well developed until today and they are contributing to sophisticated social life.

Based on these background, our research group has been studying on 1) development of new compounds with functions, 2) derivation of functions from already known materials, 3) dramatic improvement of properties enough for practical applications and these studies are carrying out with our original ideas and techniques.



Of course, we are enjoying our studies in particular for superconducting materials, because this research field has “dreams” of high performance, such as very high critical temperature and excellent current carrying properties, which are hardly predicted by theories. In other words, experimental results have been conducting new theories for understanding new phenomena in this field. The critical current density, which is the upper limit current density carried under zero resistance, is one of the most important properties for practical applications, however, it has many complicated determining factors which are not well understood. Sometimes we found breakthroughs leading large improvement of superconducting properties which can be applied for industrial productions. Application fields of superconducting technologies are illustrated in the figure.

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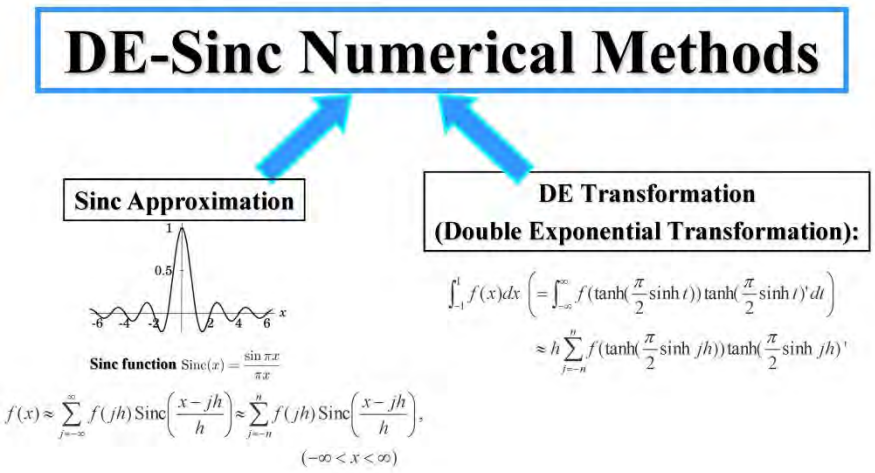
Research field	Numerical Analysis, HPC(High performance Computing)	
Keyword	Double exponential formula, Sinc numerical methods, Numerical linear algebra, Krylov subspace methods	

Research content

It is needless to say that the numerical computation is the basic technology supporting the current industry. In our laboratory, we are developing basic algorithms for numerical computation with the slogan " Faster and More accurate". Specific recent research themes include the following.

(I) Ultra-high precision numerical methods "DE-Sinc numerical methods"

The DE-Sinc numerical methods are Sinc numerical methods developed by Professor Stenger of University of Utah, incorporating DE transformations developed in Japan, by Professor H. Takahashi and Professor M. Mori. These methods have the feature that numerical errors can be reduced to the limit if the problem meets certain conditions, and they have the possibility of being applicable not only to computations in the natural sciences and engineering fields, but also to finance and social science widely.



(II) Efficient numerical methods for solving very large systems of linear equations, in particular, Krylov subspace iterative methods

Based on the research of the IDR (s) method, one of the most efficient solvers of very large systems of linear equations, we recently developed a more efficient solver, the "GBi-CGSTAB method", which is one of the Krylov subspace iterative methods. At present, we are reviewing the Krylov subspace iteration methods fundamentally, and developing a new solver.

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Research field	Mathematical Biology, Applied Mathematics	
Keyword	Mathematical modelling, mathematical biology, Lotka-Volterra equations, chaos, stability, ordinary differential equation, functional differential equation	

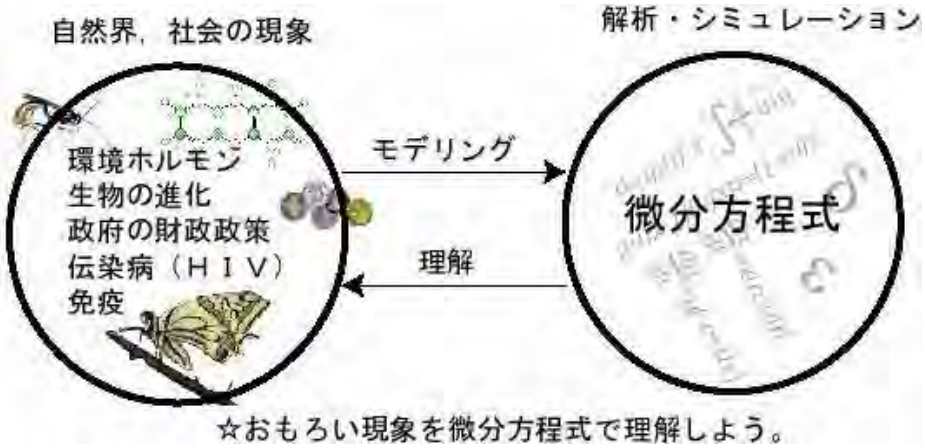
Research content

The dynamical systems are very popular not only for mathematicians but for all scientists. Mathematics had been developed together with physics from 19th century to 20th century, but now is expected to grow with biology. The construction of mathematical models for various phenomena in biology and the understanding their structures and functions are anticipated to solve the phenomena.

Our laboratory studies to understand various nonlinear phenomena in biology based on mathematics as follows.

1. First, find out the interesting and important phenomena in biology.
2. Construct the mathematical models to describe the phenomena.
3. Analyze the models by using analytical methods and computer simulations
4. When we obtain the mathematical property appeared in phenomena, we can use the models to understand the biology. Otherwise, we revise our mathematical models and repeat the above process.

For example, when the flue pandemic is expected to occur, it is difficult to do experiment in the real world but we can use mathematical models. It is expected that we can propose a useful strategy to prevent the pandemic by applying mathematical results obtained from mathematical analysis and numerical simulations.



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Research field	Analysis, Algebra	
Keyword	Representation theory of Lie groups, Whittaker model, Composition series of representations, Ring of commutative differential operators	

Research content

Representation theory of groups and systems of differential operators

My research interests are representation theory of Lie groups and Lie algebras. Especially, I have been interested in analytic aspects of them, such as systems of differential operators on homogeneous spaces and rings of commutative differential operators with group symmetry.

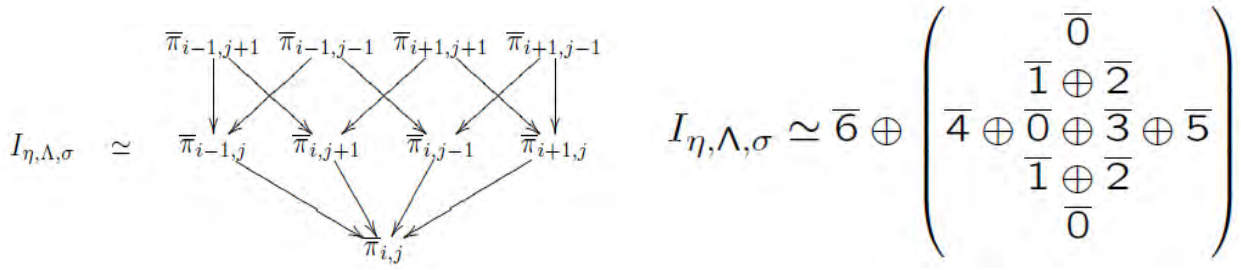
Recently, I am studying the structure of the standard Whittaker $(\mathfrak{g}, K)$-modules for real reductive linear Lie groups. These modules are admissible $(\mathfrak{g}, K)$-modules consisting of functions $f(g)$ in the space of Whittaker functions which satisfy the following conditions:

(1) $f(g)$ is a joint eigen-function of the center of universal enveloping algebra of $\mathfrak{g}$ with eigenvalue χ_Λ.

(2) $f(g)$ grows moderately at infinity.

If the eigenvalue Λ is generic, I completely determined the structure of the standard Whittaker $(\mathfrak{g}, K)$-modules.

When the eigenvalue Λ is integral, the structure of the standard Whittaker $(\mathfrak{g}, K)$-module is much more complicated. I determined the composition series of the standard Whittaker $(\mathfrak{g}, K)$-modules with regular integral eigenvalue Λ in the cases $G = SL(2,\mathbb{R}), U(n,1), Spin(n,1), SL(3,\mathbb{R})$ and $Sp(2,\mathbb{R})$. Now I am trying to show general properties concerning the standard Whittaker $(\mathfrak{g}, K)$-modules of split groups, such as "self-duality" and "good behavior under translation functors".



Figures: Structure of the standard Whittaker $(\mathfrak{g}, K)$-modules of $U(n,1)$ and $SL(3,\mathbb{R})$

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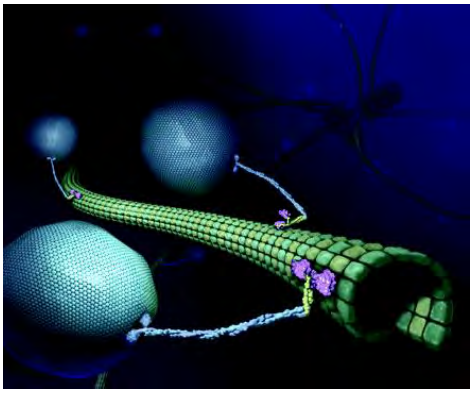
Research field	Biophysics, Motility mechanism of motor proteins	
Keyword	Molecular motor, Single molecule imaging, intracellular transport	

Research content

Life system works under the physics law. However, people tend to image that the life system is governed by a novel mechanism, as it is too complicated and sophisticated. Protein is the basic component of the life system, and is a molecular machinery of nanometer-sized that has been evolutionary created by the nature. Our research goal is to reveal the mechanism of the protein machineries on the basis of physics and chemistry laws. Especially, we are interested in the basis of the conversion of chemical energy to work or order by protein molecules. We are currently working on the molecular motor kinesin, which walks along a filament using two feet by converting chemical energy (see the picture below), to understand its walking mechanism.

To address these issues, we employ experimental techniques that allow us to visualize and manipulate protein molecules at a single molecule level under the light microscope: (1) detect movements of individual proteins at a nanometer accuracy by tracking fluorescence dyes attached to proteins, (2) detect conformational changes of proteins in the range of few nanometers using fluorescence resonance energy transfer, (3) measure the forces single protein molecule exerts at a pico-newton accuracy or measure the strain of proteins as they were deformed by external forces, using optical trap. Using these various single molecule technologies, we are studying to uncover the mechanism how the biological nano-machinaries works



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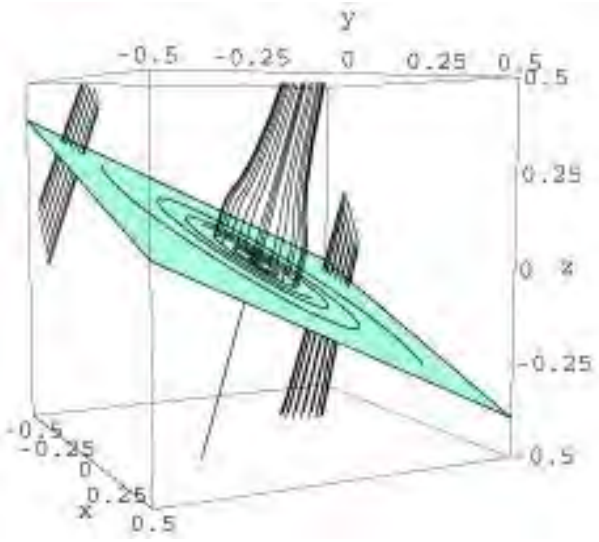
Research field	Topology, Dynamical System	
Keyword	Gottschalk's conjecture, minimal set, chaos, fractal	

Research content

No one believes the weather forecast; "It will be fine two weeks later". In my case, I don't believe the weather forecast of this weekend. The weather forecast is very difficult in science because the weather is chaotic. The chaos is a phenomenon that will be easily changed under the small perturbation of the current state. Please imagine the TV program of the weather focus. Nowadays we can see the video of the move of the cloud. You can easily imagine the situation that the weather will be different along three days under the small difference of the starting placement of the cloud. This is a chaos phenomenon.

The chaos phenomenon is one of the subjects of the dynamical system. The study of the dynamical system started 100 years ago in the filed of the astronomy, the three-body problem. Please imagine the situation when three stars move under the gravity. It is easy to make its differential equations in physics, but they are known to be quite difficult to solve mathematically. Even if they are open to solve, we can characterize the geometrical feature of the solution such as the collision, this is the dynamical system.



The target of my study is to solve the Gottschalk's conjecture; "There is no minimal flow on the three dimensional sphere?". This conjecture was proposed 70 years ago, but is still open. I started to try to solve this problem when I was a student of the doctor course, and have challenged it with the college all over the world.

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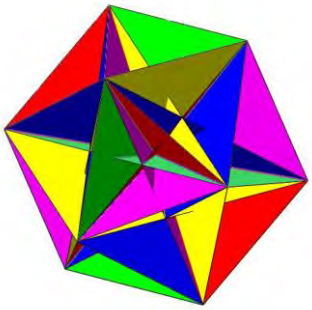
Research field	Representation Theory	
Keyword	Fourier Analysis, Harmonic Analysis, Lie group, Lie algebra, Invariant Theory, Algebraic Groups, Homogeneous Spaces	

Research content

There are various types of “symmetries” in this world. For example, flowers have beautiful symmetric shapes; the space which we live has its internal symmetry, i.e., it spreads out uniformly and it has the same property at any place; there are many beautiful tiling patterns in old Islamic abbeys like Alhambra for decorations; we, human, have a vertical symmetry along the center line of our body.

In mathematics, there exists regular polyhedrons which have beautiful symmetry, but there are only 5 of them! Of course periodic tiling patterns can be reformulated in mathematical languages, and it turns out that only 17 types of periodic patterns are possible. How we can conclude such kind of definite answer? This is achieved by the theory of groups acting various geometric (or algebraic) objects. I am strongly interested in those symmetries appearing in mathematics.



Once we know symmetries are governed by the concept of groups, we can also find other different kind of symmetries, for example, symmetries of algebraic/differential equations (this is called Galois Theory), internal symmetry of geometry (Theory of Homogeneous Spaces), or symmetry among combinatorial objects, mathematical formulas with symmetry (related to Invariant Theory). So we can apply group theory to study those symmetries and their applications are also my favorite things.

Let’s find beautiful and interesting symmetries together.

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Research field	Solid State Physics	
Keyword	Quantum Statistical Mechanics, Computational Physics, Strongly Correlated Systems, Quantum and Frustrated Spin Systems, Topological Phase Transition, Multiferroics and Cross Correlation	

Research content

We mainly focus on strongly correlated systems, including quantum spin and electron systems with various types of fluctuations. Many body effects which are not included in so-called band calculations are studied using numerical methods (computer simulations). Our theoretical results are compared with experimental data for strongly correlated materials such as transition metal oxides and conductive organic systems.

Our recent results incude:

- Investigation for the presence and its mechanism for novel electric polarizations in multiferroics iron-based oxide $BiFeO_3$, in collaboration with experimental groups [1].
- Investigation for the existence of the electronic chirality and the magneto-electric effects which cause optical anomalies in Cobalt-based oxide $Ba_2CoGe_2O_7$. International collaboration with experimental groups has been performed [2].
- Investigation for the full understandings of low energy electro-magnetic excitation spectra in perovskite-type manganites $RMnO_3$ which show electromagnon excitations [3].
- Theoretical studies for the mechanism of electric-field-induced magnetic-domain flips in orthoferrites $RFeO_3$. We proposed clumpings of multiferroics domain wall (domain walls involving multiple types of order parameters), which causes gigantic and non-volatile magneto-electric effects [4].

References:

[1] Magnetic control of transverse electric polarization in BiFeO3, M. Tokunaga, M. Akaki, T. Ito, S. Miyahara, A. Miyake, H. Kuwahara and N. Furukawa, Nature Comm. **6**, 5878/1-5 (2014).

[2] Chirality of Matter Shows Up via Spin Excitations, S. Bordacs, N. Furukawa 他 11 名, Nature Physics **8**, 734-738 (2012)

[3] Theory of electromagnon in the multiferroic Mn perovskites: Vital role of higher harmonic components of the spiral spin order, M. Mochizuki, N. Furukawa, N. Nagaosa, Phys. Rev. Lett. **104**, 177206 (2010)

[4] Composite domain walls in a multiferroic perovskite ferrite, Y. Tokunaga, N. Furukawa, H. Sakai, Y. Taguchi, T. Arima, Y. Tokura, Nature Materials **8** (2009) 558-562.

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Research field	Atomic, molecular, and optical physics, Atomic spectroscopy	
Keyword	Coherent control, Rydberg atom, Cold Rydberg atom	

Research content

Aiming at understanding underlying nonlinear physics behind interaction of atoms with electromagnetic fields, we have conducted several experimental studies in the research field of atomic, molecular, and optical physics. Some of our main subjects are listed below:

(1) Cold Rydberg atoms (Fig.1)

(2) Coherent control of atomic wave function (Fig.2)

(3) Interaction of strong microwave (MW) fields with Rydberg atoms (Fig. 3)

(4) Spectroscopy of highly excited Rydberg states of atoms (Fig. 2)

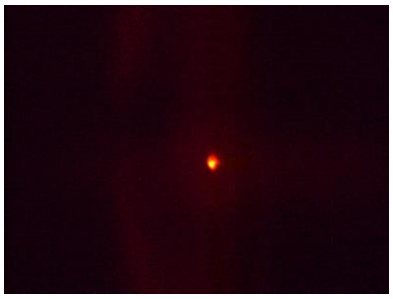

Fig. 1 Emission from the cold Rb-87 atoms trapped in the MOT

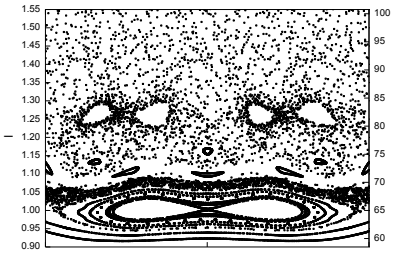

Fig 3. Phase-space plot of Rydberg atom orbit in bichromatic MW fields

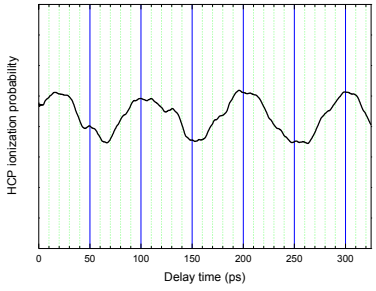

Fig. 2 Ionization signal of nondispsersing atomic wave packet

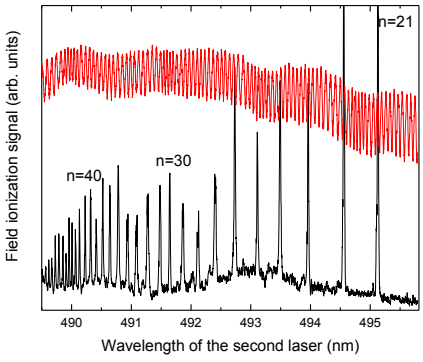

Fig. 4 Triplet Rydberg states spectra of Mg atoms

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Research field	Condensed Matter Physics, Physics of Friction	
Keyword	Friction, Lubrication, Pinning, Depinnig, Earthquake, Granular Systems, Tribology, Nanothchnology, Stick-Slip Phenomena, Amontons and Coulomb's law, superlubricity	

Research content

Physics of Frcition

Friction is one of the most familiar physical phenomena, and had been studied from ancient age. But the fundamental mechanism of friction is not unclear still now. Recently new experimental techniques and the progress of computer, numerical techniques, analytical methods enable us to investigate frictional phenomena from microscopic scale and lead us the new stage of the investigation of friction. We are studying various frictional phenomena, e.g. atomic scale friction, friction of single junction, friction of multi-junction system, the validity of Amontons and Coulomb's law, friction of granular systems, superlubricity, earthquake and so on by employing numerical, analytical and experimental techniques. Our final aim is to understand various frictional phenomena in a unified way.

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Research field	Probability Theory, Spectral Theory	
Keyword	Brownian motion, Laplacian, Diffusion process, heat kernel	

Research content

In probability theory, we give mathematical models which describe random phenomena and motions and analyze them. Recently, mathematical finance, in which we consider models of the movements of stock prices by stochastic processes and discuss the pricing of financial derivatives and optimization problems, are popular.

There are many phenomena in which we should take randomness into account and probability theory is related not only to economics but also to physics, technology, biology and so on. Historically probability theory has been developed in the relation to the latter subjects.

I study stochastic processes corresponding to second order differential operators, for examples, Laplacians and Laplace-Beltrami operators on Riemannian manifolds by using stochastic differential equations and theory of partial differential operators. As applications, I study spectral properties of the operators by investigating corresponding heat traces. In particular I am interested in Selberg trace formula, which shows a close relationship between spectral properties of second order operators and the classical mechanics. We can say that considering stochastic process is to carrying out functional integration. Some physicists study the same problem by using path integrals, but our arguments are mathematically rigorous.

I have been studying Riemannian surfaces and I am now trying to extend my field, for example, to the spaces of positive definite matrices. These spaces have attracted attention in statistics and in representation theory. In statistics the covariance matrix is a symmetric positive definite matrix and, in representation theory, it is a typical example of Riemannian symmetric space. I hope we can contribute to both areas by constructing the Brownian motions on these spaces.

On the other hand, when we look at classically known objects from modern point of view, we sometimes find new facts. In my study of Selberg trace formula, we need to consider geometric Brownian motion and its integral in time. These objects are closely related to Bessel processes, a classical stochastic process studied for a long time. Recently I studied the first hitting time of Bessel processes and it leads us to a formula for the zeros of Bessel functions. From the formula we can easily carry out numerical computations for the zeros, which represent some energies of a physical system. This result was not expected at all at the beginning.

I am going to continue my study on probability theory and its applications, keeping interests in various problems in wide range of fields.

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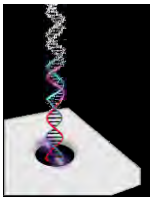
Research field	Surface Science, Biophysics, Nanotechnology	
Keyword	nanoscale devices, DNA, single molecule detection techniques, atomic force microscopy (AFM), heart, mechano-electric feedback, computational model	

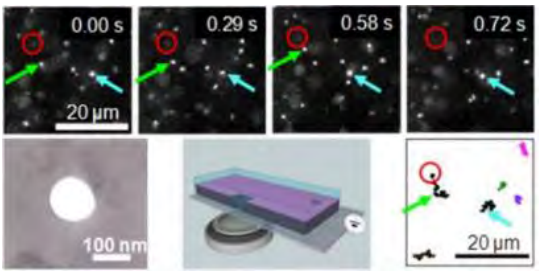
Research content

Nanotechnology has provided various fabrication techniques to create devices and the systems using diverse materials in nanometer-length scale. Such devices have discovered novel phenomena and physical properties in the similar length scale. These features have also upgraded the specification of conventional devices such as sensor sensitivity. We have developed a home-built system to detect single DNA molecules using nanometer scale pores, named nanopore. Currently, nanopore sensing is one of the most promising future DNA sequencer. Here are our recent research projects.



Fabrication of nanopore

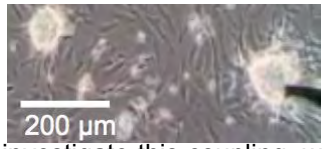
Our nanopore is milled on a freestanding SiN membrane of thickness < 200 nm. By using microfabrication techniques, such membrane and nanopore can be made. Furthermore, conductive films or patterned electrodes can be added to nanopore by evaporation or sputtering to control the potential at the nanopore.



DNA dynamics near nanopore

A DNA, a long molecule, often clogs inside a pore, which unfortunately eliminates its high sensitivity. To study how a DNA clogs, we have developed our nanopore device on the stage of a fluorescence microscope. This system allows us to visualize the DNA dynamics before a DNA enters a pore (see figure).

Heart diseases such as arrhythmia are the second most common cause of death, however the origins of these diseases are not known completely. Recently, numerical simulations of the heart have indicated that the mechanical excitation-contraction coupling is necessary to regulate the heartbeat rhythm. To investigate this coupling, we have built an instrument to induce external mechanical stimulation experimentally on a cardiac cell aggregate.



Periodic mechanical stimuli on cardiac cell aggregate

In contrast to electric stimulation, the effect of mechanical stimuli on an aggregate was spatially limited but similarly regulated the spontaneous beatrate. However, a slight change of either the phase or period led to arrhythmia.

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Academic society	The Mathematical Society of Japan	
Research field	Probability Theory, Partial Differential Equations	
Keyword	Stochastic optimal control, Hamilton–Jacobi–Bellman equation, viscosity solution	

Research content

My research interests are in the areas of probability theory and partial differential equations (PDEs). There is a close connection between these two areas: the probability theory is very useful for solving problems in partial differential equations, and vise versa. I'm especially interested in such relationships arising in the stochastic optimal control theory. From the probabilistic point of view, it is concerned with the expectation for certain functionals of stochastic processes, while it is regarded as a solution to the so-called Hamilton–Jacobi–Bellman equation (HJB equation) in the PDE theory.

My recent research mainly focuses on the following topics:

- Ergodic problem for Hamilton–Jacobi–Bellman equations
- Criticality theory for viscous Hamilton–Jacobi equations
- Large time behavior of solutions to semilinear parabolic equations
- Homogenization for fully nonlinear partial differential equations

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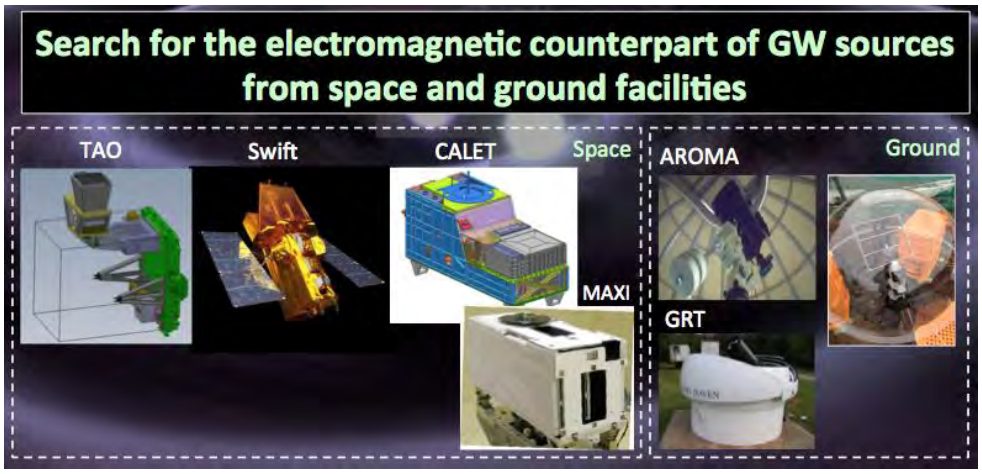
Research field	Astrophysics, X-ray and gamma-ray astronomy	
Keyword	Gravitational wave astronomy, Gamma-ray burst, Terrestrial gamma-ray flash, Sprite	

Research content

My main research goal is to discover the electromagnetic counterpart of gravitational wave sources from various space and ground observations. In 2015, Laser Interferometer Gravitational-Wave Observatory (LIGO) detected the gravitational-wave signal from the astrophysical source for the first time. A gravitational wave was predicted by Albert Einstein in his theory of general relativity. The gravitational-wave signal detected by LIGO was caused by the merging event of two several tens of solar mass black holes. As "neutrino astronomy" was established by the detection of neutrinos from the supernova explosion, the discovery of the electromagnetic counterpart of gravitational-wave sources is crucial to start the new astronomy of gravitational waves. I will challenge on discovering the electromagnetic signal of gravitational wave sources based on various observations.

- Search for X-ray and gamma-ray counterpart of gravitational-wave sources from NASA Swift satellite and CALET and MAXI experiments onboard the International Space Station.
- Development of a future space mission to search for the electromagnetic counterpart of gravitational-wave sources.
- Search for optical counterpart of gravitational-wave sources from the ground telescopes
- Development of a wide-field optical telescope.
- Research of transient sources (e.g., gamma-ray bursts) using the space and the ground data.



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Research field	Nonlinear Integrable Systems	
Keyword	(Discrete) Painlevé systems, Special solutions, Weyl groups, Integrable systems	

Research content

My research interests are nonlinear integrable systems and related topics. Recent studies are on special solutions and symmetries of the discrete Painlevé equations and their higher order analogues. The discrete Painlevé equations have been proposed as the second order ordinary difference equations which are reduced to the Painlevé equations in a continuous limit. A generalization of them to the higher order have been also studied. It is well known that these equations admit some special solutions described in terms of discrete analogues of hypergeometric functions or Schur functions when the parameters of the equations take some special values. I am interested in construction of such solutions explicitly.

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Research field	High-Energy Astrophysics,	
Keyword	Astrophysics, Cosmic-ray physics, Gamma-ray bursts, Supernova remnants, Laboratory astrophysics	

Research content

I'm interested in high-energy astrophysics.

(1) Gamma-ray bursts (GRB)

Gamma-ray bursts (GRBs) are the most violent explosive phenomena in the universe, which take place at the cosmological distance. Owing to the observational and theoretical arguments, it has been widely believed that gamma-ray photons are emitted by relativistic jets toward us, however, the central engines, that eject the jets, have not yet been fully understood. There are only a few (at least known) phenomena capable of supplying an extreme amount of energy instantaneously, such as the explosion of a massive star, the merger of compact objects, a strongly magnetized neutron star. These are clearly different sources, however, all are likely. The issue is what the main population is. I have investigated the emission mechanism of GRBs, aiming to reveal the origin of GRBs.

(2) Acceleration of High Energy Cosmic-Rays; Difusive shock acceleration

The origin of Galactic cosmic rays (CRs) protons with energies up to 10^{15} electron volt (PeV), has been one of the long-standing problems in astrophysics. At present, young supernova remnants (SNRs) are the most probable candidates for being the major accelerators of CRs, which are sometimes also thought to have been potential accelerators capable of producing charged particles at PeV scale. The acceleration mechanisms of CRs have also been studied for a long time. As of today, the most plausible physical process is suggested to be the diffusive shock acceleration (DSA) mechanism. This is supported by the observational fact that some young SNRs are found to be gamma-ray bright around their shock fronts. However, whether the DSA can fully explain all aspects revealed by the accumulating multi-wavelength observations still remains in doubt. I have investigated the DSA theory in detail, aiming to reveal the origin of CRs.

Department of Chemistry and Biological Science

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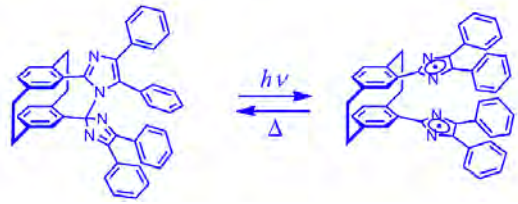
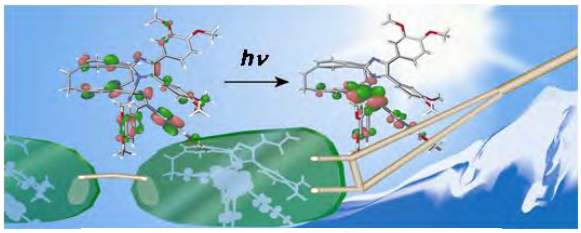
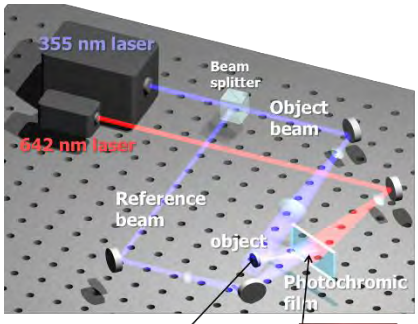
Research field	Physical Chemistry, Photochemistry, Functional Material Chemistry	
Keyword	Photochromism, Spin chemistry, Photosynergetics	

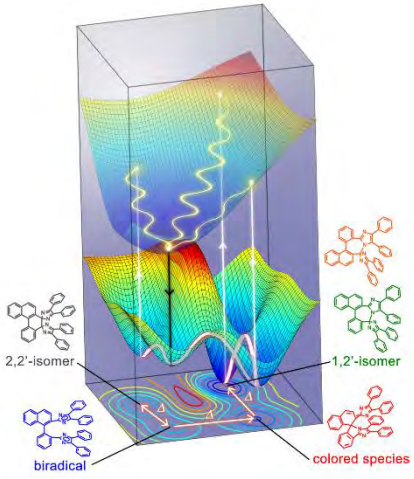
Research content

Photochromism is simply defined as a light-induced reversible change of color. In general, a colorless photochromic molecule colors upon irradiation with UV light, and returns to the initial colorless state either thermally or by subsequent irradiation with visible light. Although a photochromic molecule with high quantum yield and fast thermal back reaction was unknown, we have successfully developed fast photochromic molecules that show instantaneous coloration upon UV light irradiation and fast thermal bleaching within a few microseconds to a few hundred milliseconds in the dark at room temperature. In addition, we also succeeded for the first time in developing a real-time holographic material using a photochromic molecule, and in developing a photochromic fluorescence molecule that enables rapid fluorescence switching.









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Research field	Molecular Genetics, Cell Biology, Piezophysiology	
Keyword	Yeast *Saccharomyces cerevisiae*, Extremophiles, High pressure, Adaptation, Ubiquitination, Tryptophan permease, Leucine permease, Peptide transporter	

Research content

Integration of Piezophysiology and Yeast Molecular Genetics

The majority of the biosphere is occupied by the ocean, with an average depth of 3,800 m, and hence various marine organisms are subjected to high pressure of 380 atm. Why can deep-sea organisms survive under high pressure? On the other hand, a few hundred atmospheric pressures can also be loaded on our teeth or knees in our regular life. The challenges in piezophysiology are to identify the critical factors in cell growth, viability and metabolic processes under high pressure toward the establishment of molecular basis for high-pressure adaptation. Integration of yeast molecular genetics and piezophysiology has promoted the understanding of the effects of high pressure on cellular processes. In particular, we have demonstrated that degradation of yeast tryptophan permease was regulated by the ubiquitin system as a quality control of membrane proteins in response to high pressure. We are also exploring genes in deep-sea microbial genomes that are useful for industrial applications.

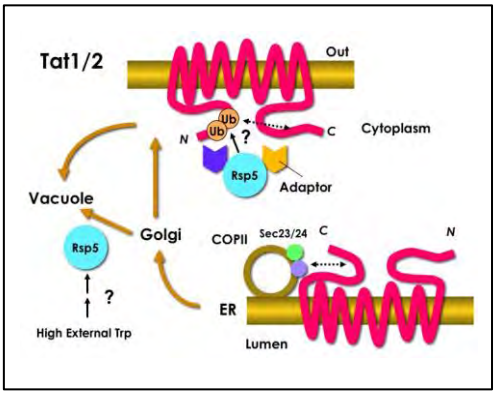
◆Research topics

(1) Ubiquitin-dependent regulation of yeast tryptophan permease under high pressure

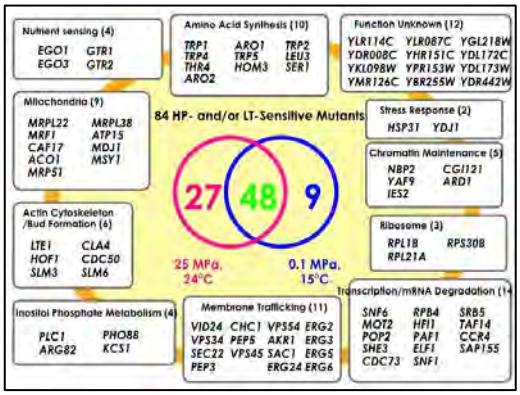
(2) Functional analysis of amino acid permeases

(3) Analysis of yeast genes required for high-pressure and low-temperature growth

(4) Exploration and application of extremozymes from deep-sea microorganisms



Ubiquitin-dependent regulation of tryptophan permease



High-pressure and low-temperature growth genes

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Research field	Physical Chemistry, Molecular Spectroscopy, Structural Chemistry	
Keyword	Infrared Spectroscopy, Raman Spectroscopy, Excited Sates, Time-Resolved Spectroscopy, Molecular Structure, Developments of New Spectrometers	

Research content

Our laboratory studies molecular structures of unstable and/or short-lived molecular species by using molecular spectroscopy, for example electronic absorption, infrared absorption, and Raman scattering spectroscopies. In addition to ordinary molecular spectroscopy, we use nanosecond to femtosecond time-resolved infrared and Raman spectroscopies, in order to elucidate molecular structures of photoexcited molecules.

■Snapshots of molecules

We measure snapshots of molecules, namely time-resolved molecular spectra at a certain moment and analyze molecular structures of short-lived molecular species such as photoexcited molecules using nanosecond (10^{-9} s), picosecond (10^{-12} s), and femtosecond (10^{-15} s) laser pulses (Photo 1).

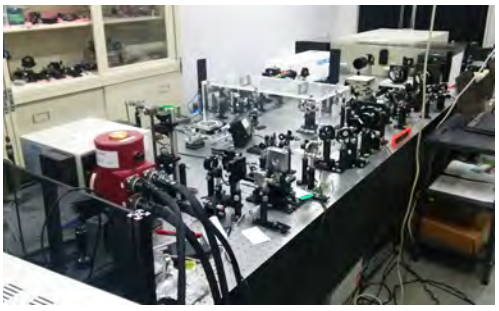

Photo 1 Time-resolved infrared and Raman spectrometers.

■Extremely unstable molecular species

Charge species (radical ions, divalent ions, and so on) of π-conjugated molecules play important roles in functional materials involving charge transfer such as organic electroluminescent devises and organic solar cells.

Organic radical ions and divalent ions are generally unstable at room temperature and in the air. We measure and analyze infrared absorption spectra of such unstable molecular species by using a Fourier-transform infrared spectrometer contained in an inert gas glovebox system (oxygen and water concentrations: <0.1 ppm) (Photo 2).

Photo 2 Experimental setup for infrared and electronic absorption measurements in inert gas globebox system.

■Development of Raman imaging spectrometer and its application

We developed a portable Raman imaging spectrometer in collaboration with some institutions. This apparatus enables us to obtain two-dimensional image based on Raman spectra in non-destructive and non-contact manner. We measured *Ukiyo-e* and their woodblocks in the Edo period and identified some pigments used at that time.

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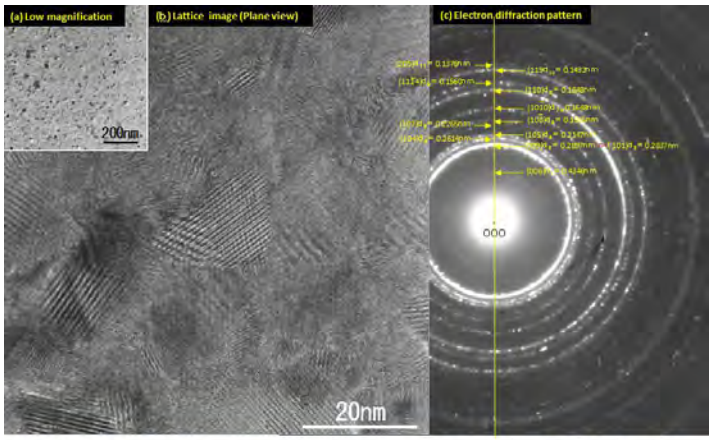
Research field	Synthesis and characterization of the functional inorganic thin films	
Keyword	Materials Science, Inorganic Chemistry, Solid State Physics, Solid State Chemistry, Inorganic Functional Thin Films, Transparent Oxide Electronics	

Research content

Reactive sputter deposition of the inorganic functional films with various performances:

Reactive sputtering using alloy targets should be one of the most promising techniques to achieve very high deposition rate for various industrial applications because sputtering yield of the metallic surface is much larger than that of the oxide surface and also the higher sputtering power density can be applied for metallic targets with the higher thermal conductivity. The reactive sputtering process, however, is strongly affected by the O_2 flow ratio; the deposition rate exhibits hysteresis with respect to the O_2 reactive gas flow rate. Such behavior originates in the oxidation state of the target surface, resulting in the marked decrease in deposition rate with the increasing O_2 flow. Therefore, the sputtering conditions should be precisely controlled so as to obtain high-quality transparent conductive oxide (TCO) films by reactive sputtering processes with a high deposition rate and with high reproducibility. In order for the precisely controlled deposition a specially designed feedback systems of discharge impedance or plasma emission intensity combined with mid-frequency pulsing were adopted. In this presentation, deposition processes of various functional oxide films with large area uniformity and with very high deposition rate based on the reactive sputtering technologies are under research. Especially the very high rate deposition of various TCOs, such as Al-doped ZnO (AZO), Sn-doped In_2O_3 (ITO), Nb-doped TiO_2 (NTO), or Sb (Ta)-doped SnO_2 (ATO, TTO) films by reactive sputtering using Zn-Al, In-Sn, Ti-Nb or Sn-Sb (Ga) alloy targets, respectively, have been studied in detail.



TEM Images and electron diffraction Pattern on In-Ga-Zn-O thin films

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Research field	Synthetic Organic Chemistry, Natural Products Synthesis	
Keyword	Marine Natural Products, Antibiotics, Nucleoside relating Bioactive Compounds	

Research content

The seeds for new pharmaceutical products are mainly explored from the organic compound provided by natural source (mainly microorganism and plant). However, the quantity of those samples obtained from the natural source is often a very small amount, and therefore the evaluation of those samples is insufficiently examined. In our laboratory, development in the synthetic route to supply such rare natural products by chemical synthesis and the new reaction to establish an efficient synthetic route is studied. It will be enabled to provide the rare organic compounds found in natural source in large quantities.

Main research subjects

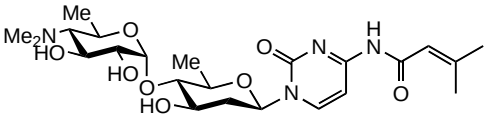
Stereoselective synthesis of purine nucleosides via intramolecular glycosylation

Synthetic study on the natural products containing cyclic ether moiety

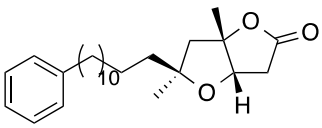
Development on novel transformation of functional groups starting from β,γ-unsaturated α,α-dimethoxy esters

Construction of tetrahydrofuran ring by annulation of aldehydo-aldoses and substituted olefins

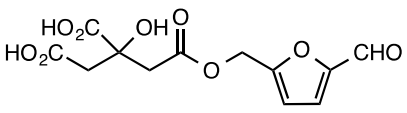
Natural products of which the total synthesis was achieved in our laboratory



Cytosaminomycin C

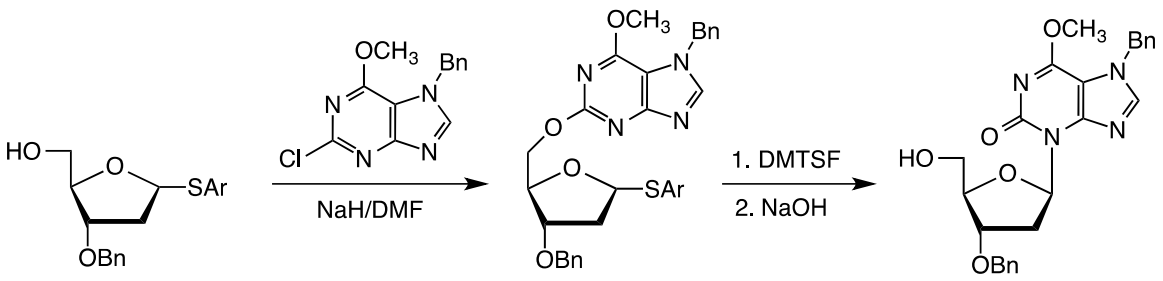


plakortone L



mumefural

Example of novel reaction developed in our laboratory



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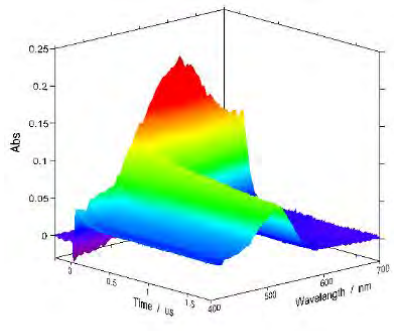
Research field	Physical Chemistry, Photochemistry	
Keyword	Photochemistry, Excited State, Laser Spectroscopy, Jet Spectroscopy, Photochemistry of Substituted Nucleic Acid Bases, Photodynamic Therapy, Drug-induced Photosensitivity, Photothermal Spectroscopy, Microreactor, and Photocatalytic Reaction	

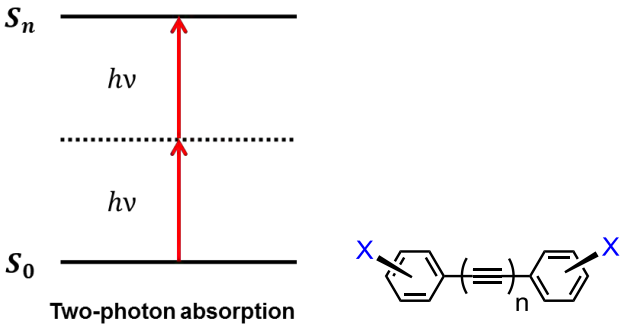
Research content

The world is filled with “Light”. Light is an electromagnetic radiation, and can interact with matter. As a result of the interaction between light and a molecule, absorption of a photon by a molecule occurs to make a molecule in an excited state. The geometry, the electronic structure, and the reactivity of the excited molecule would be largely different from those of the ground state molecule. In this laboratory, molecular structure and reaction dynamics of the excited molecules are investigated with various laser spectroscopies; the laser-induced fluorescence, the photoionization spectroscopy coupled with the time-of-flight mass spectrometry, the laser flash photolysis, the photoacoustic spectroscopy, and time-resolved thermal lensing.

1. Investigation of molecular structure in a supersonic jet expansion.
2. Photochemistry of thio- and/or aza-substituted nucleic acid bases and application of these compounds to medical treatment of photodynamic therapy.
3. Photochemistry of non-steroidal anti-inflammatory drugs (NSAIDs). Elucidation of initial action mechanism of drug-induced photosensitivity by NSAIDs.
4. Photochemistry in a microreactor. Study on enantioselective photochemistry and photocatalytic reaction in a microreactor.
5. Non-resonant two-photon absorption spectroscopy of diphenylpolyynes with photoacoustic spectroscopy



3D-transient absorption spectra of a NSAID.



Two-photon absorption spectroscopy of diphenylpolyynes.

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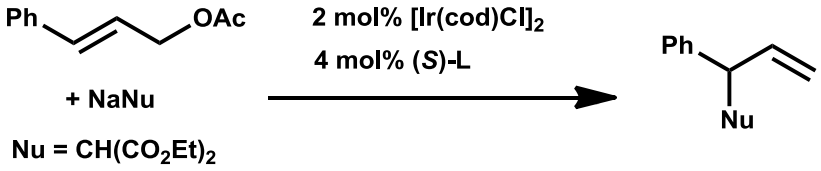
Academic society	The Chemical Society of Japan. The Society of Synthetic Organic Chemistry, Japan. The Kinki Chemical Society, Japan.	
Research field	Organic Synthetic Chemistry, Organometallic Chemistry	
Keyword	Transition Metal Catalysis, Homogeneous Catalyst, Highly Selective Synthesis, Asymmetric Synthesis, Heterocycle	

Research content

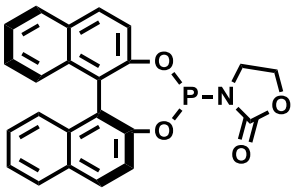
I am interested in transition metal-catalyzed reaction. My research focuses on asymmetric synthesis and synthesis of heterocycles.

1. Asymmetric Synthesis



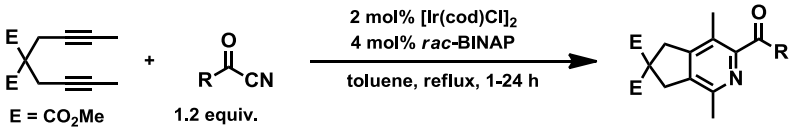
Yield 94% b/l=>99/1 93% ee

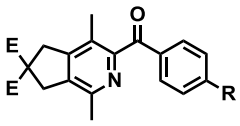
R. Takeuchi et al. *Adv. Synth. Catal.* 2008, *350*, 2725.



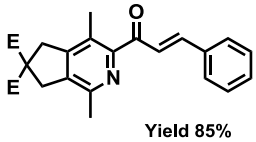
(*S*)-L

2. Synthesis of Heterocycles

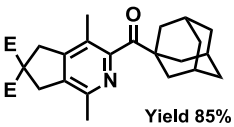




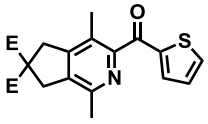
R = H; Yield 74%
R = Me; Yield 99%
R = Cl; Yield 98%



Yield 85%



Yield 85%



Yield 89%

R. Takeuchi et al. *J. Org. Chem.* 2016, *81*, 5393.

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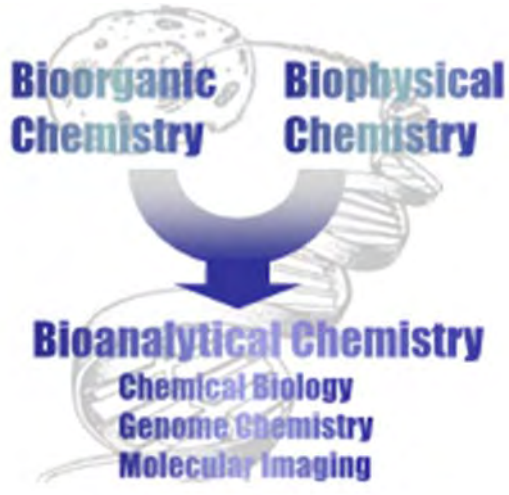
Research field	Bioanalytical Chemistry	
Keyword	Bioorganic Chemistry, Chemical Biology, Genome Chemistry, Molecular Imaging	

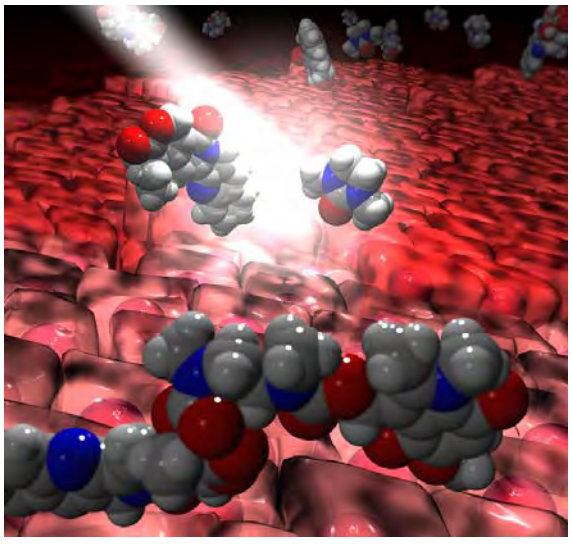
Research content

Research in the Bioanalytical Chemistry Laboratory involves synthetic chemistry, chemical understanding of properties of excited-state molecules and the application for developing novel photo-functional materials, cancer targeted drugs, and medical imaging systems. Since molecules excited with ultra-violet light or ionizing radiation show different property and reactivity from those of in the ground-state, we are trying to develop functional molecules based on the new concepts.

Member in the laboratory are working on the following projects to design of functional molecules for application in the fields of medicial-, bio-, and nanotechnologies.

1. Design of DNA aggregates that act as drug carriers
2. Development of radiation-activated prodrugs
3. Study on photochemical oxydation and the application to nano-scale devices
4. Synthesis of a novel molecular probes for cancer diagnosis





Professor	**HASEGAWA, Miki**	
Degree	Doctor of Science	
E-mail	hasemiki@chem.aoyama.ac.jp	
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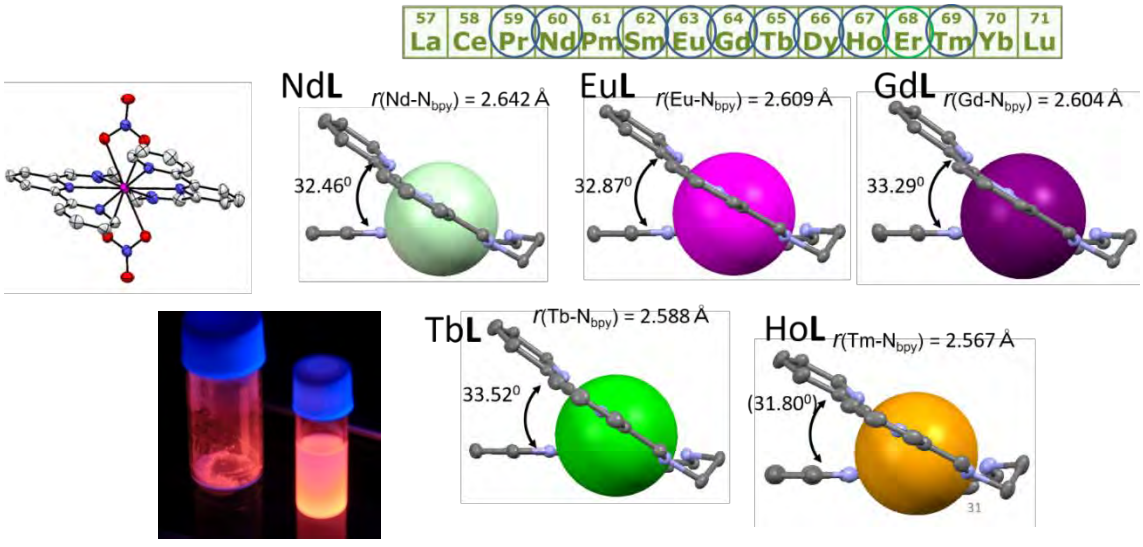
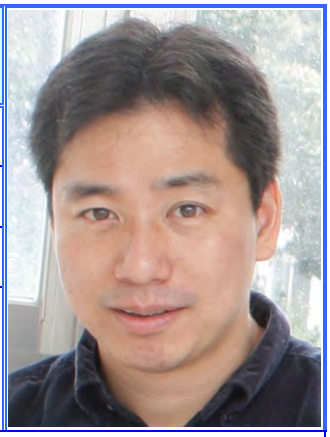
Academic society	Chemical Society of Japan, Japan Society of Coordination Chemistry, Japan Photochemistry Association, The Society of Polymer Science Japan, The Photofunctional Research Association Japan, The Society of Nano Science and Technology, and American Chemical Society	
Research field	Photochemistry of Metal Complexes	
Keyword	Metal Complexes, Luminescence, Fusion Materials	

Research content

The aim of our research is the development of new photo-function and to evaluate photo properties of metal complexes based on molecular sciences. Metal complexes, generally, have various coordination systems between organic ligands and metal ions resulting varieties of materials in function. Recently, we focus a series of lanthanide ions, such as Eu with red-emission, Tb with green. Our several papers already demonstrated the possibility of molecular sciences in lanthanides' luminescence of designed molecular structure. For instance, the helicate structure in the complexes can keep the optical and structural properties in the solid and in solutions. Polarized optical properties are also in progress with the derivation of these mother complexes.



Recent selected papers:
[1] M. Hasegawa, H. Ohtsu, D. Kodama, T. Kasai, A. Ishii, S. Sakurai, K. Suzuki, *New J. Chem.*, **38**, 1225-1234 (2014).
[2] S. Ogata, A. Ishii, C. L. Lu, T. Kondo, N. Yajima, M. Hasegawa, *J. Photochem. Photobiol. A*, **334**, 55-60(2017).
[3] A. Ishii, M. Hasegawa, *Sci. Rep.*, **7**, 41446 (2017).
[4] H. Wada, S. Ooka, D. Iwasawa, M. Hasegawa, T. Kajiwara, *Magnetochemistry*, **2**, 43-54(2016).
[5] A. Ishii, M. Hasegawa, *Chem. Lett.* **45**, 1265-1267 (2016).
[6] S. Sato, A. Ishii, C. Yamada, J. Kim, C. H. Song, A. Fujiwara, M. Takata, M. Hasegawa, *Polymer J.*, **47**, 195-200(2015).
[7] A. Ishii, M. Hasegawa, *Sci. Rep.*, **5**, 11714 (2015).

Professor	*HIRATA, Hiromi*	
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Academic society	The Japanese Biochemical Society, The Japan Neuroscience Society, Japanese Society of Developmental Biologists, The Molecular Biology Society of Japan, Society for Neuroscience, International Zebrafish Society	
Research field	Brain Science, Developmental Biology, Molecular Biology, Physiology, Ethology, Genetics	
Keyword	Neuron, Synapse, Muscle, Disease, Epilepsy, Spinal muscular atrophy, Muscular dystrophy, Aging, Progeria, Live imging, Optical illusion, Zebrafish	

Research contents

Toward understanding the molecular basis of motor behavior in animals

Aristotle (384–322 BC), an ancient Greek philosopher, classified organisms into animals and plants by their sensorimotor behavior. From the era of ancient Greece, animal behavior has attracted men and women of all ages. I was also fascinated to see animal movement from childhood and currently study molecular basis of locomotion and behavior of animals. To investigate motor system, we use zebrafish, a tropical aquarium fish. Zebrafish is an excellent vertebrate model for this study. First, all stages of development occur externally and rapidly, with early motor behaviors seen from 17 hours post-fertilization. Second, forward genetics can be applied to identify genes essential for proper behaviors. Third, the embryos are transparent facilitating live imaging of morphology and activity of neurons. Finally, neuronal activity can be recorded using patch-clamp methods in live zebrafish. By making use of these advantages, we have identified many genes regulating locomotion and behavior and clarified pathogenetic basis of human motor disorders. We also developed imaging of inhibitory glycinergic synapses in live zebrafish for visualization of synaptic plasticity.

1. Motor genetics. We identified genes that regulate motor behaviors.
2. Environmental adaptation by synaptic plasticity. Animals show rapid adaptation to environmental changes such as weather change and environmental noise. We revealed the molecular basis of activity-dependent dynamics of inhibitory glycinergic synapse that triggers environmental adaptation of animals.
3. Aging. We developed genetic tools for aging study in zebrafish.

[Publications]

Nakahata, Y. et al. Activation-dependent rapid postsynaptic clustering of glycine receptors in mature spinal cord neurons. *eNeuro.* 4: 1, 1–20 (2017).

Ogino, H. and Hirata, H. Defects of the glycinergic synaptic in zebrafish. *Front. Mol. Neurosci.* 9: 50, 1–18 (2016).

Boubakri, M. et al. Loss of ift122, a retrograde intraflagellar transport complex component, leads to slow, progressive photoreceptor degeneration due to inefficient opsin transport. *J. Biol. Chem.* 291: 24465–24474 (2016).

Knierim, E. et al. Mutations in subunits of the activating signal cointegrator 1 complex are associated with prenatal spinal muscular atrophy and congenital bone fractures. *Am. J. Hum. Genet.* 98: 473–489 (2016).

Ogino K. et al. RING finger protein 121 facilitates the degradation and membrane localization of voltage-gated sodium channels. *Proc. Natl. Acad. Sci. USA* 112: 2859–2864 (2015).

Stödberg, T. et al. Mutations in *SLC12A5* in epilepsy of infancy with migrating focal seizures. *Nature Commun.* 6: 8038 (2015).

Kotani, Y. et al. Neuromuscular regulation in zebrafish by a large AAA+ ATPase/ubiquitin ligase, mysterin/RNF213. *Sci. Rep.* 5: 16161 (2015).

Hirata H. et al. Defective escape behavior in DEAH-box RNA helicase mutants improved by restoring glycine receptor expression. *J. Neurosci.* 33: 14638–14644 (2013).

Hirata H. et al. Mutations of ZC4H2 are associated with arthrogryposis multiplex congenita and intellectual disability and through impairment of central and peripheral synaptic plasticity. *Am. J. Hum. Genet.* 92: 681–695 (2013).

Professor	MIYANO, Masashi	
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Academic soceity	Crystallographic Society of Japan Biochemical Society of Japan American Crystallographic association, American Biochemical and Molecular Biological Society	
Research field	Structural Biology, Enzymology, Biophysical Chemistry	
Key words	Protein X-ray Crystallography, Enzyme Mechanics, Lipid related proteins	

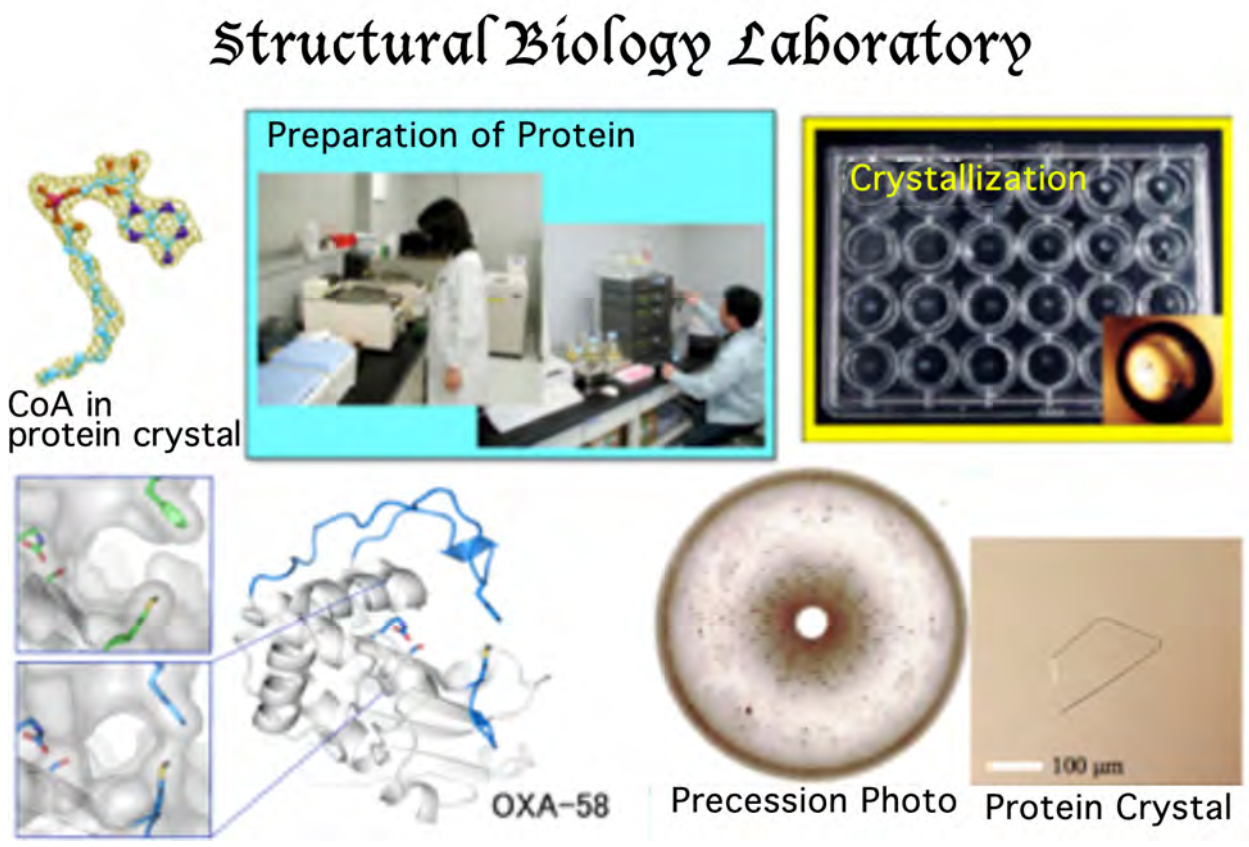
Research conte

To determine the proteins of Medicinal targets in atomic details, and their functions are revealed based on the atomic structures. The information is crucial in the drug development. In particular, we are investigate the pollen-allergy and asthma relevant proteins and the multi-drug resistant β-lactamase.

The process of protein X-ray crystallography to determine the protein structure as follows; Prepare the large-quantity and high- quality target protein, and crystalize them in crystallographic quality. Then collect the diffraction data and analyze to solve the structure. Now we can elucidate and verify the protein function based on the the atomic structure of the target.

Research projects

(1) Structural and reaction mechanism of the multi-drug resistant β-lactamase OX-58.
(2) Molecular mechanism on the lipid recognition by lipid related proteins.
(3) Structural and enzyme mechanism on long-chain fatty acyl CoA synthetase from thermophilic bacteria.
(4) Membrane protein structure and function on immuno-relevant proteins.
(5) Structure and engineering of lipid-mediator neutralizing monoclonal antibodies.



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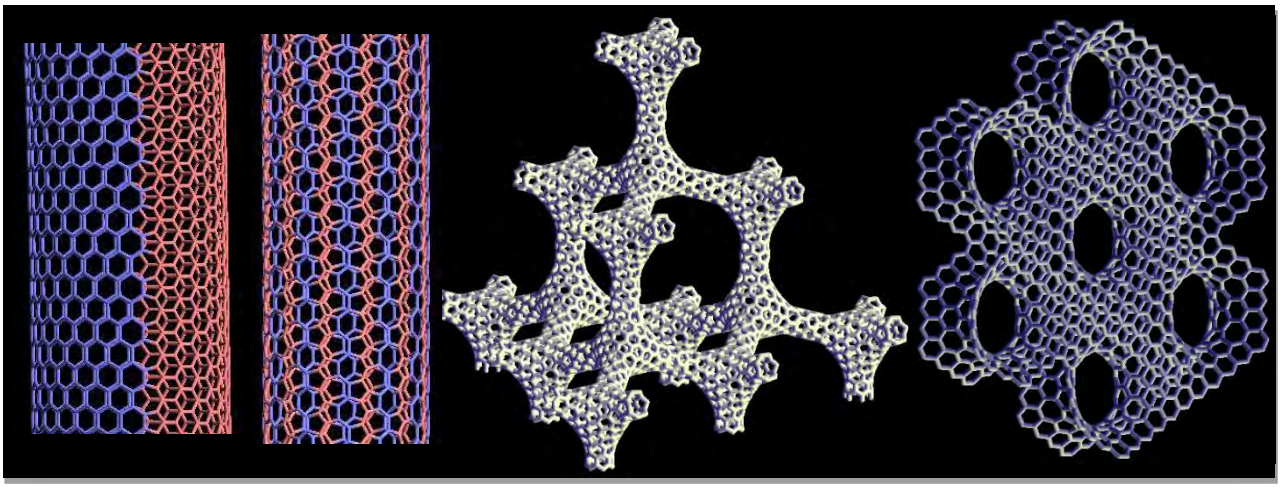
E-mail	nakada@chem.aoyama.ac.jp	
Homepage		
Academic society	The Physical Society of Japan, The Carbon Society of Japan, The Chemical Society of Japan	
Research field	theoretical chemistry, solid state physics, physical chemistry	
Keyword	nanocarbon , nanographene, π-electronic states	

Research content

The main research interest of our laboratory is the π-electronic structure of sp^2 carbon nanomaterials. The rich variety of sp^2 nanocarbons of zero-, one-, two- and three-dimensions is realized by introducing various defects or boundary conditions into the perfect crystal of sp^2 carbon, i.e., a graphene sheet. A chiral vector as a boundary condition turns graphene into a 1D nanotube and an arrangement of 12 pentagons determines the kind of 0D fullerene molecule. A pair of edge defects makes 1D graphene ribbons possible whose electronic states near the Fermi energy strongly depend on the shape of the edges. We extend the possibility of the kind, number and arrangement of such defects or boundary conditions introduced in the graphene network. We study the relation between the topological nature of the graphene-based networks and the π-electronic structure, and design novel sp^2 carbon nanomaterials with specific electronic properties of interest.



The network structures of sp2 carbons: two nanotubes with topological line defects (left), nanotube junctions of tetrapod shape (center), and double-layered graphene with nanopores (right).

Department of Electrical Engineering and Electronic

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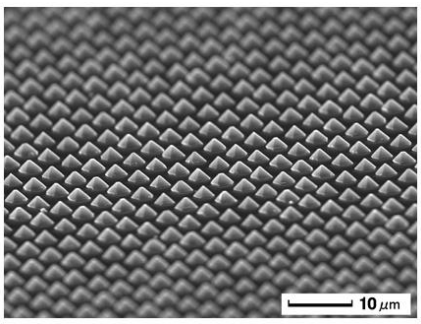
Homepage		
Academic society	The Japan Society of Applied Physics (JASP), The Magnetics Society of Japan (MSJ), The Institute of Electrical Engineers of Japan (IEEJ), The Institute of Electronics, Information and Communication Engineers (IEICE), Japan New Diamond Forum (JNDF)	
Research field	Thin film synthesis & processing, Thin film and surface physics, Diamond chemical vapor deposition	
Keyword	Diamond, amorphous carbon and Iridium films, epitaxial growth, microfabrication	

Research content

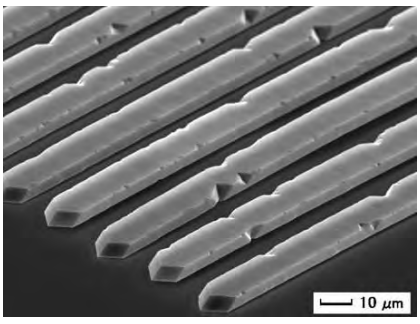
Fabrication of Device Grade Epitaxial Diamond Films and its Micro Processing

Diamond is expected as the ultimate semiconductor material because of its unique properties. For practical use, it is necessary to develop large scale and high quality single-crystal diamond growth technique. In our laboratory, diamond is epitaxially grown on iridium (Ir) film by chemical vapor deposition (CVD) method. We have already succeeded to fabricate 1 inch size self-standing diamond wafer. Furthermore, we are developing patterned nucleation growth (PNG) technique to improve the quality of diamond. By limiting the nucleation region in pattern such as dot, stripe, grid etc., diamond grows laterally from the nucleation region and finally forms continuous film via coalescence. By this PNG technique, it is possible to improve the orientation and reduce the dislocation and the bowing of diamond films. Heteroepitaxial diamond films have been already commercialized by our partner company using these techniques.

1 inch self-standing heteroepitaxial diamond film



Epitaxial diamond grains grown from dot patterned nucleation regions



Line shaped epitaxial diamond grown from stripe patterned nucleation regions

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Academic society	The Institute of Electrical and Electronics Engineers (IEEE) The Institute of Electrical Engineers of Japan (IEEJ) The Institute of Electronics, Information and Communications Engineers (IEICE) Japan Society of Kansei Engineering (JSKE)	
Research field	Biomedical Engineering, Human-Machine System Engineering, Affective Engineering	
Keyword	Biosignals measurement, Human-machine systems, Biofeedback systems	

Research content

Living systems are “the most elaborate machines.” Researches on living systems has brought innovative therapeutic, diagnostic and rehabilitation technique in the medical and welfare fields. My research team is interested in "living systems" by engineering view, and is developing innovative applications on human-machine systems using biosignals measurement and biofeedback technique. Current research topics are categorized in groups as follows:

1. Biosignals measurement by variety of measurement technique.
2. Evaluation of living systems’ function by analyzing biosignals.
3. Development of human-machine systems and biofeedback systems.

Main research topics are following:

- Development of driver monitoring/stimulating technique and biofeedback systems for sleepiness inhibition.
- Modeling of facial skin temperature variations for development of novel physiological index.
- Evaluation of objective feeling of use/preference for products based on psychological physiological indices and application for product design.
- Fundamental study for development of an engineering method of “encouragement.”

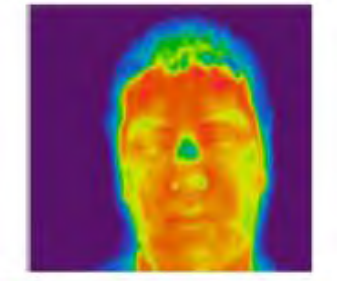

Fig. Facial skin thermogram

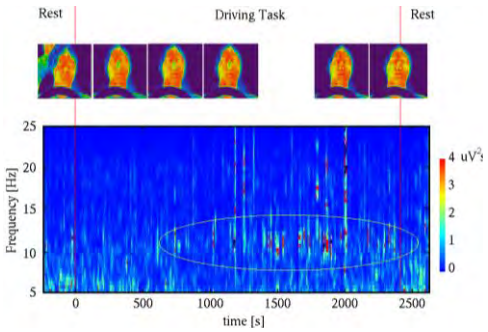

Fig. Driver monitoring/stimulation

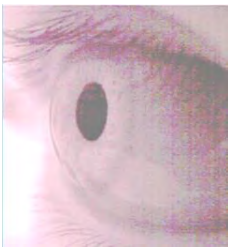

Fig. biosignals

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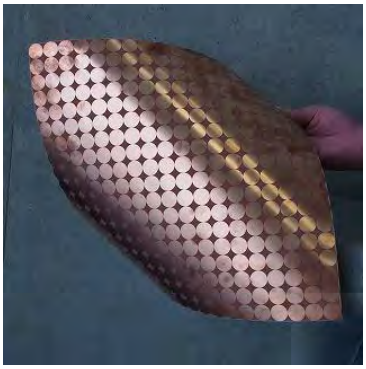
Academic society	The Instisute of Electronics, Information and Communication Engineers (IEICE), The Institute of Electrical Engineers of Japan (IEEJ), Architectural Institute of Japan, The Japan Institute of Electronics Packaging, Institute of Electrical and Electronics Engineers (IEEE)	
Research field	Radio wave engineering, electromagnetic compatibility, microwave and millimeter-wave engineering	
Keyword	Radio wave absorbers, shielding materials, material constant measurements, microwave filters, numerical analysis, antennas	

Research content

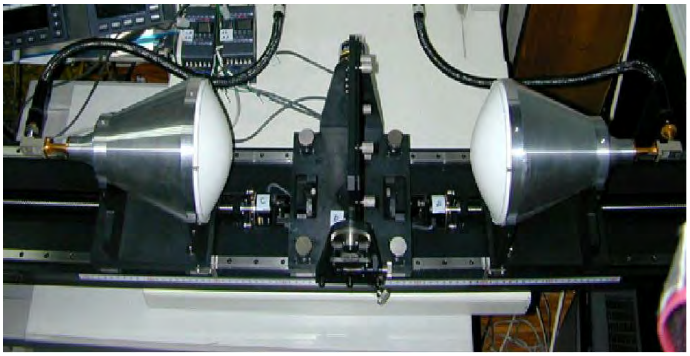
As a radio wave application, "biological and electromagnetic compatibility engineering" is the main research topic of my laboratory. In the situation where the radio wave environment deteriorated as seen in the spread of cellular phones in recent years, for research in this field includes I) How to protect electronic equipment and human body, II) how to absorb or not to radiate unwanted radio waves, and III. how to evaluate these, etc. Our laboratory is actively research on the following research for contributing to society.

1. Design and measurement of wave absorbers and shielding materials
2. Analysis of radio wave absorption to human bodies and its shielding
3. Non-destructive measurement of material constant in millimeter-wave band
4. Peripheral technology of millimeter-wave automotive radars and microwave ovens
5. Electromagnetic analysis method such as Finite-Difference Time-Domain (FDTD) method, moment method.

As far, 390 papers, 227 international conference proceedings, 1239 domestic conference proceedings and 27 patents are published. The following pictures are the typical examples of our research products.



Ultra-thin wave absorber



Lens method for material constant measurements

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Academic society	The Institute of Electrical Engineers of Japan, The Japan Institute of Power Electronics Japan Society of Energy and Resources	
Research field	Power Electronics, such as control of power converters and electrical motors	
Keyword	Power electronics, PM motor, speed sensor-less control, adaptive obsever, solar car	

Research content

Power electronics is the important research area to reduce the energy consumption. One of the main research topics of my laboratory is the speed sensor-less control of PM motor or induction motor. The ACFO (Armature Current Flux Observer) speed/position sensor-less control, developed in my laboratory, has been applied to the compressor drive system for air-conditioners and refrigerators, because the control is stable and easy to design. The speed sensor-less control realized the variable speed operation with reduced cost since the one-chip microcontroller became available. To realize the stable speed sensor-less control in a wide speed range, exact values of motor parameters and exact compensation of inverter control error are required. Many technical knowledge and skills are stored in my laboratory. The speed sensor-less control of induction motor was also applied to a 10kW wind-power generation system. In these applications, synchronized control with the commercial power system is required. Other Main research topic of my laboratory is an active power filter with a new circuit configuration, which can compensate the reactive power and harmonic current generated by various loads.

As an activity from the educational view point, my laboratory developed a solar car AGU-Aglaia , and has been attending to the solar car races, such as WSR in Akita more than 25 years and WAC in Australia (from Darwin to Adelaide) four times.

Some Papers;

1) T. Fukumoto, H .Hamane, Y. Hayashi, "Reduction of Cyclic Speed Change Using a Band-Pass Filter for Compressor PMSM Sine-Wave Position Sensor-Less Drives", IEEJ Trans. IA, No.127,Vol.7 pp.715-722(2007-7)
2) T .Fukumoto, Y. Kato, K. Kurita, Y .Hayashi, "Performance Improvement of Induction Motor Speed Sensor-Less Vector Control System by the Phase Current Non-Zero Control in Low Speed Range", IEEJ Trans. IA, No.128,Vol.3 pp.274-281(2008-3)
3) T. Fukumoto, Y. Kato, K. Kurita, Y. Hayashi, "Performance Improvement of Induction Motor Speed Sensor-Less Vector Control System Using an Adaptive Observer with an Estimated Flux Feedback in Low Speed Range", IEEJ Trans. IA, No.128,Vol.3 pp.329-339 (2008-3)
4) T. Fukumoto, S. Togashi, Y .Hayashi, "Performance Improvement of IPMSM Position Sensor-less Vector Control System by the Online Identification of Stator Resistance and Permanent Magnet Flux" , IEEJ Trans. IA, No.129,Vol.7 pp.698-704 (2009-7)

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Academic society	Try before thinking.	
Research field	Electronic circuit design. LSI circuit design.	
Keyword	Basic Electronic Circuits I, Basic Electronic Circuits II, Analog Electronic Circuits, Digital Electronic Circuits.	

Research content

Outline

To advance LSI design technology and fine process technology, SoC (System on Chip) is going to be realized. However, many problems occur to analog circuits in SoC as the low voltage supply and large leakage current. Therefore, I am going to research the mixed signal circuit design and the sensor circuit design for SoC.

Content

(1) Mixed signal circuits: the analog to digital converter, the digital to analog converter, PLL and amplifier.

(2) Wearable equipment with neighborhood wire-less communication.

(3) Front-end analog circuits for any sensors and MEMS microphones.

Results

(1) Matsuya and Mesuda "A Stereo Transmission Technique Using PDM Data And Synchronized Clock Channels." IEICE transactions Fundamentals, Vol.E92-A, No.2, pp.1650178.1-, 2009.02

(2) Ioka, Watanabe, Matsuya "Noise Characteristic of the Chaotic Double Loop Delta Sigma Modulator" International Journal of Bifurcation and Chaos, Vol. 26, No.21, pp.1650178.1-1650178.8, 2016.11.

(3) Kitagawa、Matsuya "1-bit audio consortium award for excellent work" 2006.12

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Homepage	http://www.ee.aoyama.ac.jp/Labs/yoneyama-www/index-e.htm	
Academic society	The Society of Instrument and Control Engineers(SICE), The Robotics Society of Japan(RSJ), The Institute of Electrical Engineers(IEEJ), Japan Society for Fuzzy Theory and Intelligent Informatics(SOFT),The Institute of Systems, Control and Information Engineers(ISCIE), IEEE	
Research field	Control Engineering, Systems Engineering	
Keyword	Robust Control, Fuzzy Systems, Sampled-Data Control, Tracking Control, Robotics	

Research content

Outline: In my laboratory, control engineering and systems engineering based on modern control theory are the main topics. With emphasis on theoretical-oriented research, application to the physical control systems, including robotics and drones, is my goal. The details on the research topics are as follow;

Research Topics: The following research topics are currently on-going. However, the related research topics are of another consideration.

1. Nonlinear Control Based on Fuzzy Systems

Fuzzy systems have a great potential to describe nonlinear systems. Nonlinear control based on fuzzy systems is one of my major topics.

2. Robust Control

In physical systems, system identification errors, system parameter variations, disturbances/noises into systems are of concern in designing controllers. Robust control design that prevents from those is a major issue.

3. Control for Time-Delay Systems

Time-delay occurs in transmitting signals and computing control gains for most physical systems. It may lead to instability of the systems. Control design of time—delay systems is an important problem.

4. Sampled-Data Control

Although systems are continuous-time, discrete-time control inputs are implemented when digital devices are employed. Sampled-data control design that controls continuous-time systems are required.

5. Tracking Control

The target of the objects is not always a constant value, and may be time-varying in many practical situations. Tracking control design that makes the system output follow a varying target is of a major concern.

6. Applications to Physical Systems

As applications of control systems, control of humanoid robots and drones is of concern. Stable waking patterns on robotics, tracking control of drones and evading obstacles are of research interests.

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Academic society	The Japan Society of Applied Physics (JSAP) The Electrochemical Society of Japan (ECSJ)	
Research field	Material Science and Device Engineering, Crystal Growth, Electronics, Bioelectronics	
Keyword	CVD growth of Graphene, Graphene-based Electronic Devices, Bio-Electronics Bio-Sensors, Bio-Fuel Cells	

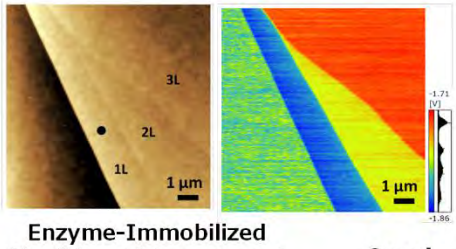
Research content

Novel Electronic Devices based on Carbon Materials

We challenge to fabricate novel electronic devices. We focus on carbon materials such as graphene, graphite and diamond films. These 2D sheet materials are compatible with sophisticated semiconductor device fabrication technologies, and have good bio-compatibility. Moreover, wide varieties of surface chemical modification and decoration can be applied to these 2D materials. We are now investigating on optical devices using luminescent graphene sheets, bio-sensors based on graphene field effect transistors, Bio-fuel cells using enzyme-immobilized graphene electrodes and graphene-based optically transparent microwave antennas. We also investigate on crystal growth of graphene, where we challenge to synthesize specific graphene sheets that are suitable to each device application. We study about the relationship between physical and chemical properties, and crystallographic properties (number of layers, morphology, defects).

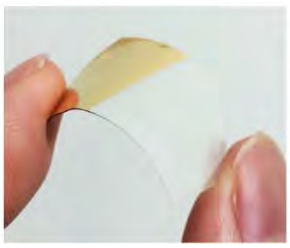
In our laboratory, we tackle interdisciplinary research integrated with several research fields, material science, device electronics, chemistry, electrochemistry and biology in order to realize the target devices.

AFM & KFM graphene surface

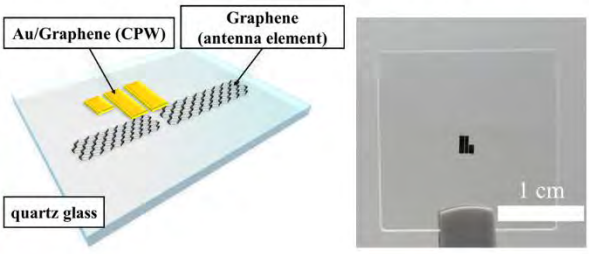


Graphene (20 x 20 mm²) transferred onto SiO_2/Si

Enzyme-Immobilized Flexible and transparent Graphene Electrodes



Graphene Transparent RF Antenna



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E-mail	sotobayashi@ee.aoyama.ac.jp	
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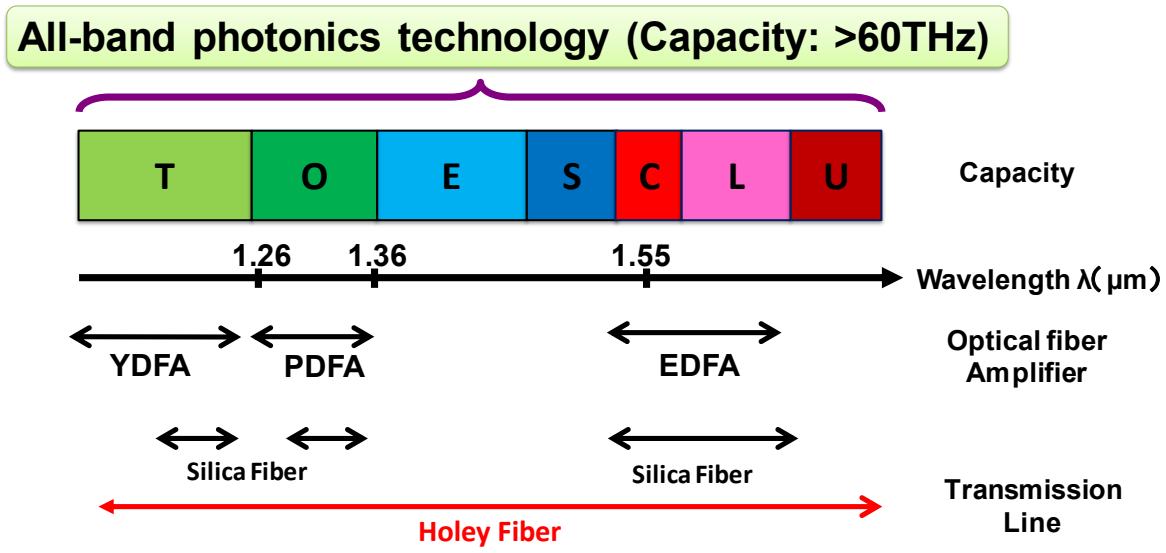
Academic society	The Optical Society of America The Institute of Electrical and Electronics Engineers The Japan Society of Applied Physics, The Institute of Electronics, Information and Communication Engineers, The Institute of Electrical Engineers of Japan	
Research field	Optics and Quantum Electronics	
Keyword	Optical network, optical fiber communications, photonic device, microwave photonics, radio on fiber, semiconductor laser, otical modulation	

Research content

Index Terms

Photonics, Optics, Photonic Network, Optical communication,
Optical time division multiplexing (TDM), Wavelength division multiplexing (WDM), Optical code division multiplexing (CDM), Subcarrier multiplexing (SCM),
Photonic processing, Nonlinear optics, Ultrafast phenomena,
Photonic link, Photonic node, Photonic access,
Optical phase conjugation (OPC), Wavelength conversion, Optical time gate, Supercontinuum (SC),
Photonic label switching router (LSR), Photonic routing, Photonic packet switching, Label swapping
Optical fiber, Semiconductor optical amplifier (SOA), Four wave mixing (FWM), Photonic gateway。

Optical frequency resources with wide capacity are required for the construction of photonic transport systems with high performance and flexibility.



We considered that a pioneering new waveband for the optical communication is a key issue to realize this concept of the all-band photonics technology.

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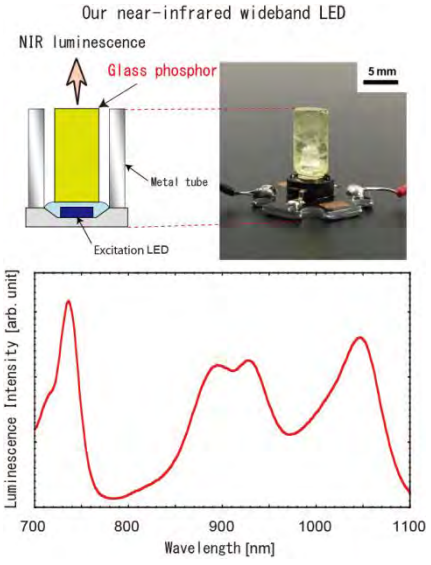
Academic society	The Japan Society of Applied Physics, Phosphor Research Society The Electrochemical Society of Japan, The Japanese Association for Crystal Growth, Japan Council for Near Infrared Spectroscopy, The Japan Institute of Metals and Materials, The Iron and Steel Institute of Japan	
Research field	Crystal Engineering, Optoelectronic Properties of Materials	
Keyword	Rare-Earth doped Glasses、Crystal Growth of Compound Semiconductors、Phosphor, Near-infrared, Wideband, LED, NEA, Electron Source	

Research content

Control of interaction of photons and electrons by functional materials

Electrons in materials are able to interact with photons. Our laboratory tries to realize new optoelectronic devices by “synthesis of new functional materials to control of interactions of photons and electrons” and “improving the performance of functional materials to control of interactions of photons and electrons”. Specific research projects are shown as below.



【**Near-infrared wideband LED**】Near-infrared (NIR) light-sources are suitable for agricultural applications, since luminescence around NIR region have higher penetration depths in the samples than other wavelength regions. Wideband light-sources are desirable for the absorption spectrometry in order to measure a broad region of an absorption spectrum. Therefore, our laboratory proposes a novel NIR wideband light-source that combines a NIR wideband phosphor with an LED in one package. This light-source is smaller and have longer lifetime than a halogen lamp. Moreover, this light-source is simple and useful for practical uses. To realize our novel light-source, our laboratory tries to synthesize phosphor using glasses doped with rare-earth ions. Our idea is based on that the luminescence wavelength is controlled by rare-earth ions, and the wideband luminescence is achieved using glasses as host materials.

【**Semiconductor photo cathode**】Electron beam sources are important for an electron microscopy and a micro fabrication machine. Recently, semiconductor photo cathodes (photo cathodes using semiconductors with a negative electron affinity (NEA) surface) have progressed for high-performance and unique electron beam sources. Our laboratory developed a novel multi-chamber system for a growth of semiconductor films and NEA surface treatments in vacuum. Using our novel system, our laboratory tries to reveal mechanism of NEA surface, and tries to improve the performance of NEA surface.

Department of Mechanical Engineering

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Research field	Precision Engineering	
Keyword	Precision Engineering, Cutting, Grinding, Air Bearing, Metrology	

Research content

Because of large wheel-workpiece contact area, thermally induced damage such as workpiece burn frequently becomes a problem in creep feed grinding (high wheel depth of cut and low workpiece speed) and high efficiency deep grinding (high wheel speed, high wheel depth of cut and high workpiece speed). These thermal aspects are investigated experimentally and theoretically on the surface grinding machines installed in the laboratory as shown in Fig.1. Figure 2 shows a grinding temperature measured by an infrared thermometer and a FEM analysis result of workpiece temperature with a moving heat source is shown in Fg.3.


Fig. 1

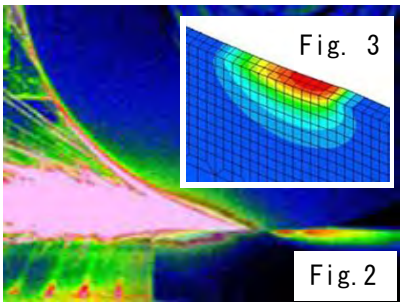
Fig. 3

Fig. 2

In a metrology room of the laboratory, where temperature is controlled within 20±0.2 degrees Celsius, we have a roundness measuring machine (Talyrond), a surface roughness measuring machine (Form Talysurf), a coordinate measuring machine (CMM) and so forth. Each axis of the CMM is guided by an aerostatic bearing to assure high accuracy. Air bearings are widely used in ultra high accuracy machines and we have developed FEM programs to obtain pressure distribution for compressible and imcompressible lubricant, which is available in book form in Japanese. Fig. 4 is a porous thrust bearing, having higher load capacity and stiffness. We are studying on the spindle rotational accuracy as shown in Fig. 5, investigating the effect of the spindle form error by using the spindle like Fig. 6 having the form error of 0.003 mm intentionally.

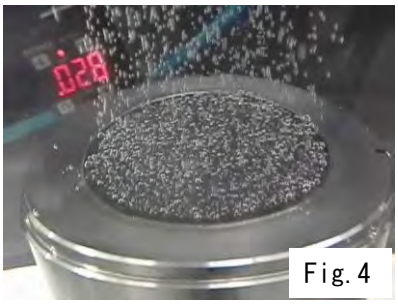
Fig. 4

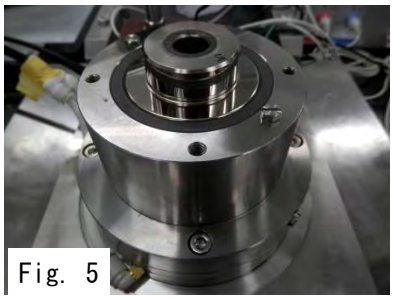
Fig. 5

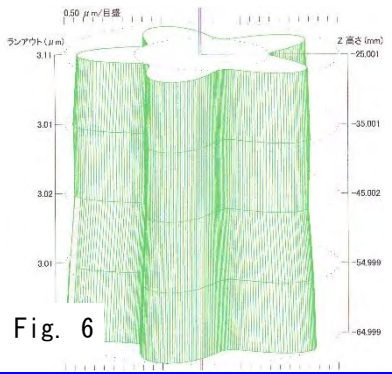
Fig. 6

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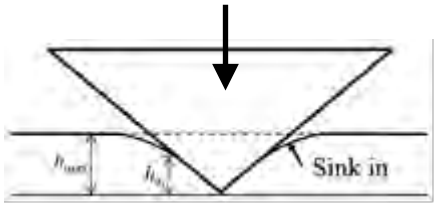
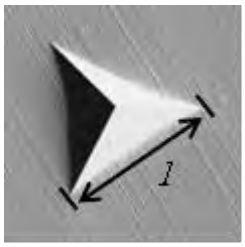
Research field	Fracture and Strength of Materials, Materials Engineering	
Keyword	Strength of Materials, Fatigue, Fracture, Stress Corrosion Cracking, Crack Growth Behavior, Hardness, Fractography	

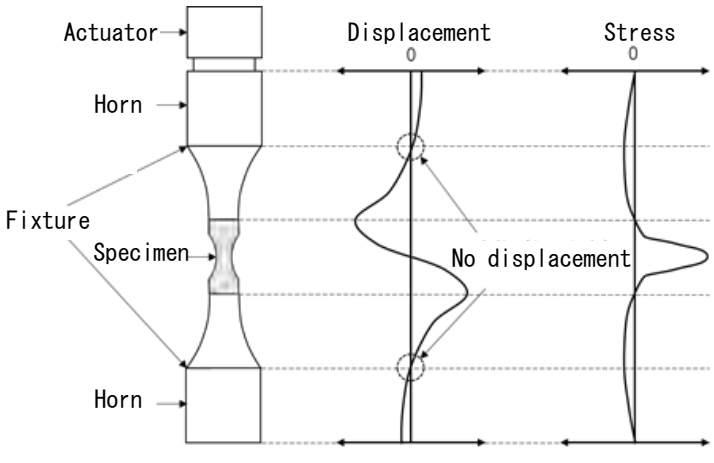
Research content

The research scope related substantially to the "Fracture of Materials" in the Ogawa laboratory. Fracture behavior usually takes place under uncontrolled condition in our life. Since the uncontrolled fracture becomes critical problem, which sometimes results in loss of human lives, it should be eliminated in our society. Our research aims to predict the fracture and to control it safely. In order to realize our objectives, we try to develop equipment and software for achieving controlled fracture, methods and techniques for clarifying the fracture mechanism. These research activities are highly evaluated in the nuclear, automobile and welding engineering fields, whose associations and makers are corroborated for the subjects of fatigue crack growth (FCG), fracture toughness and stress corrosion cracking (SCC). The details of the topics are as follows.

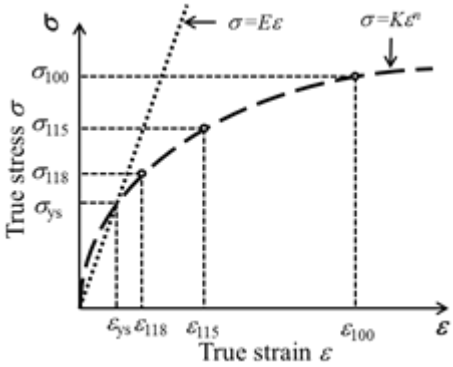
(1) Fatigue strength and FCG evaluation by ultrasonic testing
(2) FCG and SCC for the materials used for hydrogen container
(3) Fatigue evaluation of materials used for nuclear engineering
(4) Fatigue strength of welded joints for automobile body
(5) Local mechanical properties predicted by nano indentation test
(6) Reliability of strength for advanced composite materials used for aerospace engineering corroborated with JAXA







Mechanism of ultrasonic fatigue testing machine



Local mechanical properties predicted by nano indentation test

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Research field	Thermal Engineering, Heat Transfer	
Keyword	Heat Transfer, Solid-Liquid Phase Change, Thermophysical Properties for functional Fluids	

Research content

In thermal engineering laboratory (Kumano Lab.), researches on Solid-liquid phase change phenomena are carried out based on thermodynamics and heat transfer engineering. Especially, in order to transport thermal energy, flow characteristics and heat transfer characteristics of phase change slurry with high thermal density, are investigated, experimentally and analytically. Moreover, flow and generation characteristics of gas hydrate, improvements of energy equipment used for refrigerating foods, cooling electronic equipment and measurements of themophysical properties are investigated.

Current research topics are as follows.

1. Flow and heat transfer characteristics of ice slurry, hydrate slurry
2. Supercooling characteristics of phase change emulsion
3. Flow and heat transfer characteristics of phase change emulsion
4. Generation characteristics of gas hydrate slurry
5. Measurements of thermophysical properties of thermal energy storage materials and functional fluid
6. Numerical analysis for complex system using phase field model

TBAB hydrate slurry

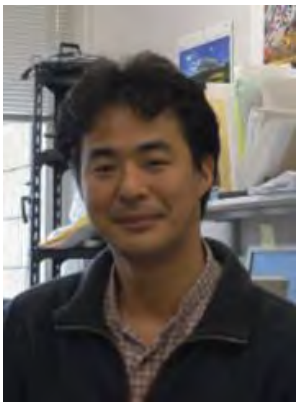
Recent papers

H. KUMANO, T. ASAOKA, et. al., Effect of Initial Aqueous Solution Concentration and Heating Conditions on Heat Transfer Characteristics of Ice Slurry, Int. Journal of Refrigeration, Vol.41, 2014, 72-81

H. KUMANO, T. ASAOKA, et. al., Measurement of Latent Heat of Tetra-n-butyl Ammonium Bromide Hydrate and Specific Enthalpy of its Slurry, Int. Journal of Air-Conditioning and Refrigeration, Vol.23, No.3, 2015, 1550025

H. KUMANO, T. ASAOKA, et. al., Formation Characteristics of Propane Hydrate Using Fiber Layer, Int. J. Air-Conditioning and Refrigeration, Vol.23, No.4, 2015, 1550030

H. KUMANO, Y. YAMANADA, et. al., Effect of initial aqueous solution concentration on rheological behavior of ice slurry, Int. Journal of Refrigeration, Vol. 68, 2016, 218-225

Professor	*CHO, Hideo*	
Degree	Ph.D. in Engineering	
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Academic society	Japanese society of Non-destructive inspection Japan society of Mechanical engineers Japan society of corrosion engineering	
Research field	Non-destructive evaluation, corrosion engineering, health monitoring	
Keyword	Laser ultrasonics, Acoustic emission, Optical fiber sensor, stress corrosion cracking,	

Research content

One of interests in my research to develop novel non-destructive monitoring system for evaluating integrity loss of large infrastructure such as bridges, oil storage tanks and buried pipe works. For this purpose, a novel acoustic emission (AE) monitoring system using an optical fiber as sensors and cables have been developed. The optical fiber AE sensor enables us to monitor high temperature components, immersed structures. Another interest is to evaluate bond quality of adhesive components for using advanced ultrasonic measurements. Zero-group-velocity Lamb waves and interface waves monitored with a laser ultrasonic system can estimate bonding qualities such as adhesive strength and area.

Research topics in our laboratory are

1) Development of novel optical fiber AE monitoring system
2) Bond quality estimation of a surface modified layer with laser spallation method.
3) Development of novel corrosion monitoring system using both AE and corrosion potential fluctuation measurement.
4) Surface pressure distribution estimation of a flange connection with ultrasonic

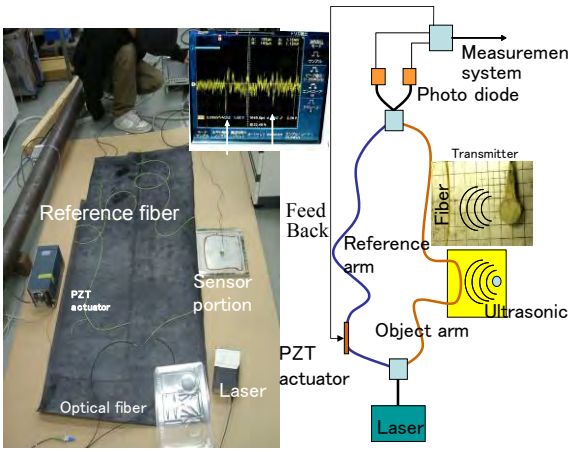

Fig. Developed novel optical fiber AE monitoring system

Recent published papers

1) Hideo Cho, Naoki Shoji and Hiroaki Ito, Estimation of fracture behavior in a pressured Al-Mg-Si alloy heat exchanger based on AE pattern recognition technique, Progress in Acoustic emission XVIII, pp.251-256 (2016)
2) Hideo Cho, Yudai YAGUCHI and Hiroaki ITO, Characterization of the bond quality of adhesive plates utilizing zero-group-velocity Lamb waves measured by a laser ultrasonics technique, Mechanical Engineering Journal Vol.2, No.1, p.14-00335 (2015)

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Research field	Thermo-fluid engineering, Heat transfer engineering, Bio-thermal engineering	
Keyword	Heat Pipe, Heat Removal, Heat Transfer, Micro Heat Exchanger, Nanofluid, Thermal Storage, Bio-Heat Transfer	

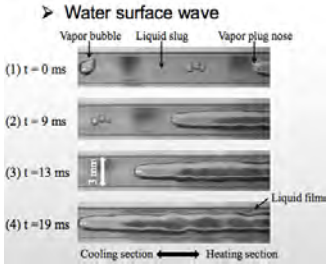
Research content

Main research theme

Pulsating Heat Pipe Using Self-Rewetting Fluid

The primary purpose of this study is to investigate oscillating behavior using various working fluids in the open-loop PHP (OLPHP). The self-rewetting fluid as a working fluid is a dilute aqueous solution of alcohols with a large number of carbon atoms (such as butanol and pentanol). These solutions can be considered as self-rewetting fluids because such fluids display nonlinear dependence of the surface tension with temperature.

References: (1) Experimental study on pulsating heat pipe using self-rewetting fluid as a working fluid: Visualization of thin liquid film and surface wave, Heat Pipe Science and Technology, An International Journal (2015), DOI: 10.1615/HeatPipeScieTech.2015013430.
(2) Effect of working fluid in heat transport characteristics of pulsating heat pipe, Transactions of the JSME (in Japanese) (2016), Vol. 82, No. 834 p.15-00529.



Passive Heat Transport Device Using Thermo-Sensitive Magnetic Fluid

An experimental investigation of a mini-heat transport device incorporating a thermo-sensitive magnetic fluid was performed. The experimental parameters measured were the magnetic force, the position of the magnet, and the temperature of the magnetic fluid.

References: (1) A mini heat transport device based on thermo-sensitive magnetic fluid, Nanoscale and Microscale Thermophysical Eng. (2007), Vol.11, pp.201-210.
(2) Heat Transfer Characteristics of a Thermo-sensitive Magnetic Fluid in Micro-channel, J. of Thermal Science and Technology(2009), Vol. 4, No. 3, pp. 332-339.

Magnetic fluid→

Medical Thermal Engineering Based on Thermal and Fluid Control

In the present study, the characteristics of both flow and heat transfer in a pharyngeal cooling cuff for the treatment of brain hypothermia were investigated experimentally and analytically. The pharyngeal cooling cuff, which is a balloon-like structure placed in the pharynx, was developed for medical purposes.

References: (1) Heat Transfer Characteristics of a Pharyngeal Cooling Cuff for the Treatment of Brain Hypothermia, Journal of Biomechanical Science and Eng.(2010), 5(1), pp.85-93.
(2) Effects of Pharyngeal Cooling on Brain Temperature in Primates and Humans: A Study for Proof of Principle, Anesthesiology(2012), Vol.117, pp. 117-125.

Pharyngeal cooling cuff→

Biological phantom→

OTHER SUBJECTS: Thermal Storage Material at High-Temperature Region, Heat Transfer Technology by Biomimetics, Innovative Heat Transfer Enhancement Technology

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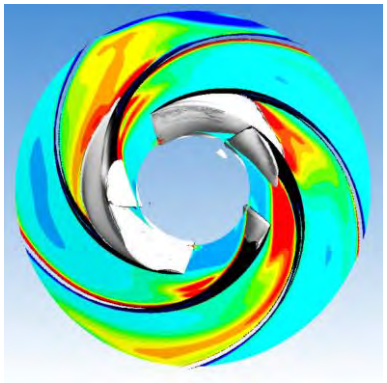
Research field	Fluid Mechanics, Jet Propulsion, Fluid Mechinery, Turbomachinery	
Keyword	Aeronautical Engines, Rocket Engines, Fan, Compressor, Pump, Turbine, Flow Induced Vibration, Cavitation, Jets, Computational Fluid Mechanics, Experiments	

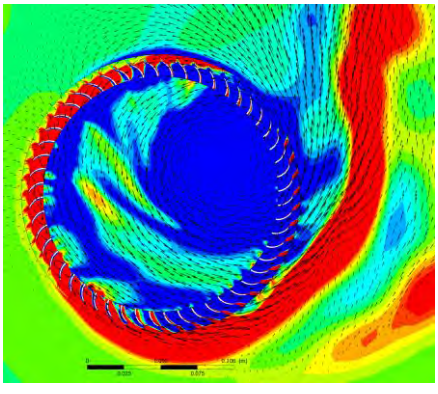
Research content

- Surge and rotating stall occurring in an axial fan.
- Rotating stall in a cross-flow fan.
- Flow instability in a Sirocco fan.
- Rotating flow instability in co-axial double disks.
- Cavitation surge and rotating cavitation in centrifugal pumps.
- Flow induced vibration in a centrifugal water turbine.
- Atomization of liquid jet for combustion.
- Flow instability in heated fluid, especially geysering.
- Noise from an axial fan.
- Noise from supersonic jets.
- Unsteady aerodynamics of ducted/unducted co-axial counter-rotating rotors.
- Unsteady fluid dynamics of fluid lubrication.
- flow control by a plasma actuator.
- Unsteady flow field of underwater explosion.
- Feature extraction and anomaly detection in flows or fluid machines by machine learning.



Rotating Cavitation in pump.

Flow oscillation in water turbine.



Rotating stall in cross-flow fan

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Academic society	Society for Experimental Mechanics (SEM), the Japanese Society for Experimental Mechanics (JSEM), the Japan Society of Mechanical Engineers (JSME), the Japanese Society for Non-destructive Inspection (JSNDI), the International Society for Optical Engineering (SPIE), the British Society for Strain Measurement (BSSM), the Society of Materials Science Japan (JSMS), and the Japan Society for Composite Materials (JSCM)	
Research field	Experimental Mechanics, Mechanics of Materials	
Keyword	Optical Methods, Viscoelasticity, Fracture Mechanics, Contact Mechanics	

Research content

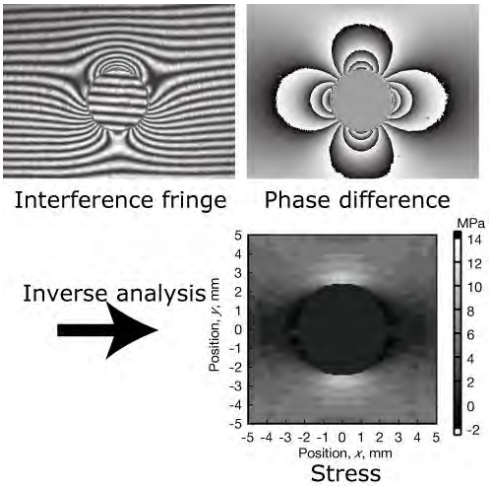
■Recent Research Projects

A. Optical methods for strain measurement (digital image correlation, digital volume correlation, interferometry, photoelasticity, image processing)
B. Inverse problems in solid mechanics (virtual fields method)
C. Time- and temperature dependence of failure behavior of CFRP
D. Fracture parameter
E. Viscoelastic properties and behavior
F. Super high strain rate testing

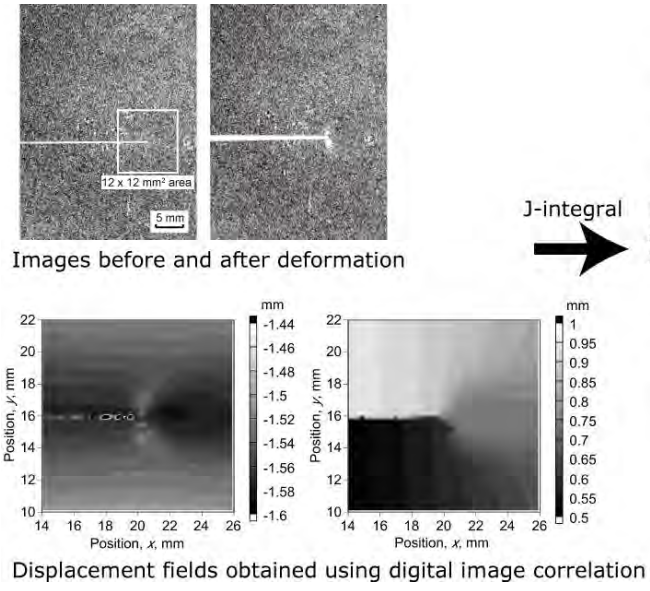
■Recent Publications

Yoneyama, S. and Arikawa, S., Instantaneous Phase-stepping Interferometry Based on a Pixelated Micro-polarizer Array, Theoretical and Applied Mechanics Letters, 6(4), 162–166 (2016).

■Optical Methods and Inverse Analysis



■Evaluation of Fracture Parameter



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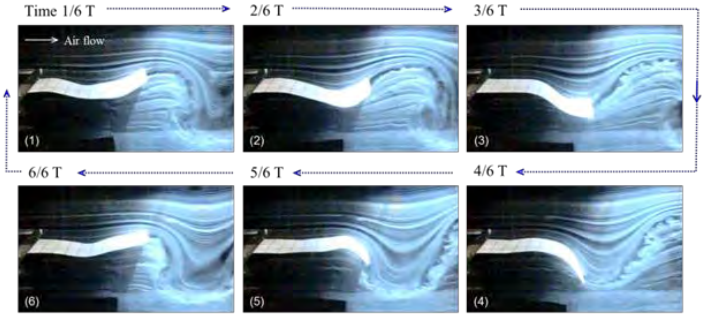
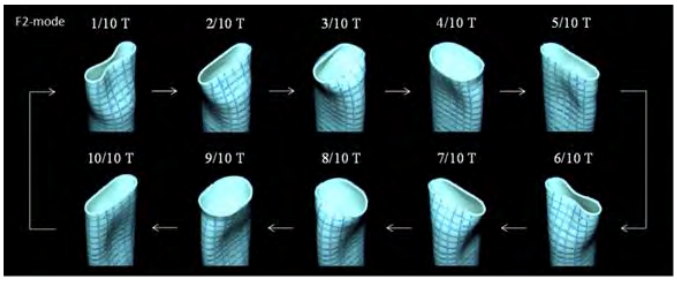
Academic society	The Japan Society of Mechanical Engineers	
Research field	Mechanical dynamics, mechanical vibrations, vibration control	
Keyword	Fluid structure interactions, flow induced vibrations, aero- and hydro- elasticity, flutter, active vibration control, flow control, rotor dynamics, control devices and actuators	

Research content

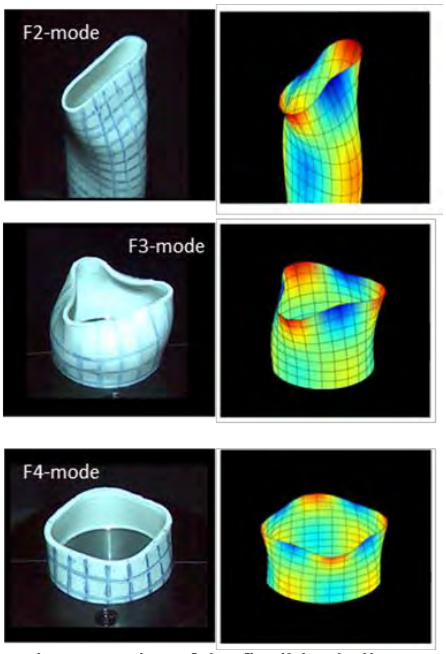
My principal research interests are in fluid-structure interactions, flow-induced vibrations, aero- and hydro- elasticity and active flutter control. This research is related to and is of interest to the web (thin film/membrane)-handling machines, and power-generating and aeronautical industry. Some research projects are partly theoretical (computational or analytical) and partly experimental. The dynamic stability and flutter characteristics of thin plates and shells in fluid flow are investigated anew by means of the modern computational and analytical tools. The following photographs are flutter of a thin plate in axial air flow, circular cylindrical shells subjected to inner flow, a flexible rotating disk in a confined fluid and the flutter model of a flying rocket.



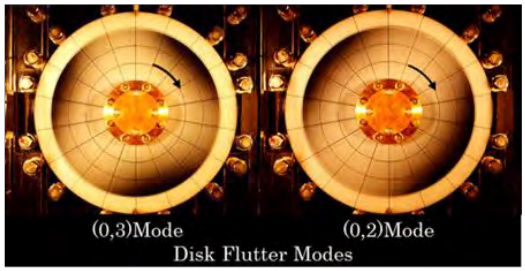
Flutter of a thin plate/film in axial flow



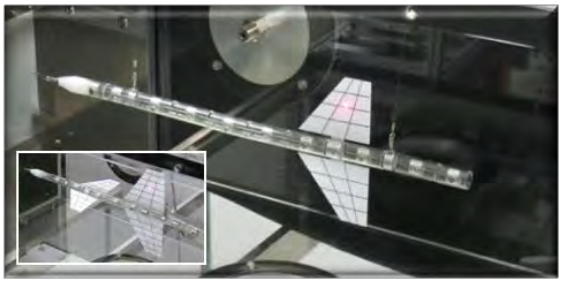
Flutter of a circular cylindrical shell subjected to inner flow



Flutter modes of the flexible shell



Flutter of a rotating disk in a confined fluid



Flutter model of a flying rocket

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Research field	Control of mechanical system, Dynamics of machine, Aerospace engineering	
Keyword	Flexible structure, Vibration, Dynamics, Control, Spacecraft, Robotics, Multibody dynamics	

Research content

We deal with dynamics and control of mechanical systems, especially spacecraft and robot systems. According to my research fields, studies on following topics are focused on:

1. Analysis on the mechanical system with extremely flexible structure

In order to analyze the behavior of mechanical system which has extremely flexible structure, e.g. solar sail, membrane structure, efficient method for analysis is developed. The method utilizes complementarity of the mechanical system and it can achieve numerical analysis with low computational cost and moderate accuracy.

2. Control of the mechanical system with extremely flexible structure

Controller design method is studied in order to control the mechanical system which has flexible structure, e.g. flexible link manipulator. In the study, construction of mathematical model for controller design is focused on, and mathematical model is derived by the use of multibody dynamics in order to improve controller design process and control performance.

3. Passive damping system for distributed parameter system by the use of magnetostrictive alloy

Study on the passive damping system by the use of magnetostrictive alloy is few and application of the system to distributed parameter system is not studied enough. In our study, system and strategy of the passive damping system for distributed parameter system is developed.

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Research field	TQM Concepts, Quality Information Systems, TQM Methods, Affective Engineering	
Keyword	Value Evaluation, Quality Information Analysis, Multi Attribute Decision Making, Preference Relation, Text Mining, Education Support Systems	

Research content

Development of TQM Concepts, Quality Information Systems, and TQM Methods

In the most companies, TQM are applied and many types of information systems are developed which treat qualitative information related to the products and services. Quality information systems involve wide range of information, which involve manufacturing quality information, customer satisfaction, employee satisfaction, process capability, engineering ability, market trends, companies' KPI. In order to develop quality information systems, we need deep understanding about human preference, human evaluation, or human aspect of decision making. We also need to develop and configure TQM concepts, which are bases of the quality information systems. Our research area covers the following 4 area, development of TQM concepts, quality information systems, TQM methods, and affective analysis based on biological information.

1. Development of TQM Concepts and Quality Systems
   Development of Japanese TQM Concepts such as Deming Prize, ISO 9000, Quality Management Level Research, and TQM Promotion. Development of Identification Methods of Evaluation Structure for the Products and Companies.
2. Development of Quality Information Systems
   Development of Quality Information System mainly based on Quality Functional Deployment. Development of Quality Information Extraction Systems based on SNS. Development of Educational Support System.
3. Development of TQM Methods
   Development of the Methods related to Total Quality Management, e.g. Quality Control Methods, Problem Solving Methods, Affective Engineering Methods, Products Planning Methods, Evaluation Methods, Text Analysis Methods, Multi Attributes Decision Making Methods.
4. Development of Affective indices by the use of Biological Information
   Development of Affective Evaluation Methods based on Eye Tracking or EEG Analysis. Analysis of Relaxing Situation in the Work Environment.

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Academic society	The Japanese Society of Artificial Intelligence(JSAI), Institute of Electrical Engineering of Japan(IEEJ)	
Research field	Anomaly detection, equipment diagnosis, Theory and application of statistical machine learning	
Keyword	Support Vector Machine, Ensemble Learning, Data Mining, Human Agent Interaction	

Research content

Our research team analyzes different data sets by using machine learning technique, which have attracted attention in artificial intelligence research field, to find the latent mathematical model and develops new and improved machine learning technique, which can deal with big data. Recently, we have been researching the theory and application of statistical machine learning in the following four research areas.

1. **Development of anomaly detection technique based on energy consumption data and information communication data by using statistical machine learning**

In this research area, we are researching “Comparison among different machine learning methods for anomaly detection based on communication data of control system”, “Development of anomaly detection technique based on big energy consumption data”, “Development of cyberattack detection technique for Advanced Metering Infrastructures”, “Development of communication data simulator for control systems” and etc.

2. **Research of equipment diagnosis and equipment remaining life assessment based on statistical machine learning**

In this research area, we are researching “Development of transformer remaining life assessment method based on gas data in oil”, “Development of power line remaining life assessment method based on gas data in oil”, “Development of CV cable degree of degradation assessment method based on partial discharge”, “Development of anomaly detection method for hydro electric power plants”, and etc.

3. **Research of efficient machine learning for Human Agent Interaction**

In this research area, we are researching “Development of new topic discovery method based on information independency”, Development of independent topics trancing method”, and etc.

4. **Research of ensemble learning such as Bagging and AdaBoost**

In this research area, we are researching “Development of online learning method for Bagging”, “ Development of online learning method for Boosting”, and etc.new topic discovery method based on information independency”, Development of independent topics trancing method”, “Development of SVM for unbalanced data and etc.

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Research field	Management Engineering	
Keyword	Management Systems, Business Process Management, HVAC management.	

Research content

It has become increasingly important for an engineer, who might not necessarily be aiming at corporate manager in his/her career, to understand how corporate management works. In corporate management, not only the technologies themselves but also their current and future positioning in the market and profitability should be considered.

In this laboratory, we deal with the topics relating to the corporate management, using engineering methodologies. The main area of research interest is application systems and their underlying methodologies supporting business management.

The research purpose is to help person or organization to enable effective plan- do-see cycles to achieve each goal. It covers activities of companies, as well as non-business organization such as education organization. Specifically addressed are models and systems on strategic management, financial analysis, project management, and environmental performance evaluation.

Original Papers:

1. Tsuyoshi Kaseya, Wei Zang, Satoshi Kumagai, Shuuzou Kishima; “Target for heat capacity consumption that considers safety, energy savings, and comfort: A room heat capacity model using a two-phase difference integration method, International J. of Energy and Environmental Engineering, Vol.8, no.1, pp.1-8, 2017, DOI: 10.1007/s40095-016-0225-1
2. Kan Nakayashiki, Wei Zang, Satoshi Kumagai;” Hedging financial and environmental risk in portfolios: Constructing and evaluating eco-funds”, Asian J. of Management Science and Applications, Vol.3, No.2, pp.38-49, 2017
3. Satoshi Kumagai, Kanae Morishige, Shuuzou Kishima ;” Air-conditioning Accounting for Appropriate Room Heat Consumption, IEEJ Transactions on Electronics, Information and Systems, Vol.137 No.1 pp.184-196 DOI: 10.1541/ieejeiss.137.184
4. Nobuyoshi ICHIKURA Satoshi KUMAGAI ;” Budgeting for restaurant chain in consideration of withdrawal condition”, Journal of Japan Association for Management Systems, Vol.32, No.2, pp.219-226.
5. Daiki Sakata, Yusuke Akiyama, Masaaki Kaneko, Satoshi Kumaga ;” Education System to Learn the Skills of Management Decision Making By Using Business Simulator with Speech Recognition Technology”, Industrial Engineering and Management Systems, Vol.13, No.3, (Sept 2014), P267-277.
6. Satoshi Kumagai ;” Development of the environmental policy priorities index for Japan 2010 (JEPIX 2010), WIT Transactions on Ecology and the environment, Vol.162, WIT press, 2012, p.35-52.

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Research field	Combinatorial Optimization, Cooperative Game Theory, Algorithm Design	
Keyword	Single and Parallel Machine Scheduling, Coalition Formation Games, Network Formation Games,	

Research content

- **Combinatorial Optimization**

  Combinatorial optimization is a research area at the intersection of discrete mathematics, theoretical computation, and operations research, which deals with problems for finding the best feasible object, where each feasible object has discrete value and/or structure. Many practical applications are dealing with optimization, and can be formulated as combinatorial optimization such as sequencing and scheduling, network flow and routing, assignment and resource allocation, etc.

- **Cooperative Game Theory**

  Game theory studies how to describe and analyze social interactive decision situations, and cooperative game theory addresses how each player decides with whom to cooperate based on his or her preference. Cooperation between players can be carried out by forming groups or by forming relations. Finding stable outcomes for a given situation is the main interest of the field. In particular, stability testing, existence problem of stable outcomes, and construction problem of stable outcome are the central problems.

- **Algorithm Design**:

  An algorithm is a procedure with a finite number of steps which produces some output for specified input. Algorithm design concerned with the development of efficient algorithms for solving computational problems, which involves problem formulation, designing an algorithm, proof of correctness, efficiency analysis, and implementation. Related fields include operations research, graph theory, theoretical computer science, theory of computational.

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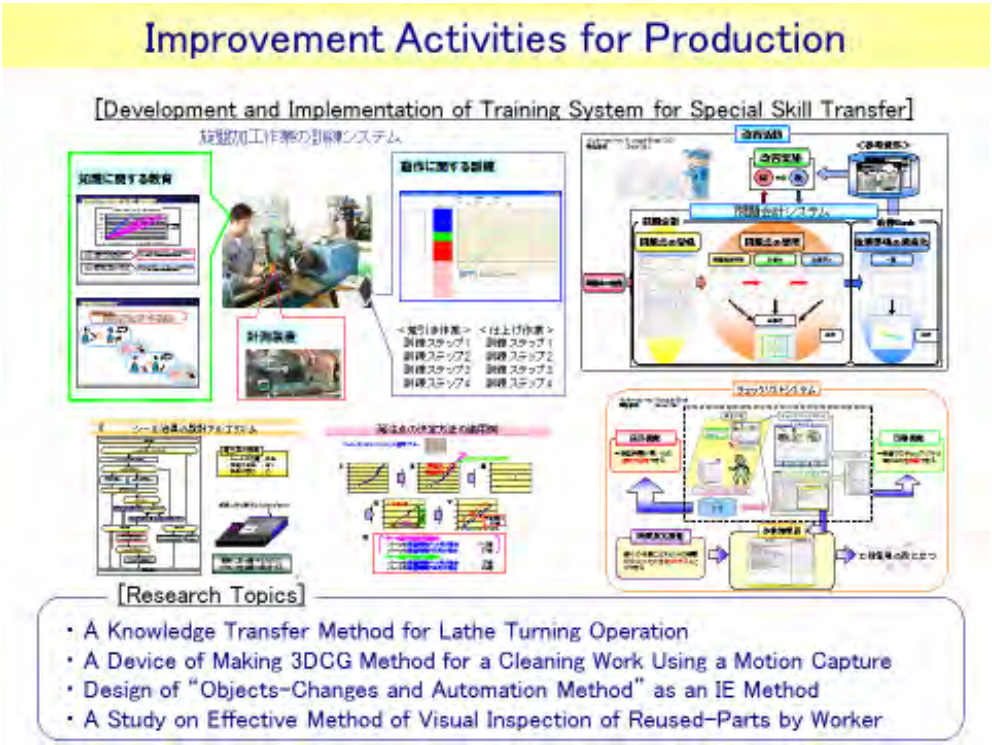
Research field	Industrial Engineering, KAIZEN, Production Control	
Keyword	Industrial Engineering, Kaizen Activity, Skill Training, Production Information System, Environmental Education, Industrial Engineering Education	

Research content

Industrial Engineering is basic philosophy and method to solve problems on production. In order to improve productivity on production, improvement (KAIZEN) activities are the most important ones in many companies.

My lobratory menber are mostly interested in the research of (1) improvement (KAIZEN) activities for production in actual factories and (2) prototype-less production system in a virtual factory. Also, our current interest includes (3) improvement for agriculture, (4) development of manufacturing education system, and (5) environmental education. My lobratory has conducted resarch with actual many manufacturing factories and companies.

The following picture shows an example our research on improvement activities for production.



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Research field	Manufacturing Systems Engineering, Service Science and Engineering, Production and Operations Management, Collective Intelligence Engineering	
Keyword	Human Computation, Crowdsourcing, Games with a Purpose (GWAP), Gamification, Serious Games, Prediction Markets	

Research content

Manufacturing or service-providing systems are always enforced to adapt themselves to a changing market environment and to evolve for maintaining and enhancing their competitiveness in it. Thus, beneath the superficial process of manufacturing goods or providing service, various knowledge processing activities, such as finding, transferring, integrating and utilizing knowledge, are carried out by the members of the system, and thereby it is enabled for the system to adapt and evolve. My research team is interested in this organizational or collective intelligence, and aims at deepening the understanding of and developing effective supporting tools for it. Current research topics include but are not limited to the following:

Analyzing and Training Embodied Knowledge/Skills through Simulation Games

This topic studies various embodied knowledge/skills both cognitive and physical, and develops effective means for training them. For example, a simulation game mimicking dynamic table assignment task in a restaurant is developed and its play log data are analyzed to reveal tacit skills for the task.

Analyzing and Modeling Collective Cognition through Participatory Simulation

A team of operators as a collection can operate a large-scale manufacturing or service-providing system flexibly and resiliently, even though none can completely grasp its changing environment. This topic tries to analyze and model the capability of this collective cognition and studies how to support it.

Human Computation Games and Systems for Supporting Managerial Decisions

Human computation games and systems, for example those based on prediction markets, for supporting various managerial decisions are designed, implemented and tested in this topic. Possible application areas include demand forecasting, project management, and revealing market opportunities.

Mechanism Design for Organizational Creative Problem Solving Process

Innovations cannot be captured as a simple decision-making which selects a solution from a given set. They can rather be captured as a creative problem solving process comprising distributed knowledge processing activities. This topic tries to design a suitable mechanism for it to enhance its productivity.

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Research field	Innovation Management, Management of Technology	
Keyword	Diffusion of Innovation, R&D Strategy, Patent Analysis, Platform Business, Data Analysis	

Research content

The research interests include innovation management, diffusion of innovation, R&D strategy, patent analysis, platform business, data analysis and text mining.

Main Publications

- Ueno, T., Kajiyama, T., **Ouchi, N.**, 2016. A method for creating package images that reflect consumer taste impressions. *The IEICE Transactions on Electronics, E99-D* (1), 102-110.
- Arai, Y., Kajiyama, T., **Ouchi, N.**, 2014. Impact of social networks on diffusion of products. *Journal of Technology Management for Growing Economies 5* (1), 35-50.
- Sasagawa, M., Kajiyama, T., **Ouchi, N.**, 2014. A study of pricing strategy in platform business: a multi-agent simulation approach. *International Journal of Technology Marketing 9* (4), 421-435.
- Saiki, T., Shin, J.H., Watanabe, C., Tou, Y., **Ouchi, N.** and Takahashi, T., 2010. Global co-evolution as a source of a high-profit resilient structure: a lesson from Shin-Etsu Chemical. *International Journal of Society Systems Science 2* (1), 63-83.
- **Ouchi, N.**, Watanabe, C., 2009. The impact of diversifying technologies in related areas on firm's profitability: the case of Canon's copying machines and printers. *International Journal of Entrepreneurship and Innovation Management 10* (2), 178-198.
- Watanabe, C., Lei, S., **Ouchi, N.**, 2009. Fusing indigenous technology development and market learning for higher functionality development - an empirical analysis of the growth trajectory of Canon printers. *Technovation 29* (4), 265-283.
- Watanabe, C., Kondo, R., **Ouchi, N.**, Wei, H., 2004. A substitution orbit model of competitive innovations. *Technological Forecasting and Social Change 71* (4), 365-390.

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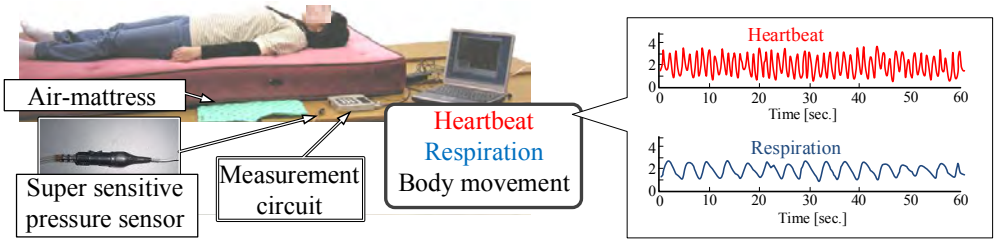
Research field	System engineering, Sensing engineering, Signal processing, System analysis	
Keyword	System, Measurement, Sensor, Bio-signals, Signal prosessing, System analysis	

Research content

Our laboratory is engaged in system construction utilizing sensing technology which is an important technology in system engineering. Since the system engineering is cross-disciplinary field, we cover a wide range of fields as research subjects, and we are currently working on the following three themes.

1. Development of sensing device and system to measure bio-signals (heartbeat, respiration, brainwave, brain blood volume, etc.), security/disaster events (fire, earthquake, intruder), human motions/skills (working, running, golf, and listening skill for learning language, and environment information (low frequency noise generated by windmill, accuracy of the drilling hole in the construction, etc.).
2. System analysis utilizing time series signals obtained from sensing devices.
3. Research on signal processing method to separate/extract/remove signals and estimate state variables in the system.

The following figure shows an example of sensing device developed in our lab. The device could detect heartbeat, respiration, body movement without any attaching sensors on the subject's body lying on the bed. The super sensitive pressure sensor developed in our lab. can detect very tiny pressure changes.



[Recent Publications]

1. Algorithm for Estimation of Scratching Time, *IEEE Sensors Journal*, (In press)
2. Multiple-Input/Multiple-Output Characteristics of Piezo Devices and an Application for Triage, *IEEE Sensors Journal*, vol.17, no.5, pp.1434-1442 (2017)
3. NIRS Based Language Learning BCI System, *IEEE Sensors Journal*, vol.16, no.8, pp.2726-2734 (2016)
4. A Sleep Model and an Observer Using the Lotka-Volterra Equation for Real Time Estimation of Sleep, *Artificial Life and Robotics*, vol.21, no.1, pp.132-139 (2016)
5. Room Ventilation Control by a Self-Sensing Fan, *IEEE Sensors Journal*, vol.16, no.7, pp.2094-2099 (2016)

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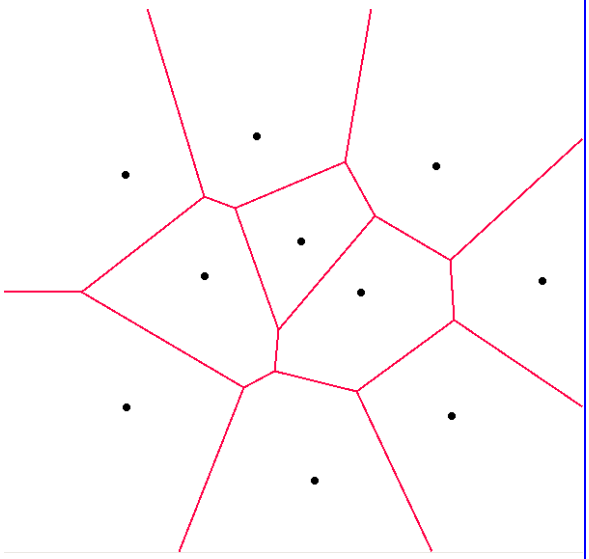
Research field	Geographical Information Processing, Computational Geometry, Operations Research.	
Keyword	Spatial Data Analysis, Traffic Analysis, Interpolation, Voronoi Diagram.	

Research content

Geometry has many applications using modern information technologies such as GNSS, SNS, IoT, and so on, by which we obtain huge volume of data accompanied with spatial positions. Therefore, geometry supports many kind of decision makings.



For example, suppose that there are several groceries in an area, as are represented by black dots in the right figure. If varieties and prices of items sold by them are almost same, people living in the area chooses the nearest grocery. In this way, each grocery has its dominant region, as represented by a polygon in the figure. The obtained diagram is called the Voronoi diagram. The total area of a dominant region is proportional to the number of the users if it is assumed that the density of population is uniform. In addition, if we have a plan to open a new grocery. In order to maximize the profit to be obtained from it, we will find the position at which the total area of its dominant region is maximal.

One of the origin of the research of the Voronoi diagram came from Descartes in 17th century, so this concept seems rather antique. However, its applications are diverse, especially when it is connected with information technologies. For example, one of my research topics is to develop pedestrian movement models, from which we can predict the trajectories of pedestrians. This kind of research will become more significant when the positional data of people are easily measured and collected.

Reference:

A. Nakamura, M. Ishii and H. Hiyoshi, Uni-directional pedestrian movement model based on Voronoi diagrams, *Proceedings of the 8th International Symposium on Voronoi diagrams in Science and Engineering, Qindao*, China, 2011, 123–126.

Department of Integrated Information Technology

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Research field	Data Science, Artificial Intelligence, Intelligent Information Processing, Knowledge Engineering, Discovery Science, Information Science	
Keyword	Data Mining, Social Network Analysis, Knowledge Discovery, Knowledge Acquisition, Machine Learning, Personalization	

Research content

Recently, with the rapid spread of high performance computers and the Internet, large amounts of electronic data are accumulated in various fields including commerce, industry, science, and medicine. Data mining is a field that aims at discovering useful knowledge or regularity from those large-scale data and making it useful in the real world. More recently, it is also called data science. Among them, the main topics of my laboratory are 1) visualizing massive data that allows us to analyze the data from diverse viewpoints, 2) information diffusion analysis over large social networks on the Internet such as friendship networks derived from SNS, and 3) information recommendation that more appropriately accommodates users' needs. In addition, On the other hand, a computer can process a large amount of data efficiently and accurately, but it is still difficult for computers to discover and refine new knowledge/regularity from various kinds of information in a flexible manner as human beings do. To overcome this difficulty, my research team is also working on research to develop techniques that dynamically acquire and refine empirical knowledge we possess through interactions between computers and users. Those techniques allow intelligent systems to be smarter and more user-friendly as their use becomes longer and to provide other users with knowledge that they have acquired.

[Recent publications]

- M. Kimura, K. Saito, K. Ohara, and H. Motoda: "Speeding-up node influence computation for huge social networks", International Journal of Data Science and Analytics, Vol. 1, No. 1, pp. 3-16 (2016)
- K. Ohara, K. Saito, M. Kimura, and H. Motoda: "Accelerating Computation of Distance Based Centrality Measures for Spatial Networks", Proc. of the 19th International conference on Discovery Science (DS2016), pp. 376-391 (2016)
- K. Saito, K. Ohara, M. Kimura, H. Motoda: "Change Point Detection for Burst Analysis from an Observed Information Diffusion Sequence of Tweets", Journal of Intelligent Information Systems, Vol. 44, No. 2, pp. 243-269 (2015).
- K. Ohara, K. Saito, M. Kimura, and H. Motoda: "Change point detection for information diffusion tree". Procs of The 18th International Conference on Discovery Science (DS2015), pp. 161-169 (2015).
- K. Ohara, K. Saito, M. Kimura, and H. Motoda: "Resampling-Based Gap Analysis for Detecting Nodes with High Centrality on Large Social Network", Proc. of the 19th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD2015), pp. 135-147 (2015)

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Research field	Human-Computer Interaction, Virtual Reality, Audio Engineering.	
Keyword	Virtual Reality, Augmented Reality, 3D User Interface, Haptics, Non Verbal Communication, 3D Audio, Cognitive Psychology.	

Research content

Human sensory organs, which are likely to be less accurate than machines, have superior aspects of high-quality measuring instruments. For example, two only ears catch sound in the range of 0 dB to 120 dB, and recognize the direction and distance of sound with high accuracy. The sense of vision has the extraordinary ability to give 3D structured meaning to 2D images instantaneously.

On the other hand, sensory organs are developed by differentiation in the process of evolution, and still leave an undifferentiated form. The taste of curry is not felt as curry with olfactory plucking, and the sound of a TV set feels as if it is coming out of the picture though the speaker of the television is in a different position from the screen. It can be said that the mechanism by which plural sensory information is integrated in the brain and feedback is a testimony that a human being is a living thing.

IT technology has made great progress, but it is developing in terms of interface with humans as a living thing. In our laboratory we conduct research to make IT technology more adaptable to human's sense of multimodality and physicality, making it easier to use. It is also a goal to elucidate the relationship between human sensory mechanism and physical function and to develop techniques useful for welfare and communication in an aging society

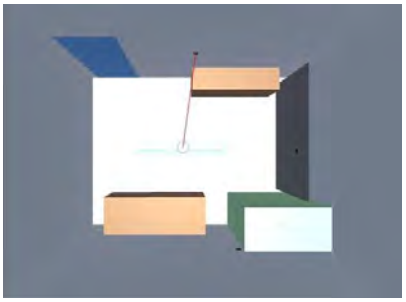
・Recent research fields

Installation of physical objects to virtual reality: We want to drink a cup of coffee even if wearing a head-mounted display (HMD). How to install the presence of a physical cup into the virtual world?

・3D Audio for 360° image: How to pick up sounds and make them head-tracked in a 360° motion picture system?

・Touch and Vision： How to design web advertisement system where you can touch a product with a haptic device and experience its hardness.

・Visualization of eye-tracking data in 3D space (right)



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Research field	Design engineering, Educational Technology, Graphical Science	
Keyword	Model-based Learning, Graphical Science, Care system, Agent application	

Research content

Information system theme

1. e-Learning and Supporting System: The e-learning system as an effective educational method is examined by its systemized example at the stage where its effectiveness is also verified in specialized education. (Model Based Learning System)

2. Design Information Processing System: Model engineering systems with Java class libraries have been developed since FY1997, and accumulation of various libraries has advanced. This theme develops classes for numerical analysis and creates libraries with applications.

3. Graphic information cognition support: A computer-supported environment is used for evaluation and development method of spatial figure recognition ability. The objective is to improve the environment for understanding figures and acquire knowledge.

4. Intelligent blended learning environment: In the blended learning, combined method of face-to-face lessons and e-learning, learners meet problems of applying the Web (to get lost in the Web, disconnected with teachers). Optimal blended learning methodologies are investigated and aim to realize an environment where students can learn effectively by making use of "knowledge" created from students using the Web in the classroom.

5. Multipurpose human type agent for care support by local community: Development of a comprehensive workbench for the elderly watching system by human type agent. Mainly to improve the behavior of humanoid agent on carer side (local side), and to synchronize display of communication route (UDP communication) and human type agent.

6. Blended Learning Environment by AR (Augmented reality): Development of an information interface for education and develop an interface by AR to investigate the characteristics and effects of recommended systems using characters.

Machine design · Hardware theme

7. Innovative structural materials project: Development of the user interfaces necessary for utilizing each resource for end users and application system developers. It can provide them as an application system development environment as group of micro services.

8. Structural design system with dynamic model: Demonstration of large-scale structure which can be constructed by class library by combining basic structural elements.

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Academic society	Institute of Electronics Information Communication Engineers, Information Processing Society of Japan Society of Instrument and Control Engineers Robotics Society of Japan	
Research field	Computer Vision, Machine Vision, Robot Vision,	
Keyword	Image Understanding, Video Analysis, Remote Sensing, Human Observation, and Video Security.	

Research content

Research Subject of 2016

1. Three dimensional modeling from RGB images or RGB-Depth images.
2. Three dimensional shape reconstruction and understanding
3. Human action description
4. Biometric human identification
5. Audio and video captioning

Recent Publications

1. Yukiyasu Domae, Shinjiro Kawato, Haruhisa Okuda, Kazuhiko Sumi, et.al., "Self-calibration of Hand-eye Coordinate Systems by Five Observations of an Un-calibrated Mark", IEEJ Trans. Elec., Inf. and Sys., vol. 132,No.6,pp.968-974,2012/6.
2. Kazuhiko Sumi, "Past, Present, and Future of Human Observation", 9th IEEE International Conference on Advanced Video and Signal based Surveillance (AVSS) 2012, Beijin China, 2012/9 (keynote talk)
3. Naoshi Kaneko, Tomohiko Saito, Kazuhiko Sumi, and Yutaka Miyaji,"Real-time virtual dress fitting system using gaming sensor and 3D textile simulation", Quality Control via Artificial Vision (QCAV2013), pp. 53-57, 2013/5.
4. Yuki Yoshikawa, Tomohiko Saito, and Kazuhiko Sumi, "Dense 3D Measurement with Integration of Pattern Projection Stereo and Binocular Stereo", Quality Control via Artificial Vision (QCAV2013),pp.181-184,2013/5.
5. Yukiyasu Domae, Haruhisa Okuda, Yuichi Taguchi, Kazuhiko Sumi, and Takashi Hirai, "Fast Graspability Evaluation on Single Depth Maps for Bin Picking with General Grippers", Proc. International Conference on Robotics and Automation (ICRA), pp.1997-2004, 2014/5
6. Kazuhiko Sumi, "Time-series Range Data Analysis for Pedestrian Group Segmentation", 4th International Conference on Informatics Electronics and Vision, Kitakyushu Japan, 2015/6 (invited paper)

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Academic Society	IEEE, The Institute of Electronics, Information and Communication Engineers, Information Processing Society of Japan	
Field	Networked Sensing, Ubiquitous Computing	
Keywords	Near-field wireless communication, sensor networks, activity recognition, the Internet-based systems	

Research

I am investigating a new system to accommodate real-world interaction using the Internet. We deployed a sensor network in a local city in 2012. Recently, we have been focusing on crowd sensing and created several systems. One of them is road surface sensing using an accelerometer embedded in a smartphone. The developed system is called YKOB and currently our research group is creating a platform for collecting human generated data on the Web.

Another topic we are looking at is sensing human activities. Recently, we have developed a system to quantify the activeness of a meeting based on the interaction among the participants of the meeting using a microphone of smartphone. Further research includes analysis of human interaction using EEG and ECG to investigate the relationship between the observable behavior and the unseen signals inside a human body.

[Recent Publications]

(1) Yagi, Y., Takahashi, J., Lopez, G., and Tobe, Y."COLLONA: Design and Implementation of Corridor-Level Localization Toward Indoor Pedestrian Navigation," Int. Journal of Computing and Network Technology, issue 2, vol.4, (2016).

(2) Wang, S., Basalamah, A., Kim, S.M., Guo, S., Tobe, Y., and He, T. "Link-Correlation-Aware Opportunistic Routing in Wireless Networks." IEEE Trans. Wireless Communications 14(1): 47-56 (2015).

(3)Thepvilojanapong,N., Saito, H., Murase, K., Ito, T., Kanaoka, R., Leppänen, T., Riekki, J., and Tobe, Y."Hand-to-Hand instant message communication: Revisiting Morse code." ICPADS 2014: 313-319 (2014).

(4) Thepvilojanapong, N., Tsujimori, T., Wang, H., Ohta, Y., Zhao, Y., and Tobe, Y.: "Impact of Incentive Mechanism in Participatory Sensing Environment", proc. The Second International Conference on Smart Systems, Devices and Technologies, (2013).

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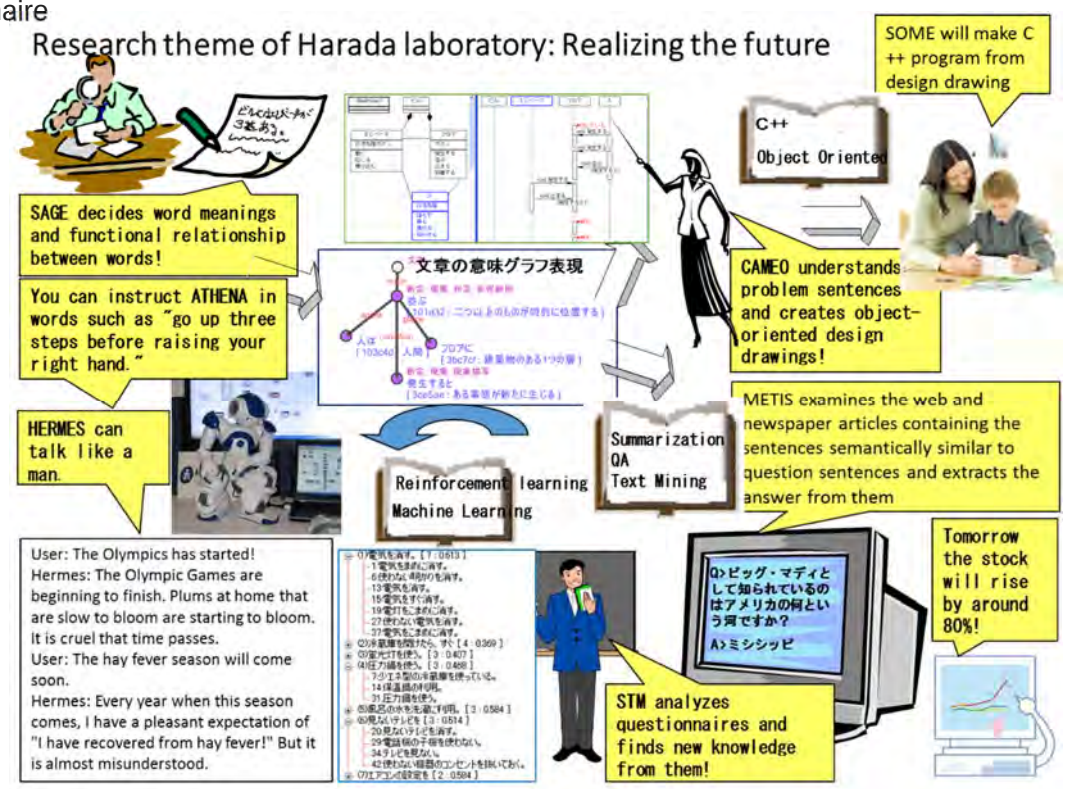
Academic society	Information Processing Society of Japan(IPSJ), The Japanese Society for Artificial Intelligence(JSAI), The Association for Natural Language Processing(NLP), The Institute of Electronics, Information and Communication Engineers(IEICE), IEEE, ACM, AAAI	
Research field	Artificial Intelligence, Natural Language Processing	
Keyword	Semantic Analysis, Automatic Summarization, Question Answering, Text Mining, Automatic Programming, Dialogue Robot, Machine Learning	

Research content

The theme of Harada laboratory is "Let's make a thinking computer and a learning computer".
The picture on the right below shows the projects of Harada lab. The semantic analysis system SAGE decides the meaning of words in Japanese sentences and the functional relation between words as precisely as 97% or more as shown in the center of the right. Based on this, a question answering system METIS (published from the homepage) that searches the web and newspaper articles containing the sentences semantically similar to question sentences and extracts the answer from them, an automatic object-oriented designing system CAMEO which analyzes the requirement sentences about a problem and generates the class diagram and sequence diagram, a text mining system STM that classifies questionnaire into semantically similar clusters, a dialogue system Hermes can talk with a human in Japanese, and a dialogue robot ATHENA which interacts with humans and performs tasks requested by words have been developed.



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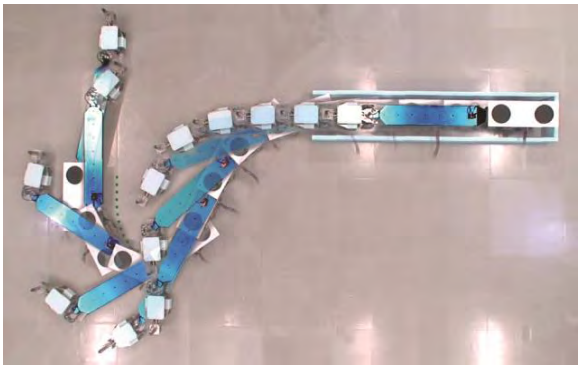
Academic society	Robotics Society of Japan (RSJ), Society of Instrument and Control Engineers (SICE), Japan Society of Mechanical Engineers (JSME), Japan Society for Precision Engineering (JSPE), and International Federation of Automatic Control (IFAC)	
Research field	Robotics, Control Engineering, and Information Engineering	
Keyword	Nonlinear control, Nonholonomic system, Mobile Robotics, Differential Geometry, Computational Geometry, Motion Planning	

Research content

Our group's research is in mobile robotics, especially on analysis, design and control of complex and highly nonlinear robotic systems such as coupled vehicle systems specially designed to transport large scale heavy structural objects, undulatory locomotors performing energy efficient inertia traveling, and unmanned aerial vehicles with high maneuverability. Current research topics are as follows.

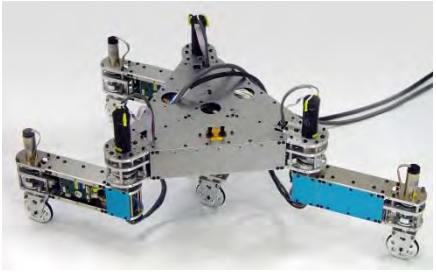
(1) Control of coupled vehicle systems: Motion of the system is quantitatively specified by the shape of a parametric curve path and its moving velocity.

A Cooperative Transportation System

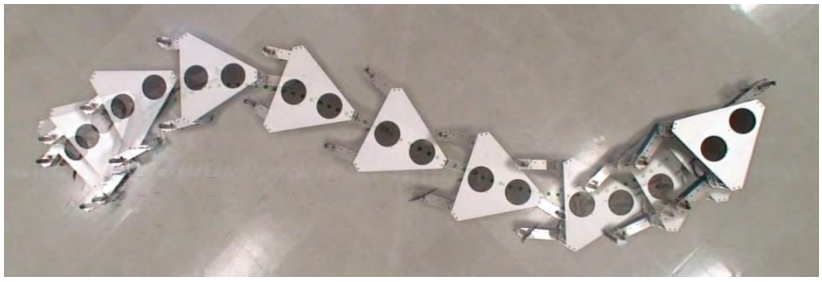


A Garage Entry Operation

(2) Control of undulatory locomotors : Stable roller-skating motion is performed through a visual feedback control system.



A Trident Steering Walker



A Bezier Curve Path Following Motion

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Academic society	Institute of Electrical and Electronics Engineers (IEEE), Academy of Human Informatics (AHI), Information Processing Society of Japan (IPS), The Society of Instrument and Control Engineers (SICE), The Japan Society of Mechanical Engineers (JSME)	
Research field	Wearable Information Systems, Wearable Environment Systems, Human Informatics, IT Healthcare, Next Generation Multimedia Devices	
Keyword	Wearable devices, multimedia systems, bio-signal analysis, mobile computing, human-machine interfaces, health informatics	

Research content

Spreading and speeding-up wireless-communication network, and appearing smart home appliances, smartphones have become a necessary multimedia device for our daily life. At the Wearable Information and Environment Systems Laboratory (W.I.L.), we aim at supporting a more comfortable and healthy life, by extending the performances of smartphone, together with conducting research and development about new wearable devices, interfaces, and systems, towards next-generation multi-media system (hardware and software). Research projects carried-out at W.I.L. deal with one or several following topics.

1） Collecting various physiological signals in daily life conditions using pre-existing and/or self-made wearable sensors.

2） Proposing original analysis methods and techniques through signal processing and data mining, to be able to extract high-level information and estimate human physical and mental status (e.g. physical condition, behavior, and emotion).

3） Investigating real-time feedback methods that can adapt automatically to individual preferences and dynamic characteristics using cutting-edge wearable devices such as wrist watches, smart glasses, head-mounted displays, smartphone and such, or developing new original actuation wearable devices (vibration, thermos-reaction, etc.).

4） Gathering information about the surrounding environment via wireless communication to estimate accurately and timely the context, to integrate people's information and living environment (e.g. air conditioner and Lighting apparatus) and provide compatible comfort living and social environment.

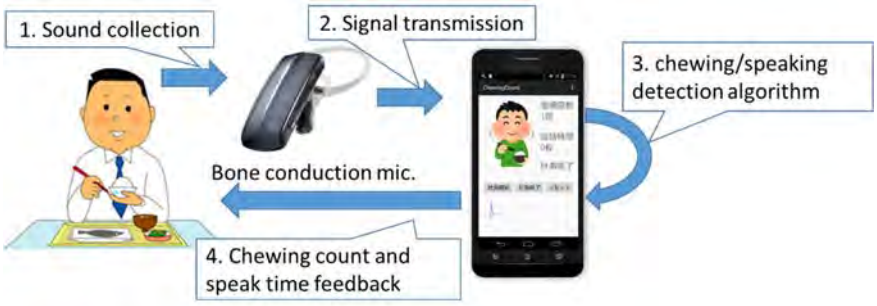

Fig. 1 Chewing education support system

Fig.2 PICO-Band: Personal Intelligent COmfort control Band

College of Science and Engineering

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Academic society	Japan Association of Language Teachers、Association for the Advancement of Computing in Education、EUROCALL	
Research field	Learner autonomy, Collaborative learning; computer-aided language learning	
Keyword	Student generated podcasts、 Intercultural exchange, lifelong learning,	

Research content

I am trying to duplicate with mid-size classes the success I have had implementing democratic reforms in small-size classes, where learning-centered learning is easier to manage. The goal is to allow learners a choice, i.e., learner autonomy, while establishing a collaborative learning situation. Learners should play a large role in deciding the structure and workings of the class. Learners and instructor are bound by a contract to achieve agreed-upon goals.

2011 Publications
David Reedy and James Pagel, *Matching up Pre- and Post-Test Scores with Student Questionnaire Responses: Can Motivation Be Predicted?* CALL: What's Your Motivation

2012 Publications
Hiroyuki Obari, James Pagel, and Steve Lambacher. *The Utilization of Digital Storytelling and Blog Activities Employing Mobile Technologies.* INTED 2012 Proceedings

2013 Publications

James Pagel and Stephen Lambacher. *Utilizing Mobile technologies for Developing English Language Skills : IS Mall and Call really what it is cracked up to be.* INTED2013 Proceedings

2011 Presentations

Building Learning Environments
JALTCALL 2011, Building Learning Environments, Kurume, Japan, June 4, 2011. (co-presented with David Reedy)

Assessing Student Use of and Response to an E-learning Component Integrated in One School's English Classes on the Undergraduate and Graduate Levels
EUROCALL 2011, The CALL Triangle, Student, Teacher and Institution, Nottingham, U.K. September 2, 2011. (co-authored with David Reedy)

Expanding Cultural Exchange Opportunities Using Internet Technologies: The Chat Room. GLoCALL 2011, Go Global, Go Local, Manila, Philippines, October 28, 2011.(co-presented with David Reedy)

2012 Presentations

A Blended 'Mobile-Learning' Environment to Improve the English Listening, Presentation, and Blogging Skills of Japanese Undergraduates. The 15th International CALL Research Conference. Providence University, Taichung, Taiwan. May 25, 2012. (co-authored with Stephen Lambacher and Hiroyuki Obari)

How Evaluating a CALL Project Leads to the Rationale for a Complete Curriculum Overhaul. The 15th International CALL Research Conference. Providence University, Taichung, Taiwan. May 25, 2012. (co-presented with David Reedy)

Imposing CALL Calls for Reflection, with Curriculum Reform as the Result. GLoCALL 12. Peking University of Foreign Studies. Peking, China. October 19, 2012. (co-presented with David Reedy)

2013

Student and Teacher Perceptions of Computers and Mobile Devices Used for Foreign Language Learning. INTED 2013. Valencia, Spain. March 4, 2013. (co-authored with Stephen Lambacher.)

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Academic society	Association of Christian English Teachers, JALTCALL, EUROCALL, KOTESOL, Japan Association of Language Teachers, Japan Association of College English Teachers, Asspociation of Christian Universitites and Coleges in Asia	
Research field	TESOL, Language Policy, Computer Assisted Language Learning	
Keyword	TESOL, TEFL, Teaching English in English	

Research content

Publications

- 🕮 Student and Instructor Attitudes Towards CALL and MALL in L2 Classes, Aoyama Information Science 44
- 🕮 Instructors' Attitudes Towards CALL and MALL in L2 Classrooms, Critical CALL (2015.12)
- 🕮 Prominence Communication English 1 Tokyo Shoseki Co., Ltd (2015.04)
- 🕮 Aoyama Gakuin Seed Book 12, Aoyama Gakuin English Research Center（2014.12）
- 🕮 Prominence Communication English 3 Tokyo Shoseki Co., Ltd (2014.04)
- 🕮 Prominence Communication English 2 Tokyo Shoseki Co., Ltd (2013.04)
- 🕮 Prominence Communication English 1 Tokyo Shoseki Co., Ltd (2012.04)
- 🕮 "Preparing preservice teachers to teach EFL writing: Motivations, perceptions, expectations and challenges" p1-13, Aoyama Standard Thesis Collection 6（2011.01）
- 🕮 "A Five-year CALL Project Leads to the Analysis of Motivation with an Eye on Curriculum Reform", p140-141, Fourteenth International CALL Conference Proceedings, Vol. 14, August 2010
- 🕮 Aoyama Gakuin Seed Book 3, Book 7 Aoyama Gakuin English Research Center（2009.12）
- 🕮 Aoyama Gakuin Seed Book 2, Book 6 Aoyama Gakuin English Research Center（2008.12）
- 🕮 "Implementing ICT in English Testing and the Producing English Education Material" p3-26 Aoyama Information Science 35（2008.01）
- 🕮"The Road to Creating Multi-Skill Classrooms Using CALL" p27-42 Aoyama Information Science 35（2008.01）
- 🕮 "A Mid-term report on a Five-year Project to Integrate e-Learning in all Department English classes in the College of Science and Engineering", JALTCALL JALT CALL Journal Volume 3 Number 3 (2007.12)
- 🕮"A New Approach to Implement CALL: The Road to Creating Multi-Skill Classrooms Using Pairing", p49-64, Aoyama Standard Thesis Collection（2007.03）
- 🕮 English Language Classes in Japanese Tertiary Education, 288p、JACET Classology Research Committee (2006.12)
- 🕮 "The Value of Peer Evaluations in Group Activities", p247-263, Aoyama Standard Thesis Collection 1（2006.03）
- 🕮 NHK Radio New Fundamentals of English 2 120p, Japan Broadcasting Corporation (2004.04～2005.03).
- 🕮 The English You Need When You Study Abroad 207p. Chukei Publishing (2003.06)

Presentations

- Instructors' attitudes toward CALL and MALL in L2 language classroom, University of Padova EUROCALL 2015
- Spreading the spirit of globalization, National University of Singapore ClaSIC 2014 12.3
- Fostering international awareness through the chat room, The University of Danang, Vietnam 2013.11.30
- From Innovation to Realization: A case study in curriculum reform, Orchard Hotel, Singapore ClaSIC 2010 12.2
- A Five- year CALL Project Leads to the Analysis of Motivation with an Eye on Curriculum Reform Bordeaux University, France, EUROCALL 2010 9.9
- From a Five-project CALL Project Leads to the Analysis of Motivation with an Eye on Curriculum Reform, Antwerp University, Belgium, Antwerp CALL 2010 8.20
- Matching up Pre- and Post-test Scores with Student Questionnaire Responses: Can motivation be predicted? Kyoto Sangyo University, JALTCALL 2010 5.29
- Motivational factors at play among students taking part in an department-wide e-learning program Universidad Politécnica de Valencia, Spain EUROCALL 2009 9.10
- Effective Methodologies outside the Classroom: Working on Building Oracy and Confidence in the Chat Room, Johor, Malaysia, MELTA 2009 6.11
- An Extra Credit E-learning Program for Students in a Single Department: What Motivates Whom?, Toyo Gakuen University, Tokyo, JALTCALL 2009 6.1

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Academic society	The English Linguistic Society of Japan (ELSJ), The Japan Society of English Usage and Style, The Society of English Grammar and Usage, Japan Association of Systemic Functional Linguistics (JASFL)	
Research field	English Linguistics, Discourse Analysis	
Keyword	Discourse Analysis, Pragmatics, Cognitive Linguistics, Information Structure, Anaphoric Relations,	

Research content

(2000-)

I.Publications

1. "Informational Status of Preposed Constituents of English Inversion" 2000/06/01 *English Usage and Style* (The Japan Society of English Usage and Style) vol.17 pp.20-29
2. "Informational Importance of Inverted *When*-Clauses" 2000/12 *Thought Currents in English Literature* (The Society of English Literature of Aoyama Gakuin University) vol. 73 pp.125-141
3. "A Study of Initial and Final Purpose Clauses in Written Discourse" 2002/11/16 *Journal of Aoyama Gakuin* (The Society of Common Courses of Aoyama Gakuin University) vol. 43 pp.121-132
4. "Some Remarks on Written Demonstratives *This* and *That*" 2004/06/01 *English Usage and Style* (The Japan Society of English Usage and Style) vol.21 pp.23-34
5. "Remarks on Focus-Based Analysis of English Demonstratives" 2007/01/16 *Journal of Aoyama Standard* (The Society of Aoyama Standard) vol.2 pp.297-317
6. "Informational Importance and *Because*-Clauses" 2008/01/10 *Journal of Aoyama Standard* (The Society of Aoyama Standard) vol.3 pp.301-325
7. "Remarks on Preposed and Postposed Constituents of English Inversion" 2009/1/16 *Journal of Aoyama Standard* (The Society of Aoyama Standard) vol.4 pp.287-302

II. Textbooks

1. *Snapshot* 2002/04/01 Asahi Press
2. *Multiple Voices from around the World* 2003/04/01 Asahi Press

III. Research with External Funds

Language War: A Study of Relationships between Politics and Language Culture from "Contrastive" Aspects of Language (Grant-in-Aid-for Scientific Research C) 2002/04～2004/03

IV. A Public Lecture

Searching for the Origin of Everyday English Words 2001/10/27 The Culture Courses of Atsugi City, Kanagawa Pref.

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Research field	Applied Cognitive Linguistics, Cognitive Linguistics, Pragmatics	
Keyword	Cognition, Conceptual Projection, Primary Metaphor, Metonymy, Categorization, Comparison,	

Research content

Learning a language is one of the most complex human accomplishments. Among the various different views about language, cognitive linguistics emphasizes that language is best comprehended as a reflection of general cognitive processes, the social nature of humans as a species, and the unique ways, through which humans experience and interact with the physical world. According to this empirical view of cognitive linguistics, language cannot be separated from human embodiment. The concepts to which we have access are closely associated with our embodied experiences and the embodied concepts can be extended to provide more abstract concepts. This process is called conceptual projection on which the CMT (Conceptual Metaphor Theory) is based on. The CMT explains that humans use their understanding of the physical world as a framework for representing more abstract concepts and the direction is unidirectional. In other words, metaphors map structure from a source domain to a target domain but not vice versa.

My research interests are in applying the cognitive linguistics thesis to teaching English and currently my research focuses on investigating the effects of the conceptual projection utilizing primary metaphor on the development of Japanese learners' knowledge about abstract concepts. The followings are recently published articles:

Takimoto, M. (2015). A corpus-based analysis of hedges and boosters in English academic articles. ***Indonesian Journal of Applied Linguistics 5*** (1), The Language Center of UPI and TEFLIN, 141-156.

Takimoto, M. (2015). Assertions and lexical invisibility in EFL learners' academic essays. ***Journal of Pragmatics 89***, Elsevier Publishing, 85-99.

Takimoto, M. (2016). Evaluating the relative effects of cognitive approach with 3D content and non-cognitive approach on the development of EFL learners' knowledge about the different degrees of sureness. ***Cognitive Linguistic Studies 3*** (2), John Benjamins Publishing Company, 347-368.

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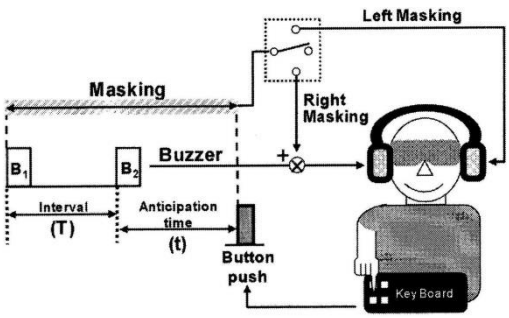
Academic society	Japanese Society for Medical and Biological Engineering (JSMBE). Physiological Society of Japan. Japan Neuroscience Society. Society of Biomechanisms Japan (SOBIM). Japan Society for Medieval European Studies.	
Research field	Affective computing/Soft computing, Cognitive science, History of science and technology	
Keyword	Affective design, Brain cognitive science, Scientific sociology, Biological information analysis	

Research content

1. Research on human brain function analysis using magnetoencephalography (MEG)
2. A study of natural philosophy in pre-modern Romance literature
3. Study on pre-modern Christianity of Japanese propagation
4. A study of images of the modern society brought by the industry and technology

"Disturbance of time perception caused by auditory masking", Biomechanism, 29:146-151, 2005.



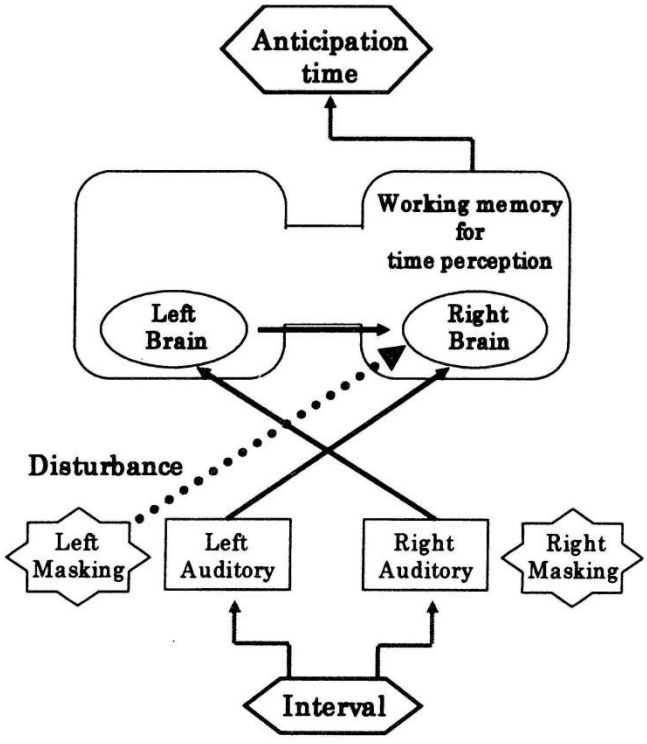


Fig.3 A model for anticipation time evaluation.

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Academic society	Japan Society of New Testament Studies, Japanese Biblical Institute, Japan Society of Christian Studies, Society of Biblical Literatures.	
Research field	New Testament and Christian Origins.	
Keyword	Feminist Perspective. Rhetorical Analysis.	

Research content

Methodology

Rhetorical/historical/social analysis. By integrating theses three methods, it will be possible to re-contstruct the rhetorical-historical situation of the New Testament. Utilizing the Post-Feminist theory on "wo/men," I aim to interpret the Scriptures from a Japanese woman.

Texts Interested

I am interested in the rhetorical/ historical situations of wo/men the Galatians, the First Corinthians, the Pastoral Epistles and the Book of Revelation.

Particular Focus

Power dynamics between the Roman Empire and churches can become to be visible through the rhetorical arguments and discussions on the relationship between church order and the household codes (Colossians 3:18-4:1; Ephesians 5:22-6:9; 1Peter 2:18-3:7; 1 Tim. 2:11—15;5:3—8; 6:1-2; Titus 2:2-10; 3:1-2:1). This may be called as the rhetoric of the household codes, which can be seen in the philosophical argumentations of the ancient time from Plato and Aristotle to the Stoic School. In these argumentations the virtues of male rulers are principally equivalent of the virtues of the patriarch, and also a head of a church. Whilst the first church could have been built on equal basis, the second the third generations might have used the rhetoric of household codes as an absolute order of church.

Thus the baptismal formula in Galatians 3:28 might have lost substance in early Christianity. In order to re-constuct the rhetorical/historical situation of the Pauline Epistles such as the Galatians and the First Corinthians, it requires to examine the ideology behind the texts.

Publication

The World After 3.11 and the Scriptures : Recovering the Word.

Chapter 7: Remembrance of the Dead and Recovering the Community: Rhetorical/Historical Analysis of the Revelation. Chapter 8 : Recovering of the Humanity a view from Technology: Biblical Hermeneutics and Promethean Fire and Technology.

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Research field	L2 composition, English for Specific Purposes (ESP): science communication, Computer-Assisted Language Learning (CALL), English as a Lingua Franca (ELF)	
Keyword	English for science and technology, CEFR/ CEFR-J, CALL and L2 writing instruction, Mobile learning, Rubric & video-based evaluation methodologies, project-based learning, content-based teaching, ELF and EAP writing instruction, Intentional vocabulary instruction	

Research content

My research interests are somewhat diverse; however, they are related to second-language composition instruction, computer-assisted language learning and English for specific purposes. Since I am primarily a classroom instructor, who is interested in innovative teaching methodologies and technologies, my research tends to investigate classroom practices which support learner autonomy and motivation. (See research topics below.)

L2 writing instruction/CALL & Web 2.0 technologies:
Understanding Genre and Modalities through Video Storyboarding-- EFL instructors often struggle when trying to create teaching approaches that foster more native-like modalities in their students' discourse—both spoken and written. The goal of such efforts is to help students develop a wider repertoire of sentence and verbal modality, and create syntax that indicates the predication of attitude, condition, and/or action. This suggests the more general question: How can instructors create project-based approaches that empower students to understand rhetorical positioning and its affect on this type of language use? One means of achieving these objectives is through video storyboarding assignments. Other related research: The integration of course management systems (CMS) into EFL writing classrooms, Motivation and the role of CALL in L2 writing instruction, and Implementing online vocabulary training programs.

English for specific purposes (ESP):
Pedagogical Concerns and Approaches to EAP Writing Instruction within an ELF Program-- English as a Lingua Franca (ELF) research lends itself well within the domain of spoken English where speakers actively negotiate meaning within shared contexts. In an ELF circumstance, speakers are not bound by native speaker (NS) norms; rather, their "success" can be measured by their ability to communicate functionally. Yet, what are the implications for writing instruction within an ELF program? And more specifically, how should college-level ELF instructors address the issue of English for Academic Purposes (EAP) writing since, broadly speaking, EAP assumes that non-native speakers (NNS) should conform to native forms of language use. I have suggested several pedagogical approaches meant to assist L2 writing practitioners who work within existing ELF programs and explored how *some* tenets of ELF can be incorporated into a multiple-draft, process approach writing classroom. Other related topics: Developing basic communication skills for the sciences through project-based learning and content-based teaching.

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Academic society	Poetics and Linguistics Association(PALA), The English Literal Society of Japan, The English Linguistics Society of Japan, The Japan Society for Medieval English Studies,, The Modern English Association, Japanese Association for Studies in the History of the English Language,、Japan Society for Historical Linguistics (JSHL) The English Research Association of Hiroshima(ERA)	
Research field	Historical Pragmatics, English Medieval Literature, History of English Language, English Philology	
Keyword	Diachronic Stylistics、Text Analysis,, Middle and Early Modern English, Mysticism,	

Research content

Some text genres are always related to particular communicative goals; and if authors want to achieve their aims, they have to go beyond the subject matter, and make explicit their point of view in order to persuade their audience. In the domain of religion, guiding the addressee through intertextual material is an important task of discourse. My present research topics include the following themes, but are not limited to them:

The repetition and variation in Middle English devotional prose.

It is worth exploring the repetition and variation from the perspective of stylistics and pragmatics. The evidence is gathered from fourteenth-century devotional writings, - Geoffrey Chaucer, Richard Rolle, Walter Hilton, Julian of Norwich, and Margery Kempe. My surveys have shown the basic function of repetition is foregrounding the plot by making audience take notice of repeated words and phrases. To grasp the stylistic effect of the repetition, a perspective on discourse is indispensable. Subsequently, I compare the repetitions in shorter and longer versions by Julian of Norwich. It is assumed that twenty years between the two versions gave her time to contemplate the revelation and rewrite with deeper insight.

Diachronic aspect of metadiscursive practices

I am exploring metadiscourse in the light of pastoral intention to teach, to reprove, to encourage through the communicative and educational purpose. It is worth considering the communicative intention of the personal relationship between preacher and congregation by looking at the phenomenon from a historical angle.

Speech Acts in Middle English Mystical Prose

The aim of the research is to investigate the various manifestations of directives in the mystical prose in the fourteenth century. As the prose by medieval mystics aim for moving the disposition of its hearers and readers to assent to, and follow their religious precepts by conveying their ineffable experience, we can assume there are variety of persuasive techniques of rhetoric.

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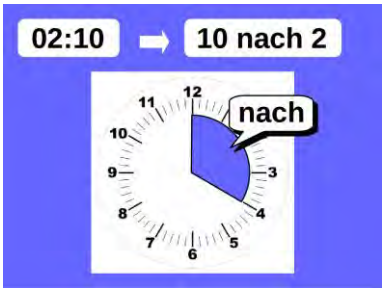
Academic society	Japanische Gesellschaft fuer Germanistik (Japanese society for German studies), Verband der Deutschlehrenden in Japan (Organization of German language teachers in Japan)	
Research field	German language teaching, media studies	
Keyword	German, CALL, Open educational resources, propaganda, film	

Research content

Research and development of the **Adaptable Open Textbook**: a multi-medial, free and freely licensed German textbook

- Creative Commons License: Interested teachers can use and change the whole textbook and its accompanying materials (or also just parts of it) and re-publish the resulting works and materials
- The textbook itself can be used as a printed book, or be used as a PDF-file with electronic devices (computers, tablets, smartphones, ebook readers, etc.)
- Accompanying PowerPoint presentations for grammar explanations, group works, etc.
- Vocabulary training software, available via QR codes or embedded links in the textbook (no need for installation: the training software is written in Html / JavaScript and can be used with any JavaScript-enabled web browser)
- Accompanying audio files: the mp3 files can be accessed via QR codes or embedded links in the textbooks
- Videos of the lessons main points can be accessed via YouTube



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Research content

Developing a Web Search Engine to Learn Specific Terms in the Science and Engineering Field

In the school of engineering at the University of Tokyo we are developing a web search engine to assist in learning specific terms in the science and engineering field. This tool is based on the spoken science and engineering language data collected from the classroom, we collected 177,834 words, and created a corpus. Based on the examination of this corpus, each research field uses different vocabulary words and utilizes collocations which are made out of a basic verb with a specific noun. Thus, we developed this tool, organizing the frequently used noun, its translation, collocation, and example sentences. The professors in each department also checked all the contents and decided which terms were more important to learn than others. In the future, we plan to keep collecting more spoken science and engineering language data, increase the number of words, add both English and Japanese sounds, and publish the updated tool as soon as possible. Thus, students in the science and engineering field from all over the world can use this tool for their research and their language learning. We hope that this E-learning tool will help contribute to language education in the science and engineering field.

Language Learning Strategies

I have studied language learning strategies to help all students succeed in language learning. In my dissertation, I examined differences in the use of specific language learning strategies between high and low achievers by using e-mail queries, concurrent interviews, and follow-up e-mails over a semester. The results showed that although both high and low achievers reported comparable amounts of time studying the language per week, high achievers spent their time more wisely (strategically) by being more active in producing language, and their practice distributed over multiple times to monitor their performance. This suggests that the quality of strategy use is one of the factors which makes a distinction in the level of achievement in the language learning, and introducing the appropriate strategies to tasks in the classrooms may be beneficial to learners' success in language learning. Therefore, at Aoyama Gakuin University, I will pay attention to individual students' goals by examining each student, and I will prepare many different approaches and strategies to provide the best possible English learning environment, so that I can help all students, both the students who are good at the language and who are not, to succeed in achieving their individual goals.

The Salt of the Earth,The Light of the World

Aoyama Gakuin School Motto

College of Science and Engineering

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